TRIZ for Business Plan Evaluation

A Thesis

by

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Περίληψη

Η δημιουργία ενός αποτελεσματικού επιχειρησιακού σχεδίου, η ανάθεση πόρων κατά το βέλτιστο τρόπο, και η αξιολόγηση των αποτελεσμάτων μπορούν να αποδειχθούν δύσκολο έργο για κάθε επιχείρηση ή εταιρεία. Επιπλέον, δεν υπάρχουν πολλοί τρόποι για μια επιχείρηση να υπολογίσει εκ των προτέρων την επιτυχία του επιχειρησιακού της σχεδίου. Σε αυτήν τη διπλωματική εργασία χρησιμοποιούνται οι μέθοδοι TRIZ, xTRIZ, Root Conflict Analysis (RCA+), PEST Analysis, Porter's Five Forces Analysis, SWOT Analysis, Cost-Effectiveness ή Cost-Benefit Analysis και Multi-Criteria Decision Analysis για να παρασχεθεί ένας σταθερός και πιο ολοκληρωμένος τρόπος αξιολόγησης της στρατηγικής ενός επιχειρησιακού σχεδίου. Η προτεινόμενη διαδικασία βοηθά μια επιχείρηση να συνειδητοποιήσει σε τι κατάσταση βρίσκεται, να σκεφτεί ποιο μέλλον προτιμά και να βρει έναν τρόπο για να το κατορθώσει.

Introduction

The main goal of this thesis is to propose a way to evaluate a business plan but also to assist in eliminating the risks and in some cases lead to innovation. The tools of the process that will be presented are found in literature and the whole process, which is a combination of these tools, is based completely on my logical conclusions and was not included in any of the literature I studied. In order to prove that this process is right, I applied it on the business plan of a real enterprise.

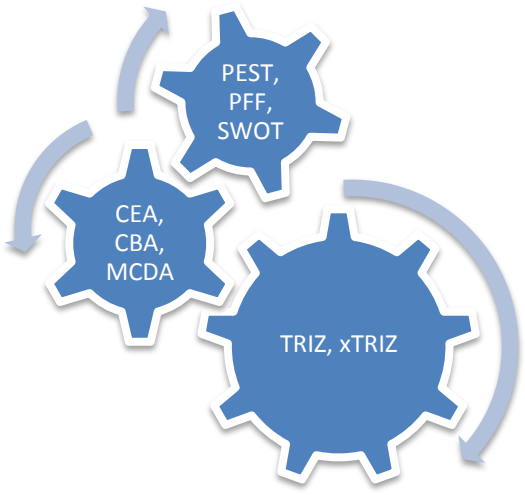
The biggest challenge was to utilize TRIZ (Theory of Inventive Problem Solving), which originates from engineering, in the business plan evaluation process. Nevertheless, TRIZ has evolved much, becoming useful not only in engineering but in other disciplines as well.

It should be obvious by now that this is not a standard evaluation based in financial ratios, but instead a systematic process that analyzes and evaluates the whole strategy of a business. In order for a strategy to be successful, all the actions taken need to contribute to a certain direction and the harms must be eliminated as much as possible. Additionally, it is important for every part involved to be fully aware of the business's weaknesses. This will translate in increased gain and reduced costs.

The process that this thesis presents:

- analyzes the business plan in depth
- examines all the actions used from a business to achieve a certain goal
- provides alternative strategies facilitating the decision making process
- evaluates the final result.

To make this a successful project other tools were used as well, with TRIZ constituting the core of this process. Starting with TRIZ and xTRIZ, all these tools will be presented first, and then the whole process will be described step by step. An application example will follow, after assuring that every method is described and understood.



1 TRIZ

1.1 About TRIZ

TRIZ (teoriya resheniya izobretatelskikh zadatch), which in English translates as Theory of Inventive Problem Solving, is a problem-solving, analysis and forecasting tool derived from the study of patterns of invention in the global patent literature. It was developed by the Soviet engineer, inventor, scientist, journalist and writer Genrich Altshuller and his colleagues, in the years between 1946 and 1985.

TRIZ is a method based on logic and data, not intuition. It relies on the study of the patterns of problems and solutions.

It offers a comprehensive toolkit with simple tools for understanding problems and detailed techniques for system analysis to arrive at solutions and stimulate new ideas for purposes ranging from simple improvements to radical inventions. (Ilevbare et al., 2011)

1.2 Why TRIZ?

TRIZ uses the world's knowledge to help us systematically unlock our own knowledge, unlike other methods like brainstorming, mind mapping, etc., which offer random help. Its method ensures that all the blanks are filled and no solutions are missed. More importantly, the fact that TRIZ is based on proven successful patents provides a safe path towards problem-solving and innovation.

Even though most of TRIZ applications have been addressing technological areas and engineering disciplines, several research works demonstrated that the fundamental TRIZ principles could be observed in a number of different areas such as Business and Management, Advertisement, Investment and Arts. (Ilevbare et al., 2011)

1.3 Main tools and techniques of TRIZ

The main tools within TRIZ, as displayed in (Ilevbare et al., 2011), are the following:

- 40 inventive principles, for solving *contradictions*.
- 8 trends of evolution of technical systems, for identifying directions of technology development.
- 76 standard solutions, for solving system problems.
- 2500 effects, which are concepts extracted from the body of engineering and scientific knowledge and used for inventive problem solving.
- Function analysis and substance field analysis.
- Nine windows, for understanding the context of a problem and finding solutions.
- Creativity tools, for overcoming psychological inertia.
- ARIZ (Algorithm for Inventive Problem Solving).

For simplicity, only the tools that will be used in business plan evaluation will be further analyzed.

1.4 TRIZ systematic approach to problem solving

When facing a specific factual problem, the first move is to state it in a conceptual format. Then, by applying TRIZ conceptual solutions which derive from an overlap of 40 inventive principles, 8 trends of evolution and 76 standard solutions, the problem can be matched with the most preferable one. After that, the conceptual solution needs to be translated into a factual solution. This process as pictured by (Ilevbare et al., 2011) is shown in Figure 1.1:

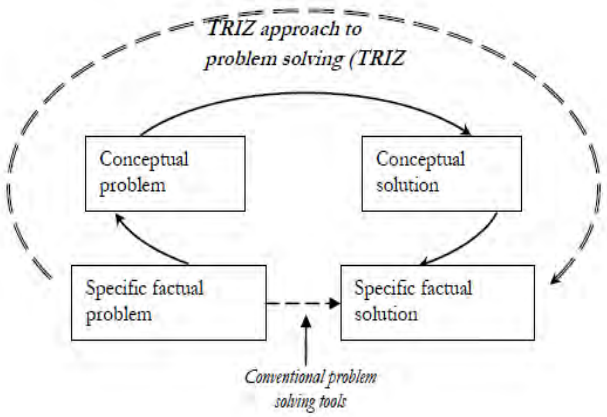


Figure 1 - TRIZ systematic approach to problem solving (the TRIZ prism) (Ilevbare et al., 2011)

1.5 TRIZ concepts

Contradictions

Contradictions are one of the main concepts of TRIZ. There are three types of contradictions as presented in (Ilevbare et al., 2011):

- Administrative contradictions: when the expected result of a process comes with an undesirable phenomenon.
- Technical contradictions: when trying to improve a certain aspect of a system, some of the functions are unfavorably affected or harmful functions are introduced.
- Physical contradictions: when certain requirements cannot be met from a physical point of view.

Ideality

One of the main objectives of TRIZ is to increase the degree of Ideality of a system. Ideality can be expressed mathematically as:

$$Ideality = \frac{\sum Benefits}{(\sum Costs + \sum Harms)} = \frac{\sum Useful\ Fuctions}{(\sum Inputs + \sum Harmful\ Fuctions)}$$

where

- *Useful Functions* consist of wanted actions and
- *Harmful Functions* are all those unintended, undesirable actions that oppose to the main goal.

Similarly to the technical systems, businesses tend to evolve according to the generic TRIZ trend of increasing the degree of Ideality. (Souchkov, 2010)

(Souchkov, 2010) defines Ideality for a business as:

$$Ideality = \frac{Value\ Creators - Value\ Reducers}{Costs}$$

where

- *Value Creators* are all parameters, useful features and functions of a Value Proposition which are positively perceived by the market.
- *Value Reducers* are contradictions and harmful functions that reduce the perceived value.
- *Costs* are all direct and indirect expenses required to generate and maintain the Value Creators.

Increasing the degree of Ideality provides a more competitive value proposition or in this case a business plan, with more chances of success. It is obvious that in order to increase Ideality and additionally competiveness, a business might follow one or all of the following directions:

- Increasing Value Creators.
- Decreasing Value Reducers, eliminating Harmful Functions.
- Minimizing Costs.

Evolution of a technique

Patterns of evolution are useful for developing solutions to problems and predicting the future evolution of a technique. (Ilevbare et al., 2011) Trends of evolution are used to solve the "perennial optimization versus innovation dilemma" that will be presented later.

Evolution may come from the increase of Ideality as mentioned above or from the transition to another technique.

The eight distinct trends that guide a technique's development as presented in (Ilevbare et al., 2011) are:

- Less human involvement: more automation and self-systems.
- Non-uniform development of parts.

- Simplicity – Complexity – Simplicity: a repeating pattern where a system starts by being simple, increases in complication and then is simplified again.
- Increasing dynamism, flexibility and controllability.
- Increasing segmentation and use of fields: progressive use of smaller parts until parts are so small that together they have a field effect.
- Matching and mismatching: the system evolves to deliver all the required functions more effectively. It becomes matched to deliver all its benefits, not just its primary benefits. The system can also be deliberately mismatched to improve performance.
- Increased Ideality (described in detail above).
- Stages of evolution: systems slowly improve when they are newly invented, and afterwards there is a rapid increase in Ideality which tails off until further improvement is no longer possible and new systems are required.

Resources

An important aspect towards improvement is searching for the available resources and new ways to acquire them. Before any decisions are made, a business needs to review its arsenal.

Resources can be grouped according to the following (Ilevbare et al., 2011):

- Natural or environmental.
- System resources.
- Functional resources.
- Substance resources.
- Energy/field resources.
- Time resources.
- Space resources.
- Information resources.

1.6 TRIZ tools

Forty Inventive (Business) Principles

All kinds of contradictions can be solved using these inventive principles. They were extracted by exploration of patent information by Altshuller.

(Mann, Domb, 1999) placed these principles of TRIZ in the context of business management and organizational innovation. They state that this version of the forty inventive principles exists merely to stimulate creative thinking about business situations and is not meant to eliminate the need for detailed, in-depth analysis of a particular inventive situation. The original format can always be used when facing a technical problem.

In the same paper, it is also proposed that formulating an ideal final result and the reasons that it cannot be achieved, usually leads to the

identification of contradictions. This fact needs to be noted since proposing a better business plan is based on solving these contradictions.

The forty inventive principles will be displayed above without analytical explanation. (Mann, Domb, 1999) provide an analytical description for each of them.

*Light blue color is used for the changed principles.

1. Segmentation	2. Taking out (Separation)	3. Local quality	4. Asymmetry	5. Merging
6. Universality	7. "Nested Doll"	8. Anti-Weight	9. Prior counteraction	10. Prior action
11. Cushion in advance	12. Equipotentiality	13. "The other way round"	14. Spheroidality - Curvature	15. Dynamics
16. Partial or Excessive Actions	17. Another dimension	18. Mechanical vibration	19. Periodic Action	20. Continuity of Useful Action
21. Skipping or Rushing through	22. Blessing in disguise	23. Feedback	24. Intermediary	25. Self-service
26. Copying	27. Cheap disposables	28. Replace mechanical system	29. Pneumatics and Hydraulics	30. Flexible membranes
31. Porous materials	32. Color change	33. Homogeneity	34. Discarding and recovering	35. Parameter change
36. Phase transition	37. Thermal expansion	38. Strong oxidants (Boosted interactions)	39. Inert atmosphere	40. Composite materials (structures)

Table 1 - 40 Inventive (Business) Principles

Function Analysis

Analysis of function of a system is closely tied with the understanding of the benefits delivered by that system. This helps to clarify how well the benefits are being delivered and what harms are present.

Function analysis is performed by breaking down a system into simple units and laying them in form of Subject – Action – Object. (Ilevbare et al., 2011)

Someone can consider these actions in terms of achieving a certain goal or becoming an obstacle for the business. Function analysis makes sure there are no harmful functions unnoticed when searching for a business plan's defects.

2 xTRIZ and RCA+

The xTRIZ method is presented in (Souchkov et al. 2007). The authors state that xTRIZ was developed in order to analyze business and management problems, to identify root conflicts and causes, to select the problems to solve, to generate new ideas and solution strategies, and evaluate the final results.

The basic premise behind It, is that the TRIZ methodology for solving complex and difficult problems that demand out-of-the-box thinking, is independent from the area of application and can address all kinds of problems arising in other types of systems such as businesses.

The process that will be described utilizes not only TRIZ tools but also Root Conflict Analysis (RCA+), a Comparative Ranking Scorecard and Multi-Criteria Decision Matrix. xTRIZ consists of six steps but it can usually end up being an iterative process.

The six-step process as pictured in (Souchkov et al. 2007) is:

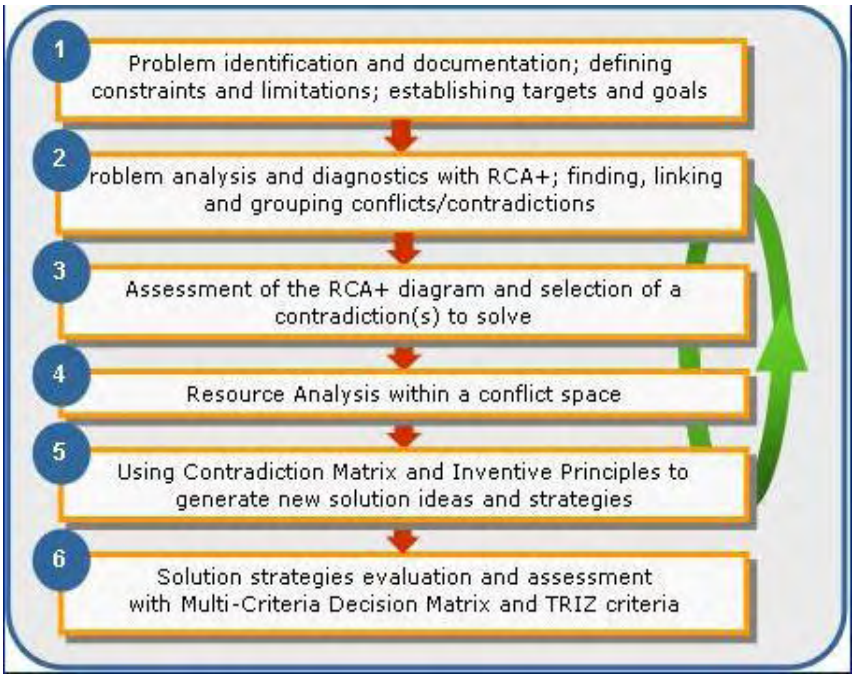


Figure 2 – Six-step basic xTRIZ process

xTRIZ's steps will be described with as much detail as possible without examples (xTRIZ process will be displayed thoroughly in the application part).

Step 1 - Problem Analysis

In order to apply this process, a problem or a major target needs to be set first. TRIZ's Function Analysis can be a useful tool in this Step, but more analysis will be provided later.

It is also important, before moving to the second step, to identify the basic criteria for evaluation, the constraints and the limitations that will be encountered.

Step 2 – Applying RCA+ to Extract and Map Contradictions

In this step RCA+ is utilized. RCA+ is targeted at extracting and presenting contradictions that contribute to a general problem in a structured tree-like way rather than exploring negative causes only in a random manner (Souchkov et al. 2007). This is why, with RCA+, someone can locate underlying reasons which contribute to one or several problems inside a business.

We initiate the procedure by choosing the main negative effect to be analyzed. This selection is tied to the major criteria for evaluation that were set earlier. "RCA+ helps explore all factors that have contributed to this negative effect by revealing and presenting all interrelated contradictions. An RCA+ diagram is built in a top-down manner by presenting a cause and asking a series of control questions to understand whether the presented cause is a contradiction or not, whether it needs other conditions or not, and what underlying causes are leading towards this specific cause." (Souchkov et al. 2007)

The important features of an RCA+ diagram are:

- All negative causes are tagged with a minus (-) sign and all positive with a plus (+) sign.
- Causes with both positive and negative effects are identified as contradictions and are to be tagged with a plus-minus (+-) sign.
- Contradictions that are closer to the top-level problem contribute more that problem.
- The bottom-level contradictions, usually express problem solutions that have a broader range of consequences for the entire system.
- Solving bottom-level contradictions, usually leads to long-term solutions with potential side benefits and solving top-level contradictions helps to obtain faster but short-term solutions.
- The RCA+ diagram involves two types of relationships between causes:
    - OR – when two or more independently acting causes contribute to a certain effect.
    - AND – when both causes together provide a negative effect.
- As a result, removing any one of the causes of a negative effect that is caused by both of them (AND), will result to the negative effect's abolition. This of course, will not happen when there is an OR relationship.

Step 3 – Contradiction Analysis

Selecting the contradiction(s) to analyze is based yet again on the evaluation criteria of Step 1. The ideal scenario here is to search for a single contradiction which will lead to a single solution that eliminates all alternative causes simultaneously. Souchkov et al. propose that the

best way to do this is to combine several potential solution directions by applying inventive principles from one or more contradictions simultaneously into one and translating that direction to a solution that fits in the overall context of the system.

(Souchkov et al. 2007) propose three strategies to selecting the contradiction(s) to solve:

- Select the highest contradiction(s) in a chain that contributes to the main negative effect. Usually results in solutions solving a very specific problem.
- Select a root contradiction within a broader scope.
- Combine both approaches and perform comparative ranking of all contradictions along the entire chain of contradictions to select the most promising.

An example of Comparative Ranking will be presented in the application part of this thesis.

Step 4 – Resource Analysis

After selecting the contradiction to solve, an inventory of the available resources within the systemic context of the contradiction needs to be created. This process uses one of the main tools of TRIZ, Resources.

Step 5 – Solution Strategies Generation

The standard method in this step is to apply the "contradiction matrix for business and management" (Mann, Domb, 1999). Shuffling (as proposed earlier) through the 40 Inventive Principles and using a technique of choice (like brainstorming) to create solution ideas, results to the creation of a table of ideas – solution strategies.

Step 6 – Ideas Evaluation and Assessment

After concluding with this process for the first time, this same process can be repeated for other contradictions and result to several solution strategies.

The evaluation of these strategies needs to be a mixture of the selected criteria, the business's goals and costs. In the following chapters, two methods of evaluation will be introduced.

3 PEST Analysis

PEST analysis is a tool used to measure the effect the broader macro-environment has on a business's operation. Macro-environment is divided into four dimensions: political, economic, social and technological, which constitute the PEST acronym. The data that PEST analysis provides help the business forecast future trends in its broader environment. (Papadakis V., 1999)

In the example below, several macro-environment factors are listed for each of the four dimensions.

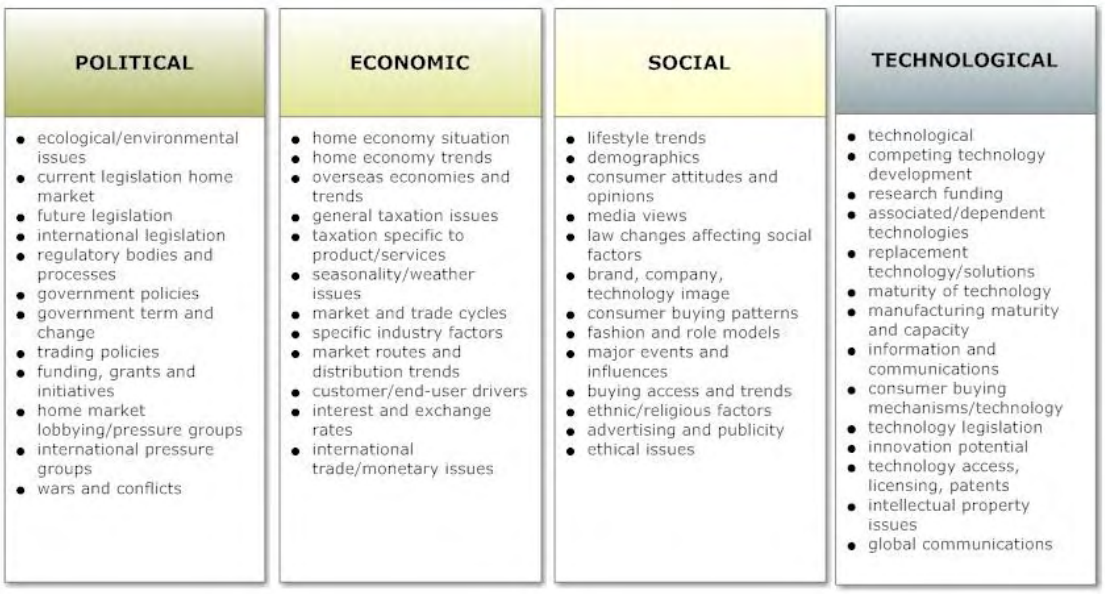


Figure 3 – PEST Analysis Example

4 Porter's Five Forces Analysis

This structural analysis of an industry helps a business determine the nature of competition in its micro-environment. An integrated analysis of a business's competition is necessary for the formation of a complete strategy. (Papadakis V., 1999)

Porter's Five Forces are:

- threat of new entrants
- threat of substitutes
- bargaining power of suppliers
- bargaining power of buyers
- industry rivalry

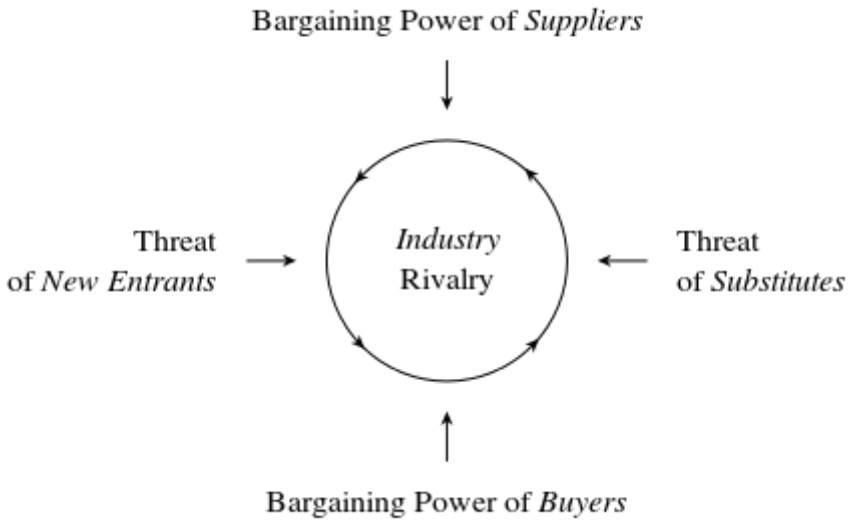


Figure 4 – Porter's Five Forces (Wikipedia)

5 SWOT Analysis

SWOT Analysis is a planning method used to evaluate the strengths, weaknesses, opportunities and threats involved in a business venture. It helps a business specify its objectives and identify the internal and external factors that are favorable and unfavorable to achieve these objectives.

The technique is credited to Albert Humphrey, an American business and management consultant. (Wikipedia)

Figure 5 – SWOT Analysis (Wikipedia)

6 Multi-criteria Decision Analysis (MCDA)

Multi-criteria decision matrix, a tool of MCDA, is used in the xTRIZ method to evaluate the solution strategies. For a more profound analysis, MCDA will is described in its own chapter.

MCDA is used to provide a classification of options, from the most to the least preferred, depending on the objectives to be achieved. It breaks a problem into more manageable pieces, to allow judgments to be made more easily. Usual is the case where some conflict or trade-off appears amongst the objectives. A typical conflict is created between costs and benefits as Dodgson et al. mention.

MCDA consists of eight steps, but since the most ground is covered from TRIZ, only the final steps will be described and used in the evaluation process, prospectively or retrospectively since it is fit for both. Prospective evaluation requires organizing the criteria and objectives in a way that facilitates the scoring options. On the other hand, retrospective evaluation is the examination of the overall results at the level of objectives.

Organizing the aforementioned criteria requires a hierarchical representation - a value tree, where the criteria are clustered under higher-level and lower-level objectives. The objective on the top of the tree is obviously the overall result, which takes both costs and benefits into account. The next level separates costs and benefits so they can be further analyzed in the following levels.

The next step is describing the consequences for each criterion. In the case of more complex problems, where a value tree is required, it is often necessary to construct a separate consequence table for each option.

Scoring the options on the criteria is the next important and tricky step. The tricky part is that all of the criteria now need to be compared together. The authors describe this problem as comparing apples to oranges and this is how it is done. “The key idea is to construct scales representing preferences for the consequences, to weight the scales for their relative importance, and then to calculate weighted averages across the preference scales.” (Dodgson J.S. et al., 2009) Although there are many ways to do this, (Dodgson J.S. et al., 2009) illustrates relative preference scales, which is a simple tool. Imagine a scale where the most and least preferred options (scored with 100 and 0 respectively) are anchored at its ends. A score needs to be assigned in every option to declare its strength of preference.

Checking the consistency of the scores on each criterion is usually part of the previous step. It helps to ensure valid results by revealing inconsistencies in the initial assessment of scores. The method for checking consistency differs from one type of scale to another.

Weight assessment for each of the criteria is used to reflect a criterion’s relative importance to the decision. Weights are needed because as mentioned before the units may differ from one criterion to another.

Dodgson et al. mention that most proponents of MCDA use the method of *swing weighting* to elicit weights for the criteria. Assigning the weights can lean on the importance of each criterion and also the difference between the least and most preferred option in a scale. The numbers used for weights need to be representative of the ratios of the valuation of the differences in preferences between the top and bottom scores of the scales.

After the completion of the above steps, it is time for the calculation of the overall weighted scores at each level in the hierarchy. Extracting the overall preference score for each option requires the use of the following mathematical formula:

$$S_i = \sum_{j=1}^{n} w_j s_{ij}$$

where S_i is the overall preference score for option i, s_{ij} is the preference score for option i on criterion j, and w_j the weight for each criterion.

After calculating the overall scores at each level, the next logical step is to calculate the overall weighted scores. (Dodgson J.S. et al., 2009) emphasize on the fact that the simple weighted averaging calculation is justified only if all the criteria are **mutually preference independent**. This means that all preference scores assigned to all options on one criterion must be unaffected by the preference scores on the other criteria. Even if some criteria seem to be correlated, it is important that the options are scored independently.

The final scores may reveal a decisive option – solution, or a slight difference which means that the process should be iterated or difficult decisions should be made. In any case, (Dodgson J.S. et al., 2009) provides many paths that decision makers can take after acquiring the results.

7 Cost-Effectiveness (CEA) and Cost-Benefit (CBA) Analysis

Apart from MCDA, there are other methods that assist in the evaluation process and the choice of the proper strategy – solution. CEA and CBA help this process in various aspects and they are both useful in different phases of the evaluation process.

CEA points out the least-cost way of achieving an objective when multiple options exist. To achieve that, relative costs and outcomes are compared for each one of the strategies or the actions that constitute a strategy. Typically, the CEA is expressed in terms of a ratio where the denominator expresses gain and the numerator is the cost associated with this gain.

CBA, on the other hand, values the expected impacts of an option in monetary terms. It is used to calculate and compare benefits and costs of a project. Its purposes are to determine if the investment that is about to be made is sound, and to provide a basis for comparing projects.

Although it is difficult to distinguish between these two methods, their essential difference lies on the fact that CBA assigns a monetary value to the measure of effect while CEA uses relative costs and gain. (Dodgson J.S. et al., 2009), Wikipedia.

8 S-Curves and Trends of Evolution

This is a chapter mostly referring to businesses and organizations involved with product designing, which include an R&D department. The most comprehensive presentation of S-Curves in association to R&D was found in (Mann, 1999). In this paper, S-Curves and TRIZ's Trends of Evolution are used in R&D Strategy Planning.

In order for the aforementioned organizations to be successful, an evaluation process of where their products lie on the technology evolution is crucial. These products must also meet the needs of some market. S-Curves and Trends of Evolution are used mostly on strategic decisions related with mature products, although in my opinion they could prove useful in competition.

The "perennial optimization versus innovation" dilemma is basic in strategy decisions about mature products and, as Mann mentions, it is two-fold. "It includes:

- knowing whether or not there is another technology generation to innovate towards
- knowing how far along the S-Curve the business – product is at the moment and therefore, being able to balance the customer value of the current product versus the amount of R&D investment required to mature the new generation product to a state where it offers customers the same or greater level of value."

TRIZ provides the technology maturity determination tools needed for this kind of decisions. According to (Slocum, 1999), TRIZ recommends the use of four metrics to help in this process. These four curves plot the maturity of a technology from different perspectives: performance, number of inventions, the inventive level of those inventions and profitability.

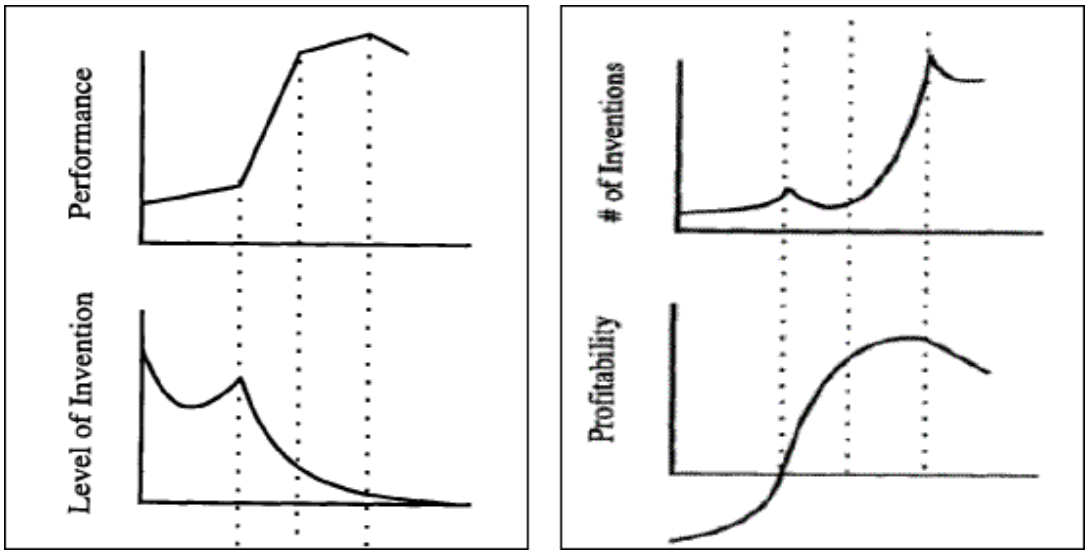


Figure 6 - Altshuller's "Lifeness" of Technological Systems

Performance is often the easiest to obtain data for, Mann says. To use these data, it is important to know which performance parameters to use in the analysis, and the difficulty there is that the relative importance of different parameters often changes as the product matures.

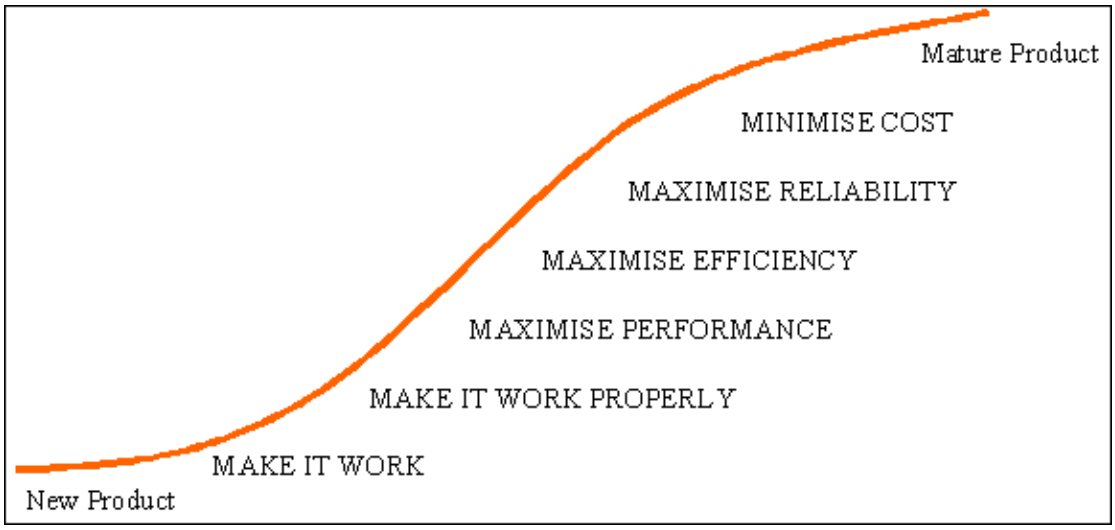


Figure 7 - Typical Invention-Focus S-Curve [Mann, 1999]

As the typical invention-focus S-Curve shows, there is a circular logic to selecting appropriate performance metrics to evaluate a product. (Mann, 1999) states that parameters related to product efficiency are commonly found to be the most appropriate measures of performance in S-Curve Analysis.

Number of inventions can be found online since there many patent databases exist. Nonetheless, the results need to be checked for the relevance of the inventions to be confirmed.

Discovering the level of invention can be an extremely time consuming process, as Mann mentions, when a product has notable history.

Profitability is probably the most difficult to obtain data for and depends heavily on the role of the product for the company.

Two other metrics, not developed by Altshuller, are displayed in (Mann, 1999):

- Cost Reduction Related Inventions refers to improvements that make the product cheaper and it can be a useful pointer to the maturity of a product.
- Symptom Curing correlates to "Level of Invention" metric and refers to inventions that reduce the defects of a product.

9 Business Plan Evaluation Process

The main task of this thesis is to show how TRIZ can be utilized in the business plan evaluation process. Constituting the main tool in this project, TRIZ is used in many different occasions and levels of the evaluation process.

Initiating the evaluation process means setting the goals of the business plan. These goals can originate from a business's image of the future, analysis of the market preferences, past mistakes or the need for innovation. The clarity of these goals is crucial for this process since everything is based on the achievement of the goals and doubt between the decision makers can prove destructive.

To assist in setting the goals, three techniques described in chapters 4, 5 and 6 can be utilized. PEST analysis is essential when conducting a strategic analysis or doing market research, because it provides a company with the macro-environmental factors it needs to take into consideration. On the other hand, Porter's Five Forces analysis gives an overview of the micro-environmental factors a company needs to take into account. Macro and micro environments, both affect the operation of a company, and this is the reason why PEST and Porter's Five Forces analyses have a major role in the development of a company's business plan. Although these techniques produce an analytical image of a company's environment, SWOT analysis is another method that should be performed before any goals are set by a business. SWOTs are extremely useful in later steps when the company takes actions to achieve its objectives, and relate to both macro and micro environment of the company.

After the goals are set, all the actions inside a business plan need to be inspected and decisions are to be made on which of these actions are contributing to the achievement of a goal or in which way they bring risk or harm to the business. This can be done using TRIZ's Function Analysis. As mentioned before, a harmful function is not necessarily an obvious maleficence, but also a function that does not contribute to a certain goal. As a result of this interpretation, an action can be useful in regard with a goal and harmful for another. These kinds of actions are called *contradictions* in the TRIZ language.

Following harmful functions' detection, xTRIZ must be used to eliminate the harm and resolve any contradictions. The choice of contradictions to solve depends significantly on the business's goals and how deep into the business's structure the changes will reach. In this case, MCDA can assist with the choice of the right contradiction, as it weights the available options against previously agreed criteria. Of course, the ideal situation would include the resolution of every contradiction and the application of RCA+ in every harmful function.

xTRIZ not only analyzes a problem to its roots, but also provides many alternative solutions – strategies, in form of ideas, for the decision makers to take into consideration. The methods used in xTRIZ are quiet

simple to understand and proved to be easy to use in the application part of this thesis that will be presented afterwards.

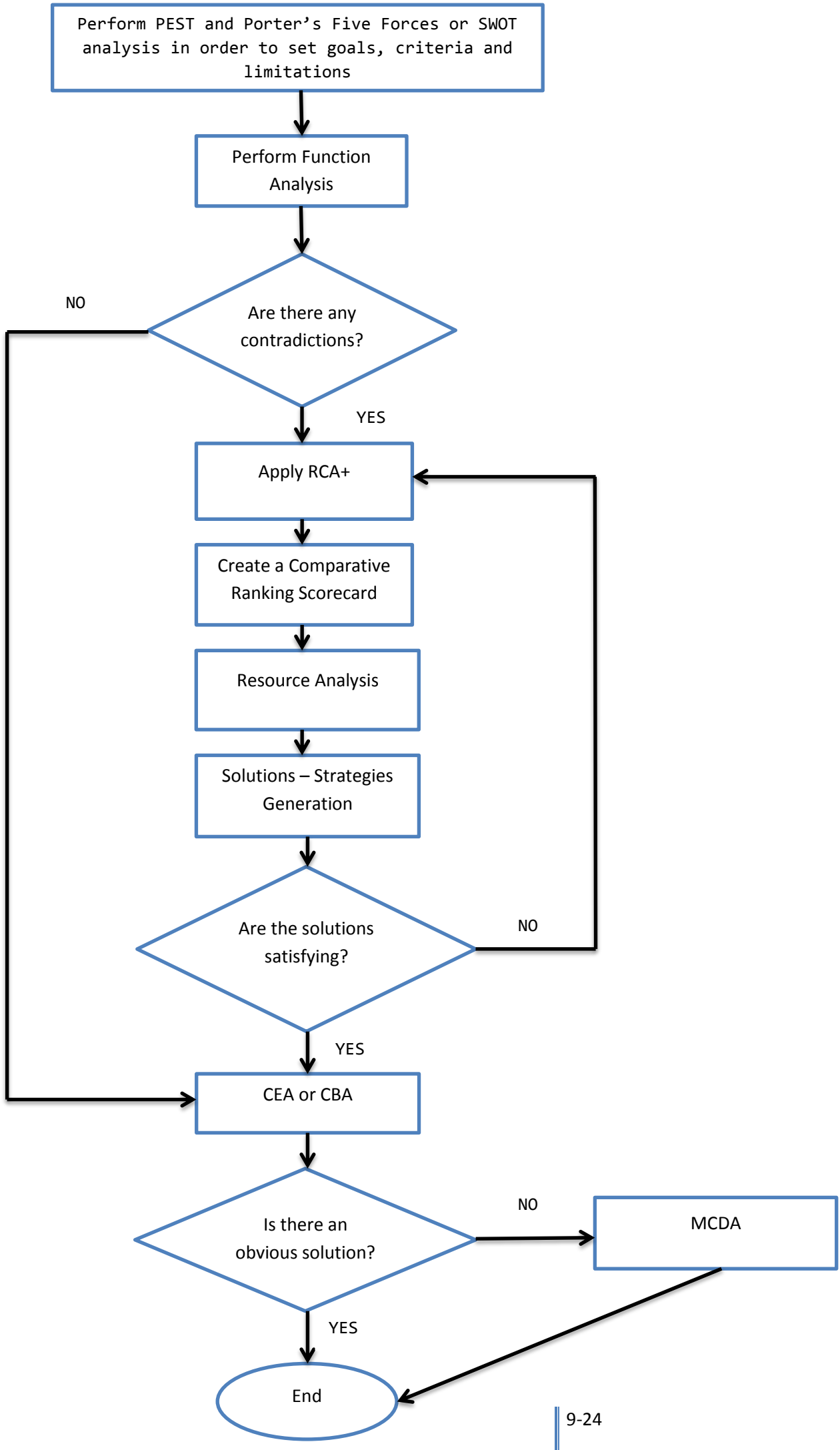
The next step involves the use of MCDA, CEA or CBA so that the ideas produced by xTRIZ can be evaluated as reasonable or risky strategies. In any case, my opinion is that CBA or CEA play a key role in the evaluation process and should be carried out before Step 6 of xTRIZ and namely, before the final MCDA is performed.

Depending on the nature of the business's services, translation in monetary terms may or may not be appropriate. As mentioned before, CBA and CEA are both useful in different kinds of businesses. Using CBA to translate a solution in monetary terms is usually not an easy task and requires research and experience. This also applies in the case of CEA where many different kinds of costs must be taken into consideration.

When every possible solution is expressed in a form of costs-to-efficiency ratio or in monetary terms, and if difficulties arise in the decision making process, then it is wise to perform an MCDA to help out with this task.

Finally, it is very important to mention that if any product design and creation is included in a business, S-Curves and Trends of Evolution can work as a map of where to take the business next or of what is wrong with the current product(s). It can also assist in evaluating a product prior or after any of the aforementioned processes are applied.

The flowchart for this process is presented above. There is no starting point because someone can use these methods separately. Also, some details that are mentioned above are excluded for simplicity. S-Curves and Trends of Evolution which apply in certain types of businesses cannot be presented as a general case.


Perform PEST and Porter's Five Forces or SWOT analysis in order to set goals, criteria and limitations
Perform Function Analysis
Are there any contradictions?
NO
YES
Apply RCA+
Create a Comparative Ranking Scorecard
Resource Analysis
Solutions – Strategies Generation
Are the solutions satisfying?
NO
YES
CEA or CBA
Is there an obvious solution?
NO
MCDA
YES
End

10 Application of the Business Plan Evaluation Process

In this part of my thesis, I applied TRIZ tools, useful for business plan strategic evaluation, to "Water and Waste Water Municipal Enterprise of Volos"'s (WWMEV) business plan. It is important to note that, in some cases, I required the help of an experienced CEO of WWMEV and an experienced economist, when I was out of my field of expertise.

Locate the Harmful Functions

The first task in hand, was to understand the goals set by WWMEV and categorize the actions and measures taken to achieve these goals. WWMEV sets three clear goals, improvement of their services to the customers (citizens), environmental protection and corporate social responsibility. For the achievement of these goals, three lines of action are set, each described with measures, actions and research.

It is clear in TRIZ, that every action which does not contribute to a certain goal is a harmful function for that goal. I located these harmful functions and tried to eliminate them, or at least find a more acceptable action (although TRIZ is against making compromises). This is a form of function analysis used by TRIZ.

A fairly common state is those harmful functions or even problematic actions to be well known by a business. Nonetheless, function analysis is a useful tool that helps recognize harm even in areas that we did not think it existed.

Apply RCA+ to Map Contradictions

After analyzing the measures and actions taken by WWMEV for the achievement of certain goals, I found a particular action to be a contradiction. More specifically, WWMEV was planning to drill for new sources of water. Although this is necessary for the company to improve its services, it is not an action in line with environmental protection. The next step towards improvement is to solve this contradiction-problem, and decide if the solution leads to a better business plan with higher probability of success.

So, for this task I performed a Root Conflict Analysis (RCA+) and it is presented above.

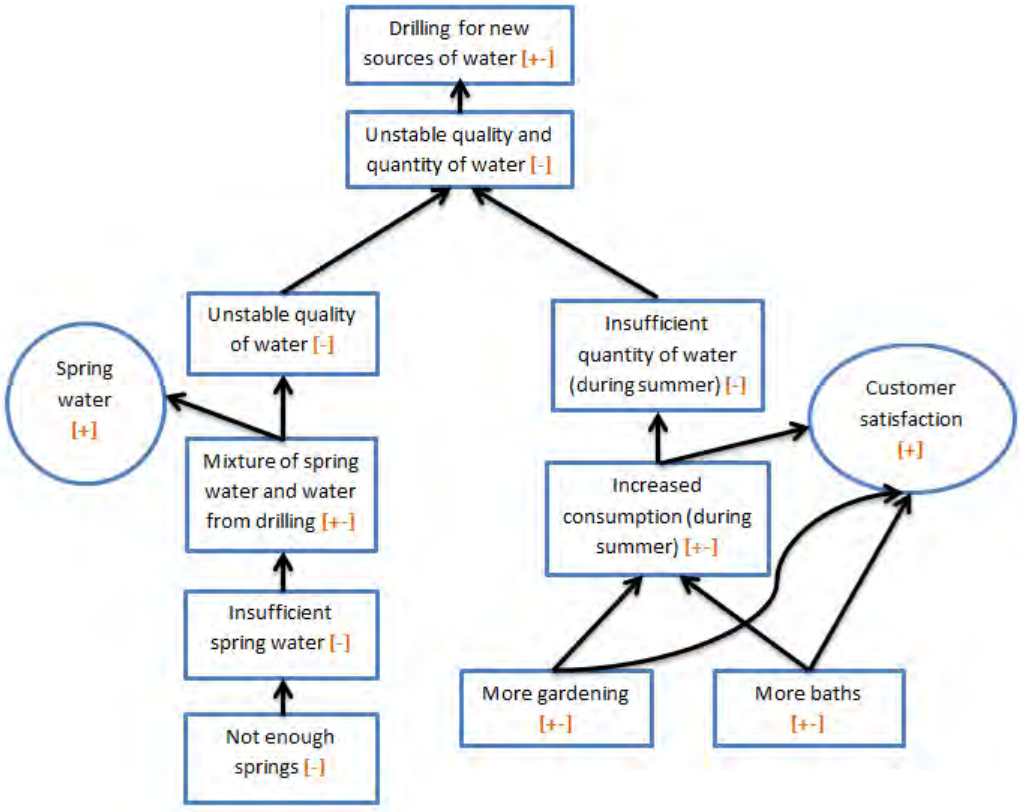


Figure 8 - Root Conflict Analysis

The contradictions found form RCA+ are:

No.	Contradiction	Positive Effect	Negative Effect
1	Mixture of spring water and water from drilling	Spring water	Unstable quality of water
2	Increased consumption (during summer)	Customer satisfaction	Insufficient quantity of water (during summer)
3	More gardening	Customer satisfaction	Increased consumption (during summer)
4	More baths	Customer satisfaction	Increased consumption (during summer)

Table 2 – Contradictions

The next step was the creation of a Comparative Ranking Scorecard and I proceeded to it for educational purposes, although the wiser choice was quiet obvious. The contradictions must be ranked according to previously agreed (or in this case on the fly) criteria.

Contradiction	1	2	3	4	Score
Mixture of spring water and water from drilling	-	1	1	1	3
Increased consumption (during summer)	-1	-	0	0	-1
More gardening	-1	0	-	0	-1
More baths	-1	0	0	-	-1

Table 3 – Comparative Ranking Scorecard

Mixture of spring water and water from drilling is the contradiction I selected to investigate.

Resource Analysis

When a contradiction was selected, I made an inventory of the available resources using TRIZ's resources. The following results were obtained:

- Natural or environmental resources : potential springs
- System resources : channel pressure reduction, distribution automation

Solution Strategies Generation

Finally, to resolve the contradiction selected, I applied the contradiction matrix for business and management and brainstormed (with help from the experienced) on those inventive principles one by one.

- Segmentation led to the need for more springs.
- Separation led to the idea of using different distribution networks for drinking water and water for other uses.
- Prior counteraction led to the idea of storing spring water during the months of increased aquifer (because during those months an amount of spring water does not fit inside the distribution network and as a result it goes to waste).
- Cushion in advance could also lead to the previously mentioned idea.
- Periodic action led to channel pressure reduction.
- Feedback led to the idea of recycling water (i.e. using purified sewage water for gardening and agriculture)
- Pneumatics and hydraulics led to the necessity of reducing leakages.
- Flexible membranes led to desalination.

Many of those ideas are already exploited and this can be a common fact, as TRIZ methods cover any probabilistic ground. TRIZ's 40 inventive principles

are meant to help with brainstorming, fill in the blanks and overcome psychological inertia.

Also, it is obvious that some contradictions, weaknesses or problems can pop-up during this analysis, like the necessity of reducing leakages, which is a technical problem that TRIZ can help with.

To leave no doubt, someone can repeat the same process for other contradictions or problems that arise, and produce alternative strategies that result in a better overall business plan.

Ideas Evaluation and Assessment

Following the ideas generation, I should perform a Cost-Effectiveness Analysis (CEA) to determine which of those ideas are worth carrying out.

The first move in CEA is to create a factual solution for each idea and find out how effective this would be and what resources would need to be acquired. By doing this, some solutions may prove to be costly or even unrealistic. In this case study for example, it is obvious that the idea of using different distribution networks for drinking water and water for other uses, is incredibly expensive. This means that I can exclude this idea from the CEA.

On the contrary, the ideas that are already exploited are crucial to the CEA as a comparison measure and may even prove to be worth repeating. Those ideas are:

- channel pressure reduction
- leakage reduction
- desalination

Although the already exploited ideas would not add construction costs, they could be less effective or expensive to maintain. CEA produces a costs-to-effectiveness ratio which distinguishes the best solution(s). Unfortunately, performing a realistic CEA is quite hard for a single individual and more so when research needs to take place, since a water supply project is not a simple task. This is why I do not display the implementation of CEA.

Finally, if many of those solutions prove to be worthy carrying out, a Multi-Criteria Decision Analysis will provide the necessary help for the right decisions to be taken.

Conclusions

The first issue I would like to address is the difficulty level of this process and how user friendly it can be. Despite not being a TRIZ expert myself, I found TRIZ's and xTRIZ's techniques rather easy to apply and even easier to understand. Even with issues outside of my area of expertise, forty inventive principles would help me produce great ideas. TRIZ pushes the brain to think and innovate by helping it overcome psychological inertia. The same applies for RCA+, which assisted a lot with asking the right questions and analyzing the problem to its main causes.

TRIZ's tools can be successfully combined with more wide-spread evaluation techniques like PEST, Porter's Five Forces, SWOT, CB, CE and MCD analyses.

This evaluation process serves as a compass for businesses, by proposing the next suitable course of action in any step. Its structure guides the parts involved, helps them avoid harmful decisions and does not leave blind spots in a business's function.

In conclusion, this project was very educating and I strongly believe that it was also successful.

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Abstract

Creating an efficient business plan, deciding the best way to assign resources and evaluating the results can be a difficult task for any business or company. Furthermore, there are not many ways for a business to calculate beforehand the success of a business plan. In this thesis, TRIZ (Theory of Inventive Problem Solving) and its tools, xTRIZ, Root Conflict Analysis (RCA+), PEST Analysis, Porter's Five Forces Analysis, SWOT Analysis, Cost-Effectiveness or Cost-Benefit Analysis and Multi-Criteria Decision Analysis are utilized in order to provide a stable and more complete way to evaluate the strategy of a business plan. The proposed procedure helps a business realize its state, think of a preferred future and find out how to get there.