MASTER THESIS

Patent Valuation In High-technology Industry Company

Based On A System Dynamic Framework

Master's degree in Management Engineering

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Review

Licenses and assignments of intellectual property rights are common operations in the technology markets, as well as the use of these types of assets as loan security. These uses give rise to the growing importance of financial valuation of intellectual property, since knowing the economic value of patents is a critical factor in order to define their trading conditions. [6]

This paper uses the Taguchi method to analyse a patent valuation method, designed by Oentoro, R. G. (2014) [1], which is based on system dynamics and the AHP method. The Taguchi method allows us to simplify the system dynamics to an only one equation wich simplify the model in 8 initial factors. Based on the equation and in the analysis of three of the most important patent valuation software (IPIntellisource, IPScore, and Toolip Valuation), the main weakness can be known and they will help to improve the patent valuation in the company.


台灣科大

Summary

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1. Introduction

Original design manufacturer (ODM) is the term used to refer companies which design and manufacture products specified and eventually branded by other firms. The ODM business model is mainly used in the fast-moving consumer electronics industry. Eight of the fifty Taiwan´s Top Corporates (Cheng-uei precision industry co. Ltd. ,Compal electronics inc., Hong Hai precision industry co. Ltd., Inventec Corp., Qisda Corp., Quanta computer Inc., Wistron Corp., Wpg Holdings LTD.,) are ODM companies. This type of business is a kind of outsourcing in which the manufacturing company not only manufacture the product but also provide the service to help the other company develop their R&D capability, patch the product line, after-sales service, reduce the investment risk or time regarding their R&D Department while producing the new products.

ODMs are a relentless focus on process and product innovation, which is why they create their own intellectual property and are very proactive in patenting it. At this juncture where the innovation has such importance, the patent valuation is increasing its significance in companies' strategy.

This study took a case study about W, a company with the headquarters in Taiwan which operates in Asia, Europe, and North America. Their clients are primarily international, branded computer related companies. W Corporation which is already one of the biggest ODM company in Taiwan was established on 30 May 2001 and handles the services for Notebook PCs, Desktop systems, Server and Storage system, IA (Information Appliances), handheld devices, Networking and Communication products, also listed in Taiwan Stock Exchange since 2003.

Wang and Lestari (2013) [2] identify the competency needed to be successful in high-tech

industry emerging market. The high-tech company must have the new product development which will determine through their R&D capability and product process innovation and the second one through a business network which will determine through the company's R&D partnership towards the other company and inter-organization network. This study pursues these two approaches in order to help the high-tech company become more mature in their R&D and gain better technology capability and reach their maximum profit.

Oentoro, R. G. (2014) [1] used the combination of AHP (Analytic Hierarchy Process) and System Dynamics (SD) to calculate the patent value that used in the high-tech Industry, three patents were considered to be applied in a product to determine the most profitable patent.

1.1. Motivation

The importance of the intangible assets in the value of a company has increased during the last years, for that reason determine its value is one of the problems that the companies have to solve in them everyday operations. Patents are one of the main intangible assets and their importance is highly in technology companies. Make an approach to the market technics and known how a real company focuses this problem to show the differences with the theoretical methods and the markets software will be very beneficial to me and will help the company improve the approach to this problem.

1.2. Objectives of the project

This study using the Taguchi method combined with the system dynamic and the AHP, developed by Oentoro, R. G. (2014) [1], wants to know the effectiveness of the model

developed based on the factors that the company can control and determine their real weight in the model. Comparing the model with the most sophisticated software in the market, the most important lacks of the model would be determined, this paper wants to show the way to solve them in order to improve the model.

2. Literature review

In valuating patent, the fundamental issue is how much the returns from all the modes of exploitation of the patent are greater than the returns without the patent. To solve this problem there are some different methods, which Pitkethly, R. (1997) [3] summarized in increasing order of sophistication as:

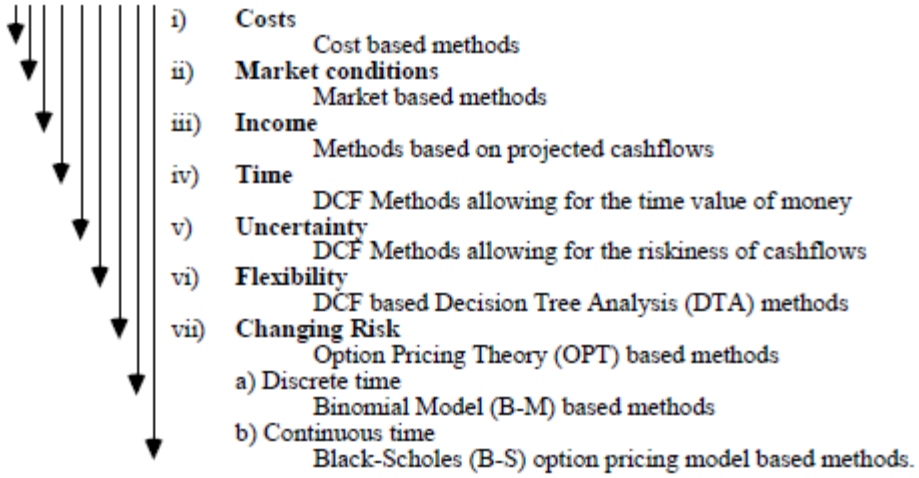

Figure 1. Patent valuation methods. Pitkethly, R. (1997)

Cost based methods

This method assumes that there is a direct relation between the development cost of the intellectual property and it's the economic value. To calculate this cost, there are two techniques:

- Replacement cost method: Estimations are performed on the basis of the costs that would be spent to obtain an equivalent patent asset with similar use or function.

- Reproduction cost method: Estimations are calculated based on the costs of purchase or develop a replica of the patent undervaluation.

This method is based on the economic principle of substitution. The patent will be as good as it cost to develop or buy another similar. But, is not easy to apply this method when the patent is unique.

Cost based methods ignore the future benefits that an asset could give to their inventor for its commercialization or its license.

This method not only takes into account the directly cost, like materials and salaries, it also evaluates the opportunity cost, such as the cost of delay the development of the patent or the profits lost relating to the investment opportunities lost. This cost is taken on the date of the valuation and not in the date that they were expended, the depreciation of the money is not reflected in the model.

Market-based Methods

This method is based on the prize paid for similar patents in the traded between different parties in an active market. It also takes in account royalty rates.

The only case where the market-based methods will be useful is when there are similar patents involved in very recently commercial transactions in similar markets.

Income based Methods

Improvements on cost-based methods of valuation include at least some forecast of future income from a patent and thus some appreciation of the value of the patent as opposed to just its estimated market price or its cost. This will inevitably also involve some element of forecasting the future cash flows. However, it is only with the addition of trying to account for

the elements of time and uncertainty in future cash flows as is the case with conventional discounted cash flow (DCF) methods that one begins to get valuation methods which have some sound theoretical foundations. There are no doubt some who propose methods using projections of future cash flows to value patents without taking account of time or risk but such methods can be ignored. The key issue in these methods is how the forecast cash flow is arrived at.

The Income Approach estimates future income from an intangible asset, minus the asset's current value, to determine a present value.

The asset's owner must predict three things to determine an asset's value:

- Future income stream.
- Number of years the income stream will continue.
- Risk(s) associated with the income stream, such as obsolescence or market/industry risks.

A discount rate is applied to the present value to account for the risks involved in future revenue earned from the asset.

Discounted Cash Flow based methods

This method help to avoid the problem that generates the change in the value of the money during the time and the riskiness of the forecast cash flows.

Both problems can be solved using risk-adjusted discount rate which contemplates both problems or separates the two issues of risk and time and can help avoid problems when the risk adjustment varies over time as it will with patents.

Decision Tree Analysis based methods

Decision tree analysis is not only a DCF method. They also allow evaluating the flexibility on the life cycle of the patents. Patents sometimes have different stages where they lapse or be abandoned, Decision tree analyses use rates to include the risk involved in this stage and following each type of decision whilst in practice a constant rate is usually used.

Option pricing theory

That theory is based on financial options and financial options market, an option is defined as a right to purchase or sell an underlying asset but not an obligation, where the price of the asset is subject to some form of random variation.

Discrete time

This method is based on the binomial model. It claims to solve to solve the problem of changing discount rates which conventional DCF / DTA methods cannot solve easily. It uses the basic assumption that the returns to a call option on a share are equivalent to those of a portfolio or 'synthetic option' consisting of borrowing some money and buying some of the underlying shares. If one assumes that there are no arbitrage opportunities the price of the option on an underlying share will be given by the price of this synthetic option. This allows the construction of equivalent risk neutral decision tree probabilities so that the expected payouts can be discounted at the risk-free rate. This avoids the need to set an appropriate risk-adjusted discount rate for each branch in the tree.

Continuous time

In this category there are two difference methods, but both are based on the black Scholes theory: "For the case of continuous time though, if one assumes that there are no arbitrage opportunities the price C of a European Call Option on an underlying share is"

$$C = SN\left(\frac{(\ln(S/E)+(r+\frac{1}{2}\sigma^2)t)}{\sigma\sqrt{t}}\right) - Ee^{-rt}N\left(\frac{(\ln(S/E)+(r+\frac{1}{2}\sigma^2)t)}{\sigma\sqrt{t}} - \sigma\sqrt{t}\right)$$

Figure 2. Black-Scholes equation

The equation that Black and Scholes provided was based on several key assumptions:

- Interest rates are constant over time.
- Share prices follow a random walk where the distribution of prices at the end of a given time period is log normal with the variance assumed constant over time.
- Only European options are considered.
- Markets are friction free with no transaction costs, no margin requirements or other penalties for short sales and borrowing or buying any fraction of a share is possible.
- Dividend payments on the underlying share are excluded.

The input requirements to evaluate an asset are:

- S the current price of the underlying asset
- E the exercise price of the option
- t the time to expiry
- σ the standard deviation of the underlying asset returns
- r the risk-free interest rate.

Furthermore, the value of an option can be seen to increase:

- The higher the underlying asset value
- The longer the time to expiry
- The lower the exercise price

- The higher the variance of the underlying asset returns
- The higher the risk-free interest rate.

Black-Scholes method is developed for financial options, but conventional methods cannot cope very well with managerial flexibility, for evaluate non-financial, also called Real options. There is an equivalence between the inputs required to value financial options and those involved in valuing real options:

Table 1. Financial Options vs Real Options

Symbol	Financial option on share	Real option
S	Current price of the underlying share	Present value of project cash flows
E	Exercise price of the option	Investment cost of project
T	Time to expiry	Time left to invest in
σ	Standard deviation of underlying returns	Standard deviation of the project value
r	Risk-free interest rate	Risk-free interest rate

How valuable growth options are according to Kester depends on:

- The time projects can be deferred.
- The project risk.
- The level of interest rates.
- The exclusivity of the project.

3. Model development

3.1. Model description

“System dynamics is a computer-aided approach to policy analysis and design. It applies to dynamic problems arising in complex social, managerial, economic, or ecological systems — literally any dynamic systems characterized by interdependence, mutual interaction, information feedback, and circular causality.” [7]. Oentoro, R. G. (2014) [1] develop a model with five sub-models, which are:

Demand Order

Demand order sub-model is one of the most relevant, affecting and having effect in production, sales, profit, development and R&D. The initial demand is generated based on market size for the W company that was obtained in the market combined with the percentage of the commercial level, the advantage, and the potential market share that W company could get in the market. The demand will change every period according to the demand growth, but the capacity expansion will limit the capacity of produce all the demand.

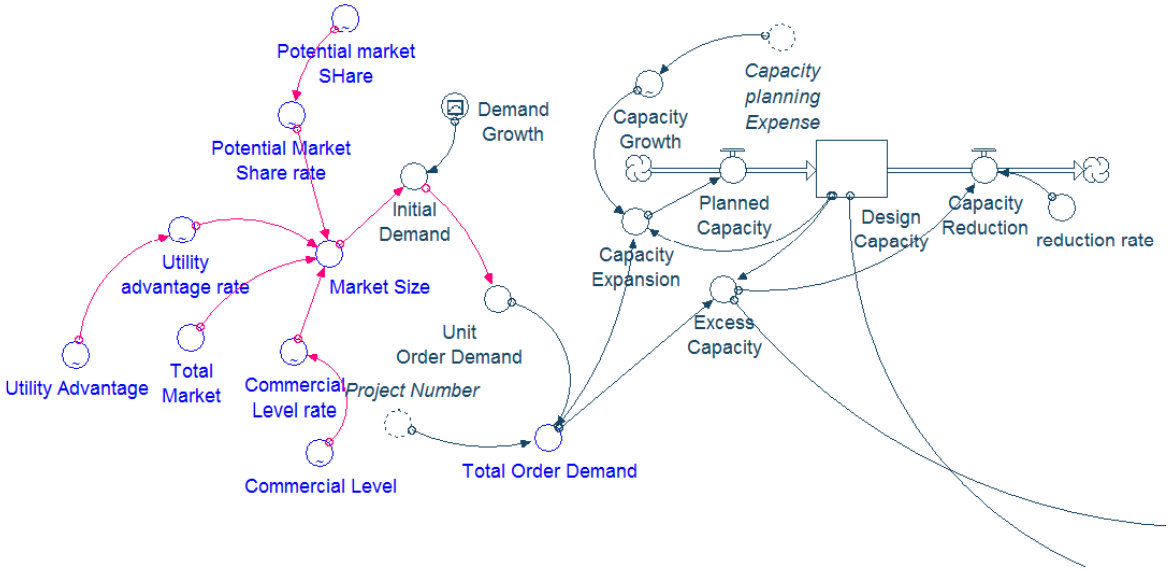

Figure 3. Demand Order Sub-Model

Project Management

Project development consists of 7 different steps, denoted as C0-C6. C0 is proposal phase, C1 represent the planning phase, C2 is R&D design, C3 & C4 LAB pilot, and ENG pilot run phase, C5 represent Production phase, and the last one C6 is mass production. The proposed model to represent this process is the next:

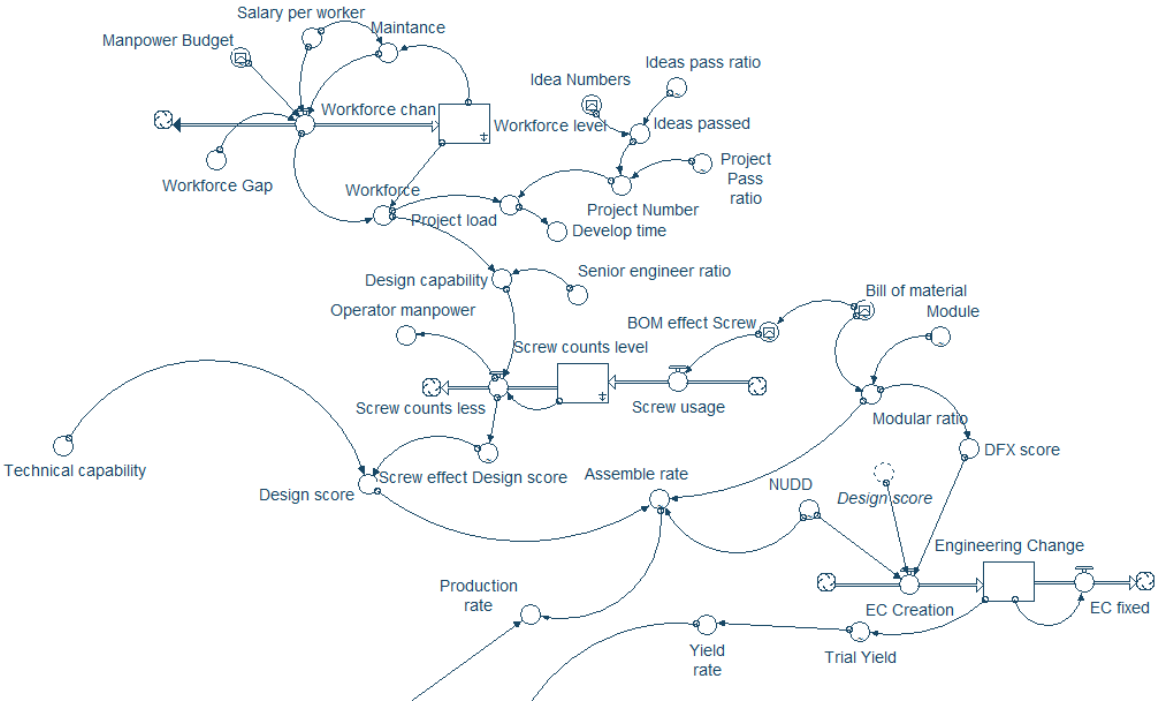

Figure 4. Project management Sub-Model

Production Control

In ODM's companies, the production is the same as the sales, it means that all the production will be sell. It is because the production is based on the request of the clients. The production control sub-model use the demand obtained from the demand order sub-model and the trial production as well as the capacity expansion to obtain the yield products.

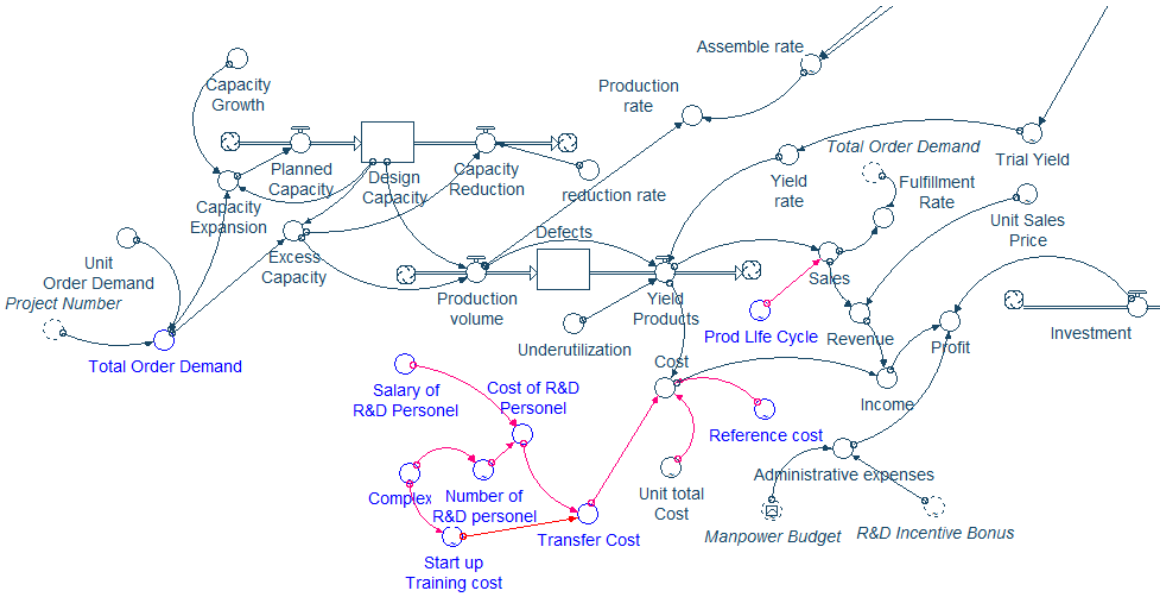

Figure 5.Production Control Sub-model

Research and Development

It can be say that Research and development are the core component of the patent valuation system because it is focused on the technical development. There are two options to make the technical development, one is that the company develop it by their own R&D and the other is acquiring the patents from outside. Technical development expense is derived from the percentage of investment, and divided into R&D expense and Royalty. The delay was set to 3 periods, it means that when the money was put in the new patent will be renewed or acquire after this time period.

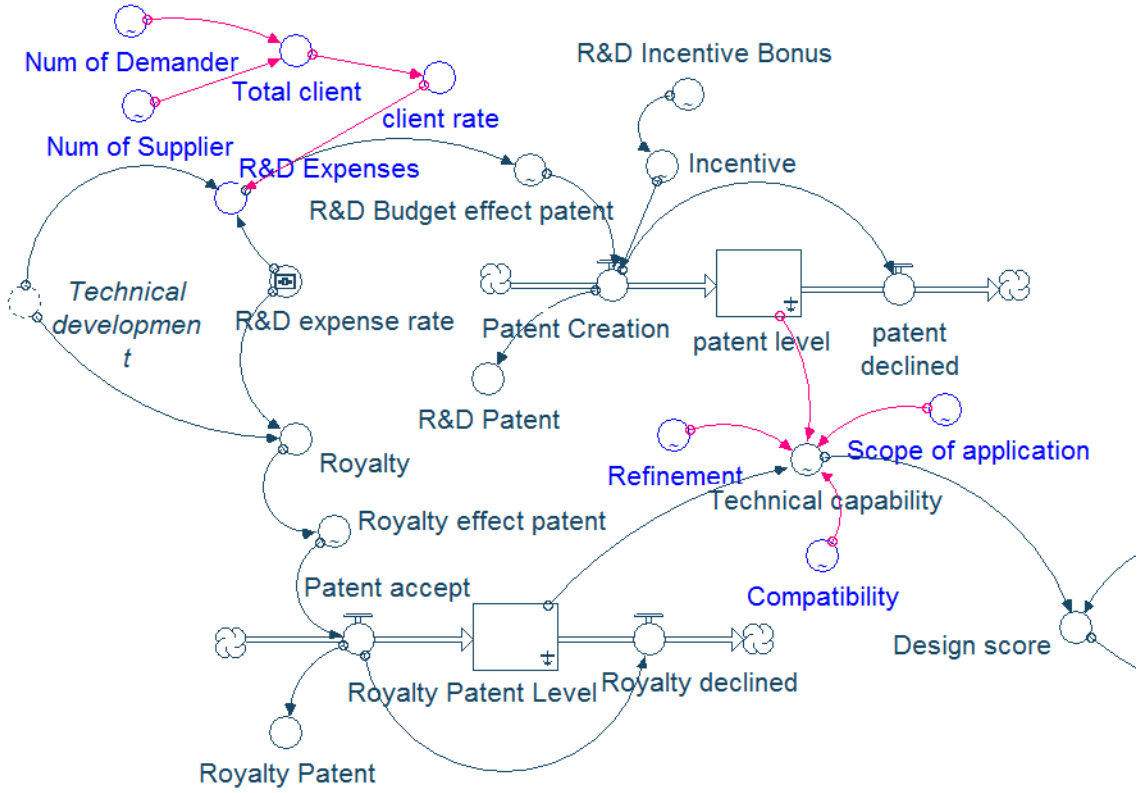

Figure 6.Research and Development Sub- Model

Financial Planning Department

This sub-model analyse the viability of the company. The products sales are the revenue of the company and the administrative cost and the production cost will determine the expenses of the company. Deducting the expenses from the revenues, the company profit will be obtained. In addition, the investment that will be made by the company also was taken from the profit that is obtained by the company each period. And then it also controlled by the expense rate based on the company policy. Below is the process flow diagram that was used by the company to run their business.

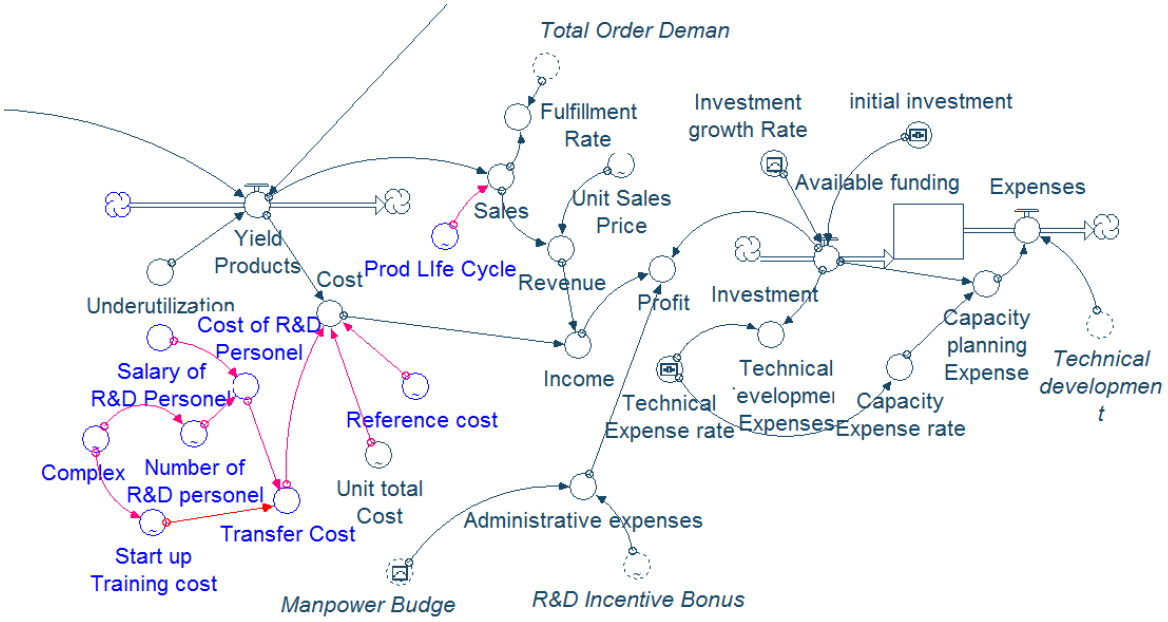

Figure 7. Financial Planning Sub-model

3.2. Model analysis

Oentoro, R. G. (2014) [1] model is based on the value of 14 factors evaluated during the patent life each 3 months. Those factors are:

- Refinement: Evaluates the completeness of technology, it affects to the research and development sub-model
- Application Scope: Evaluates the scope of technology, it affects to the research and development sub-model.
- Compatibility: Evaluates the degree to which it advances existing technology. It affects to the research and development sub-model.
- Complexity: Evaluates the level of difficulty of the patent, it affects to Production control sub-model.

- Reference Cost: Is the cost of research and development process, it affects to the financial planning sub-model.

- Product Lifecycle: Evaluates the maturity level of technology in the market, it affects to the production control sub-model.

- Potential Market Share: Evaluates the potential level of gaining the market, it affects to the demand order sub-model.

- Utility/advantage: Evaluates the possibility to create a new market, it affects to the demand order sub-model.

- Number of Supplier: Is the number of technology suppliers, it affects to the research and development sub-model

- Number of Demander: Is the number of technology demanders, it affects to the research and development sub-model.

- Commercial Level: Evaluates the degree of which a technology can reach commercial success, it affects to the demand order sub-model.

- R&D Cost: The cost of research and development process, it affects to the financial planning sub-model.

- Transfer Cost: The cost of changes in technology, it affects to the financial planning sub-model.

- Market Size: The value of the total market of the firm, it affects to the demand order

sub-model.

After analysing how the model works, the relationship between the factors can be resume in the next table:

Table 2. Factors Relationship

Factors	Determined by				Related with	
	1st level	2nd level	3th level	4th level	Controllable Factors	Noise factors
R&D cost	Reference Cost				Reference Cost	Yield rate
	Unit Total Cost				Unit Total Cost	Production time
	Transfer Cost	Start Up training Cost	Complexity		Complexity	
		Cost of R&D personel	Salary of R&D personnel		Salary of R&D personnel	
			Number of R&D personnel	Complexity	Underutilization	
	Yield Products	Underutilization				
		Yield Rate				
		Production Time				
Transfer Cost	Start Up training Cost	Complexity			Complexity	
	Cost of R&D personel	Salary of R&D personnel			Salary of R&D personnel	
		Number of R&D personnel	Complexity			
Market Size	Potential Market Share Rate	Potential Market Share			Potential Market Share	Total Market
	Utility Advantage Rate	Utility Advantage			Utility/Advantage	
	Total Market				Commercial Level	
	Commercial Level Rate	Commercial Level				

In the left column are represented the non-initial factors used to determine the patent value, on the right side of them are the factors of the model which determine the value of the factor. There are up to 4 degrees of dependency, it means that the initial factor which determines the patent value factor, has other operations and relationships until arrive at the patent value factor.

The controllable factors, represented on the right side, are the initial and controllable factors of the model which affects to the non-controllable factors and the patents value. Some of them are the patent value factors, but other does not appear directly on the valuation model, but they affect to some patent value factors.

Noise factors are the non-controllable values which affect to the patent valuation factors. One of them, total market, is an initial value, but the company can do nothing to modify it. The other two, Yield rate and Production time, are not initial factors and probably they can be controllable by the company, but they depend on of too many factors and their relevance in the patent valuation are assumed not relevant to the initial analyse.

The factors on the left side and some in the first, second and third level are the patent valuation factors which have a dependency of other factors and the intermediate factors which depend on and can be controllable by other initial or non-controllable factors.

The R&D cost can be defined by the reference cost, the unit total cost, the complexity, the salary of R&D personnel, the underutilization, and the noise factors yield rate and production time. It means that modifying those factors we can improve the R&D cost. There is another important thing in that relationship, it is noted that the complexity appears in two difference rows, thus means that for the patent valuation, the complexity (a patent valuation factor) is really more important than the obtained in the AHP method.

Transfer cost depends on the complexity and the salary of R&D personnel, but it also affects to the R&D cost.

Market size depends on 3 patent valuation factors (commercial level, potential market size and utility advantage) and the noise factor Total Market. In this case, it is seen also that the relevance of the commercial level, the potential market size and the utility/advantage in the patent valuation will be bigger than the indicated in the AHP by the experts.

Based on this analysis, we can resume the patent valuation factors in 4 groups:

- Independents: Application Scope, Refinement, Compatibility, Product life cycle, Number of supplier and number of demander.

- Determined by other factors: Market size, R&D cost.

- Affect other factors: Reference Cost, Complexity, Salary of R&D personnel, utility/advantage, Potential market share, commercial level.

- Affect and determine other factors: Transfer cost.

The other conclusion which is extracted from the table is that we can determine the patent value in one period if we know the initial factors: Reference cost, Unit total cost, complexity, Salary of R&D personnel, underutilization, Potential Market share, Utility/advantage, Commercial level, application scope, refinement, compatibility, product life cycle, number of supplier and number of demander. This 14 initial factors which are represented in the next table:

Table 3. Initial Factors

Initial Factors	
Independent	**Related With Others**
Application Scope	Salary of R&D personnel
Refinement	Underutilization
Compatibility	Unit Total Cost
Product Life Cycle	Reference Cost
Number of Supplier	Complexity
Number of Demander	Potential Market Share
	Utility/Advantage
	Comercial Level

3.3. Patent Valuation Model

In Oentoro, R. G. (2014) [1] the patent valuation is based on the maximum and minimum value of the patent valuation factors and the comparison between the value in the i period of the

factor and those factors. The problem is that there are not any standardised values and each patent has its own maximum and minimum values defined for the data obtained after the simulation. The other problem observed in the patent valuation is that the formula used to get the value of each factor does not the difference between the factors for which high value is good are the factors for which a low value is good.

Before to apply the simulation to know the importance of the initials factors in the patent valuation, it is necessary to define a standardized method to determine the patent value using the AHP and the patent valuation factors.

The first step will be determined the minimum and the maximum value and if the factor represents something which high values improve the patent value or something which low values improves the patent value. Based on the historical data these values are determined in the next table:

Table 4. Factor Values

Factor	High Level	Low Level	High/Low Values
Refinement	12	5	High Values
Application Scope	12	5	High Values
Compatibility	12	5	High Values
Complexity	10	4	Low Values
Reference Cost	225000	175000	Low Values
Product Life cycle	1,02	0,98	High Values
Potential Market Share	5	1	High Values
Utility/advantage	5	1	High Values
Num of Supplier	15	7	High Values
Num of Demander	12	5	High Values
Commercial Level	5	1	High Values
R&D Cost	40.000.000.000 NTD	750.000.000 NTD	Low Values
Transfer Cost	900.000 NTD	200.000 NTD	Low Values
Market Size	2.000.000	100.000	High Values

The patent value will be defined as the sum of the patent value in all the periods on it is supposed to be working. For each period, it will be defined the patent index which is the sum of the multiplication of the factor punctuation in that period by the AHP index.

To calculate the factor's punctuation are defined two equations differentiating the factors which high values improve the patent value and the factors which low values improves the patent value. The equations are:

- Low values: $PP = \frac{max\text{-}Value}{max\text{-}min}$ (Eq.1)

- High Values: $PP = \frac{\text{Value-min}}{\text{max-min}}$ (Eq.2)

Where the PP is the factor punctuation of one patent value factor in one period, the max and the min are the values defined in Table 4. Factor Values and the value is the value obtained for one patent valuation factor in one period in the simulation. To obtain the patent index in one

period is defined the next equation:

- $Patent\ Index(Y_j) = \sum_{i=1}^{13} PP_i \times AHP_i$ (Eq.3)

Where the PP is the factor punctuation of each factor obtained for that period, and the AHP is the experts valuation for each patent defined in the next table:

Table 5. Factor's AHP

Factors	AHP	Factors	AHP
Refinement	0,024	**Utility/advantage**	0,08
Application Scope	0,1	**Number of Supplier**	0,066
Compatibility	0,113	**Number of Demander**	0,117
Complexity	0,008	**Commercial Level**	0,153
Reference Cost	0,013	**R&D Cost**	0,034
Product Life cycle	0,028	**Transfer Cost**	0,013
Potential Market Share	0,066	**Market Size**	0,185

Finally to obtain the patent value for j periods, it will be applied this equation:

- $Patent\ Value = \sum_{j=1}^{j} Y_j$ (Eq. 4)

3.4. Experiment Design by Taguchi Method

The purpose of this experiment is to obtain an equation which can calculate the patent value only based on the initial factors and without the use of the system dynamic. For the experiment

are defined 14 initial factors, 3 non-controllable factors, 3 interactions and the error. Only the interactions between the factors which affect to the market size have been analysed because looking into the Stella model it is noticed that the interaction between the factors which affect the transfer cost and the R&D cost are not relevant.

All the factors are defined as two level factors:

Table 6. Simulation Input

Factor	Level 1	Level 2	Controlable
Reference Cost	190000	220000	Controlable
Unit Total Cost	6150	13700	Controlable
Complexity	4	8	Controlable
Salary of R&D personel	175000	215000	Controlable
Underutilization	0,025	0,05	Controlable
Prod Life Cycle	0,99	1,01	Controlable
Utility Advantage	2	5	Controlable
Application Scope	7	12	Controlable
Refinement	6	11	Controlable
Compatibility	7	11	Controlable
Number of Supplier	9	13	Controlable
Number of Demander	6	11	Controlable
Potential Market share	1	4	Controlable
Comercial level	1	4	Controlable
Total Market	18000000	22000000	No Controlable
Yield Rate	0,99	1,01	No Controlable
Production Volume	2500000	6500000	No Controlable
Utility Advantage*Potential market share			Interaction
Utility advantage*Comercial level			Interaction
Potential Market share*Commercial level			Interaction
Error			Error

To analyse the experiment is used a Taguchi L32. The table is represented in Appendix 1. To make able the noise factors to the simulation there have been made some modifications in the Production Control Sub-model.

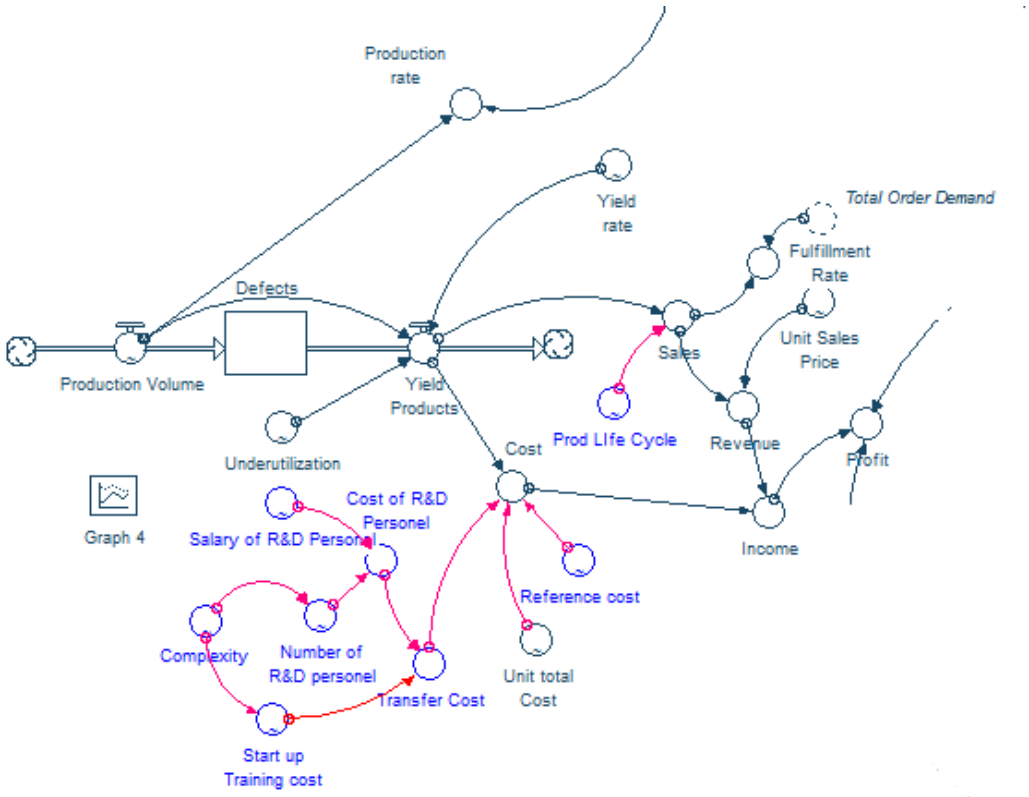

Figure 8. New Process Flow Diagram of Production Control Sub-Model

Comparing “Figure 8. New Process Flow Diagram of Production Control Sub-Model” with “Figure 5.Production Control Sub-model” the main differences are in the production volume and in the yale rate. Those factors are now defined as initial factors, this is the reason that now there are not any input for this factors, thus allow to modify those factors according to the levels of the experiment.

Stella software allows us, with the function check units, to check that the changes made in the model are correctly done and does not affect the consistency of the model. At the run toolbar, we click the “check units” option. Knowing that the changes made in the model so not affect to the models consistency, we can continue the simulation.

Using the import data function in Estella the 128 dates of the initial factors are input in the Stella model. The initial factors are defined as a graphical function, so 128 different simulations as different periods are done. The 1 scenario will be the first period and the last period will be the 128 scenarios. The input data are resume in Appendix 2.

After the simulation, the value of the patent valuation factors are obtained for each scenario (Appendix 3.), with this data is calculated the patent value for each period (Appendix 4.)

Once the data has been acquired, the analysis starts using Minitab. Stat > DOE > Taguchi > Analyze Taguchi Design. The options selected for the analysis are:

- Graphs
    - Signal to noise ratios: Check to display main effects and interactions plots for the signal to noise ratios.
    - Means: Check to display main effects and interaction plots for means.
    - Display interaction plot matrix: Check to display all the plots for the selected interactions in a matrix on a single page.
- Analysis
    - Display tables for:
        - Signal to noise ratios: Check to display response tables for the signal to noise ratios.
        - Means: Check to display response tables for means.
    - Fit linear model for:
        - Signal to noise ratios: Check to display linear model results for signal to noise ratios.
        - Means: Check to display linear model results for means.
- Analysis Graphs:
    - Standardized: Check to use standardized residuals in residual plots.

- Residual plots:
  - Normal plots: Check to display a normal probability plot of the residuals.

- Options
  - Nominal is best: the goal is to target the response and you base the S/N ratio on standard deviations.
  - Use adjusted formula for nominal is best: Check to use the adjusted formula for the nominal is best S/N ratio

- Storage
  - Signal to noise ratio: Store signal to noise ratios in the worksheet.
  - Means: Store means in the worksheet.

The most relevant results of the analysis are showed in “Table 7. Estimated Model Coefficient for Means. Model with interaction analysis”

Table 7. Estimated Model Coefficient for Means. Model with interaction analysis

Term	Coefficient	SE Coef	T	P
Constant	0,446099	0	*	*
Utility Advantage	-0,04424	0	*	*
Potential Market share	-0,058926	0	*	*
Commercial Level	-0,071615	0	*	*
Reference Cost	0,003901	0	*	*
Unit Total Cost	0,011047	0	*	*
Complexity	0,005603	0	*	*
Salary of R&D personel	0,000932	0	*	*
Underutilization	-0,000378	0	*	*
Prod Life Cycle	-0,007	0	*	*
Application Scope	-0,035714	0	*	*
Refinement	-0,008571	0	*	*
Compatibility	-0,032286	0	*	*
Number of Supplier	-0,0165	0	*	*
Number of Demander	-0,041786	0	*	*
Utility Advantage*Potential market share	0,008501	0	*	*
Utility advantage*Comercial level	0	0	*	*
Potential Market share*Commercial level	0,008544	0	*	*
Error	0	0	*	*
S=0	R-sq = 100%		R-sq (adj) = 100%	
Note*: Could not graph the specified residual type because MSE = 0 or the degrees of freedom for error = 0.				

According to that note, the program check for the significance of a 3 way interaction, so the model have no degrees of freedom left for an error term which means all of P values will = *. The conclusion of that is that the interaction supposed are not relevant, so the next step will reply the simulation without the interactions. After repeating the experiment without the interaction, the most interesting results are the next:

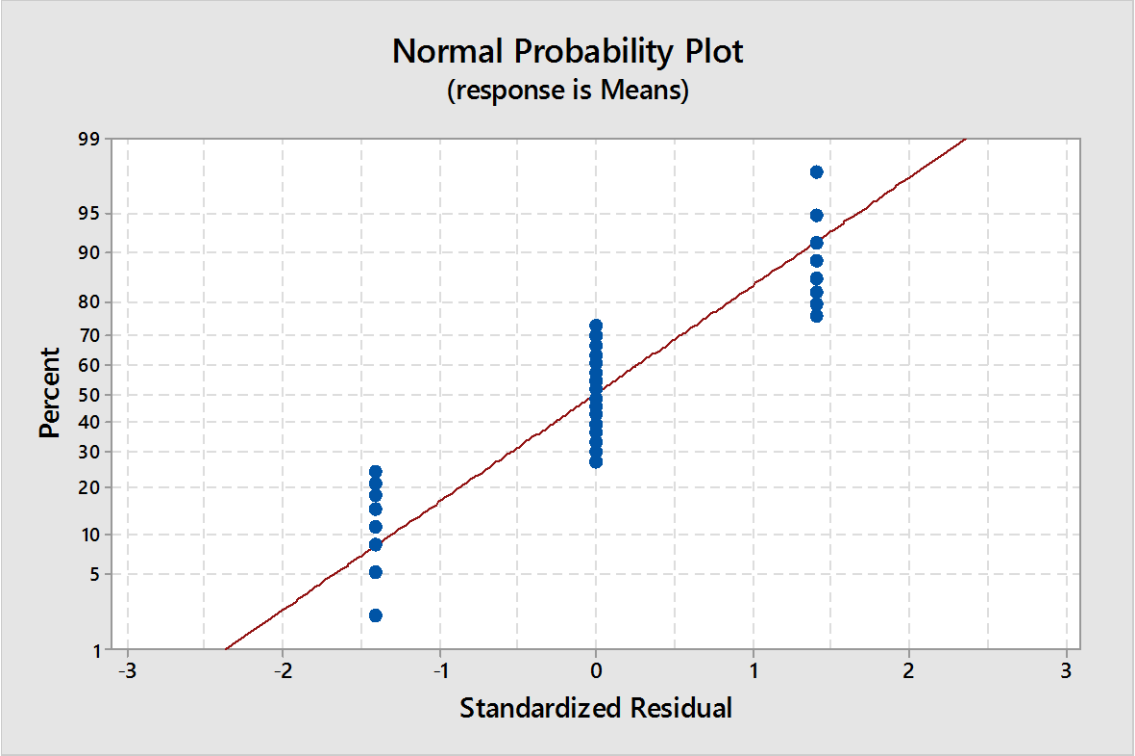

Figure 9. Normal Probability Plot

The residuals appear to deviate from the straight line. Even though the residuals are non-normally distributed. So the model does not be correct.

Table 8. Estimated Model Coefficients for means. Without interactions

Term	Coefficient	SE Coef	T	P
Constant	0,446099	0,002923	152,605	0
Utility Advantage	-0,04424	0,002923	-15,134	0
Potential Market share	-0,058926	0,002923	-20,158	0
Commercial Level	-0,071615	0,002923	-24,499	0
Reference Cost	0,003901	0,002923	1,335	0,2
Unit Total Cost	0,011047	0,002923	3,779	0,001
Complexity	0,005603	0,002923	1,917	0,072
Salary of R&D personel	0,000932	0,002923	0,319	0,754
Underutilization	-0,000378	0,002923	-0,129	0,899
Prod Life Cycle	-0,007	0,002923	-2,395	0,028
Application Scope	-0,035714	0,002923	-12,217	0
Refinement	-0,008571	0,002923	-2,932	0,009
Compatibility	-0,032286	0,002923	-11,045	0
Number of Supplier	-0,0165	0,002923	-5,644	0
Number of Demander	-0,041786	0,002923	-14,294	0
S=0,01654	R-sq = 99,1%		R-sq (adj) = 98,3%	

In “Table 8. Estimated Model Coefficients for means. Without interactions”, based on the p-values it is showed that there are 5 factors which do not affect too much to the model (p>0,05), Reference cost, salary of R&D personnel, complexity, and underutilization. For that reason, they will be eliminated for the next analyse.

Following this process, we achieve an analyse only with 8 factors: Application Scope, Compatibility, Number of supplier, number of demander, utility/advantage, commercial level, unit total cost and Potential market share. The main results of the analysis of this simulation are:

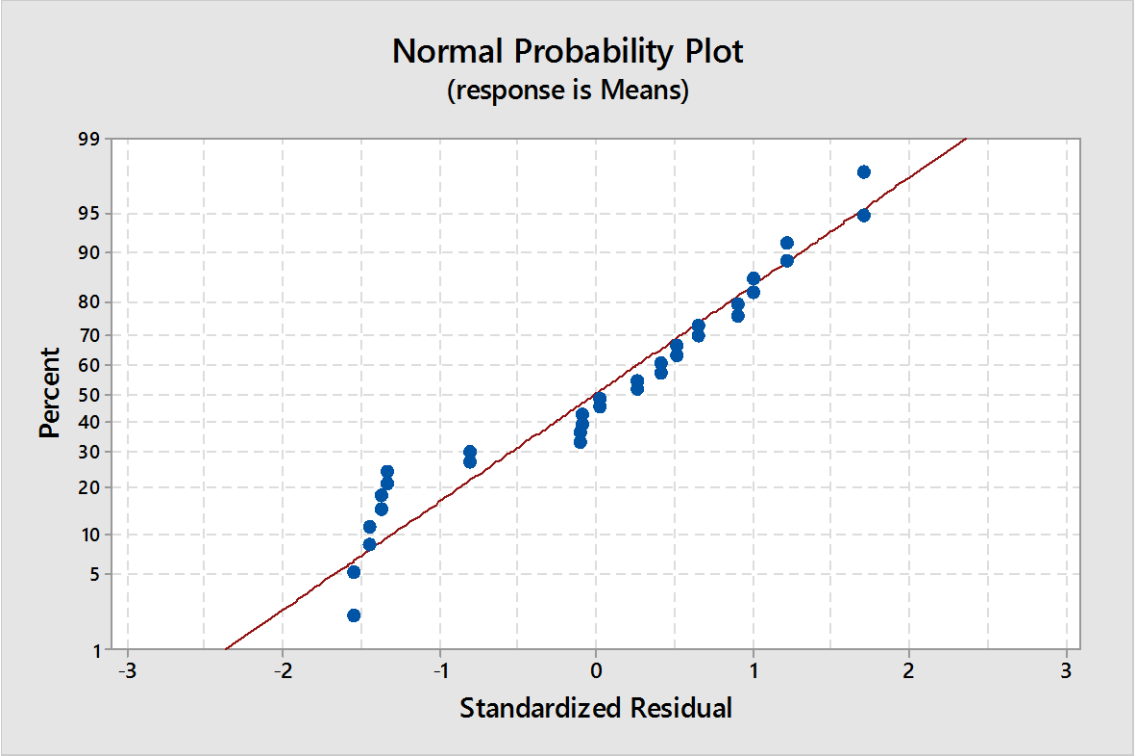

Figure 10. Normal Probability Plot 8 Factors

In “Figure 10. Normal Probability Plot 8 Factors” the residuals are normally distributed. The normal probability plot of the residuals approximately follows a straight line.

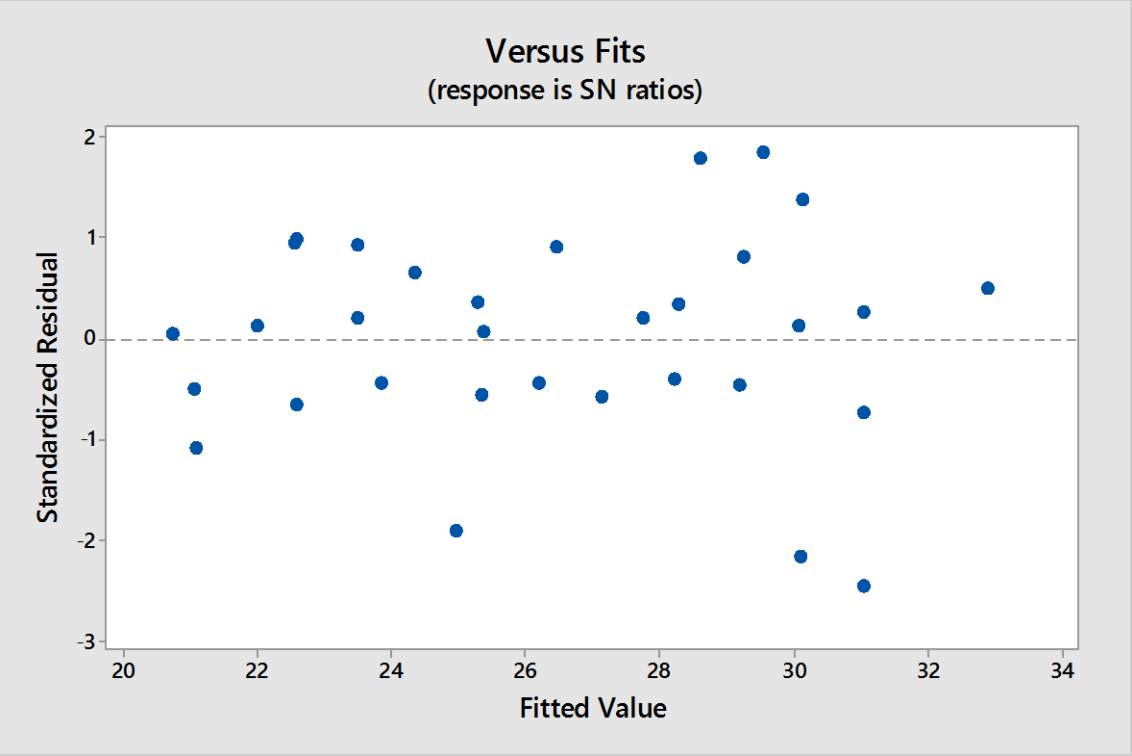

Figure 11. Residual versus Fits

There aren't any patterns in "Figure 11. Residual versus Fits", residual is randomness distributed. It indicates that the model residuals are ok.

Table 9. Estimated Model Coefficients for means.Final analysis

Term	Coefficient	SE Coef	T	P
Constant	0,4461	0,003703	120,473	0
Utility Advantage	-0,04424	0,003703	-11,947	0
Potential Market share	-0,05893	0,003703	-15,913	0
Commercial Level	-0,07162	0,003703	-19,34	0
Unit Total Cost	0,01105	0,003703	2,983	0,007
Application Scope	-0,03571	0,003703	-9,645	0
Compatibility	-0,03229	0,003703	-8,719	0
Number of Supplier	-0,0165	0,003703	-4,456	0
Number of Demander	-0,04179	0,003703	-11,285	0
S=0,02095	R-sq = 97,9%		R-sq (adj) = 97,2%	

In "Table 9. Estimated Model Coefficients for means.Final analysis", R-Sq is also known as the coefficient of determination or multiple determination, is a statistical measure of how close

the data are to the fitted regression line. It is also known as the coefficient of determination, or the coefficient of multiple determination for multiple regression.

The definition of R-squared is fairly straightforward; it is the percentage of the response variable variation that is explained by a linear model. Or: R-squared = Explained variation / Total variation.

R-squared is always between 0 and 100%:

- 0% indicates that the model explains none of the variability of the response data around its mean.
- 100% indicates that the model explains all the variability of the response data around its mean.

In general, the higher the R-squared, the better the model fits. For this model, R-Sq is up the 95% so the model can be considered correct.

R-square adjusted is the percentage of response variable variation that is explained by its relationship with one or more predictor variables, adjusted for the number of predictors in the model. This adjustment is important because the R-squared for any model will always increase when a new term is added. A model with more terms can seem to have a better fit because it has more terms.

R-squared-adjusted determines how well the model fits your data when you want to adjust for the number of predictors in the model. The adjusted R-squared value incorporates the number of predictors in the model to help you choose the correct model.

In that case, comparing the results obtained in the first analysis in which all the factors was

introduced with the last one, in which only 8 factors was introduced. The difference between their R-Squared adjusted is 1.1%. For this case in which the factors are not given, and they are based on predictions, the loss of the 1.1% can be assumed in order to improve the correctness of the data introduced in the model.

In Table 9 is showed, that the 8 factors are all significant with a p-value under 0.05, it means that we cannot delete any other factor.

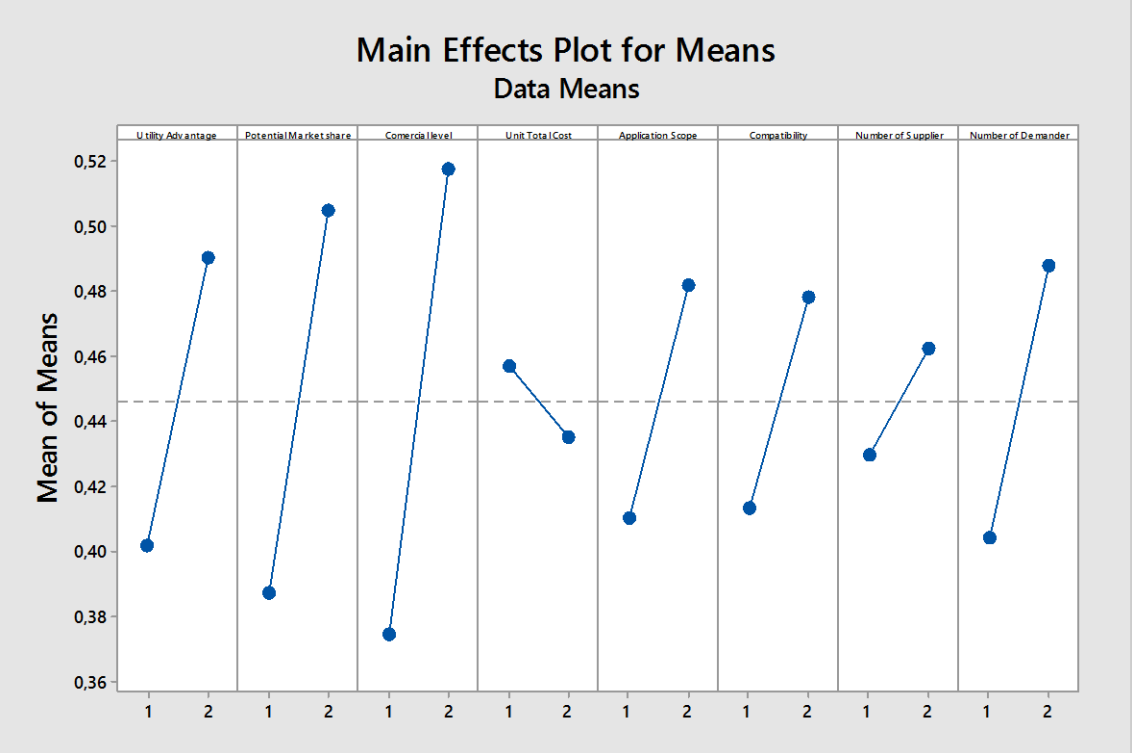

Figure 12. Main effects Plots for Means

Figure 12 show the main effects of the factors, as much high is the slope of the factor much important will be in the model.

Using the values of the coefficients showed in Table 9 is purposed the equation to define the patent punctuation as:

$$PP = 0{,}44610 + 0.04424 * \frac{Utility}{Advantage} + 0{,}05893 * Potential\ Market\ share + 0{,}07162 * Comercial\ Level - 0{,}01105 * Unit\ Total\ Cost + 0{,}03571 * ApplicationScope + 0{,}03229 * Compability + 0{,}0165 * Number\ of\ Supplier + 0{,}04179 * Number\ of\ Demander$$

(Eq. 5)

3.5. Equation Analysis

According to the equation obtained in the previous section, the patent value for each period can be obtained with 8 initial factors which are independent of the dynamic system model. Based on the statistical analysis it can be said that the result of the analysis will be the same as the obtained using the dynamic system model, in this section will be analysed conceptually the relationship and the means of this analyse, and also check that the values obtained for both methods are the same.

The resume of both valuation system (Dynamic analyse and equation), are showed those tables:

Table 10. Dynamic System Factors Value

Factors	AHP	%	Factors	AHP	%
Refinement	0,024	2,40%	**Utility/advantage**	0,08	8,00%
Application Scope	0,1	10,00%	**Number of Supplier**	0,066	6,60%
Compatibility	0,113	11,30%	**Number of Demander**	0,117	11,70%
Complexity	0,008	0,80%	**Commercial Level**	0,153	15,30%
Reference Cost	0,013	1,30%	**R&D Cost**	0,034	3,40%
Product Life cycle	0,028	2,80%	**Transfer Cost**	0,013	1,30%
Potential Market Share	0,066	6,60%	**Market Size**	0,185	18,50%

Table 11. Equation Factors Value

Factor	Affects	Coefficient	Percentage	Factor	Affects	Coefficient	Percentage
Application Scope	Application Scope	0,035	11,26%	**Commercial Level**	Commercial Level, Market Size	0,072	23,04%
Compatibility	Compatibility	0,032	10,30%	**Unit total cost**	R&D Cost	0,011	3,54%
Potential Market Share	Potential Market Share, Market size	0,059	18,98%	**Number of Supplier**	Number of supplier	0,017	5,31%
Utility/advantage	Utility/advantage, Market Size	0,044	14,16%	**Number of Demander**	Number Of Demander	0,042	13,42%

At Table 10 there are all the factors used in the AHP valuation method with their AHP coefficient, based on this coefficient is calculated the percentage that each one represents the patent value. At Table 11 are represent the 8 factors used in the equation, indicating which factors of the AHP method are related to each one, it coefficient at the equation and based on that coefficient is calculated the percentage of the patent value that each one represents, in order to facilitate the analysis.

In a simple view that all the factors that are not relevance, the have been keeping out of the equation, are the ones which have percentages below 3% in the AHP method. Another important observation is that the factors that have a most important variation comparing to the AHP method (Potential Market Share, Utility/advantage, and Commercial level) are the ones which affect to another AHP factor, so it can be said that this increase in them value is because they are representing to AHP factors in the equation. The other increases can be explained based on the decrease in the number of factors.

The principal characteristics of this factors are:

- Application Scope: If a technology has more scope for application, it is more valuable than a technology with a limited scope of application. The experts gave this factor the 10% of the punctuation of the patent value, in the equation, it has the weight of 11.26%. It affects to the technical capability of the patent but it has not any direct connection with other factors. This value is an initial factor estimated by the experts.
- Compatibility: As the application scope it is involved in the determination of technical capability of the patent, it means the degree that the patent can pace up with existing technology. In the AHP method, it has a weight of 11.30% which is reduced to a 10.30% in the equation. This value is also an initial factor estimated by the experts.
- Potential Market Share: Represents the potential level of gaining the market. It weight increase from a 6.60% in the AHP method to an 18.98%. The explanation of this increase is in the value of the market size. The market size was kept out of the equation because it is not an initial value and it can be defined by other factors, and the potential market share is one of them, so the weight of the market size was

shared between the factors which define it. Potential market share is an initial value which is defined by the experts.

- Utility/advantage: Represents the potential level of gaining the market, as the Potential market share, it also affects to the market size. It is why its weight has increased from 8.00% to a 14.16%. Utility/advantage is an initial value which is defined by the experts.
- Commercial Level: Represents the degree of which a technology can reach commercial success. It also affects the market size. It is why its weight has increased from 15.30% to a 23.04%. Commercial Level is an initial value which is defined by the experts.
- Unit Total Cost: Represents the cost of produce 1 unit of the patent. This value does not appear in the AHP method, but it represents the R&D cost. Considering the yield rate as noise, the unit total cost is the main factor in the R&D definition, it is why the weight of the R&D cot in the AHP method is the same as the unit total cost. Unit Total cost is an initial value which is defined by the experts.
- Number of Suppliers: Represents the number of technology suppliers. Its values decrease in the equation in comparison to the AHP, but it is similar. This value is known by the company.
- Number of demander: Is the number of technology demanders, it has increased a 1.72% in the equation comparing to the AHP method. This value is defined by the experts.

To prove the utility of the patent, it is compared the results obtained in Oentoro, R. G. (2014) [1] using the AHP method to the results that the equation gives the analysis of 3 differents patents. The patent factor's data are resumed in Appendix 5.. Applying the equation and the AHP for the 3 patents the results obtained are the next:

Table 12. Equation Results vs AHP

	Equation	AHP
Patent 1	22,97	22,46
Patent 2	25,66	25,38
Patent 3	21,25	12,88

For patent 1 and 2, the values of both methods are very similar and the difference is into the range of 2.8% of error given by the statistical analysis. The main problem is in the results obtained for patent 3, in this case, the error is up the 70%. It error can be explained based on the value of the constant of the equation. Assumed that the constant value is 0.44610 and that the value is calculated considering 40 periods unless the unit total cost will be very high (is not the case of patent 3) the minimum value of a patent will be 17.844. So here is a limitation of the equation, for the patents with a low value, the value obtained with the equation will be different than the value obtained using the system dynamics and the AHP method.

Considering that the aim of the equation is not to obtain an exactly value, it is compared with different alternatives and choose the best. It can be also considered the comparison without the sum of the constant:

Table 13. Equation Values without Constant

Patent	Equation - constant
Patent 1	5,125
Patent 2	7,816
Patent 3	3,402

In both case, equation and AHP, we observe that the best option is always the patent 2, the second one is the patent 1 and the worst option is patent 3. The equation can consider good

for this analyse.

Another important analyse to probe if the equation works like the AHP method using the system dynamics is compare the value obtained for each period of each patent using both methods. The results are resumed in this 3 graphs:

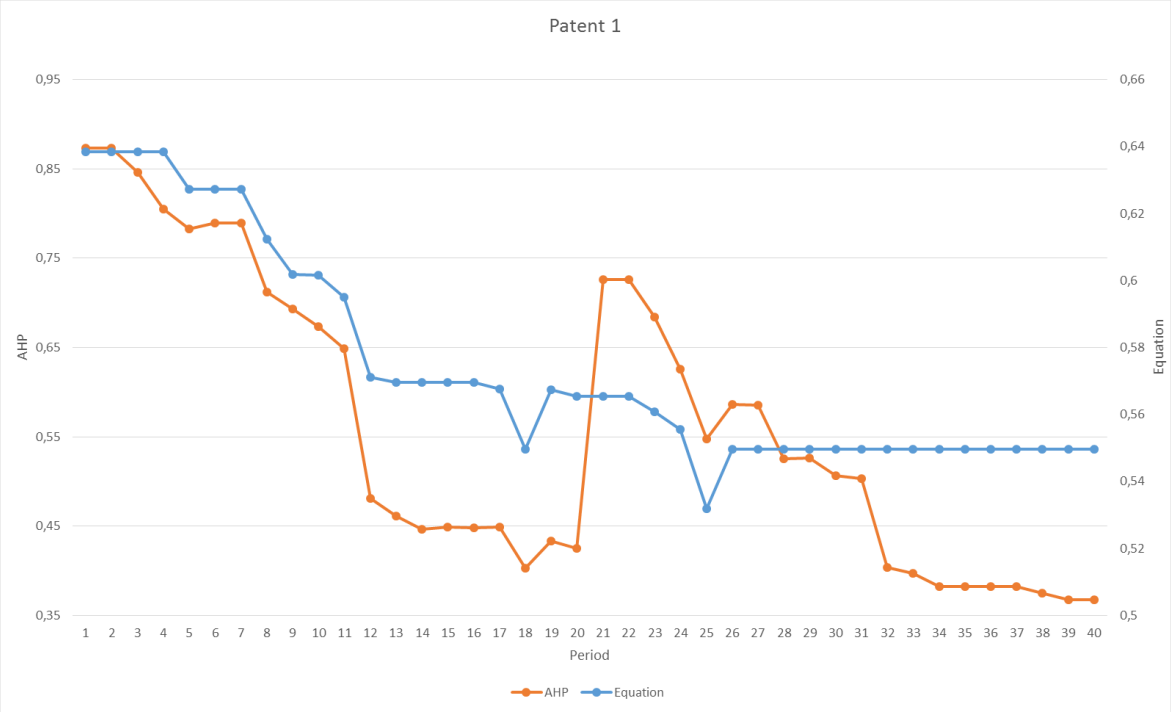

Figure 13. Equation vs AHP Patent 1

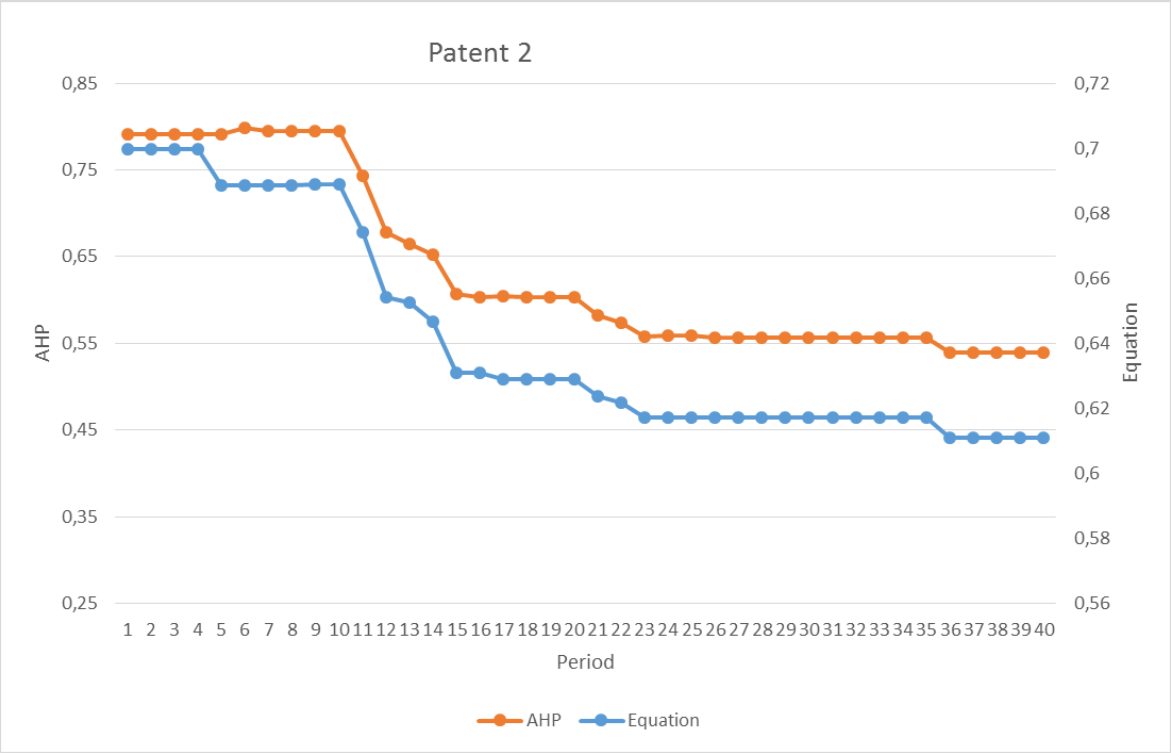

Figure 14. Equation Vs AHP Patent 2

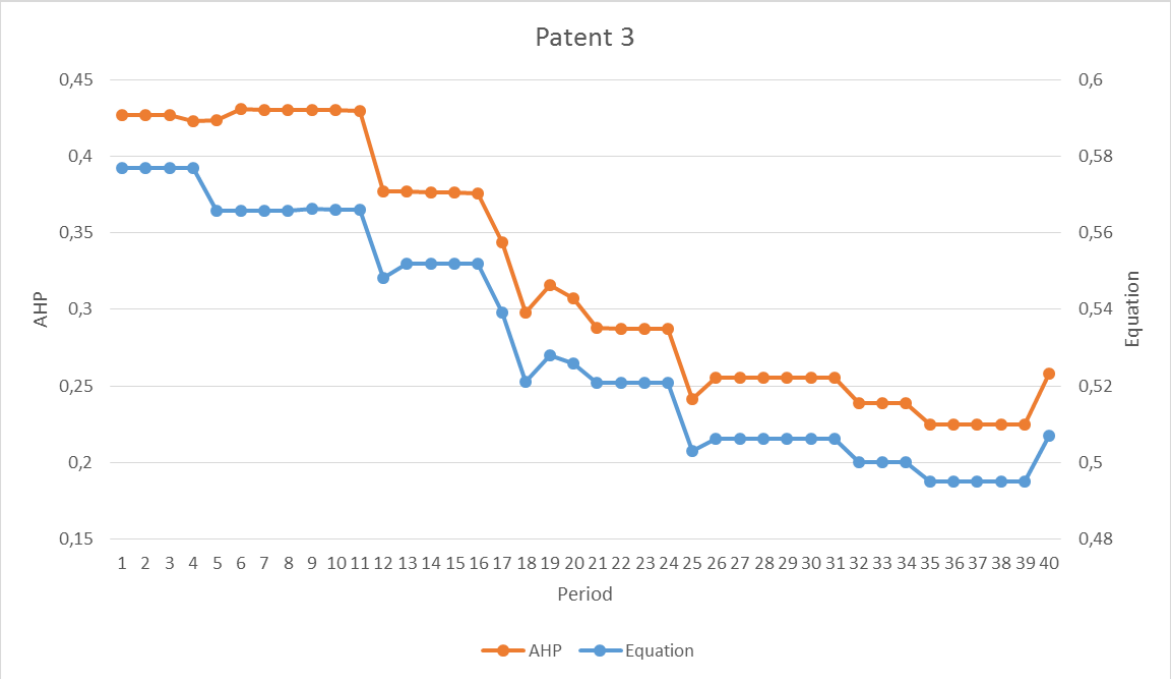

Figure 15. Equation Vs AHP Patent 3

In patent 2 and patent 3, the comparisons between the evolutions of the values are totally related and the evolution of the AHP and equation are very similar. For patent 1 the main tendency is the same, but there are 2 periods, 21 and 32, where the graphics show and abnormal behaviour. Analysing carefully the data, it is observed that the market size undergoes too big changes in its value. But the problem is not in the equation because analysed the system dynamics and doing a simulation with the model we observed that there is not any reason for it change, probably the problem is in the recompilation of the data.

Based on this analysis it can be affirmed that the equation works as well as the AHP method.

4. Patent valuation software

Patent valuation is a complex process according to the legal challenges which can occur during the application and subsequent enforcement or the initial uncurtains about the technical development or the commercial success. It means that patents have a lot of flexibility in the way that they can be managed as well as in the value their eventual value. This complexity and the need of giving them a standardized value has resulted in the development of different evaluation methods and more recently the development of software to help the companies to make this evaluation.

The direct financial value of the patent application will be the extra profits obtained by the exploitation of the patent by the company. There are many differences between the projects comprising the commercialization of inventions and the patents protecting such inventions. But, these entities are closely linked, so make a difference between them, sometimes, is complicated and unnecessary. It difference is make because is not necessary to register a patent to get a commercialization value or if a patent is not commercialized by the inventor, it could still give commercial revenues to the inventor if it licenses it and others commercially it.

In this section, the main software will be described to adapt the most important considerations to the particularities of the W company and know the limitations of the model described in the previous section. This software has been developed in order to improve and facility the patent valuation to the companies. To understand how this software works, there are presented the characteristics of the most important software in the market: IPIntellisource, IPScore and Toolip Valuation.

4.1. IPIntellisource

This software has been developed by Wisdomain, Inc. It calculates the value as the present value of the sum of profits generated by the patent. To obtain this value is estimated total market profit and the patent contribution ratio to this profit. The market is defined as the place where the valued patent is commercialized. This model uses the valued patent's IPC code to identify all patents that fall into the same code to determine its market size. The IPC code is a USA code which names the patents and helps to identify the patent characteristics. Utilizing available financial data, the model then calculates market players' average revenue/profit per patent to estimate the total market/profit size. The diagram below shows the flow of our patent valuation model.

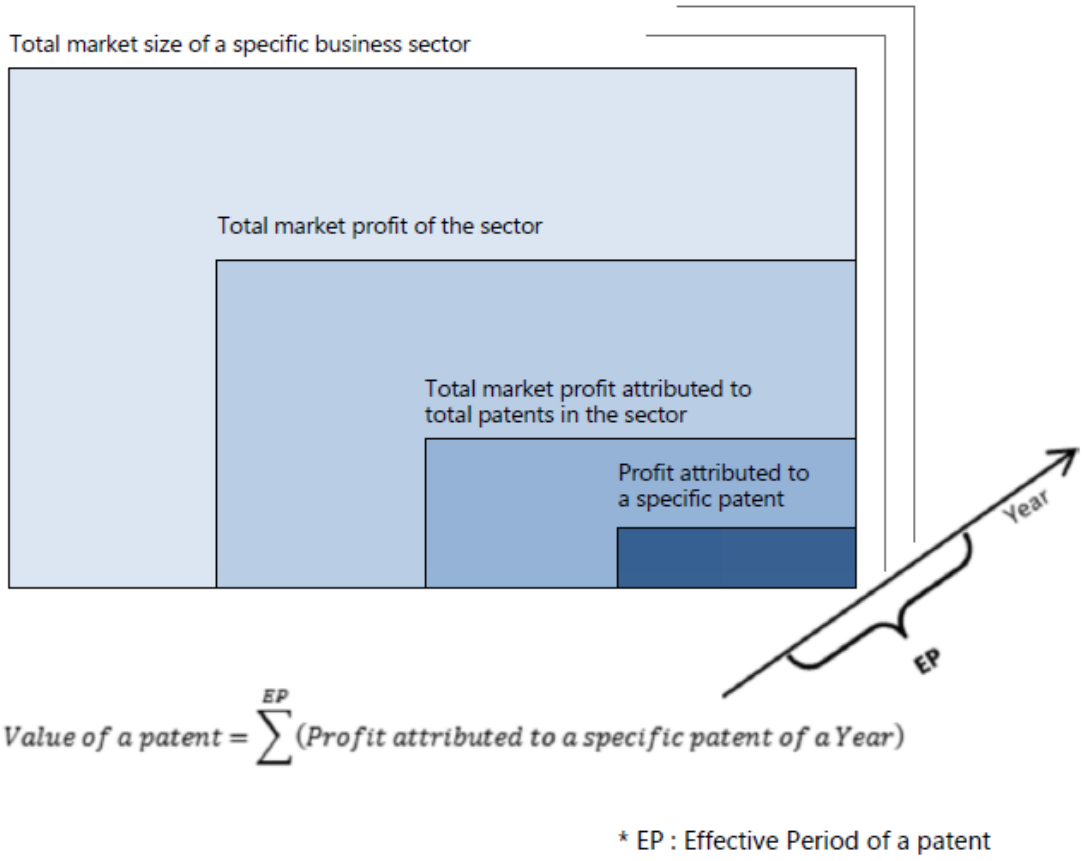

Figure 16. http://www.actionablepatents.com/

Patent value analyses 3 main categories:

- Market trends: With the IPC code the program knows the company which has registered the company, the market size consisting of technology related to Patent, the sector annual growth rate, the company average profit margin and it calculates the estimated patent contribution ratio to their total profits
- Patent Trends and Technology Valuation: Here is evaluated the total number of patents related to the technology sector and how many have held valid rights. It results in the technology score for a patent. The evaluation rating is relative to

technical fields. Thus patents with same or similar scores can have different grades depending on which technical field they belong to.

- Effective Period of Patent: The model defines the patent value by a patent's profit contribution only during the validity (life cycle) of the products for which the patent is used.

The valuation result has this structure:

Valuation Result

■ **Patent Valuation**

Market Status	Market Size (2015)	USD 494 Mil.
	CAGR	7.60 %
	Average Margin	5.44 %
	Patent Contribution	6.11 %
	Discount Rate	1.00 %
	No. of Patent Holding Companies	60
	No. of Enforceable Patents	355
Technology Evaluation	Patent Grade	A+
	Patent Score	98.69 out of 100
Timeline	Estimated Termination Date	Mar 21, 2031
	Effective Period of Patent	8 year(s), 0 month(s)
	Patent Valuation	**USD 506,553**

Figure 17. Valuation result

4.2. IPScore

IPScore has been developed by the European Patent Organisation to provide a comprehensive evaluation of patents and technological development projects. It is a free software that can be used by all companies that have a portfolio of patents and development projects, it provides a framework for evaluating and strategically managing patents and development projects and thereby integrating them into company management strategy.

It requires an input of the user, it does not use any statistical data obtained from patent's database. One important stage of the evaluation defines the business area of the patent and its relationship with the company's remaining financial area. The next step will evaluate the category of the input data, all 40 assessment factors' questions in the five categories A – E must be answered. Those input categories and the output gave by the program are described below.

Input Data

A. Legal status: This category concerns the assessment of the patent as a legal document, i.e. the legal basis for maintaining and enforcing the patent and the company's ability and motivation to do so. The category looks at determining the patent's present position in the grant process, how broad the patent's claim is and how durable it is thought to be. Is the patent monitored with regard to infringements? And if so, does the company have the means to enforce the patent? Overall, the category provides a picture of the patent's legal status and situation.
B. Technology: This category is focused on the valuation of the patent's technology, the prospects within the technology and companies' technology demand, it aims to

give an overall impression of the technology's position of strength. It looks how the technology can be substituted by other technologies, if similar products are easy to produce, whether the technology has been tested and if it creates a demand for new production equipment.

C. Market Conditions: The category aims to analyse different conditions and factors which affect the marketing options of the patent and the business opportunities created when the patent is incorporated in the product. This category, aligned with the legal status and the patent technology, show the potential inherent in the patent technology. Relevant areas are the market's competitive situation, market growth, product life expectancy in the market, licensing opportunities, etc.

D. Finance: This category determines how the patented technology affects the financial structure in the business area where it is put to use. It calculates the product cost and the earnings from the patent, coupled with the importance of these contributions to the company's total turnover, etc. It also considered the investment necessary for the production equipment. The information gathered here is put together with key figures from the company accounts to become factors in the calculations for the financial forecast.

E. Strategy: Strategy category is focused on categorized the legal document of the patent with a view to weighing the actual purpose of the patent against the qualitative and financial assessments. The company evaluates how it want to use the patent.

F. Financial results: Apart of the principal categories, the model also includes the financial category, where key figures from the company accounts are entered. This is the base to calculate how good is the patent when is put in a given business area. Key financial figures for turnover, costs, provision for depreciation and business area are entered in this financial results category.

Output Data

IPScore has 7 different reports to help to understand the patent valuation, it interpretation and analysis. They show different dimensions of the qualitative evaluation and the financial forecast. This reports can be divided in:

A. Radar Profiles: Show an overall view of the assessments of the input categories: Legal status, technology, Market conditions, and finance. It helps to see where the strengths and weaknesses in one category are.

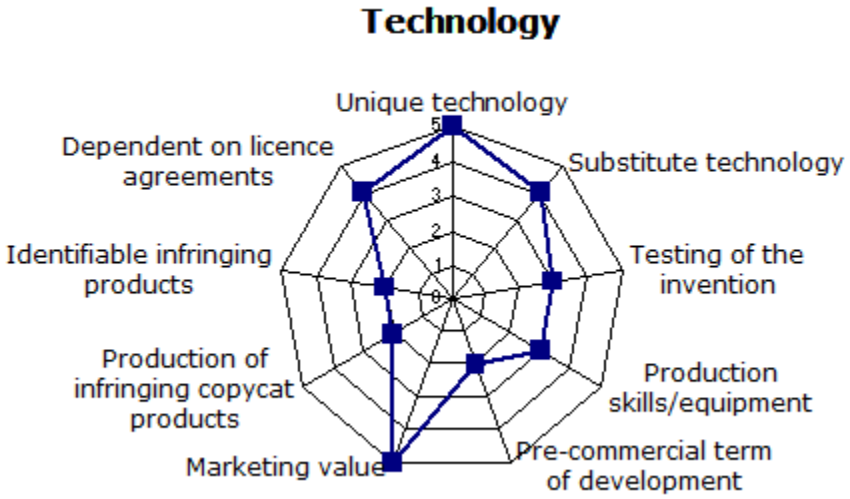

Figure 18. Radar Profile

B. Strategic Profile: The strategic profile presents distinctive features of the purpose of the patent, the patent's strategic position and its role as a legal document in the company. It is used to illustrate how the patent plays an important strategic role. It works similar to the radar profile evaluation from 1 to 5 the Correlation between patent Company and Company business strategy, securing existing markets, winning new markets, image building, ensuring "freedom to operate, part of core

technology areas, licence or sales agreement or restricting competitive development.

Calculations for net present value are based on the following assumptions:

Factor		Score		Financial assumptions
B5	Pre-commercial term of development	2	2 years [2]	2
C2	Market growth rate	5	Very high (15%) [0,15]	0,15
C3	Life expectancy	4	4 years [4]	4
C6	Potential extra turnover	4	Large (6%) [0,06]	0,06
D1	Business output maintainability	4	25% [0,25]	0,25
D2	Future cost of development	2	Very high (15%) [0,15]	0,15
D3	Cost of production	3	No increase or decrease [1]	1
D4	Investment intensity	3	100% of present investment intensity - investment-neutral [1]	1

Figure 19. Strategic Profile

C. Net present value: It is the financial forecast depicting the value of the patented technology, discounted at a selected interest rate. It shows all assumptions for the calculations. Finally, there is a built-in facility enabling direct simulation of data in the output report.

D. Charts: This output is composes of four different charts which illustrate aspects of the calculated foreseeable financial development to be achieved by implementing the patented technology: A patent account forecast on the utilization of the patented technology in the selected business area; A comprehensive total account forecast providing an overview of the quantitative relationship between the business area and other company finances; A liquidity chart covering the calculation period; A graph depicting the net present value, which can be used to determine the discount rate used in the net present value calculations.

E. Diagnoses: All the factors from the categories legal status, technology, Market conditions, and finance are grouped according to their degree of risk or potential. The final result is presented in two groups according to the score achieved.

F. Portfolios: This program allows the company to evaluate the patents in two graphs. One is a matrix depicting the evaluated patents according to their score in the risk/potential assessment factors and the other one is a bar chart showing the score of each patent in all the categories except financial results as well as the estimated net present value for each of the patents.

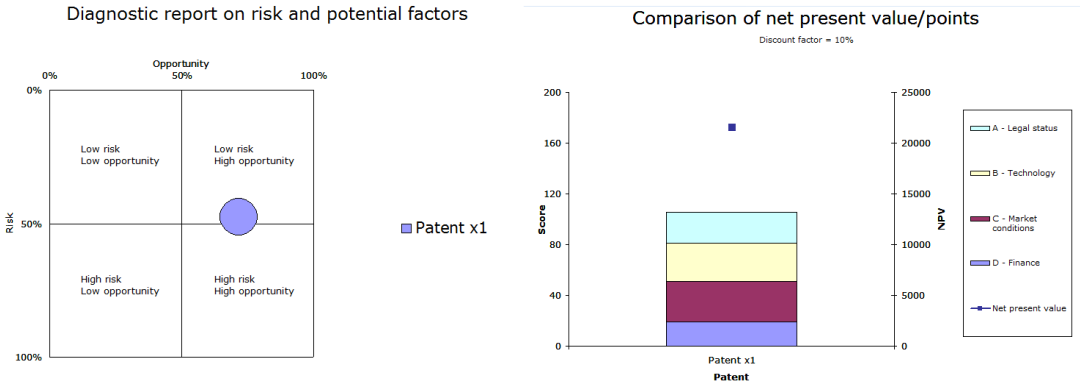

Figure 20. PortFolios

G. Reports: Supplementary reports are used to presented special-interest areas, these are radar charts radar charts showing the chosen assessment factors, grouped according to their area of interest and running across all the categories. Also, a supplementary radar chart with the different assessment factors related to the company's ability and motivation to utilize the patent and the patented technology. A final report contains selected output charts from the qualitative evaluation and the forecast of financial results, as well as a number of directional questions and topical headings that form the framework for creating a comprehensive evaluation report.

4.3. Toolip Valuation

Toolip Valuation has been developed by Tribalyte Technologies S.L., it initial algorithm was a customization of the IPScore algorithm, but today is defined as a "fully self-standing patent valuation platform covering a wider scope of theoretical valuation background, as well as a powerful system for creating valuation reports in almost any electronic format.".

Toolip valuation is based on an income model, taking into account the future projected cash flows associated with the valuated project, and computes them as a net present value by applying discount factors. It also helps the user to manage information related to the patent as legal data or financial data as well as covering technological, strategic or marketing factors. Toolip's algorithm statistically weighs all input factors and computes the future cash flows during the patent's life, calculating the monetary value of the patent as a sum of these flows. Risk and opportunity factors are also taken into account in the calculation, in order to provide a more realistic valuation.

As IPscore, Toolip separate is analysis in 5 different sectors, very similar to the IPScore's.

Input Data

A. Legal status: It analyses the current status of prosecution and the company's capacity to enforce the patent right in different markets. The user has to complete a questionnaire which will be used to calculate the legal factors that affect the patent's final monetary value, potential risk or opportunity factors.
B. Technological Impact: It evaluates the degree of completion of the research stage before commercializing the patent and the strengths or weaknesses compared to the market alternatives. In this section, technological factors that affect patent's final

monetary value, potential risk or opportunity factors which can respectively decrease or increase that value are evaluated.

C. Market projection: It is composed of some questions to determine how big is the market for the commercialization of the patent, its growth and the turnover. It also covers specific further features which can modify the market scenario.

D. Strategic position: It evaluates the strategic position of the company compared with the patent technology. This section can help the company to define its market strategy as well as improve the strategy if some questions are answered negatively.

E. Financial viability: It analyses the financial viability of the patent when it is put on the market. It evaluates how the patent can improve some factors as reducing costs or increasing profits. The questionnaire will give information about financial factors which affect the final patent's monetary value, potential risk or opportunity factors. It also covers the business turnover, costs, provisions for depreciation as well as the growth and discount rates that affect the final valuation results. The main input factors in this section are: Business annual turnover, Annual direct cost, Annual indirect cost, Investment / Depreciation, Investment / Depreciation period, Discount interest rate, Share of current company turnover and Total growth in company market. There is also a currency selection box to define the currency of your valuation results and their associated valuation reports.

Output Data

The results are divided into 5 different sections:

A. Qualitative data results: In that section the score is calculated as percentage values between 0% (worst) and 100% (best), and it's calculated for each category based

on the answer of the questionnaires. If the value is above 70% are considered strong, and below 30% is considered very weak. Based on all these factors the program also gives the overall patent score, the overall risk score and the overall opportunity score for your technology project, these values are also a percentage. The risk/opportunity is divided into four sectors according to the associated qualitative values obtained.

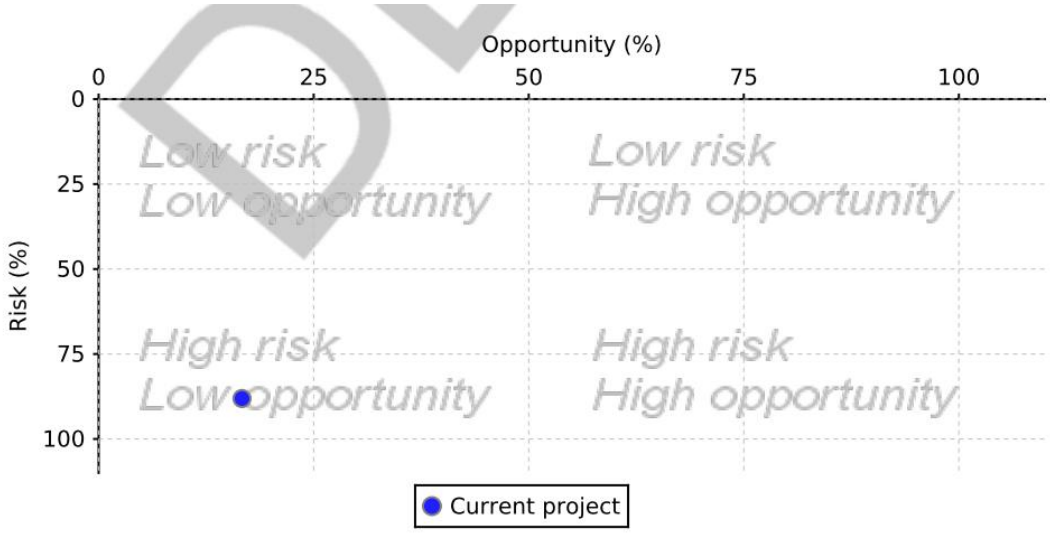

Figure 21. Risk/opportunity

B. Financial data results: Based on the financial data input, the net present value of the patent is shown, as computed for a 15 year investment period. The net present value can be considered as the main result of the valuation. It also takes into consideration the contributions of every future cash flow associated with the business area of the patented technology and adds them up, discounting the effect of time in every cash flow. It also includes some charts as Net present value vs. discount factor, liquidity forecast, Business area profits or company profits.

C. Risk/opportunity-modified net present value: This section is a combination of the risk/opportunity and the net present value. It modifies the net present value according to the opportunity risk to get a more realistic value. A double plot of the

NPV as a function of a variable risk value is shown. A low-risk value will raise the NPV, and a high-risk value will decrease the NPV accordingly. In addition, a low opportunity value will decrease the NPV, and a high opportunity value will raise the NPV accordingly.

D. Royalty rate forecast results: The results of this section are intended for their use in license agreements, and they are based on the annual business turnover and the computed mean liquidity during the life expectancy of the patent in the market. Based on this results, it shows the forecast for an annual royalty payment. The result is also expressed as the percentage of the annual business turnover and as the percentage of the mean annual liquidity. The results obtained are suggested as the reference values for setting a royalty rate pricing for licensing the patent in the selected market.

E. Relief from royalty license value: It represents the total value of the patent if it was to be licensed over its full life expectancy in the market. This quantity is usually interpreted as the total value of the patent and also as a reference for setting a total price of the technology for licensing purposes.

5. Model Valuation

After evaluating how the patent evaluation methods and software works, the first conclusion is that the factors which are going to be evaluated as well as its weighing can depend on the experts but the effectiveness of the method depends on the standardization of the evaluation of each factor.

Looking to the model developed by Oentoro, R.G. (2014), although no details have been given about the weighting of the factors that are not cost based, it can be deduced that the assessment is subjective and is not standardized. So it can be said that this is the main shortcoming of the method.

Making a categorization of the factors included in Oentoro, R.G. (2014), according to the categories that are part of the IPScore software, we get that table:

Table 14. AHP factors vs. Ipscore categories

Factor	Category
Refinement	Technology
Application Scope	Technology
Compatibility	Technology
Complexity	Technology/finance
Reference Cost	Finance
Product Life cycle	Market conditions
Potential Market Share	Market conditions
Utility/advantage	Market conditions
Num of Supplier	Technology/Market conditions
Num of Demander	Technology/Market conditions
Commercial Level	Market conditions
R&D Cost	Finance
Transfer Cost	Finance
Market Size	Market conditions

According to this table, another limitation of the model is that it does not consider any factor

related to the strategy or legal status categories, both categories are considered also in the Toolip Valuation. The importance of this categories is because they are necessary to know the patent's present position in the grant process, how broad the patent's claim is and how durable it is thought to be which can affect the profitability of the patent and the purpose of the patent. Although it is difficult to quantify these two categories, it would be good develop models which would include them both, and based on them increase or decrease the value of the patent.

The financial results, the sixth category of the IPScore, is not either considered in the model, this category would help to know with more detail how good is the patent for its own business area and calculate the turnover, costs or provision for depreciation. Probably this category could not be introduced into the model but it could be used in the valuation of another factor to improve the model.

Another weakness of the model is that there is not considered any rate to calculate the depreciation of the money during the patent life cycle, these rates are used in cost-based methods, income-based methods or in the discounted cash flows. A standard discounted rate for the sector combined with a decision tree which helps to analyse different scenarios, will help to evaluate the risk of the patent will be successful or not. It could be useful for example, when the exit of a patent depends on the customer acceptance, it the customer likes the patent the sells will increase but if the customers do not like it the sells will decrease. In that case, there are two different scenarios very different, and based on factors like potential market share or compatibility the risk of each scenario could be determined and calculate with more precision the value of the patent.

The benefits of the patent are not also considered in the model, it is true benefits are related to some factors like commercial level or utility/advantage, but there is not established the

relationship between them and the benefits. And benefits are one of the most important factors for the discounted cash flows methods.

Although the real options are not very useful to the patents developed by w company, because the volatility of them price is not very high, nevertheless in this method are considered the possibility of rejecting a patent during its development. It is an important tool to calculate the risk of developing a patent. Because it can reduce the losses from the patent.

6. Conclusions

Sterman, J.D. (2001) [5] said “system dynamics is a perspective and set of conceptual tools that enable us to understand the structure and dynamics of complex systems. System Dynamics is also a rigorous modelling method that enables us to build formal computer simulations of complex systems and use them to design more effective policies and organizations.” The model studied in this project helps the company to simplify this structure and make some simulations. In the case study, the patent valuation with system dynamics, as it proved with (eq. 5) the system simplify too much the patent valuation and it can be reduced for equation with 8 initial factors (Utility/advantage, Potential market share, commercial level, unit total cost, Application Scope, Compatibility, Number of supplier and number of demander). Although this equation has some limitations for low patent values and a deviation of 2,5%, it is proved that it works as well as the model to compare different patents. Based on the equation and comparing it with most sophisticated softwares in the market , the main weakness of the model are that it ignores some importance variables contemplated both as traditional methods and modern software like risk, legal conditions, money depreciation or benefits from the patent.

For the future research, we suggest to develop a patent valuation model based on the AHP preferences for the experts of the company, the equation developed in this project and the weakness of this model related in chapter 7 and adapt them to W company requirements and particularities, and once the model will be developed introduce it in a system dynamics model which will help to calculate the patent value. We also suggest do not reduce the patent valuation only to one number because there are a lot of factors which help to analyse some differents situations that are lost when the patent valuation is showed only in one number.

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Appendix 1

Table 15. Taguchi Experiment levels

																		Total Market	1	1	2	2
																		Yield Rate	1	2	1	2
Utility Advantage	Potential Market share	AXB	Comercial level	AXD	BXD	Reference Cost	Unit Total Cost	Complexity	Salary of R&D personel	Underutilization	Prod Life Cycle	Application Scope	Refinement	Compatibility	Number of Supplier	Number of Demander	error	Production Volume	1	2	1	1
1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1		TM1_YR1_PV1	TM1_YR2_PV2	TM2_YR1_PV1	TM2_YR2_PV1
1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	2	2		TM1_YR1_PV1	TM1_YR2_PV2	TM2_YR1_PV1	TM2_YR2_PV1
1	1	1	1	1	1	1	2	2	2	2	2	2	2	2	1	1	1		TM1_YR1_PV1	TM1_YR2_PV2	TM2_YR1_PV1	TM2_YR2_PV1
1	1	1	1	1	1	1	2	2	2	2	2	2	2	2	2	2	2		TM1_YR1_PV1	TM1_YR2_PV2	TM2_YR1_PV1	TM2_YR2_PV1
1	1	1	2	2	2	2	1	1	1	1	2	2	2	2	1	1	1		TM1_YR1_PV1	TM1_YR2_PV2	TM2_YR1_PV1	TM2_YR2_PV1
1	1	1	2	2	2	2	1	1	1	1	2	2	2	2	2	2	2		TM1_YR1_PV1	TM1_YR2_PV2	TM2_YR1_PV1	TM2_YR2_PV1
1	1	1	2	2	2	2	2	2	2	2	1	1	1	1	1	1	1		TM1_YR1_PV1	TM1_YR2_PV2	TM2_YR1_PV1	TM2_YR2_PV1
1	1	1	2	2	2	2	2	2	2	2	1	1	1	1	2	2	2		TM1_YR1_PV1	TM1_YR2_PV2	TM2_YR1_PV1	TM2_YR2_PV1
1	2	2	1	1	2	2	1	1	2	2	1	1	2	2	1	1	2		TM1_YR1_PV1	TM1_YR2_PV2	TM2_YR1_PV1	TM2_YR2_PV1
1	2	2	1	1	2	2	1	1	2	2	1	1	2	2	2	2	1		TM1_YR1_PV1	TM1_YR2_PV2	TM2_YR1_PV1	TM2_YR2_PV1
1	2	2	1	1	2	2	2	2	1	1	2	2	1	1	1	1	2		TM1_YR1_PV1	TM1_YR2_PV2	TM2_YR1_PV1	TM2_YR2_PV1
1	2	2	1	1	2	2	2	2	1	1	2	2	1	1	2	2	1		TM1_YR1_PV1	TM1_YR2_PV2	TM2_YR1_PV1	TM2_YR2_PV1
1	2	2	2	2	1	1	1	1	2	2	2	2	1	1	1	1	2		TM1_YR1_PV1	TM1_YR2_PV2	TM2_YR1_PV1	TM2_YR2_PV1
1	2	2	2	2	1	1	1	1	2	2	2	2	1	1	2	2	1		TM1_YR1_PV1	TM1_YR2_PV2	TM2_YR1_PV1	TM2_YR2_PV1
1	2	2	2	2	1	1	2	2	1	1	1	1	2	2	1	1	2		TM1_YR1_PV1	TM1_YR2_PV2	TM2_YR1_PV1	TM2_YR2_PV1
1	2	2	2	2	1	1	2	2	1	1	1	1	2	2	2	2	1		TM1_YR1_PV1	TM1_YR2_PV2	TM2_YR1_PV1	TM2_YR2_PV1
2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1		TM1_YR1_PV1	TM1_YR2_PV2	TM2_YR1_PV1	TM2_YR2_PV1
2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	2	1	2		TM1_YR1_PV1	TM1_YR2_PV2	TM2_YR1_PV1	TM2_YR2_PV1
2	1	2	1	2	1	2	2	1	2	1	2	1	2	1	1	2	1		TM1_YR1_PV1	TM1_YR2_PV2	TM2_YR1_PV1	TM2_YR2_PV1
2	1	2	1	2	1	2	2	1	2	1	2	1	2	1	2	1	2		TM1_YR1_PV1	TM1_YR2_PV2	TM2_YR1_PV1	TM2_YR2_PV1
2	1	2	2	1	2	1	1	2	1	2	2	1	2	1	1	2	1		TM1_YR1_PV1	TM1_YR2_PV2	TM2_YR1_PV1	TM2_YR2_PV1
2	1	2	2	1	2	1	1	2	1	2	2	1	2	1	2	1	2		TM1_YR1_PV1	TM1_YR2_PV2	TM2_YR1_PV1	TM2_YR2_PV1
2	1	2	2	1	2	1	2	1	2	1	1	2	1	2	2	1	2		TM1_YR1_PV1	TM1_YR2_PV2	TM2_YR1_PV1	TM2_YR2_PV1
2	2	1	1	2	2	1	1	2	2	1	1	2	2	1	1	2	2		TM1_YR1_PV1	TM1_YR2_PV2	TM2_YR1_PV1	TM2_YR2_PV1
2	2	1	1	2	2	1	1	2	2	1	1	2	2	1	2	1	1		TM1_YR1_PV1	TM1_YR2_PV2	TM2_YR1_PV1	TM2_YR2_PV1
2	2	1	1	2	2	1	2	1	1	2	2	1	1	2	1	2	2		TM1_YR1_PV1	TM1_YR2_PV2	TM2_YR1_PV1	TM2_YR2_PV1
2	2	1	1	2	2	1	2	1	1	2	2	1	1	2	2	1	1		TM1_YR1_PV1	TM1_YR2_PV2	TM2_YR1_PV1	TM2_YR2_PV1
2	2	1	2	1	1	2	1	2	2	1	2	1	1	2	1	2	2		TM1_YR1_PV1	TM1_YR2_PV2	TM2_YR1_PV1	TM2_YR2_PV1
2	2	1	2	1	1	2	1	2	2	1	2	1	1	2	2	1	1		TM1_YR1_PV1	TM1_YR2_PV2	TM2_YR1_PV1	TM2_YR2_PV1
2	2	1	2	1	1	2	2	1	1	2	1	2	2	1	1	2	2		TM1_YR1_PV1	TM1_YR2_PV2	TM2_YR1_PV1	TM2_YR2_PV1
2	2	1	2	1	1	2	2	1	1	2	1	2	2	1	2	1	1		TM1_YR1_PV1	TM1_YR2_PV2	TM2_YR1_PV1	TM2_YR2_PV1

Appendix 2.

Period	Utility Advantage	Potential Market share	Comercial level	Reference Cost	Unit Total Cost	Complexity	Salary of R&D personel	Underutilization	Prod Life Cycle	Scope of application	Refinement	Compatibility	Number of Supplier	Number of Demander	Total Market	Yield Rate	Production Volume
1	2	1	1	190000	6150	4	175000	0,025	0,99	7	6	7	9	6	18000000	0,99	2500000
2	2	1	1	190000	6150	4	175000	0,025	0,99	7	6	7	9	6	18000000	1,01	6500000
3	2	1	1	190000	6150	4	175000	0,025	0,99	7	6	7	9	6	22000000	0,99	2500000
4	2	1	1	190000	6150	4	175000	0,025	0,99	7	6	7	9	6	22000000	1,01	2500000
5	2	1	1	190000	6150	4	175000	0,025	0,99	7	6	7	13	11	18000000	0,99	2500000
6	2	1	1	190000	6150	4	175000	0,025	0,99	7	6	7	13	11	18000000	1,01	6500000
7	2	1	1	190000	6150	4	175000	0,025	0,99	7	6	7	13	11	22000000	0,99	2500000
8	2	1	1	190000	6150	4	175000	0,025	0,99	7	6	7	13	11	22000000	1,01	2500000
9	2	1	1	190000	13700	8	215000	0,05	1,01	12	11	11	9	6	18000000	0,99	2500000
10	2	1	1	190000	13700	8	215000	0,05	1,01	12	11	11	9	6	18000000	1,01	6500000
11	2	1	1	190000	13700	8	215000	0,05	1,01	12	11	11	9	6	22000000	0,99	2500000
12	2	1	1	190000	13700	8	215000	0,05	1,01	12	11	11	9	6	22000000	1,01	2500000
13	2	1	1	190000	13700	8	215000	0,05	1,01	12	11	11	13	11	18000000	0,99	2500000
14	2	1	1	190000	13700	8	215000	0,05	1,01	12	11	11	13	11	18000000	1,01	6500000
15	2	1	1	190000	13700	8	215000	0,05	1,01	12	11	11	13	11	22000000	0,99	2500000
16	2	1	1	190000	13700	8	215000	0,05	1,01	12	11	11	13	11	22000000	1,01	2500000
17	2	1	4	220000	6150	4	175000	0,025	1,01	12	11	11	9	6	18000000	0,99	2500000
18	2	1	4	220000	6150	4	175000	0,025	1,01	12	11	11	9	6	18000000	1,01	6500000
19	2	1	4	220000	6150	4	175000	0,025	1,01	12	11	11	9	6	22000000	0,99	2500000
20	2	1	4	220000	6150	4	175000	0,025	1,01	12	11	11	9	6	22000000	1,01	2500000
21	2	1	4	220000	6150	4	175000	0,025	1,01	12	11	11	13	11	18000000	0,99	2500000
22	2	1	4	220000	6150	4	175000	0,025	1,01	12	11	11	13	11	18000000	1,01	6500000
23	2	1	4	220000	6150	4	175000	0,025	1,01	12	11	11	13	11	22000000	0,99	2500000
24	2	1	4	220000	6150	4	175000	0,025	1,01	12	11	11	13	11	22000000	1,01	2500000
25	2	1	4	220000	13700	8	215000	0,05	0,99	7	6	7	9	6	18000000	0,99	2500000
26	2	1	4	220000	13700	8	215000	0,05	0,99	7	6	7	9	6	18000000	1,01	6500000
27	2	1	4	220000	13700	8	215000	0,05	0,99	7	6	7	9	6	22000000	0,99	2500000
28	2	1	4	220000	13700	8	215000	0,05	0,99	7	6	7	9	6	22000000	1,01	2500000
29	2	1	4	220000	13700	8	215000	0,05	0,99	7	6	7	13	11	18000000	0,99	2500000
30	2	1	4	220000	13700	8	215000	0,05	0,99	7	6	7	13	11	18000000	1,01	6500000
31	2	1	4	220000	13700	8	215000	0,05	0,99	7	6	7	13	11	22000000	0,99	2500000
32	2	1	4	220000	13700	8	215000	0,05	0,99	7	6	7	13	11	22000000	1,01	2500000
33	2	4	1	220000	6150	4	215000	0,05	0,99	7	11	11	9	6	18000000	0,99	2500000
34	2	4	1	220000	6150	4	215000	0,05	0,99	7	11	11	9	6	18000000	1,01	6500000
35	2	4	1	220000	6150	4	215000	0,05	0,99	7	11	11	9	6	22000000	0,99	2500000
36	2	4	1	220000	6150	4	215000	0,05	0,99	7	11	11	9	6	22000000	1,01	2500000
37	2	4	1	220000	6150	4	215000	0,05	0,99	7	11	11	13	11	18000000	0,99	2500000
38	2	4	1	220000	6150	4	215000	0,05	0,99	7	11	11	13	11	18000000	1,01	6500000
39	2	4	1	220000	6150	4	215000	0,05	0,99	7	11	11	13	11	22000000	0,99	2500000
40	2	4	1	220000	6150	4	215000	0,05	0,99	7	11	11	13	11	22000000	1,01	2500000
41	2	4	1	220000	13700	8	175000	0,025	1,01	12	6	7	9	6	18000000	0,99	2500000
42	2	4	1	220000	13700	8	175000	0,025	1,01	12	6	7	9	6	18000000	1,01	6500000
43	2	4	1	220000	13700	8	175000	0,025	1,01	12	6	7	9	6	22000000	0,99	2500000

Table 16. Taguchi experiment scenarios 1-43

ETSEIB

Table 17. Taguchi experiment scenarios 44-86

Period	Utility Advantage	Potential Market share	Comercial level	Reference Cost	Unit Total Cost	Complexity	Salary of R&D personel	Underutilization	Prod Life Cycle	Scope of application	Refinement	Compatibility	Number of Supplier	Number of Demander	Total Market	Yield Rate	Production Volume
44	2	4	1	220000	13700	8	175000	0,025	1,01	12	6	7	9	6	22000000	1,01	2500000
45	2	4	1	220000	13700	8	175000	0,025	1,01	12	6	7	13	11	18000000	0,99	2500000
46	2	4	1	220000	13700	8	175000	0,025	1,01	12	6	7	13	11	18000000	1,01	6500000
47	2	4	1	220000	13700	8	175000	0,025	1,01	12	6	7	13	11	22000000	0,99	2500000
48	2	4	1	220000	13700	8	175000	0,025	1,01	12	6	7	13	11	22000000	1,01	2500000
49	2	4	4	190000	6150	4	215000	0,05	1,01	12	6	7	9	6	18000000	0,99	2500000
50	2	4	4	190000	6150	4	215000	0,05	1,01	12	6	7	9	6	18000000	1,01	6500000
51	2	4	4	190000	6150	4	215000	0,05	1,01	12	6	7	9	6	22000000	0,99	2500000
52	2	4	4	190000	6150	4	215000	0,05	1,01	12	6	7	9	6	22000000	1,01	2500000
53	2	4	4	190000	6150	4	215000	0,05	1,01	12	6	7	13	11	18000000	0,99	2500000
54	2	4	4	190000	6150	4	215000	0,05	1,01	12	6	7	13	11	18000000	1,01	6500000
55	2	4	4	190000	6150	4	215000	0,05	1,01	12	6	7	13	11	22000000	0,99	2500000
56	2	4	4	190000	6150	4	215000	0,05	1,01	12	6	7	13	11	22000000	1,01	2500000
57	2	4	4	190000	13700	8	175000	0,025	0,99	7	11	11	9	6	18000000	0,99	2500000
58	2	4	4	190000	13700	8	175000	0,025	0,99	7	11	11	9	6	18000000	1,01	6500000
59	2	4	4	190000	13700	8	175000	0,025	0,99	7	11	11	9	6	22000000	0,99	2500000
60	2	4	4	190000	13700	8	175000	0,025	0,99	7	11	11	9	6	22000000	1,01	2500000
61	2	4	4	190000	13700	8	175000	0,025	0,99	7	11	11	13	11	18000000	0,99	2500000
62	2	4	4	190000	13700	8	175000	0,025	0,99	7	11	11	13	11	18000000	1,01	6500000
63	2	4	4	190000	13700	8	175000	0,025	0,99	7	11	11	13	11	22000000	0,99	2500000
64	2	4	4	190000	13700	8	175000	0,025	0,99	7	11	11	13	11	22000000	1,01	2500000
65	5	1	1	220000	6150	8	175000	0,05	0,99	12	6	11	9	11	18000000	0,99	2500000
66	5	1	1	220000	6150	8	175000	0,05	0,99	12	6	11	9	11	18000000	1,01	6500000
67	5	1	1	220000	6150	8	175000	0,05	0,99	12	6	11	9	11	22000000	0,99	2500000
68	5	1	1	220000	6150	8	175000	0,05	0,99	12	6	11	9	11	22000000	1,01	2500000
69	5	1	1	220000	6150	8	175000	0,05	0,99	12	6	11	13	6	18000000	0,99	2500000
70	5	1	1	220000	6150	8	175000	0,05	0,99	12	6	11	13	6	18000000	1,01	6500000
71	5	1	1	220000	6150	8	175000	0,05	0,99	12	6	11	13	6	22000000	0,99	2500000
72	5	1	1	220000	6150	8	175000	0,05	0,99	12	6	11	13	6	22000000	1,01	2500000
73	5	1	1	220000	13700	4	215000	0,025	1,01	7	11	7	9	11	18000000	0,99	2500000
74	5	1	1	220000	13700	4	215000	0,025	1,01	7	11	7	9	11	18000000	1,01	6500000
75	5	1	1	220000	13700	4	215000	0,025	1,01	7	11	7	9	11	22000000	0,99	2500000
76	5	1	1	220000	13700	4	215000	0,025	1,01	7	11	7	9	11	22000000	1,01	2500000
77	5	1	1	220000	13700	4	215000	0,025	1,01	7	11	7	13	6	18000000	0,99	2500000
78	5	1	1	220000	13700	4	215000	0,025	1,01	7	11	7	13	6	18000000	1,01	6500000
79	5	1	1	220000	13700	4	215000	0,025	1,01	7	11	7	13	6	22000000	0,99	2500000
80	5	1	1	220000	13700	4	215000	0,025	1,01	7	11	7	13	6	22000000	1,01	2500000
81	5	1	4	190000	6150	8	175000	0,05	1,01	7	11	7	9	11	18000000	0,99	2500000
82	5	1	4	190000	6150	8	175000	0,05	1,01	7	11	7	9	11	18000000	1,01	6500000
83	5	1	4	190000	6150	8	175000	0,05	1,01	7	11	7	9	11	22000000	0,99	2500000
84	5	1	4	190000	6150	8	175000	0,05	1,01	7	11	7	9	11	22000000	1,01	2500000
85	5	1	4	190000	6150	8	175000	0,05	1,01	7	11	7	13	6	18000000	0,99	2500000
86	5	1	4	190000	6150	8	175000	0,05	1,01	7	11	7	13	6	18000000	1,01	6500000

Table 18. Taguchi experiment scenarios 87-128

Period	Utility Advantage	Potential Market share	Comercial level	Reference Cost	Unit Total Cost	Complexity	Salary of R&D personel	Underutilization	Prod Life Cycle	Scope of application	Refinement	Compatibility	Number of Supplier	Number of Demander	Total Market	Yield Rate	Production Volume
87	5	1	4	190000	6150	8	175000	0,05	1,01	7	11	7	13	6	22000000	0,99	2500000
88	5	1	4	190000	6150	8	175000	0,05	1,01	7	11	7	13	6	22000000	1,01	2500000
89	5	1	4	190000	13700	4	215000	0,025	0,99	12	6	11	9	11	18000000	0,99	2500000
90	5	1	4	190000	13700	4	215000	0,025	0,99	12	6	11	9	11	18000000	1,01	6500000
91	5	1	4	190000	13700	4	215000	0,025	0,99	12	6	11	9	11	22000000	0,99	2500000
92	5	1	4	190000	13700	4	215000	0,025	0,99	12	6	11	9	11	22000000	1,01	2500000
93	5	1	4	190000	13700	4	215000	0,025	0,99	12	6	11	13	6	18000000	0,99	2500000
94	5	1	4	190000	13700	4	215000	0,025	0,99	12	6	11	13	6	18000000	1,01	6500000
95	5	1	4	190000	13700	4	215000	0,025	0,99	12	6	11	13	6	22000000	0,99	2500000
96	5	1	4	190000	13700	4	215000	0,025	0,99	12	6	11	13	6	22000000	1,01	2500000
97	5	4	1	190000	6150	8	215000	0,025	0,99	12	11	7	9	11	18000000	0,99	2500000
98	5	4	1	190000	6150	8	215000	0,025	0,99	12	11	7	9	11	18000000	1,01	6500000
99	5	4	1	190000	6150	8	215000	0,025	0,99	12	11	7	9	11	22000000	0,99	2500000
100	5	4	1	190000	6150	8	215000	0,025	0,99	12	11	7	9	11	22000000	1,01	2500000
101	5	4	1	190000	6150	8	215000	0,025	0,99	12	11	7	13	6	18000000	0,99	2500000
102	5	4	1	190000	6150	8	215000	0,025	0,99	12	11	7	13	6	18000000	1,01	6500000
103	5	4	1	190000	6150	8	215000	0,025	0,99	12	11	7	13	6	22000000	0,99	2500000
104	5	4	1	190000	6150	8	215000	0,025	0,99	12	11	7	13	6	22000000	1,01	2500000
105	5	4	1	190000	13700	4	175000	0,05	1,01	7	6	11	9	11	18000000	0,99	2500000
106	5	4	1	190000	13700	4	175000	0,05	1,01	7	6	11	9	11	18000000	1,01	6500000
107	5	4	1	190000	13700	4	175000	0,05	1,01	7	6	11	9	11	22000000	0,99	2500000
108	5	4	1	190000	13700	4	175000	0,05	1,01	7	6	11	9	11	22000000	1,01	2500000
109	5	4	1	190000	13700	4	175000	0,05	1,01	7	6	11	13	6	18000000	0,99	2500000
110	5	4	1	190000	13700	4	175000	0,05	1,01	7	6	11	13	6	18000000	1,01	6500000
111	5	4	1	190000	13700	4	175000	0,05	1,01	7	6	11	13	6	22000000	0,99	2500000
112	5	4	1	190000	13700	4	175000	0,05	1,01	7	6	11	13	6	22000000	1,01	2500000
113	5	4	4	220000	6150	8	215000	0,025	1,01	7	6	11	9	11	18000000	0,99	2500000
114	5	4	4	220000	6150	8	215000	0,025	1,01	7	6	11	9	11	18000000	1,01	6500000
115	5	4	4	220000	6150	8	215000	0,025	1,01	7	6	11	9	11	22000000	0,99	2500000
116	5	4	4	220000	6150	8	215000	0,025	1,01	7	6	11	9	11	22000000	1,01	2500000
117	5	4	4	220000	6150	8	215000	0,025	1,01	7	6	11	13	6	18000000	0,99	2500000
118	5	4	4	220000	6150	8	215000	0,025	1,01	7	6	11	13	6	18000000	1,01	6500000
119	5	4	4	220000	6150	8	215000	0,025	1,01	7	6	11	13	6	22000000	0,99	2500000
120	5	4	4	220000	6150	8	215000	0,025	1,01	7	6	11	13	6	22000000	1,01	2500000
121	5	4	4	220000	13700	4	175000	0,05	0,99	12	11	7	9	11	18000000	0,99	2500000
122	5	4	4	220000	13700	4	175000	0,05	0,99	12	11	7	9	11	18000000	1,01	6500000
123	5	4	4	220000	13700	4	175000	0,05	0,99	12	11	7	9	11	22000000	0,99	2500000
124	5	4	4	220000	13700	4	175000	0,05	0,99	12	11	7	9	11	22000000	1,01	2500000
125	5	4	4	220000	13700	4	175000	0,05	0,99	12	11	7	13	6	18000000	0,99	2500000
126	5	4	4	220000	13700	4	175000	0,05	0,99	12	11	7	13	6	18000000	1,01	6500000
127	5	4	4	220000	13700	4	175000	0,05	0,99	12	11	7	13	6	22000000	0,99	2500000
128	5	4	4	220000	13700	4	175000	0,05	0,99	12	11	7	13	6	22000000	1,01	2500000

Appendix 3.

Simulation	Refinement	Application Scope	Compatibility	Complexity	Reference Cost	Product Life cycle	Potential Market Share	Utility/advantage	Num of Supplier	Num of Demander	Commercial Level	R&D Cost	Transfer Cost	Market Size
1	6	7	7	4	190000	0,99	1	2	9	6	1	1,488E+10	470000	105300
2	6	7	7	4	190000	0,99	1	2	9	6	1	3,9469E+10	470000	105300
3	6	7	7	4	190000	0,99	1	2	9	6	1	1,488E+10	470000	128700
4	6	7	7	4	190000	0,99	1	2	9	6	1	1,518E+10	470000	128700
5	6	7	7	4	190000	0,99	1	2	13	11	1	1,488E+10	470000	105300
6	6	7	7	4	190000	0,99	1	2	13	11	1	3,9469E+10	470000	105300
7	6	7	7	4	190000	0,99	1	2	13	11	1	1,488E+10	470000	128700
8	6	7	7	4	190000	0,99	1	2	13	11	1	1,518E+10	470000	128700
9	11	12	11	8	190000	1,01	1	2	9	6	1	3,2274E+10	885000	105300
10	11	12	11	8	190000	1,01	1	2	9	6	1	8,5607E+10	885000	105300
11	11	12	11	8	190000	1,01	1	2	9	6	1	3,2274E+10	885000	128700
12	11	12	11	8	190000	1,01	1	2	9	6	1	3,2926E+10	885000	128700
13	11	12	11	8	190000	1,01	1	2	13	11	1	3,2274E+10	885000	105300
14	11	12	11	8	190000	1,01	1	2	13	11	1	8,5607E+10	885000	105300
15	11	12	11	8	190000	1,01	1	2	13	11	1	3,2274E+10	885000	128700
16	11	12	11	8	190000	1,01	1	2	13	11	1	3,2926E+10	885000	128700
17	11	12	11	4	220000	1,01	1	2	9	6	4	1,4882E+10	470000	210600
18	11	12	11	4	220000	1,01	1	2	9	6	4	3,9474E+10	470000	210600
19	11	12	11	4	220000	1,01	1	2	9	6	4	1,4882E+10	470000	257400
20	11	12	11	4	220000	1,01	1	2	9	6	4	1,5182E+10	470000	257400
21	11	12	11	4	220000	1,01	1	2	13	11	4	1,4882E+10	470000	210600
22	11	12	11	4	220000	1,01	1	2	13	11	4	3,9474E+10	470000	210600
23	11	12	11	4	220000	1,01	1	2	13	11	4	1,4882E+10	470000	257400
24	11	12	11	4	220000	1,01	1	2	13	11	4	1,5182E+10	470000	257400
25	6	7	7	8	220000	0,99	1	2	9	6	4	3,2275E+10	885000	210600
26	6	7	7	8	220000	0,99	1	2	9	6	4	8,5611E+10	885000	210600
27	6	7	7	8	220000	0,99	1	2	9	6	4	3,2275E+10	885000	257400
28	6	7	7	8	220000	0,99	1	2	9	6	4	3,2927E+10	885000	257400
29	6	7	7	8	220000	0,99	1	2	13	11	4	3,2275E+10	885000	210600
30	6	7	7	8	220000	0,99	1	2	13	11	4	8,5611E+10	885000	210600
31	6	7	7	8	220000	0,99	1	2	13	11	4	3,2275E+10	885000	257400
32	6	7	7	8	220000	0,99	1	2	13	11	4	3,2927E+10	885000	257400
33	11	7	11	4	220000	0,99	4	2	9	6	1	1,4505E+10	550000	421200
34	11	7	11	4	220000	0,99	4	2	9	6	1	3,8474E+10	550000	421200
35	11	7	11	4	220000	0,99	4	2	9	6	1	1,4505E+10	550000	514800
36	11	7	11	4	220000	0,99	4	2	9	6	1	1,4798E+10	550000	514800
37	11	7	11	4	220000	0,99	4	2	13	11	1	1,4505E+10	550000	421200
38	11	7	11	4	220000	0,99	4	2	13	11	1	3,8474E+10	550000	421200
39	11	7	11	4	220000	0,99	4	2	13	11	1	1,4505E+10	550000	514800
40	11	7	11	4	220000	0,99	4	2	13	11	1	1,4798E+10	550000	514800
41	6	12	7	8	220000	1,01	4	2	9	6	1	3,3118E+10	765000	421200
42	6	12	7	8	220000	1,01	4	2	9	6	1	8,7845E+10	765000	421200
43	6	12	7	8	220000	1,01	4	2	9	6	1	3,3118E+10	765000	514800

Table 19. Simulation results for scenarios 1-43

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Table 20. Simulation results for scenarios 44-86

Simulation	Refinement	Application Scope	Compatibility	Complexity	Reference Cost	Product Life cycle	Potential Market Share	Utility/advantage	Num of Supplier	Num of Demander	Commercial Level	R&D Cost	Transfer Cost	Market Size
44	6	12	7	8	220000	1,01	4	2	9	6	1	3,3787E+10	765000	514800
45	6	12	7	8	220000	1,01	4	2	13	11	1	3,3118E+10	765000	421200
46	6	12	7	8	220000	1,01	4	2	13	11	1	8,7845E+10	765000	421200
47	6	12	7	8	220000	1,01	4	2	13	11	1	3,3118E+10	765000	514800
48	6	12	7	8	220000	1,01	4	2	13	11	1	3,3787E+10	765000	514800
49	6	12	7	4	190000	1,01	4	2	9	6	4	1,4503E+10	550000	842400
50	6	12	7	4	190000	1,01	4	2	9	6	4	3,8469E+10	550000	842400
51	6	12	7	4	190000	1,01	4	2	9	6	4	1,4503E+10	550000	1029600
52	6	12	7	4	190000	1,01	4	2	9	6	4	1,4796E+10	550000	1029600
53	6	12	7	4	190000	1,01	4	2	13	11	4	1,4503E+10	550000	842400
54	6	12	7	4	190000	1,01	4	2	13	11	4	3,8469E+10	550000	842400
55	6	12	7	4	190000	1,01	4	2	13	11	4	1,4503E+10	550000	1029600
56	6	12	7	4	190000	1,01	4	2	13	11	4	1,4796E+10	550000	1029600
57	11	7	11	8	190000	0,99	4	2	9	6	4	3,3116E+10	765000	842400
58	11	7	11	8	190000	0,99	4	2	9	6	4	8,784E+10	765000	842400
59	11	7	11	8	190000	0,99	4	2	9	6	4	3,3116E+10	765000	1029600
60	11	7	11	8	190000	0,99	4	2	9	6	4	3,3785E+10	765000	1029600
61	11	7	11	8	190000	0,99	4	2	13	11	4	3,3116E+10	765000	842400
62	11	7	11	8	190000	0,99	4	2	13	11	4	8,784E+10	765000	842400
63	11	7	11	8	190000	0,99	4	2	13	11	4	3,3116E+10	765000	1029600
64	11	7	11	8	190000	0,99	4	2	13	11	4	3,3785E+10	765000	1029600
65	6	12	11	8	220000	0,99	1	5	9	11	1	1,4517E+10	765000	210600
66	6	12	11	8	220000	0,99	1	5	9	11	1	3,8508E+10	765000	210600
67	6	12	11	8	220000	0,99	1	5	9	11	1	1,4517E+10	765000	257400
68	6	12	11	8	220000	0,99	1	5	9	11	1	1,4811E+10	765000	257400
69	6	12	11	8	220000	0,99	1	5	13	6	1	1,4517E+10	765000	210600
70	6	12	11	8	220000	0,99	1	5	13	6	1	3,8508E+10	765000	210600
71	6	12	11	8	220000	0,99	1	5	13	6	1	1,4517E+10	765000	257400
72	6	12	11	8	220000	0,99	1	5	13	6	1	1,4811E+10	765000	257400
73	11	7	7	4	220000	1,01	1	5	9	11	1	3,3105E+10	550000	210600
74	11	7	7	4	220000	1,01	1	5	9	11	1	8,7811E+10	550000	210600
75	11	7	7	4	220000	1,01	1	5	9	11	1	3,3105E+10	550000	257400
76	11	7	7	4	220000	1,01	1	5	9	11	1	3,3773E+10	550000	257400
77	11	7	7	4	220000	1,01	1	5	13	6	1	3,3105E+10	550000	210600
78	11	7	7	4	220000	1,01	1	5	13	6	1	8,7811E+10	550000	210600
79	11	7	7	4	220000	1,01	1	5	13	6	1	3,3105E+10	550000	257400
80	11	7	7	4	220000	1,01	1	5	13	6	1	3,3773E+10	550000	257400
81	11	7	7	8	190000	1,01	1	5	9	11	4	1,4516E+10	765000	315900
82	11	7	7	8	190000	1,01	1	5	9	11	4	3,8503E+10	765000	315900
83	11	7	7	8	190000	1,01	1	5	9	11	4	1,4516E+10	765000	386100
84	11	7	7	8	190000	1,01	1	5	9	11	4	1,4809E+10	765000	386100
85	11	7	7	8	190000	1,01	1	5	13	6	4	1,4516E+10	765000	315900
86	11	7	7	8	190000	1,01	1	5	13	6	4	3,8503E+10	765000	315900

Table 21. Simulation results for scenarios 87-128

Simulation	Refinement	Application Scope	Compatibility	Complexity	Reference Cost	Product Life cycle	Potential Market Share	Utility/advantage	Num of Supplier	Num of Demander	Commercial Level	R&D Cost	Transfer Cost	Market Size
87	11	7	7	8	190000	1,01	1	5	13	6	4	1,4516E+10	765000	386100
88	11	7	7	8	190000	1,01	1	5	13	6	4	1,4809E+10	765000	386100
89	6	12	11	4	190000	0,99	1	5	9	11	4	3,3103E+10	550000	315900
90	6	12	11	4	190000	0,99	1	5	9	11	4	8,7806E+10	550000	315900
91	6	12	11	4	190000	0,99	1	5	9	11	4	3,3103E+10	550000	386100
92	6	12	11	4	190000	0,99	1	5	9	11	4	3,3772E+10	550000	386100
93	6	12	11	4	190000	0,99	1	5	13	6	4	3,3103E+10	550000	315900
94	6	12	11	4	190000	0,99	1	5	13	6	4	8,7806E+10	550000	315900
95	6	12	11	4	190000	0,99	1	5	13	6	4	3,3103E+10	550000	386100
96	6	12	11	4	190000	0,99	1	5	13	6	4	3,3772E+10	550000	386100
97	11	12	7	8	190000	0,99	4	5	9	11	1	1,4905E+10	885000	842400
98	11	12	7	8	190000	0,99	4	5	9	11	1	3,9535E+10	885000	842400
99	11	12	7	8	190000	0,99	4	5	9	11	1	1,4905E+10	885000	1029600
100	11	12	7	8	190000	0,99	4	5	9	11	1	1,5206E+10	885000	1029600
101	11	12	7	8	190000	0,99	4	5	13	6	1	1,4905E+10	885000	842400
102	11	12	7	8	190000	0,99	4	5	13	6	1	3,9535E+10	885000	842400
103	11	12	7	8	190000	0,99	4	5	13	6	1	1,4905E+10	885000	1029600
104	11	12	7	8	190000	0,99	4	5	13	6	1	1,5206E+10	885000	1029600
105	6	7	11	4	190000	1,01	4	5	9	11	1	3,2249E+10	470000	842400
106	6	7	11	4	190000	1,01	4	5	9	11	1	8,5542E+10	470000	842400
107	6	7	11	4	190000	1,01	4	5	9	11	1	3,2249E+10	470000	1029600
108	6	7	11	4	190000	1,01	4	5	9	11	1	3,2901E+10	470000	1029600
109	6	7	11	4	190000	1,01	4	5	13	6	1	3,2249E+10	470000	842400
110	6	7	11	4	190000	1,01	4	5	13	6	1	8,5542E+10	470000	842400
111	6	7	11	4	190000	1,01	4	5	13	6	1	3,2249E+10	470000	1029600
112	6	7	11	4	190000	1,01	4	5	13	6	1	3,2901E+10	470000	1029600
113	6	7	11	8	220000	1,01	4	5	9	11	4	1,4907E+10	885000	1263600
114	6	7	11	8	220000	1,01	4	5	9	11	4	3,954E+10	885000	1263600
115	6	7	11	8	220000	1,01	4	5	9	11	4	1,4907E+10	885000	1544400
116	6	7	11	8	220000	1,01	4	5	9	11	4	1,5208E+10	885000	1544400
117	6	7	11	8	220000	1,01	4	5	13	6	4	1,4907E+10	885000	1263600
118	6	7	11	8	220000	1,01	4	5	13	6	4	3,954E+10	885000	1263600
119	6	7	11	8	220000	1,01	4	5	13	6	4	1,4907E+10	885000	1544400
120	6	7	11	8	220000	1,01	4	5	13	6	4	1,5208E+10	885000	1544400
121	11	12	7	4	220000	0,99	4	5	9	11	4	3,2251E+10	470000	1263600
122	11	12	7	4	220000	0,99	4	5	9	11	4	8,5547E+10	470000	1263600
123	11	12	7	4	220000	0,99	4	5	9	11	4	3,2251E+10	470000	1544400
124	11	12	7	4	220000	0,99	4	5	9	11	4	3,2903E+10	470000	1544400
125	11	12	7	4	220000	0,99	4	5	13	6	4	3,2251E+10	470000	1263600
126	11	12	7	4	220000	0,99	4	5	13	6	4	8,5547E+10	470000	1263600
127	11	12	7	4	220000	0,99	4	5	13	6	4	3,2251E+10	470000	1544400
128	11	12	7	4	220000	0,99	4	5	13	6	4	3,2903E+10	470000	1544400

Appendix 4.

Table 22. Patent value for each scenario

Simulation	Patent Value	Simulation	Patent Value	Simulation	Patent Value	Simulation	Patent Value
1	0,220290517	**33**	0,244159815	**65**	0,36267403	**97**	0,560641474
2	0,198990289	**34**	0,22339649	**66**	0,341892615	**98**	0,539305407
3	0,222568938	**35**	0,253273499	**67**	0,367230872	**99**	0,578868843
4	0,222308544	**36**	0,253019669	**68**	0,366976821	**100**	0,57860801
5	0,336861946	**37**	0,360731243	**69**	0,312102602	**101**	0,510070046
6	0,315561718	**38**	0,339967919	**70**	0,291321186	**102**	0,488733978
7	0,339140367	**39**	0,369844928	**71**	0,316659444	**103**	0,528297414
8	0,338879973	**40**	0,369591097	**72**	0,316405392	**104**	0,528036582
9	0,230182704	**41**	0,351567528	**73**	0,380184879	**105**	0,419514575
10	0,183983321	**42**	0,304160144	**74**	0,332796063	**106**	0,373350112
11	0,232461125	**43**	0,360681213	**75**	0,384741721	**107**	0,437741943
12	0,231896341	**44**	0,36010166	**76**	0,384162396	**108**	0,437177586
13	0,346754133	**45**	0,468138957	**77**	0,329613451	**109**	0,368943146
14	0,30055475	**46**	0,420731573	**78**	0,282224634	**110**	0,322778683
15	0,349032554	**47**	0,477252641	**79**	0,334170293	**111**	0,387170515
16	0,348467769	**48**	0,476673089	**80**	0,333590967	**112**	0,386606157
17	0,375491844	**49**	0,540580064	**81**	0,519764167	**113**	0,569458628
18	0,354189025	**50**	0,519819264	**82**	0,498985276	**114**	0,54811997
19	0,380048686	**51**	0,558807433	**83**	0,52659943	**115**	0,596799681
20	0,379788261	**52**	0,558553633	**84**	0,526345409	**116**	0,596538817
21	0,492063273	**53**	0,657151493	**85**	0,469192738	**117**	0,5188872
22	0,470760454	**54**	0,636390693	**86**	0,448413847	**118**	0,497548542
23	0,496620115	**55**	0,675378861	**87**	0,476028001	**119**	0,546228252
24	0,496359689	**56**	0,675125062	**88**	0,475773981	**120**	0,545967388
25	0,309384072	**57**	0,382273532	**89**	0,488703628	**121**	0,706617484
26	0,263182164	**58**	0,334868739	**90**	0,441317402	**122**	0,660450496
27	0,313940914	**59**	0,400500901	**91**	0,495538891	**123**	0,733958536
28	0,313376098	**60**	0,39992138	**92**	0,494959597	**124**	0,733394148
29	0,4259555	**61**	0,498844961	**93**	0,438132199	**125**	0,656046055
30	0,379753593	**62**	0,451440168	**94**	0,390745973	**126**	0,609879068
31	0,430512342	**63**	0,517072329	**95**	0,444967462	**127**	0,683387108
32	0,429947527	**64**	0,516492809	**96**	0,444388168	**128**	0,682822719

Appendix 5.

Table 23. Patent 1

Period	Refinement	Application Scope	Compatibility	Complexity	Reference Cost	Product Life cycle	Potential Market Share	Utility/advantage	Num of Supplier	Num of Demander	Commercial Level	R&D Cost	Transfer Cost	Market Size	Unit Total Cost
1	9	11	10	7	210.000,00 NTD	1	3	4	12	10	3	736.104.635,87 NTD	510.000,00 NTD	3549000	6.151,00 NTD
2	9	11	10	7	210.000,00 NTD	1	3	4	12	10	3	1.036.132.274,93 NTD	510.000,00 NTD	3549000	6.145,00 NTD
3	9	11	10	7	210.000,00 NTD	1	3	4	12	10	3	1.389.690.350,90 NTD	510.000,00 NTD	3276000	6.143,00 NTD
4	9	11	10	7	210.000,00 NTD	1	3	4	12	10	3	1.341.990.212,64 NTD	285.000,00 NTD	2808000	6.145,00 NTD
5	9	11	10	7	210.000,00 NTD	1	3	4	12	10	3	850.297.165,74 NTD	285.000,00 NTD	2574000	13.835,00 NTD
6	9	11	10	7	210.000,00 NTD	1,01	3	4	12	10	3	1.140.844.909,47 NTD	285.000,00 NTD	2574000	13.835,00 NTD
7	9	11	10	7	210.000,00 NTD	1,01	3	4	12	10	3	1.323.720.494,59 NTD	285.000,00 NTD	2574000	13.835,00 NTD
8	9	11	10	7	210.000,00 NTD	1,01	2	4	12	10	3	1.368.488.276,99 NTD	255.000,00 NTD	1950000	13.835,00 NTD
9	9	11	10	7	210.000,00 NTD	1,01	2	3	12	10	3	986.539.417,79 NTD	255.000,00 NTD	1950000	13.561,00 NTD
10	9	11	10	7	210.000,00 NTD	1,01	2	3	12	10	3	1.104.449.012,10 NTD	255.000,00 NTD	1755000	13.673,00 NTD
11	9	11	9	7	210.000,00 NTD	1,01	2	3	11	10	3	1.311.990.165,56 NTD	255.000,00 NTD	1755000	13.663,00 NTD
12	8	11	9	7	210.000,00 NTD	1	2	3	11	9	2	1.416.632.162,74 NTD	255.000,00 NTD	702000	13.686,00 NTD
13	8	10	9	6	210.000,00 NTD	1	2	3	11	9	2	1.031.478.359,94 NTD	225.000,00 NTD	624000	11.167,00 NTD
14	8	10	9	6	210.000,00 NTD	1	2	3	11	9	2	1.128.616.496,52 NTD	225.000,00 NTD	468000	11.141,00 NTD
15	8	10	9	6	200.000,00 NTD	1	2	3	11	9	2	1.462.622.514,75 NTD	225.000,00 NTD	468000	11.135,00 NTD
16	8	10	9	6	200.000,00 NTD	1	2	3	11	9	2	1.687.069.994,74 NTD	225.000,00 NTD	468000	11.132,00 NTD
17	8	10	9	6	200.000,00 NTD	1	2	3	11	9	2	1.446.211.555,32 NTD	225.000,00 NTD	468000	12.527,00 NTD
18	8	10	9	6	200.000,00 NTD	1	2	3	11	9	1	1.598.819.486,45 NTD	225.000,00 NTD	390000	12.648,00 NTD
19	8	10	9	6	200.000,00 NTD	1	2	3	11	9	2	1.532.939.285,24 NTD	225.000,00 NTD	312000	12.637,00 NTD
20	8	10	9	6	200.000,00 NTD	1	2	3	10	9	2	1.607.385.624,20 NTD	225.000,00 NTD	312000	12.662,00 NTD
21	8	10	9	6	200.000,00 NTD	0,99	2	3	10	9	2	3.193.813.688,41 NTD	510.000,00 NTD	3549000	12.662,00 NTD
22	8	10	9	6	200.000,00 NTD	0,99	2	3	10	9	2	3.629.292.984,51 NTD	510.000,00 NTD	3549000	12.662,00 NTD
23	8	10	8	5	200.000,00 NTD	0,99	2	3	10	9	2	4.067.724.559,83 NTD	510.000,00 NTD	3276000	12.662,00 NTD
24	7	9	8	5	200.000,00 NTD	0,99	2	3	10	9	2	3.916.428.400,61 NTD	285.000,00 NTD	2808000	12.662,00 NTD
25	7	9	8	5	200.000,00 NTD	0,99	2	3	10	8	1	3.525.866.312,09 NTD	285.000,00 NTD	2574000	12.662,00 NTD
26	7	9	8	5	200.000,00 NTD	0,99	2	3	10	8	2	3.882.832.187,65 NTD	285.000,00 NTD	2574000	12.662,00 NTD
27	7	9	8	5	200.000,00 NTD	0,99	2	3	10	8	2	4.068.121.215,75 NTD	285.000,00 NTD	2574000	12.662,00 NTD
28	7	9	8	5	200.000,00 NTD	0,99	2	3	10	8	2	3.995.103.924,82 NTD	255.000,00 NTD	1950000	12.662,00 NTD
29	7	9	8	5	200.000,00 NTD	0,99	2	3	10	8	2	3.637.889.007,30 NTD	255.000,00 NTD	1950000	12.662,00 NTD
30	7	9	8	5	200.000,00 NTD	0,99	2	3	10	8	2	3.737.130.416,42 NTD	255.000,00 NTD	1755000	12.662,00 NTD
31	6	9	8	5	200.000,00 NTD	0,99	2	3	10	8	2	3.794.884.152,13 NTD	255.000,00 NTD	1755000	12.662,00 NTD
32	7	9	8	5	200.000,00 NTD	0,99	2	3	10	8	2	3.993.587.938,50 NTD	255.000,00 NTD	702000	12.662,00 NTD
33	7	9	8	5	200.000,00 NTD	0,99	2	3	10	8	2	3.689.817.425,21 NTD	225.000,00 NTD	624000	12.662,00 NTD
34	7	9	8	5	200.000,00 NTD	0,99	2	3	10	8	2	3.400.683.334,20 NTD	225.000,00 NTD	468000	12.662,00 NTD
35	7	9	8	5	200.000,00 NTD	0,99	2	3	10	8	2	3.683.743.518,25 NTD	225.000,00 NTD	468000	12.662,00 NTD
36	7	9	8	5	200.000,00 NTD	0,99	2	3	10	8	2	3.808.456.486,05 NTD	225.000,00 NTD	468000	12.662,00 NTD
37	7	9	8	5	200.000,00 NTD	0,99	2	3	10	8	2	3.245.494.875,58 NTD	225.000,00 NTD	468000	12.662,00 NTD
38	7	9	8	5	200.000,00 NTD	0,99	2	3	10	8	2	3.485.008.488,43 NTD	225.000,00 NTD	390000	12.662,00 NTD
39	7	9	8	5	200.000,00 NTD	0,99	2	3	10	8	2	3.048.664.790,33 NTD	225.000,00 NTD	312000	12.662,00 NTD
40	7	9	8	5	200.000,00 NTD	0,99	2	3	10	8	2	3.176.402.938,72 NTD	225.000,00 NTD	312000	12.662,00 NTD

Table 24. Patent 2

Period	Refinement	Application Scope	Compatibility	Complexity	Reference Cost	Product Life cycle	Potential Market Share	Utility/advantage	Num of Supplier	Num of Demander	Commercial Level	R&D Cost	Transfer Cost	Market Size	Unit Total Cost
1	11	12	11	8	220.000,00 NTD	1	4	5	13	11	4	1.086.728.544,76 NTD	825.000,00 NTD	1404000	6.151,00 NTD
2	11	12	11	8	220.000,00 NTD	1	4	5	13	11	4	1.189.967.756,51 NTD	825.000,00 NTD	1404000	6.145,00 NTD
3	11	12	11	8	220.000,00 NTD	1	4	5	13	11	4	1.707.250.543,82 NTD	825.000,00 NTD	1404000	6.143,00 NTD
4	11	12	11	8	220.000,00 NTD	1	4	5	13	11	4	1.862.652.725,72 NTD	825.000,00 NTD	1404000	6.145,00 NTD
5	11	12	11	8	220.000,00 NTD	1	4	5	13	11	4	1.108.463.115,66 NTD	825.000,00 NTD	1404000	13.835,00 NTD
6	11	12	11	8	220.000,00 NTD	1,01	4	5	13	11	4	1.252.998.012,11 NTD	825.000,00 NTD	1404000	13.835,00 NTD
7	10	12	11	8	220.000,00 NTD	1,01	4	5	13	11	4	1.742.025.857,25 NTD	825.000,00 NTD	1404000	13.835,00 NTD
8	10	12	11	8	220.000,00 NTD	1,01	4	5	13	11	4	1.900.688.224,79 NTD	825.000,00 NTD	1404000	13.835,00 NTD
9	10	12	11	8	220.000,00 NTD	1,01	4	5	13	11	4	1.602.924.603,52 NTD	825.000,00 NTD	1404000	13.561,00 NTD
10	10	12	11	8	220.000,00 NTD	1,01	4	5	13	11	4	1.957.198.109,12 NTD	825.000,00 NTD	1404000	13.673,00 NTD
11	10	12	11	8	220.000,00 NTD	1,01	3	5	13	11	4	2.530.990.780,75 NTD	825.000,00 NTD	1053000	13.663,00 NTD
12	10	12	11	8	220.000,00 NTD	1	3	5	12	11	3	2.426.574.279,74 NTD	825.000,00 NTD	936000	13.686,00 NTD
13	10	11	11	8	220.000,00 NTD	1	3	5	12	11	3	2.210.994.504,67 NTD	825.000,00 NTD	936000	11.167,00 NTD
14	10	11	11	7	220.000,00 NTD	1	3	5	12	10	3	2.855.017.008,51 NTD	600.000,00 NTD	936000	11.141,00 NTD
15	10	11	10	7	210.000,00 NTD	1	3	4	12	10	3	3.315.246.547,22 NTD	600.000,00 NTD	819000	11.135,00 NTD
16	9	11	10	7	210.000,00 NTD	1	3	4	12	10	3	3.735.629.372,62 NTD	600.000,00 NTD	819000	11.132,00 NTD
17	9	11	10	7	210.000,00 NTD	1	3	4	12	10	3	2.605.975.050,34 NTD	600.000,00 NTD	819000	12.527,00 NTD
18	9	11	10	7	210.000,00 NTD	1	3	4	12	10	3	3.298.311.694,06 NTD	600.000,00 NTD	819000	12.648,00 NTD
19	9	11	10	7	210.000,00 NTD	1	3	4	12	10	3	3.733.637.036,95 NTD	600.000,00 NTD	819000	12.637,00 NTD
20	9	11	10	7	210.000,00 NTD	1	3	4	12	10	3	4.138.081.177,03 NTD	600.000,00 NTD	819000	12.662,00 NTD
21	9	10	10	7	210.001,00 NTD	0,99	3	4	12	10	3	4.138.081.177,03 NTD	600.000,00 NTD	819000	12.662,00 NTD
22	9	10	10	7	210.001,00 NTD	0,99	3	4	11	10	3	3.949.986.578,07 NTD	600.000,00 NTD	819000	12.662,00 NTD
23	9	10	9	7	210.000,00 NTD	0,99	3	4	11	10	3	3.949.986.578,07 NTD	600.000,00 NTD	819000	12.662,00 NTD
24	9	10	9	6	210.000,00 NTD	0,99	3	4	11	10	3	3.949.986.578,07 NTD	570.000,00 NTD	819000	12.662,00 NTD
25	9	10	9	6	210.000,00 NTD	0,99	3	4	11	10	3	3.949.986.578,07 NTD	570.000,00 NTD	819000	12.662,00 NTD
26	8	10	9	6	210.000,00 NTD	0,99	3	4	11	10	3	3.949.986.578,07 NTD	570.000,00 NTD	819000	12.662,00 NTD
27	8	10	9	6	210.002,00 NTD	0,99	3	4	11	10	3	3.949.986.578,07 NTD	570.000,00 NTD	819000	12.662,00 NTD
28	8	10	9	6	210.002,00 NTD	0,99	3	4	11	10	3	3.949.986.578,07 NTD	570.000,00 NTD	819000	12.662,00 NTD
29	8	10	9	6	210.000,00 NTD	0,99	3	4	11	10	3	3.949.986.578,07 NTD	570.000,00 NTD	819000	12.662,00 NTD
30	8	10	9	6	210.000,00 NTD	0,99	3	4	11	10	3	3.949.986.578,07 NTD	570.000,00 NTD	819000	12.662,00 NTD
31	8	10	9	6	210.000,00 NTD	0,99	3	4	11	10	3	3.949.986.578,07 NTD	570.000,00 NTD	819000	12.662,00 NTD
32	8	10	9	6	210.000,00 NTD	0,99	3	4	11	10	3	3.949.986.578,07 NTD	570.000,00 NTD	819000	12.662,00 NTD
33	8	10	9	6	210.003,00 NTD	0,99	3	4	11	10	3	3.949.986.578,07 NTD	570.000,00 NTD	819000	12.662,00 NTD
34	8	10	9	6	210.003,00 NTD	0,99	3	4	11	10	3	3.949.986.578,07 NTD	570.000,00 NTD	819000	12.662,00 NTD
35	8	10	9	6	210.000,00 NTD	0,99	3	4	11	10	3	3.949.986.578,07 NTD	570.000,00 NTD	819000	12.662,00 NTD
36	8	10	9	6	210.000,00 NTD	0,99	3	4	11	9	3	3.761.891.979,12 NTD	570.000,00 NTD	819000	12.662,00 NTD
37	8	10	9	6	210.000,00 NTD	0,99	3	4	11	9	3	3.761.891.979,12 NTD	570.000,00 NTD	819000	12.662,00 NTD
38	8	10	9	6	210.000,00 NTD	0,99	3	4	11	9	3	3.761.891.979,12 NTD	570.000,00 NTD	819000	12.662,00 NTD
39	8	10	9	6	210.000,00 NTD	0,99	3	4	11	9	3	3.761.891.979,12 NTD	570.000,00 NTD	819000	12.662,00 NTD
40	8	10	9	6	210.000,00 NTD	0,99	3	4	11	9	3	3.761.891.979,12 NTD	570.000,00 NTD	819000	12.662,00 NTD

Table 25. Patent 3

Period	Refinement	Application Scope	Compatibility	Complexity	Reference Cost	Product Life cycle	Potential Market Share	Utility/advantage	Num of Supplier	Num of Demander	Commercial Level	R&D Cost	Transfer Cost	Market Size	Unit Total Cost
1	8	9	8	5	200.000,00 NTD	1	2	3	10	8	3	815.046.408,57 NTD	540.000,00 NTD	468000	6.151,00 NTD
2	8	9	8	5	200.000,00 NTD	1	2	3	10	8	3	892.475.817,39 NTD	540.000,00 NTD	468000	6.145,00 NTD
3	8	9	8	5	200.000,00 NTD	1	2	3	10	8	3	1.280.437.907,87 NTD	540.000,00 NTD	468000	6.143,00 NTD
4	7	9	8	5	200.000,00 NTD	1	2	3	10	8	3	1.396.989.544,29 NTD	540.000,00 NTD	468000	6.145,00 NTD
5	7	9	8	5	200.000,00 NTD	1	2	3	10	8	3	831.347.336,74 NTD	540.000,00 NTD	468000	13.835,00 NTD
6	7	9	8	5	200.000,00 NTD	1,01	2	3	10	8	3	939.748.509,08 NTD	540.000,00 NTD	468000	13.835,00 NTD
7	7	9	8	5	200.000,00 NTD	1,01	2	3	10	8	3	1.306.519.392,94 NTD	540.000,00 NTD	468000	13.835,00 NTD
8	7	9	8	5	200.000,00 NTD	1,01	2	3	10	8	3	1.425.516.168,59 NTD	540.000,00 NTD	468000	13.835,00 NTD
9	7	9	8	5	200.000,00 NTD	1,01	2	3	10	8	3	1.202.193.452,64 NTD	540.000,00 NTD	468000	13.561,00 NTD
10	7	9	8	5	200.000,00 NTD	1,01	2	3	10	8	3	1.467.898.581,84 NTD	540.000,00 NTD	468000	13.673,00 NTD
11	7	9	8	5	200.000,00 NTD	1,01	2	3	10	8	3	1.898.243.085,56 NTD	540.000,00 NTD	468000	13.663,00 NTD
12	7	9	8	5	200.000,00 NTD	1	2	3	10	8	2	1.899.058.131,97 NTD	540.000,00 NTD	390000	13.686,00 NTD
13	7	9	8	5	200.000,00 NTD	1	2	3	10	8	2	1.730.343.525,40 NTD	540.000,00 NTD	390000	11.167,00 NTD
14	7	9	8	5	200.000,00 NTD	1	2	3	10	8	2	2.335.923.006,97 NTD	540.000,00 NTD	390000	11.141,00 NTD
15	7	9	8	5	200.000,00 NTD	1	2	3	10	8	2	2.712.474.447,73 NTD	540.000,00 NTD	390000	11.135,00 NTD
16	7	9	8	5	200.000,00 NTD	1	2	3	10	8	2	3.056.424.032,14 NTD	540.000,00 NTD	390000	11.132,00 NTD
17	7	9	7	5	200.000,00 NTD	1	2	3	10	7	2	2.013.707.993,44 NTD	540.000,00 NTD	390000	12.527,00 NTD
18	7	9	7	5	200.000,00 NTD	1	2	3	10	7	1	2.548.695.399,96 NTD	540.000,00 NTD	312000	12.648,00 NTD
19	7	9	7	5	200.000,00 NTD	1	2	2	10	7	2	2.885.083.164,92 NTD	540.000,00 NTD	312000	12.637,00 NTD
20	7	9	7	5	200.000,00 NTD	1	2	2	9	7	2	3.009.513.583,29 NTD	540.000,00 NTD	312000	12.662,00 NTD
21	7	8	7	4	200.000,00 NTD	0,99	2	2	9	7	2	3.009.513.583,29 NTD	510.000,00 NTD	312000	12.662,00 NTD
22	6	8	7	4	190.000,00 NTD	0,99	2	2	9	7	2	3.009.513.583,29 NTD	510.000,00 NTD	312000	12.662,00 NTD
23	6	8	7	4	190.000,00 NTD	0,99	2	2	9	7	2	3.009.513.583,29 NTD	510.000,00 NTD	312000	12.662,00 NTD
24	6	8	7	4	190.000,00 NTD	0,99	2	2	9	7	2	3.009.513.583,29 NTD	510.000,00 NTD	312000	12.662,00 NTD
25	6	8	7	4	190.000,00 NTD	0,99	2	2	9	7	1	3.009.513.583,29 NTD	510.000,00 NTD	234000	12.662,00 NTD
26	6	8	7	4	190.000,00 NTD	0,99	1	2	9	7	2	3.009.513.583,29 NTD	510.000,00 NTD	156000	12.662,00 NTD
27	6	8	7	4	190.000,00 NTD	0,99	1	2	9	7	2	3.009.513.583,29 NTD	510.000,00 NTD	156000	12.662,00 NTD
28	6	8	7	4	190.000,00 NTD	0,99	1	2	9	7	2	3.009.513.583,29 NTD	510.000,00 NTD	156000	12.662,00 NTD
29	6	8	7	4	190.000,00 NTD	0,99	1	2	9	7	2	3.009.513.583,29 NTD	510.000,00 NTD	156000	12.662,00 NTD
30	6	8	7	4	190.000,00 NTD	0,99	1	2	9	7	2	3.009.513.583,29 NTD	510.000,00 NTD	156000	12.662,00 NTD
31	6	8	7	4	190.000,00 NTD	0,99	1	2	9	7	2	3.009.513.583,29 NTD	510.000,00 NTD	156000	12.662,00 NTD
32	6	8	7	4	190.000,00 NTD	0,99	1	2	9	6	2	2.821.418.984,34 NTD	510.000,00 NTD	156000	12.662,00 NTD
33	6	8	7	4	190.000,00 NTD	0,99	1	2	9	6	2	2.821.418.984,34 NTD	510.000,00 NTD	156000	12.662,00 NTD
34	6	8	7	4	190.000,00 NTD	0,99	1	2	9	6	2	2.821.418.984,34 NTD	510.000,00 NTD	156000	12.662,00 NTD
35	6	7	7	4	190.000,00 NTD	0,99	1	2	9	6	2	2.821.418.984,34 NTD	510.000,00 NTD	156000	12.662,00 NTD
36	6	7	7	4	190.000,00 NTD	0,99	1	2	9	6	2	2.821.418.984,34 NTD	510.000,00 NTD	156000	12.662,00 NTD
37	6	7	7	4	190.000,00 NTD	0,99	1	2	9	6	2	2.821.418.984,34 NTD	510.000,00 NTD	156000	12.662,00 NTD
38	6	7	7	4	190.000,00 NTD	0,99	1	2	9	6	2	2.821.418.984,34 NTD	510.000,00 NTD	156000	12.662,00 NTD
39	6	7	7	4	190.000,00 NTD	0,99	1	2	9	6	2	2.821.418.984,34 NTD	510.000,00 NTD	156000	12.662,00 NTD
40	6	7	7	4	190.000,00 NTD	0,99	1	2	9	8	2	3.197.608.182,25 NTD	510.000,00 NTD	156000	12.662,00 NTD