

The Product Piracy Conflict Matrix – Central Element of an Integrated, TRIZ-based Approach to Technology-based Know-how Protection

G. Schuh, C. Haag

Fraunhofer Institute for Production Technology IPT, Steinbachstraße 17, 52074 Aachen, Germany
christoph.haag@ipt.fraunhofer.de

Abstract

The paper gives a general introduction to product piracy as an economic and a methodological challenge. Technology-based know-how protection is presented and its potentials outlined. The corporate value chain is discussed as the relevant system when implementing technological know-how protection mechanisms and as an essential dimension of the so called Product Piracy Conflict Matrix (PPC Matrix). Forming the methodological analogy, the TRIZ contradiction table is presented as a starting point for the PPC Matrix. The development of the matrix is described and its implications as part of a comprehensive process model for technological know-how protection are discussed. Finally, a detailed and critical outlook both towards its application potentials and towards further research needs is given.

Keywords:

Product Piracy, Product Imitation, Technology Know-how Protection, Contradiction Matrix, PPC Matrix, Ideality Approach

1 TECHNOLOGY-BASED PROTECTION AGAINST THE NEW CHALLENGE OF PRODUCT PIRACY

Product and brand piracy has risen to a worldwide mass phenomenon [1], not only burdening luxury goods and digital media anymore but also technology-intensive branches like automotive, electronics and machinery industry. Companies are gradually facing up to this new challenge and taking action. Besides legal counteractions, an increasing number of firms is also trying to implement technology-based know-how protection as a new approach against product piracy [2]. The potential of these approaches is so far being only exploited to a limited extent which can mainly be traced back to lacking knowledge regarding the functionality, benefits and application conditions of these new know-how protection mechanisms. But as a survey by the Fraunhofer-Gesellschaft has revealed, technological and organisational protection measures are expected to be the most effective counteractions against product piracy in the future [3].

However, companies which try to identify concrete protection mechanisms and implement these measures into their running business often face problems and conflicts, which seem insurmountable: on the one hand, a burdened company quests for powerful protection strategies for its product and brands. Yet on the other hand, it is not willing to accept excessive modifications to its products and value chain. From a corporate point of view, a common requirement for instance is that the general product functionalities must not be noticeably affected by the implementation of a protection feature. In other cases, financial limitations, after sales service requirements or constraints by regulations have to be considered. Due to these restrictions, companies often face a “deadlock situation” when trying to install suitable measures against product piracy.

In order to overcome such conflicts, companies require systematic methodological support in finding appropriate measures that do not influence their value chains in a negative or harmful way. In line with this claim, the article introduces the so-called Product Piracy Conflict Matrix (PPC Matrix). This new problem-solving approach has been developed by the Fraunhofer Institute for Production

Technology IPT based on insights from numerous consulting and research activities in the field of product piracy protection.

2 THE PPC MATRIX AND ITS THEORETICAL BACKBONE

The PPC Matrix has been designed as a methodical guideline for companies to select appropriate protection measures against product piracy. Contrary to other approaches (e.g. [2] [4] [5]) the PPC Matrix pays special attention to boundary condition within the value chain of a company, which may not be influenced in an undesired or harmful way by the implementation of protection measures.

The methodology primarily addresses professionals in R&D management who are searching for means to protect their products but yet have little experience in that issue. Also it can be helpful for experts who have already considered certain protection schemes but would like to double-check their selection in order to reduce the risk that a more appropriate measure might have been forgotten.

2.1 The Contradiction Table of TRIZ as a Methodological Frame

The basic idea of the PPC Matrix is derived from the contradiction analysis as a well-established method within TRIZ. According to Altshuller, an inventive problem contains at least one contradiction. This insight arose from his observation of 40.000 patents. He identified 39 design parameters that can induce conflicts in engineers' work (e.g. to reduce “weight” and enhance “strength”). From each patent he studied, Altshuller selected several principles for each combination of conflicting parameters, finally coining a list of 40 inventive principles.

Out of these findings arose the TRIZ contradiction approach, which relies on expressing a challenging problem as a technical contradiction, for which solutions can be identified in a systematic way based on Altshuller's inventive principles. A technical contradiction exists, if improving a parameter “A” of a system causes a

different parameter “B” to deteriorate, whereas a physical contradiction exists if some aspect of a product or service must simultaneously adopt two opposing states. Expressing the problem in question as a technical or physical contradiction is therefore a prerequisite to applying the contradiction table [6]. The analysis then relies on fitting the problem to a table of conflicts between 39 technical parameters and identifying solutions based on 40 inventive principles, which have proved successful in solving these conflicts. In this sense, the contradiction table represents a comprehensive data compilation of expert knowledge on the applicability of innovative principles in solving technical or design problems (for a more detailed description of the contradiction analysis see [7]).

In certain cases, the contradiction table itself is already applicable and appropriate in the context of product piracy protection. The 40 inventive principles can be very helpful to find new, unconventional technical approaches for know-how protection. Yet in general, the direct applicability of the contradiction table is limited, mainly due to two reasons:

- Users often fail in structuring and expressing piracy problems in terms of a technical or physical contradictions due to lacking knowledge and experience. That is why more problem-specific guidance is required.
- Solutions against product piracy are clearly not limited solely to technical principles. That is why the scope of innovative solutions generated by the contradiction table is limited in the context of piracy problems.

However, the issue of creating solutions against product piracy can as a whole be viewed as a physical contradiction, due to the already mentioned conflict: on the one hand, protection mechanisms are called for, yet on the other, persons responsible are not willing to take negative or harmful alterations to their product into account. In many workshops that Fraunhofer IPT has conducted with companies in different lines of industry, this conflicting situation represented a major restriction or even a knock-out criterion against the implementation of powerful protection measures. The idea of a problem-specific contradiction analysis arose from this insight.

2.2 The Analogy Between the TRIZ Contradiction Table and the PPC Matrix

Following the basic idea of the TRIZ contradiction table, the PPC Matrix is designed to identify standard solution principles against product piracy threats, for which suitable solutions must be identified. Therefore, the structure of the PPC Matrix is quite similar to the contradiction table. The rows contain actuating parameters or levers to implement protection mechanisms. The columns on the other hand represent a list of reactive parameters that could be harmfully affected by the actuating parameters. In short, the analogies between the traditional contradiction table and PPC Matrix can be described as follows:

- Conflicts between active and reactive parameters are recorded at the intersections of the rows and columns of the PPC Matrix.
- Standard solution principles within the PPC Matrix are based on a catalogue of protection measures as a research result of the Fraunhofer IPT [2] [8].
- The application of the PPC Matrix is embedded in a comprehensive problem-solving procedure that comprises an initial problem analysis and the identification of main conflicts and is followed by the

development and validation of solutions based on standard principles proposed in the cells of the matrix.

2.3 Design of the PPC Matrix

In contrast to the TRIZ contradiction table, which uses the same 39 technical parameters to structure both row (feature to improve) and column (undesired results) of the table [6], the axes of the PPC Matrix are designed in a non-symmetric way. Although several parameters can be found simultaneously in the columns and the rows of the matrix, the structuring frameworks for the rows and the columns are different (Figure 1): Derived from a game-theoretical analysis, the parameters within the rows are classified according to the generic behavioural pattern of the imitator and original product manufacturer. On the other hand, the parameters in the columns are arranged according to the standard value chain of a company. These two basic structuring concepts will be described in detail in the following.

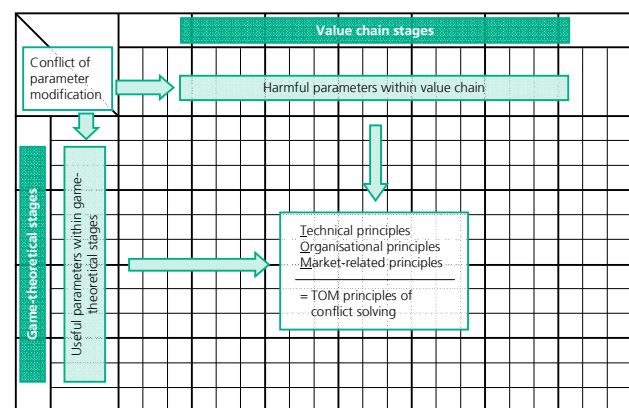


Figure 1: Concept of the PPC Matrix.

2.4 Structuring the Rows Based on Game-theoretical Analysis

From a game-theoretical point of view, there are four more or less sequential stages which are suitable to generically describe the behavioural pattern of an imitator and thus, the stages of opportunities for an original product manufacturer to take counteractions [2]:

- Selection of a product to be copied
- Analysis of the product
- Reproduction of the product
- Marketing and sales of the imitation

The first decision an imitator has to make is the selection of the product he intends to copy. Needless to say, the imitator’s decision mainly depends on the expected commercial benefits which are linked to the imitation. Hence, the initial selection and decision-making process of the imitator represents the first stage for the original product manufacturer to take action. By shifting certain parameters within the product design or business model (e.g. in terms of production techniques or after sales services), the original product manufacturer can deliberately lower the imitation attractiveness of his products.

After an imitator has decided to copy an original product, the second lever is to make the product analysis or reverse engineering as time-consuming and tedious as possible for the imitator. Various counteractions can be considered, yet most of them are directly affiliated to the

product structure or design (e.g. increase of product complexity or limitation of product access).

If the imitator has succeeded in analysing a product, the third and subsequent stage is the reproduction (in terms of manufacturing) of the original product by the imitator. For the original product manufacturer, the according lever is to impede the imitator from actually realising a reproduction. At this stage, mainly measures related to supply chain management (e.g. limiting the access to essential suppliers or components) can be considered.

Finally, assuming the imitator has actually achieved in manufacturing a false replica, the remaining lever for the affected company is to hinder the imitator in bringing his imitation to the market and gaining market shares. Counteractions primarily apply either directly to the design of sales channels or to implementing appropriate authentication means.

These four stages represent a suitable classification framework for a generic list of actuating parameters companies can modify in order to implement protection measures. The according parameters represent the rows of the PPC Matrix.

2.5 Structuring the Columns Based on the Ideality Principle

According to “ideality thinking” as a key concept of TRIZ, a technical sub-system should fulfil its desired functions without calling forth an undesired effect of the corresponding entire system. The TRIZ dictum says: effective technical solutions evoke maximal positive effects within a system and simultaneously limit possible negative effects to a minimum. The effectiveness E is a universal TRIZ ratio to evaluate the degree of ideality of technical system.

$$E = \frac{\text{Sum of the positive effects}}{\text{Sum of the negative effects}}$$

Metaphorically speaking, the ideal system provides a desired function without even existing [9]. Following this line of thinking in the context of product piracy, protective measures can be considered subsystems of an (already existing) system, i.e. of the value chain of the burdened product which has to be protected. Hence, an ideal measure against product piracy fulfils its desired function without bringing harmful effects into the value chain system it is supposed to protect. A full corporate value chain generally comprises seven stages [10]:

- Research & Development
- Procurement
- Production
- Distribution
- Marketing
- Sales
- Service

As illustrated in the introduction already, certain characteristics within the value chain may be influenced in a harmful or destructive way by the implementation of protection measures. This circumstance accounts for the conflict companies are faced with in the context of product piracy. Consequently, according to the notion of ideality, the PPC Matrix offers standard solution principles which enhance the positive (protective) effects and minimise the negative (value chain-modifying) effects.

2.6 The 26 TOM Principles

Based on the research results of Neemann [2], Fraunhofer IPT has compiled a list of 26 principles that

can be applied to dissolve the described conflict. Three basic categories have been distinguished to classify these principles:

- **Technical principles:** they are directly integrated within the product as additional features or as modifications of existing product components
- **Organisational principles:** they can be implemented within the internal organisational structure, without considering external links to markets
- **Market-related principles:** they are implemented according to customer requirements and relationships, i.e. taking the market of the burdened product into account.

According to the initials of the three categories, the 26 principles against product piracy are labelled the TOM principles (Figure 2). In analogy to the 40 inventive principles of TRIZ, the TOM principles represent standardised mechanisms in an abstract form. This implies that a principle considered justified must be adjusted to individual problem characteristics, i.e. to product and corporate boundary conditions.

Technical principles:	O4	Proprietary development of production facilities
T1 Fixed cost-intensive manufacturing	O5	Collaboration with imitator
T2 Branded functionality	O6	Chinese walls in the supply chain
T3 Product (de-)activation	O7	Contracted supplier relationships
T4 Decomposition barriers		
T5 Functional black boxes		Market-related principles:
T6 Fake black boxes	M1	Lead time
T7 De-standardisation	M2	Release management
T8 Local increase of performance density	M3	Simultaneous market launch
T9 Product authentication	M4	Price differentiation
T10 Product bundling	M5	Product differentiation
	M6	Shadow placement
Organisational principles:	M7	Mass customisation
O1 Product certification	M8	Extended life cycle services
O2 Staff retention	M9	Establishment of industry standards
O3 Codification of documents		

Figure 2: TOM principles for product piracy protection.

3 PRACTITIONER'S GUIDANCE FOR APPLICATION: A COMPREHENSIVE APPROACH FOR TECHNOLOGY-BASED KNOW-HOW PROTECTION

The Fraunhofer IPT has elaborated a user's guideline, how to apply the PPC Matrix and what critical factors to consider. A six-step procedure is suggested as a comprehensive approach to identify and implement non-legal protection measures using the PPC Matrix. Figure 3 gives an overview about the individual steps and shows, where by experience the most effort has to be put in. The approach will be introduced in the following.

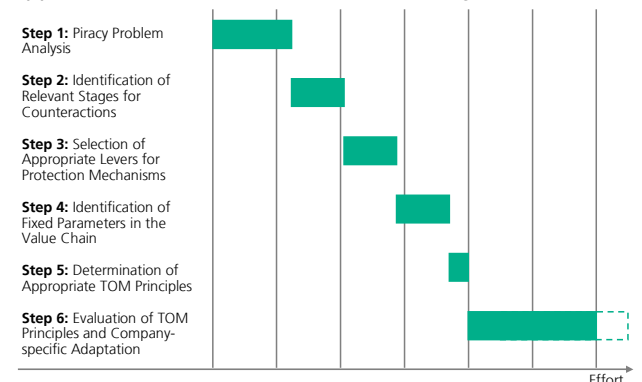


Figure 3: PPC Matrix Application.

3.1 Step 1: Piracy Problem Analysis

A detailed problem analysis is the first step to applying the PPC Matrix. During this initial phase, the company's specific situation must be investigated i.e. the actual or most likely imitation scenarios determined. The following

categorisation of imitation types (Figure 4) gives companies guidance to clarify this issue:

Companies must get a clear idea about what kind of imitation they actually have to fear. In consideration of the different types of imitation, the potential imitators can be characterised (see Figure 5). Manufacturers of brand counterfeits normally have a poor quality level in comparison to the original product manufacturer. He does not (need to) acquire comprehensive knowledge about the original product. However, his addressed markets differ largely from those of the original product.

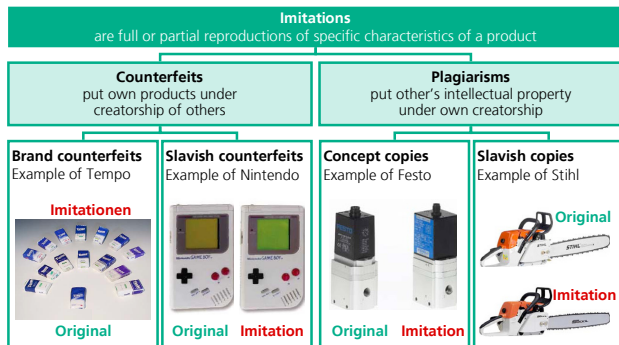


Figure 4: Generic types of product imitation. (image source: www.plagiarist.com)

Slavish counterfeits also tend to have a worse quality level than the original product. But still, sometimes they are hardly to differentiate from each other. That is why the addressed markets are quite similar.

Concept as well as slavish copies demand for comprehensive know-how adaption by the imitator. Mostly, the imitations have a high quality level and customers are very similar to those of the original product. On basis of these characteristics, there has to be considered, what kind and extent of commercial issues might be implicated by an imitation. For instance, when simple brand counterfeits are reproduced by the imitator, this probably may not immediately end up in significant sales losses because the potential customers of the imitation are not similar to those of the original product; a decrease in brand reputation is much more likely to fear for this type of imitation scenario. In other cases, concept copies will probably not result in unjustified product liability complaints, because the original product is easily to differentiate from the imitation. Only slavish counterfeits will do so and demand for appropriate counteractions.

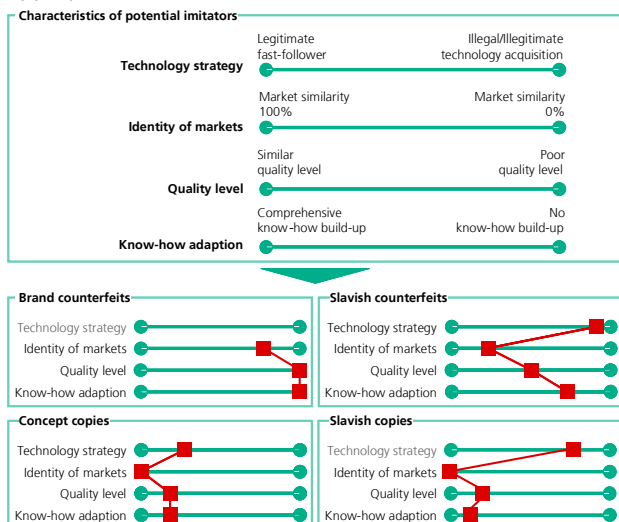


Figure 5: Characteristics of potential imitators [2].

3.2 Step 2: Identification of Relevant Stages for Counteractions

As next step, the relevant (game-theoretical) stage for taking counteractions must be identified. Questions to ask in this context are: is the considered product highly attractive to be imitated? Has the product already been analysed by potential imitators resp. has technical know-how already left the boundaries of the company (e.g. due to personal fluctuation, trade fair appearances etc.)? Have concrete product imitations already emerged or are they however foreseeable?

Depending on how far the (expected) imitation process has already stepped ahead, companies have to define their appropriate stage for counteraction. When for example the product development has not been completed yet and no critical know-how has left the company so far, the product's attractiveness to be imitated can be reduced by certain technical and commercial characteristics so that imitators will not select the product for imitation purposes in the first place. However, when the product has been analysed by imitators already and reproductions of the original product are very likely to be proceeded, the appropriate stage to take counteractions would be the marketing and sales phase of the imitation.

3.3 Step 3: Selection of Appropriate Levers for Protection Mechanisms

The third step involves identifying those levers which are available for integrating protection mechanisms. In accordance to the stage for taking counteractions, the company must think about parameters in their own business to change, in order to prevent product piracy. This may include parameters like brand appearance, product complexity or even annual part volume.

Such useful parameters for modification are listed in the rows of the PPC Matrix. Needless to say, companies do not have to focus only on one parameter i.e. row of the PPC Matrix but can also take three or four parameters into account. In this case the following steps would have to be conducted multiple.

3.4 Step 4: Identification of Fixed Parameters in the Value Chain

During the fourth step, the firm must consider the entire value chain and determine which phases are likely to be harmfully affected by modifying the selected parameters.

As taken as an example before, when decreasing the annual part volume in order to lower the imitation attractiveness of a product, the sales volume will decrease as well. It is easily foreseeable, that this kind of parameter modification will hardly be accepted because it might hurt the company's commercial performance even more than the appearance of product imitations itself.

The sales volume is included in the list of harmful parameter to be changed within the company's value chain, which constitute the columns of the PPC Matrix. The comparison of useful parameters against product piracy in the rows and harmful parameters of the value chain in the columns state the conflict which is tried to be solved in the following step.

3.5 Step 5: Determination of Appropriate TOM Principles

Within the fifth step, the core of the PPC Matrix is finally applied. First, the line containing the useful actuating parameter to implement a protection mechanism is

selected. Then the column that corresponds to the harmful reactive parameter is identified which represents the fixed aspect in the value chain that is negatively affected by an alteration of the actuating parameter. At the intersection of the line and the column, the solution principles capable of solving the conflicting situation are indicated with their respective short name as shown in Figure 6.

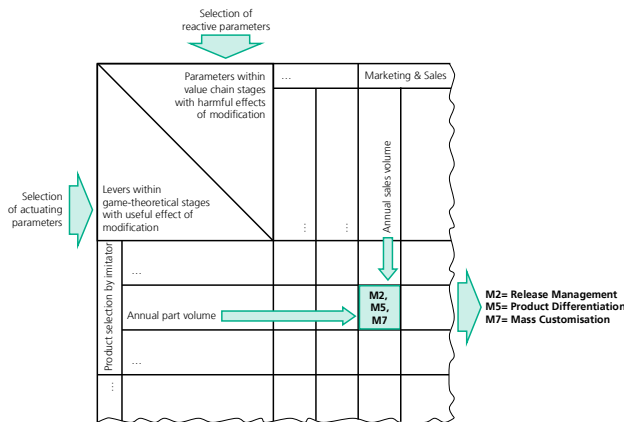


Figure 6: Identification of suitable TOM principles

There always can be more than one principle within an intersection. For each TOM principle a short description as well as application advices are given, so that the user can get a clear picture about the principle and its effect against product piracy.

3.6 Step 6: Evaluation of TOM Principles and Company-specific Adaptation

It is not automatically guaranteed, that an identified TOM principle is an appropriate measure for a specific case. Therefore in the next step it is inexpedient to evaluate a measure regarding its actual problem-solving potential for the particular product piracy scenarios.

For this last step all stakeholders that might be affected by the implementation of the measure have to be involved and asked about the principle's applicability from their point of view. After a principle has finally been approved from all experts as a suitable and applicable measure for the company to prevent product piracy and also cost calculations have confirmed its commercial benefit, the technical, organisational or market-related adaptation of this principle can be initialised.

4 REFLEXION AND OUTLOOK

First and foremost, the introduced approach for technology-based know-how protection using the PPC Matrix as methodological support can be regarded as a basic framework for companies that so far have little idea concerning the range of solution principles and their application potential. Furthermore, the PPC Matrix can provide valuable guidance for companies in validating mechanisms previously identified.

From a more academic perspective, by analysing in detail the coherences and determining factors of protection mechanisms, the matrix represents an important step in structuring this novel field of research. In this sense, the matrix represents a comprehensive compilation of expert knowledge concerning the applicability of non-legal principles in preventing product piracy.

Clearly, the matrix does not claim to deliver „turnkey solutions“ for a concrete piracy problem; in analogy to the contradiction table, it generates ideas in the sense of abstract principles, stimulates creativity and forms the

basis for further validation, implementation and enhancement steps.

The approach has proved successful in a number of consulting projects conducted by Fraunhofer IPT. In the future, Fraunhofer IPT will continually supplement the 26 TOM principles and update the matrix accordingly. Although the set of principles can already be considered highly comprehensive, the initial set must be extended mainly triggered by experiences gained in concrete industrial applications. This process has not been finalised and will be continued on an ongoing basis, thus ensuring the up-to-date status and capability of the methodology.

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