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How to Identify Strategies Against Product Piracy

Martin Kaschny*, Anja Wallouch

Business Sciences, University of Applied Sciences Koblenz, Koblenz, Germany

Email address

kaschny@hs-koblenz.de (M. Kaschny)

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Abstract

Product piracy is a growing problem businesses are encountering and in future they will have to face this problem more and more. The aim of this article is to counteract this shortfall. In order to cope with product piracy successfully, defensive measures have to be taken. Hence, we initially introduce potential protective measures of a legal, economic, political and technical nature. But although these measures may actually seem reasonable, they may not be appropriate in any situation or suited for any enterprise. The individual business situation and business environment requires an intensive exploration of measures since various options are feasible. That is why it is questionable to what extent safeguarding measures really make sense for a business. Therefore, the main part of this article addresses this very question by looking at the game theory, which serves as a possible aid in the decision-making process. Based on this, different 'what-if' scenarios are played through on polypoly and monopoly markets where the threat of product piracy is looming. The scenarios serve as case studies and would need to be adapted to the individual business and piracy situation. With the aid of the game theory, this article illustrates how a decision can be made to find a suitable defence strategy.

Keywords

Product Piracy, Measures, Game Theory, Decision-Making Process, Defense Strategy, Small and Medium Sized Enterprise, Counterfeit

1. Introduction

Product piracy is a serious damaging factor for enterprises around the globe. Studies predict the economic and social damage caused by counterfeiting and piracy for the year 2015 to amount to 1.7 trillion US dollars. In addition, an annual 2.5 million jobs are estimated to be at stake in the G20 states.[1] [2].

In order to protect oneself against the piracy threat, there is a variety of measures that vary in their effectiveness according to industry, product, business and piracy scenario. Enterprises are faced with the challenge to develop an anti-piracy strategy which is tailored to the enterprise and situation. This is a very complex and elaborate task and requires in-depth knowledge of the protective measures at hand to figure out how effective they are. Additionally, details about how product pirates operate and how they can potentially harm businesses are required. A package of measures needs to be put together which allows a business to continuously adapt to changing circumstances in a business environment and the fast moving counterfeiting industry using selected measures. These measures need to be implemented in a target-oriented way as part of a strategy and must not restrict the original scope of the enterprise, i.e., enterprises should not lose their flexibility. The cost-benefit ratio of the measures that have been put together in a strategy plan must be right to withstand the pressure of further arduous conditions in the market in the long run. [10].

When selecting the right measures to establish an anti-piracy strategy, enterprises can choose between different tools that – when combined - are supposed to provide effective protection. Protective measures can generally be categorised into legal, economic, technical and political measures.

To find out which package of measures is suitable for a business, the game theory seems to be a good solution and is understood to be the analysis of strategic decision-making processes. [9]. In a gambling environment rational behaviour

[1] "Estimating the Global Economic and Social Impacts of Counterfeiting and Piracy" was published in 2011 by the International Chamber of Commerce and supplements a study of the OECD in 2008.

patterns are considered a potential solution. The formal depiction of a game depends on the number of players, the strategic scope, the actual pay-off (individual benefit of each player) and the rules of the game. [7]. By means of the game theory, we will analyse which strategic measures an enterprise will be able to choose from in certain environmental and knowledge-related circumstances by using case examples. To start, the following chapter (2) will highlight what fundamental measures are available to counteract the product piracy threat.

2. Measures Against Product Piracy

2.1. Legal Measures

Trade mark rights form the basis for legal protection against product piracy. There are numerous national and international regulations as well as global agreements to safeguard intellectual property in an effective way. National legal measures lay the foundation for the protection of intellectual property. However, they cannot prevent enterprises being struck by internationally operating product pirate organisations. Hence, mainly European and international legal safeguards are of particular importance in the fight against product piracy across borders. In Germany these are primarily patents, utility models, registered designs, trademark laws and copyrights that provide protection against product piracy. To maintain competitiveness within Europe, the European Community started introducing regulations and ordinances that provide protection against product piracy in the mid-1980s and each individual member state is responsible for their implementation. The legal precautionary measures at European level include – amongst others - the Community Design Regulation and the European Patent Convention. Furthermore, international agreements and regulations apply like the Paris Convention which governs the international patent and trademark law as well as the design protection right. The cultural legal protection is for the main part covered by the Revised Bern Convention.

2.2. Business-Related Measures

Product pirates will always find vulnerabilities along the value chain that allow them to get hold of the relevant know-how which is necessary for imitating products. While legal measures often only pose a theoretical impediment, enterprises are able to significantly narrow the weak points that are vulnerable to attack by implementing well planned and structured business-related measures.

Human Resources is one area where protective measures are crucial to avoid sensitive information leaking through to the imitating industry by their own workforce. Shortlisted candidates should already be screened in the recruitment process, their CVs should be thoroughly reviewed and references should be obtained. If possible, additional non-disclosure and no-competition clauses should be included in the employment contract. [13]. In addition, job-rotation and the need-to-know principle can help restrict and control information in such a way that only those details that are needed for staff to do their jobs are disclosed. Hence only a handful of individuals acquire access to sensitive information.

The field of Research and Development also calls for a high level of protection. The reason why the counterfeiting industry is thriving is because they do not have to spend vast sums of money on research and development for their fake products. Sensitive information can leak through the smallest gaps. Measures to protect this highly sensitive division are for example, restricted access for external parties or staff who are not directly involved in this area. In addition, it is useful to divide staff into teams so that each employee is only familiar with a specific section. If possible, development cycles should be kept as short as possible so that design and technology of fake products are always somewhat obsolete.

Additionally, enterprises have the opportunity to take preventive action against product piracy in the field of Sales and Marketing. It does make sense to let the end consumer know where they can buy the original merchandise to rule out an accidental sourcing of fake products through other distribution channels. Likewise, manufacturers selling their products directly at the source are a way of controlling distribution channels and reassuring customers that they acquire original merchandise. Special services like after-sales-service provide an incentive to the customer to buy the original goods and not intentionally grab fake products.

2.3. Technical Measures

There are numerous technologies that can be deployed to combat product piracy and enterprises can build a protective mechanism by implementing a combination of technical measures. Technical measures can be categorised into visible, invisible and machine-aided measures.

Visible measures include for example holograms, Optically Variable Devices (OVDs) or Diffractive Optically Variable Image Devices (DOVIDs), protective films, tags and seals, security inks as well as security paper and printing. [6]. While the costs for standard holograms are at 8 – 24 Euros very low, faking them is a lot more complicated and not worth the effort due to the poor cost-benefit ratio. [5].

When technical protection measures are not visible to the naked eye, they are called invisible technologies. A special device is needed to detect the so-called, “covert technologies”. The most common invisible technologies include micro colour codes, micro prints, microscopic plastic particles, print with special inks, DNA and DNA computing, nanotechnology, nano-biotechnology, isotopic and chromogen systems. [3]. Micro colour codes and micro prints are for example, microscopic tiny particles that can be recognised by means of special reading devices or magnifying glasses and so confirm the products’ authenticity.

With the aid of machine-supported technologies data are fed in by using special devices which include adhesive tapes, barcodes, chip cards, Radio Frequency Identification Systems (RFID), Internet-Monitoring, Digital Rights Management (DRM), digital watermarks, self-destruction mechanisms, Optical Character Recognition (OCR), biometric measures,

chemical markers, intelligent packaging and tracking and tracing of goods. [1]. The use of RFID as well as barcodes is particularly recommendable when businesses want to keep track of products in a long logistics chain.

2.4. Political Measures

Political protective measures offer a significant protection level combined with an attractive cost-benefit ratio.

The most effective political measures include public relations, association work, cooperations and a well functioning communication policy. With the aid of PR and a well-functioning communication policy, businesses will achieve two positive effects. On the one hand, communication has an educational effect and thus protects customers from unconsciously purchasing fake goods. On the other hand, it warns and shows us what consequences we might be facing when we deliberately purchase counterfeits. [14]. There are many ways how this can be done: press adverts, media exposure, information campaigns in the form of exhibitions or workshops and explanations on their homepage. [4] Becoming a member of an association means that you can share your experiences with fellow stakeholders and so are able to jointly develop common strategies and campaigns against product piracy. In addition, a mutual appearance in public can raise awareness and companies might find it easier to make themselves heard amongst policy-makers. [14]. Likewise, the cooperation with a fellow competitor can be similarly beneficial by e.g., establishing a joint data base storing data about known counterfeiters or conducting joint information campaigns.

3. Game Theory and Strategic Concept

To function as a basis for the scenarios that in terms of the game theory should be played through, those measures that are similar in allocation of resources and effectiveness are pooled in measure packages. Allocation of resources mainly covers the funds, staff and time required to run an anti-piracy campaign. Consequently, the generated measure packages are the foundation for the individual strategies making use of bespoke measures according to the situation. Strategies can be categorised into passive, reactive and active strategic concepts depending on the resources required.

Passive Strategy Concepts include all basic strategies that involve fewer resources and accordingly show a comparably low effectiveness in the fight against product piracy. This strategic concept serves primarily as an early detection tool for pirate attacks. It doesn't cost much but then again only provides inadequate protection. The passive strategy concept includes for example, the Do-Nothing-Strategy and the compensation strategy. Neither method has a complex measure package that counteracts pirates' attacks. Passive strategy concepts are specifically suitable for small and young businesses, in particular, when products might not be fully developed and therefore are still of little interest to the counterfeiting sector.

The Reactive Strategy Concept considers all basic strategies that are far more time-consuming and involve more costs. They are accordingly much more effective and include mainly strategies that respond to a previous attack. The damage suffered shall be minimized and induce pirates to withdraw. The strategy portfolio ranges here from a purely legal combat strategy via an information strategy to a strategy as part of which a cooperation with product pirates can be entered. The cost-benefit ratio of a reactive strategy concept is an attractive alternative for small and medium-sized businesses. This strategy concept is particularly recommendable when fast action is required or when businesses have been hit by pirates out of the blue.

The active strategy concept includes those strategies that require a high amount of resources and are highly effective. Consequently, they are designed to keep pirates from striking and can actively and aggressively combat product piracy. They include innovation, plagiarism and attack strategy. All three strategy types require considerable financial commitment as well as a high level of resources. To go for an active strategy concept can therefore be of little interest to small and medium-sized businesses. It is more suitable for financially strong corporations and provides adequate protection against product piracy. Additionally, large businesses are more likely to have existing production and distribution processes to implement an active strategic concept.

The following demonstrates how the game theory can help select individual strategies.

4. Game Version I – Regular Game

Non-cooperative games in a strategically regular form are subject to an equal level of information of all players. [12]. Players pick their strategy autonomously without communicating to each other. [9]. Another requirement is that both players act individually rationally and only pursue their own personal benefit. The following initial case has been selected as a basis for a strategically regular game:

The medium-sized engineering company "Original Ltd" (O) manufactures large printing machines for industry purposes. Due to various pirates' attacks in this sector and the simple technical design of the printing machines, the company considers the introduction of defence strategies. In case of a pirate attack Original Ltd anticipates lost earnings[2] in the amount of 10%, if it does not defend itself.[3] In case of a defence, the lost profit is reduced by half to 5 %. Potential defence costs, however, then amount to an average of 1.5 % of profit.

The team of pirates "Fakers" (F) is meanwhile debating

[2] The profit losses expected in each case not only relate to the actual loss of profit suffered but also on any loss of image, reputation costs etc.

[3] All values used here in terms of the game theory have been estimated following a study by the VDMA for engineering companies. [15].

whether to attack Original Ltd or not. If they don't, they will miss out on the full profit potential of 100%. If they do, they will have the chance of 100 % profit, unless Original Ltd defends itself. However, in case Original Ltd does defend itself, the counterfeiting partners only assume to achieve a profit of 55%.

The game situation can be described as follows: Player O can select between the strategies "defend" (s_{O1}) and "not defend" (s_{O2}). Player F chooses between "attack" (s_{F1}) and "not attack" (s_{F2}). This results in the following strategy concept:

Table 1. *Pay-off Matrix of Game Situation*

F/O	Defend s_{O1}	Not defend s_{O2}
Attack s_{F1}	F: 100 - 45 = 55 O: 100 - 1,5 - 5 = 93,5	F: 100 - 0 = 100 O: 100 - 10 = 90
Not attack s_{F2}	F: 100 - 100 = 0 O: 100 - 1,5 = 98,5	F: 100 - 100 = 0 O: 100 - 0 = 100

The first step of the solution concept is the analysis of the preferences of O and F. [9]. In this game one has to assume that both O and F want to achieve the highest possible profit. A profit of 100 % is therefore allocated to the maximum benefit (u = 4) whereas a profit of 0% is allocated to the minimum benefit (u = 1).

Accordingly, the game Γ=(N, S, u) is characterised by [9]:

1. The number of players N = {O,F}
2. The strategic scope S = *(s_{F1} / s_{O1}, s_{F1} / s_{O2}, s_{F2} / s_{O1}, s_{F2} / s_{O2})*
3. The benefit *(u)* of players in each strategic combination:
u_F (s_{F1} / s_{O1}) 3; u_F (s_{F1} / s_{O2}) 4; u_F (s_{F2} / s_{O1}) 1; u_F (s_{F2} /s_{O2}) 1
u_O(s_{F1} /s_{O1}) 2; u_O(s_{F1} / s_{O2}) 1; u_O(s_{F2} / s_{O1}) 3; u_O(s_{F2} /s_{O2}) 4
4. The rules of the game

The benefit of players is described by various combinations of strategies that result in a combination of benefits. The quantity of all combinations of benefits result in the pay-off scope P = {(3/2);(4/1);(1/3);(1/4)} of the game [9]:

Table 2. *Pay-off Matrix of the initial Game Situation*

F/O	Defend s_{O1}	Not defend s_{O2}
Attack s_{F1}	3/2	4/1
Not attack s_{F2}	1/3	1/4

To solve non-cooperative games means that no player is interested in deviating from the chosen strategy. [9]. Therefore both players must consider the expectation towards the behaviour of fellow players in their decision for an invidual rational solution. [9]. The expectation formation on the other hand determines the applicable outline solution.

4.1. Type of Solution: Maximin Solution

The Maximin solution suggests that particular strategy to the player that allows them to achieve a comparably significant benefit, even in the least favourable scenario. The basic idea here is worst case, this strategy is therefore a playing-safe strategy and is based on pessimistic expectations. [11]. Hence both players expect the opponent to choose that version with the highest possible damage for their opponent in each case. Subsequently, players choose that strategy the worst case benefit of which is higher than the worst case benefit of the other strategy (Maximin-criterion). [9].

In this game the strategy "not defend" is least beneficial for O.

u = 1. If O chooses "defend", the least beneficial situation equals

u = 2. Consequently, O goes for "defend". Since the sector has been hit by pirates several times, O's pessimistic view seems reasonable.

With the strategy "attack" F achieves worst case a benefit of u = 3. With the strategy "not attack" their least benefit is u = 1. Thus they go for "attack". This behaviour is similarly reasonable as piracy has been known within the sector and F has to assume O to defend itself.

According to the Maximin criterion the game situation "attack"/ "defend" (s_{F1} / s_{O1}) represents the individual rational solution.

4.2. Solution Option: Nash-Equillibrium

A Nash-equillibrium is present, when both players reciprocally play "best possible answers", a situation in which their decision always depends on the opponent's behaviour. [9]. O and F choose that strategy that maximises their expected benefit. [9]. The presence of several Nash-equillibria in a game is also possible.

Original Ltd has been informed about the product pirates' criminal and ruthless methods. The company produces high quality products that are, however, easy to copy and at the moment is not implementing any protective measures whatsoever that would hamper an attack. O therefore anticipates to be attacked by the two counterfeiters. (s_{F1}). Since the team of counterfeiters must assume O to be aware of the situation, they assume that Original Ltd will protect itself against future pirate attacks. The two counterfeiters therefore, expect Original Ltd to defend itself. (s_{O1}).

O now has the choice between the strategy "defend" (s_{O1}) with a benefit of u = 2 and "not defend" with a benefit u = 1. The best response to the anticipated strategy selection of the two counterfeiters is therefore the "defend" strategy.

The two counterfeiters can now react with the "attack" strategy (s_{F1}) with the benefit u = 3 and the "not attack" strategy (s_{F2}) with the benefit u = 1. The benefit when going for the "attack" strategy is – despite Original Ltd defending itself – still higher than the strategy "not attack". Therefore the "attack" strategy (s_{F1}) is the best response to the anticipated choice of strategies of Original Ltd.

When going for the strategy combination "attack" / "defend" (s_{F1} / s_{O1}), the expectations of the players towards the strategy selection of their opponents match. This is why this strategy combination is called Nash-equillibrium.

4.3. Assessment

In both solution concepts applied here, the anticipation of the individual players plays a major role in the solution finding process. A reasonable anticipation can be designed for both types of solutions. Although the existing case will result in the same solution proposal deriving from the Maximin solution and the Nash-equillibrium, it is possible that the solutions differ. The reason is that not always all solutions concepts can be implicitly applied to any game situation. Therefore the selection of solution concepts has to be done for each specific game explicitly. The following example should demonstrate this:

O holds a monopoly position in the market. In case of an attack F plans to launch a high quality fake product that consumers won't perceive as a cheap copy but as an equivalent substitute. This will jeopardize O's monopoly position and allow two alternative actions: aggressive combat or the acceptance of a second player in the market. [1]. *The first option will involve considerable financial commitment which O, being a medium-sized enterprise, will barely be able to compensate. Additionally, there might be considerable reputational damage. However, production and distribution of the fake products would no longer be possible at the same extent.*

O expects in case of an aggressive action ("attack" / "defend") only a small profit in the amount of 25% while the counterfeiter team would achieve a profit in the amount of 20%. If O and F share the market ("attack"/ "not defend"), they will both achieve a duopoly profit in the amount of 50% each. [9]. *If F doesn't strike, there will be no financial return. In this case O would have the full 100 % profit resp. 90% profit in case of a defence.*

This results in the following pay-off matrix:

Table 3. *Pay-off Matrix in the Variation Case of the initial Game Situation*

F/O	Defend s_{O1}	Not defend s_{O2}
Attack s_{F1}	20/ 25	50/ 50
Not attack s_{F2}	0/ 90	0/ 100

In this scenario one has to assume that O is anticipating to be attacked by F. F on the other hand is aware that Original Ltd would suffer a significant loss in case it defends itself and would be better off by not defending itself. Consequently, F expects that Original Ltd is not likely to defend itself. The strategic combination (attack s_{F1} / not defend s_{O2}) represents a possible solution, in which the expectation of both players is consistent to that effect, that both mutually obtain best possible responses. According to this, the Nash-equillibrium is deviating.

Even if designed games only take some of the decisive factors into account, lessons can still be learned from the result. The variation case shows for example that when going for "defend" or "not defend" it is not only important whether there is an attack but also how this attack is done. If the costs for effective defence exceed the financial resources of a company, an attack is not worthwhile. The toleration of an attack is likewise not ideal but the Original Ltd is in this case better off than by aggressively combatting a piracy attack.

Nevertheless, one needs to bear in mind that it is highly disadvantageous for O Ltd to allow a competitor to enter into the market. The loss of the monopoly position means opening up the market and therefore further profit shortfalls and an increasingly fiercer competition in future. Therefore O Ltd should not tolerate a hasty market entry of their opponent. If they have sufficient funds available it would be wise to fight the counterfeiters with aggressive measures – even if this entails a financial loss. The game theory can help make the decision for this purpose too. However, several rounds must be played.

5. Game Version II – Extensive Game

Non-cooperative games in an extensive way are characterised by all players moving one after the other i.e., having different information levels. [9]. Moreover, "secret information" of just one player is possible. Typical solution concepts are the "subgame-perfect balance", the "sequential balance" and the "trembling-hand-perfect balance". [9].

In the following the different defence strategies are included in the game theoretic scenario.

Original Ltd, ready to defend itself, can select between 3 strategy concepts: passive, reactive or active defence. O estimates the costs for a short-term passive strategy concept to be at 0.5% of the profit. An attack by F results in additional profit losses in the amount of 9.5%. To pursue a reactive strategy concept, O would have to spend 1.5 % of profit. The limited partnership loses in case of an attack some 6.5 % of profit. O as a medium-sized company can only implement an active strategy concept when incurring a severe financial loss. They lack - amongst other things - adequate staffing. An active strategy concept would therefore cost unreasonable 15 % of profit. In case of an attack the profit loss would only account for 2 %.

F can generate 100% profit, so long as O goes for the passive strategy concept.

A 100% profit for the team of counterfeiters is realistic despite the defence strategy of Original Ltd., as in this case a pursued passive strategy concept provides no countermeasures that would hamper the pirates' activities in any way. They merely serve as an early detection instrument and, if applicable, the compensation of any damages suffered within the enterprise.

A reactive strategy concept leads to a profit of 50 % for F. Should O pursue an active strategy concept, F would suffer a loss of 10 %, since F would not be able to cover the expenses.

Player O can choose between three options: "passive strategy concept" (s_{O1}), "reactive strategy concept" (s_{O2}) and "active strategy concept" (s_{O3}). Player F can choose between two possible actions: "attack" (s_{F1}) and "not attack" (s_{F2}).

Consequently, there are different strategy combinations

with the following pay-off values for O and F:

Table 4. *Pay-off Matrix of of Game Situation*

F/O	Passive s_{O1}	Reactive s_{O2}	Active s_{O3}
Attack s_{F1}	F: 100 O: 100-0,5-10,5 = 89	F: 50 O: 100-1,5-6,5= 92	F: -10 O: 100-15-2= 83
Not attack s_{F2}	F: 0 O: 100-0,5= 99,5	F: 0 O: 100-1,5= 98,5	F: 0 O: 100-15= 85

The extensive game form allows players to incorporate any previous information in their decision. [9]. As in this way previous moves done by fellow players can be taken into account, the solution of the game is defined by the order of moves. [1]. The rules of the game state that O makes the first move and then it is F's turn. Both players have a pool of "common knowledge": the rules of the game, the rational behaviour of both players, the *number of players (N) the* action quantities *(s_i)* and the respective benefits *(E_1 bis E_6)*. According to that, this is a game with full information. [9].

The game $\Gamma = (N, S, E)$ is characterised by [1]:

1. The number of players: $N = \{O,F\}$
2. The point in time *(t)* when it is each player's turn: it's O's turn first then it is F's turn.
3. How both players can move: $O = s_{O1}, s_{O2}, s_{O3}$ und $F = s_{F1}, s_{F2}$
4. The benefits (E) for the players associated with the respective subgames:
$E_1 = (100/89)$, $E_2 = (0/99,5)$, $E_3 = (50/92)$, $E_4 = (0/98,5)$, $E_5 = (-10/83)$, $E_6 = (0/85)$
5. The player's level of information: game with full and perfect information

The game tree can be shown as follows:

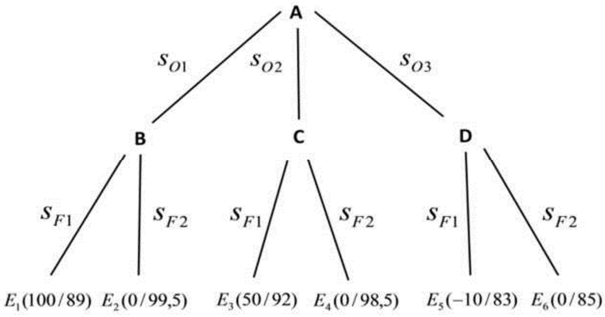

Fig 1. *Game Tree with perfect Information*

The game starts at start node A and flows from top to bottom. The game tree reflects all possible moves of O (s_{O1}, s_{O2}, s_{O3}) und F (s_{F1}, s_{F2}) in the respective branches. B, C and D are decision nodes, i.e., a game situation where a player has to make a decision with respect to the way of movement *(move)*. A subgame is initiated at the start node and at each decision node. This subgame involves at least one decision situation of one player. [12]. E_1 to E_6 are the terminal nodes in the game where no decisions can be taken any longer. They correspond each to one final score.

5.1. Subgame-Perfect Balance

The subgame-perfect balance is suitable as a solution concept for the displayed game. This allows the determination of a balance solution. Strategy combinations only then constitute a balance solution if it is better for neither player to deviate from their strategy. [9]. The equillibrium solution is determined in a backward induction where the game is initially divided into its subgames. Subsequently, the best activity will be determined for each subgame, which is deemed to be the equillibrium. The branch that does not lead to the solution is removed. The equillibrium pay-off of subgames will be allocated to the upstream subgame until there are no more real subgames. The combination of the optimum strategies determined in this way, represents the subgame-perfect equillibrium of the game. [8].

In the present game O starts with the first move and has the choice between 3 possible actions (passive, reactive, active). Then it is the counterfeiters' turn. Since this is a game with complete and perfect information, the counterfeiters are aware at which decision node (B, C or D) they are following the decision of Original Ltd. F can therefore, go for that option that assures the best possible outcome of the game. Accordingly, the real decision problem lies with O. As part of the backward induction, the game is divided into its subgames and played through starting from the back to the starting point of the actual game:

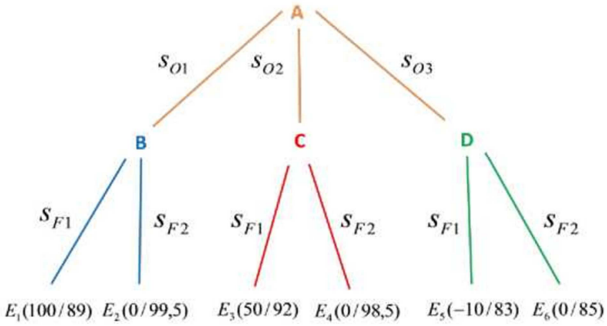

Fig 2. *Game Tree with associated Subgames*

In each subgame only one player makes one decision. [8]. In the three subgames of the lower layer *(B, C and D)* the counterfeiters are the players. In the subgame of the upper layer, *(A)* O is the player.

Subgame B offers F the choice between the options "attack" *(S_{F1})* and "not attack" *(S_{F2})* and therefore, between 100% profit *$E_1(100/89)$* in case F attacks and 0% profit *$E_2(0/99,5)$*,

if F does not attack. So in this subgame the optimum equillibrium is the option "attack" *(S_{F1})*. The option "not attack" *(S_{F2})* will be eliminated.

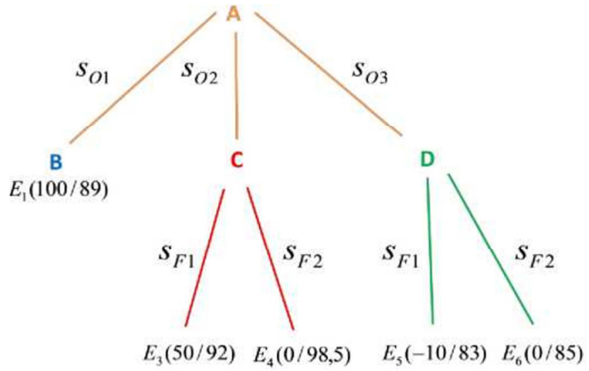

Fig 3. *Game Tree following Eliminiation of initial, not optimal Move*

Subgame C ends with the pay-offs *$E_3(50/92)$*, so long as the option "attack" *(S_{F1})* is selected or *$E_4(0/98,5)$*, so long as the option "not attack" *(S_{F2})* is selected. The counterfeiters will in this case also go for an attack, as this involves the higher benefit of 50% profit. The branch with the option "not attack" *(S_{F2})* will be eliminated.

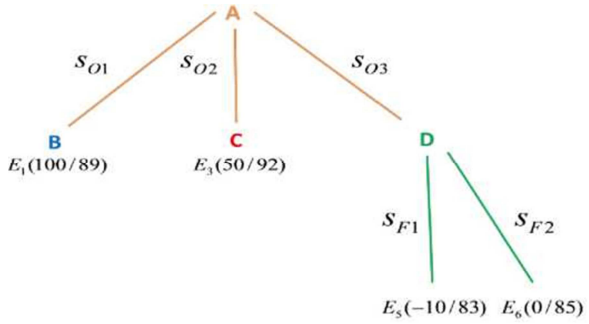

Fig 4. *Game Tree following Elimination of the second, not optimal Move*

In subgame D the action "not attack"*(S_{F2})* is for the first time better for the counterfeiters, since F would suffer a loss of 10% *$E_5(-10/83)$ with an attack*. Although the decision for "not attack" does not involve a profit, it does likewise, not involve any loss *$E_6(0/85)$*. Consequently, the optimum balance in subgame D will be achieved with the action "not attack" *(S_{F2})*. The action "attack" *(S_{F1})* is to be eliminated.

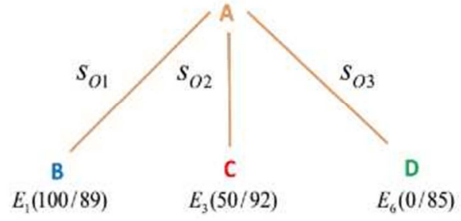

Fig 5. *Game Tree following the Elimination of the third, not optimal Strategy*

As a last step in the backward induction the optimum balance for Original Ltd in subgame A has to be determined. Subgame A represents at the same time the origin of the actual game tree, where Original Ltd. starts with its first move. If Original Ltd. goes for "passive strategy concept" *(S_{O1})*, the counterfeiters will go for "attack" *(S_{F1})*. The result of the game would be *$E_1(100/89)$*. If they go for "reactive strategy concept" *(S_{O2})* the game ends with *$E_3(50/92)$*. The action "active strategy concept" (S_{O3}) ends with *$E_6(0/85)$*. Therefore O is in the best position with a pay-off of 92% at *$E_3(50/92)$*, if the reactive strategy concept is selected. Therefore the other two actions have to be eliminated.

If you look at the game tree as a whole (see Fig. 9), it becomes clear that Original Ltd. would be in a better position with outcome *$E_2(0/99,5)$*. The backward induction shows, however, that this result would never happen. To come to this result, the counterfeiters would have to decide for "not attack" *(S_{F2})*, after Original Ltd has chosen "passive strategy concept" *(S_{O1})*. Since F would be in a more unfavourable situation, this outcome is not likely to happen. This possibility therefore represents a kind of "empty threat" (or in this case rather a "hollow promise"). An empty threat is an action that would not be taken, if put to the test. It must be deemed unreliable. [9]. The same applies to the actions with the game result *$E_4(0/98,5)$* and *$E_5(-10/83)$*. Only the combination of actions "reactive strategy concept" *(S_{O2})* and "attack" *(S_{F1})* pose an equillibrium solution as a strategy combination. *(S_{O2} / S_{F1})* is a strategy combination where it makes no sense for either player to deviate from their strategy in a subgame. *(S_{O2}* / S_{F1}) is therefore a subgame-perfect equillibrium and represents the solution of the game.

5.2 Variation of Game in Extensive Form

Original Ltd. is a large well-positioned, globally operating group. The team of counterfeiters are interested in placing a high quality fake product in the market. The costs for a short-term strategic concept are at 0.1 % of profit.[4] *A 100% profit seems realistic for the team of counterfeiters despite Original Ltd.'s defence strategy since a passive strategy concept pursued in this case would not include any countermeasures that would hamper the pirates' actions. These measures mainly serve as early detection means and to possibly compensate any damages incurred within the enterprise.*

If F attacks, O will lose 25% of profit, since F will enter the market as a serious competitor. To pursue a reactive strategy concept Original Ltd would have to invest 0.3% of profit. In case of an attack, it loses some 10% of profit. The implementation of an active strategy concept would cost O 3% of profit. Any additional loss of profit in case of an attack amounts to 2%. So long as O goes for a passive strategy concept, F can achieve a profit of 100%. In case of a reactive strategy concept, F only achieves 50% profit. If O pursues an active strategy concept, F will generate a loss of 10%.

[4] Since the profit in a large corporation is usually significantly higher than that of a medium-sized company, the percentage value of costs must be considerably lower than in the original game.

The game tree would look like this:

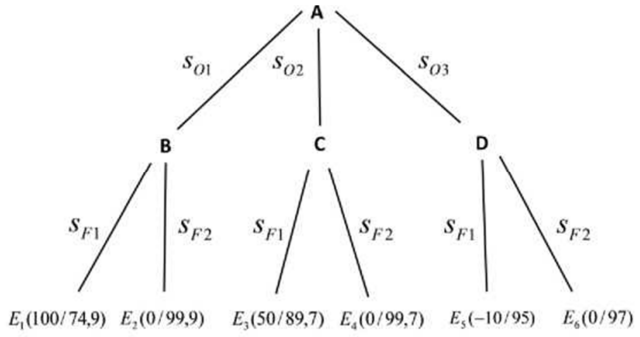

Fig 6. *Game Tree in the Variation Case*

The backward induction process of subgames B, C and D leads to the same result as in the original case since the ratio of the pay-off value has not changed for the counterfeiters. Subgame A gives Original Ltd the opportunity to choose between the activities "passive strategy concept" with pay-offs $E_1(100/74,9)$, "reactive strategy concept" with $E_3(50/89,7)$ and "active strategy concept" with $E_6(0/97)$. O achieves the optimum balance with the option "active strategy concept" (S_{O3}) and the associated score $E_6(0/97)$.

Thus (S_{O3} / S_{F2}) is a strategy combination in which it is better for neither player to deviate from their strategy in any subgame. The strategy combination "active strategy concept"/ "not attack" (S_{O3} / S_{F2}) is the subgame-perfect balance and represents the solution to the game.

6. Conclusion

The game-theoretical analysis of the second game version and the associated variation case allow a conclusion with respect to suitability and applicability of the three developed strategy concepts in practice. The solution concept of the original case leads to the conclusion that a reactive strategy concept provides the best type of defence for the described scenario. In the variation case an active strategy concept seems to be the better option. Which strategy concept is best suited to combat product piracy is hence, strongly dependent on the hypothetical case. Therefore when designing games one needs to bear in mind that facts are depicted as true to detail as possible. Otherwise the game theory may lead to an unreasonable result.

Since O in the original case was a medium-sized engineering company and their business is purely based on one technology, product pirates would pose a major threat. To go for an active strategy concept is, however, quite unattractive for a medium-sized business due to the high costs involved. This is why this scenario will allow frequent pirate attacks which will then be counteracted by companies using reactive measures.

In the variation scenario, O is a large international corporate group. Consumers of poor quality counterfeits often associate the poor quality and other characteristics of the fake product with the original product. In addition to revenue losses, these enterprises suffer therefore severe reputational damage which is very difficult to mend. The game theory concludes an active strategic concept as a solution with the consequence that product pirates lose interest due to the tedious efforts needed. This is reasonable since large organisations on the one hand, have the necessary funds available yet on the other hand, they are more willing to spend them in the light of the impact of product piracy.

Neither in the original case nor in the variation scenario is a passive strategy concept considered an ideal solution. Although a passive strategy concept only involves little investment, it doesn't provide adequate protection in case of an attack. This is why a passive strategy concept seems to be a rather unlikely option for established enterprises.

This assessment may not however, always be referred to as correct. Not least, the game theoretic application has made it clear that company-specific factors like the size of the company, the industry, the type of market, the type of intellectual property to be protected and so on are the crucial factors that determine which strategy concept may be the most suitable option for a business. At the end of the day, which or whether one of the strategy concepts is a suitable solution for a business, needs to be examined by the enterprise itself on a case-by-case basis. Likewise, it depends on the respective circumstances. In any case, the game theory can help understand the underlying competitive situation.

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