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Enhancing SWOT analysis with TRIZ-based tools to integrate systematic innovation in early task design

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Abstract

SWOT analysis is the classical tool for framing the key elements towards problem design/development in various fields of activity and at various levels of interest (e.g. leadership, strategy, production process, marketing, product development, distribution, business model, operational management, etc.). Revealing the major strengths, weaknesses, threads and opportunities does not necessarily lead to an effective project formulation. Key pieces of information are usually missing in the classical SWOT analysis, like the relevance of each strength, weakness, thread and opportunity in meeting the intended vision and targets, as well as compatibility of the elements. A structured framework for setting up a comprehensive SWOT analysis is introduced in this paper. TRIZ-based tools are part of this framework for defining reliable solutions to various barriers and conflicting problems emerging from SWOT elements. This framework brings innovation in the early phase of the planning process of the envisaged system, thus minimizing the risk to define low effective areas of intervention. A case study on process improvement demonstrates the relevance of the proposed approach.

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Keywords: SWOT, TRIZ, task planning and design, innovation;

1. Introduction

Paradoxically, instead of simplifying things, society’s progress has led to more challenges for individuals, organizations and nations. This is because more complex dynamic non-linear systems bear, evolve and interact under complex patterns with higher frequencies and intensities. Thus, superposed crisis points have become usual

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phenomena on a daily basis. Very few time remains for consolidation, focus being more and more directed towards solving problems, conflicts and overpassing various types of barriers. Quasi-continuous transition phases have become nowadays' reality. But a long-term system's transition exhausts the actors involved and increases the likelihood for occurring new problems and complications. Therefore, the primary watchword of our times is innovation, in the attempt of identifying and robustly applying non-linear approaches to cross faster, with no or low compromises, over the complex of challenges that face a given system.

The issue here is that innovation is a challenge by itself [1]. It involves changings, a special behavior, risk taking and a plenty of creativity, implies non-linear, evolving processes, strives for convergence with minimum effort, looks towards (local) ideality, faces with inertia in learning and adopting new rules, practices and means, and requires a certain balance between efficiency and effectiveness in moving from a certain state (of competitiveness) to a superior one. Specific methods and methodologies for innovative problem solving have been developed by now [2], [3], [4], [5], [6], etc. Beyond the common sense, practice has already proved that effectiveness of these methods is context dependent, including in the context the experience/expertise and intellectual capacity of the applicants, too, which actually play a major role on the quality of the final solution [3], [5], [7], [8]. Larger or lower adoption of these methods clearly depends on individuals' commitment to allocate time and effort for truly understanding how to use them in an effective way. A brief look on the literature and on various surveys done in industry demonstrates that a short list of methods is somehow largely adopted in practice by non-experts in the field of innovation engineering and management [9], [10], [11]. In this short list, brainstorming and SWOT (whose outputs are brainstorming results, too) occupy top positions. The major problem with these tools is that even if they are largely applied in practice, they represent only the starting phase of a problem solving process and the hard work begins somehow afterwards, when solutions have to be formulated [12]. From this point, tools like TRIZ could become useful means to complete the exercise of solution formulation [8], [12]. However, even TRIZ application is a challenge for most of the people that have come in contact with its instruments [2], [8], [13]. Considering that the work is guided by an expert, a supplementary problem occurs, too. Effectiveness of TRIZ application depends, beyond the TRIZ expertise of the applicants, in the quality of problem formulation [2]. There are various studies that show that, in many cases, SWOT analysis is poorly formulated [14]. Several reasons lead to such results, the major one being the lack of systematic construction of SWOT. As in many cases, even apparently simple tools like SWOT require a proper training and experience for an adequate construction and use [14].

Thus, the objective of this paper is to introduce an approach that improves the foundation of SWOT analysis from the perspective of logical consistency (no contradiction between its elements), functional completeness (relevant elements to be in place) and systematic connectivity (a clear path between SWOT elements and improvement projects related to solution formulation). The article is organized as follows. In section 2 basic aspects of SWOT analysis, as well as current scientific contributions that link SWOT with TRIZ are introduced. It is shown that, even if there are real merits of the previous researches to enhance the quality of SWOT analysis using TRIZ tools and concepts, there are still some areas not yet explored. Section 3 is dedicated for the theoretical description of the approach. At the beginning, TRIZ is actually applied to design the approach. Further, specific tools of quality planning and innovation engineering are logically placed within the approach to provide a systematic framework for SWOT development and structured connection with solution formulation. Application of the theory on a real case study of process improvement in the IT sector is illustrated in section 4. The paper ends with conclusions and ideas for future researches.

2. Background

This section is structured into three subsections. It starts with a brief introduction of the key issues of the SWOT analysis, continues with highlights of previous contributions that treat SWOT in relation with TRIZ and ends with the gap formulation and justification of researches done in this paper. It is shown that SWOT analysis must be linked to the vision of the system under consideration and its elements have to be ranked in a more refined way such as to increase accuracy in setting up priorities for solution formulation. Also, a deeper look at the SWOT elements and their relationships is necessary such as to grab possible hidden resources and to bring the analysis closer to the root causes.

2.1. SWOT basics

SWOT analysis is about identification of strengths, weaknesses, opportunities and threats in relation with a given subject that has to be developed [15]. Making a SWOT chart might look not so difficult, but practice shows that an effective foundation of the four categories of items from a SWOT analysis is not a minor task [14], [16], etc. There are some researches on improving the elaboration of SWOT analysis [17], [18], [19]. They consider various approaches to enhance communication between people for shearing ideas, as well as to organize the analysis process on well-defined vectors. An interesting model for correct understanding of the SWOT framework is proposed by H. Smith [14], which uses for SWOT modelling the problem formulator of the I-TRIZ formalism promoted by Ideational International in the software package Innovation Workbench® [20]. The Smith's model interprets SWOT as follows: strengths counteract weaknesses and also create opportunities; weaknesses counteract opportunities and also create threats; threats counteract opportunities [14]. A step towards a more structured tackling of SWOT is done by R. King [12], which proposes that the elements of SWOT to be defined on affinity groups, thus classical SWOT being transformed into the so-called SWOT-RS (Radar Screen).

2.2. Previous contributions for enhancing SWOT with TRIZ

It is the merit of R. King to experiment, from 2004, the use of TRIZ and Bipolar Conflict Graph as extensions of SWOT-RS in order to construct the system under consideration closer to "ideality" [12]. In this respect, a degree of importance (on a scale from 1 to 10) and a weight (between 0 and 1) are associated to each strength, weakness, opportunity and threat of an affinity group. The ratio between the weighted weaknesses and the weighted strengths is named the present degree of conflict (CP) and associates this index with the inverse of the degree of ideality from TRIZ [12]. The ratio between the weighted threats and the weighted opportunities is named the potential degree of conflict (CV). Criticality in terms of innovation requirements is given by the values of CP and CV. Indicatively, values above 0.5 require careful attention and TRIZ inventive principles are called to direct the applicants towards reliable solutions [14]. Another demarche to link SWOT with TRIZ is done by H. Smith, which applies I-TRIZ algorithm for automatically generation of rules (strategies) between the SWOT elements in order to solve problems (e.g. Find an alternative way to obtain [the] (Strengths) that offers the following: provides or enhances [the] (Opportunities), eliminates, reduces, or prevents [the] (Weaknesses)) [14].

2.3. Gap formulation and the scientific challenge

Both SWOT-RS and SWOT-I-TRIZ are powerful tools towards systematic identification and resolution of various contradictions in organizations and technical systems. However, there are some areas related to SWOT grounding and connection with the phase of design and/or development (improvement) of the system that could be taken deeper into consideration. One issue is about the lack of systematic deployment of the vision into SWOT. In our opinion, an effective SWOT analysis requires a clear rendering of vision into SWOT elements. The second issue is the request for a more accurate determination of both the impact and weight of each SWOT element in the equation of solution formulation to the given problem. The third aspect is related to a more profound consideration of the SWOT elements during their identification such as to increase chances of grabbing all essential aspects about the analyzed system and to improve the framework of problem formulation (the key issue for a successful solution generation). Withal, the gap to ideality would be reviewed from a slight wider angle than it is proposed by R. King [12]. The relationships between the SWOT elements could be also enhanced beyond the space revealed by I-TRIZ problem formulator, as H. Smith suggests [14]. Finally, the path towards solution formulation should be somehow more flexible to the context of applicants, by encouraging the use of a more diverse palette of tools for inventive problem solving and exploration of various deployment patterns of the SWOT elements into design strategies.

Thus, from a scientific point of view, the challenge is to enhance SWOT analysis such as to make it more flexible without high increase in complexity, make it more consistent and complete without involving high expertise and skills, and improve its connectivity with the forthcoming steps of the design process without needing supplementary formalisms.

3. The methodology

In the first part of this section the basic guidelines for Enhanced-SWOT design are revealed. The second part of this section is dedicated to roadmap description, as it came out by applying the basic guidelines.

3.1. Design framework for SWOT enhancement

The scientific challenge introduced in section 2.3 opens the door for basic-TRIZ (matrix of contradictions, inventive principles) in the foundation of Enhanced-SWOT. Results are systematized in Table 1.

Table 1. Guidelines for SWOT enhancement using TRIZ matrix of contradictions and inventive principles

Challenge	Translation into TRIZ	Inventive principles	Generic guidelines for SWOT enhancement
Flexibility - Complexity	35. Adaptability vs. 36. Complexity	15. Dynamicity 29. Reconfigurable construction 37. Expansion 28. Replacement of a traditional system	Some characteristics of the system or its environment must be automatically adjusted or altered to ensure optimal performance at each stage of the considered operation Use the expansion or contraction property of the system
Completeness / consistency - Expertise	8. Volume covered by the static element vs. 26. Quantity of substance 29. Accuracy to run the system vs. 26. Quantity of substance	35. Transformation of system properties 3. Increase of the local quality 32. Change transparency 30. Elastic construction	Change the concentration of the state Make a transition from a homogeneous structure of the system or of its external environment to a heterogeneous structure Use "additives" to see systems or processes that are difficult to see
Connectivity - No supplementary formalisms	33. Convenience in use vs. 18. Clarity of the flow in the process	13. Inversion/ reversion 17. Translation into a new dimension 1. Act towards system segmentation 24. Mediators	Instead taking an action that is dictated by the specifications of the problem, implement an opposite action Use a multi-level connection (interface) of systems instead of a single level (layer) Increase the degree of system's segmentation Use an intermediary system to do an action

The guideline referring to „additives for revealing some hidden aspects of the system" inspires us to use formalisms that convert natural language into numeric values like, for example, the practices from QFD in the relationship and correlation matrices [21]. This automatically suggests the need of ranked inputs in the system like, for example, depiction of vision into ranked metrics (e.g. using ANP [22] or AHP methods [23] and Saaty's scale [24]). Moreover, the same guideline reveals the dimension of hidden resources, as in TRIZ philosophy. Thus, another direction of exploration might be the use of Ishikawa method [21] and "5 Why?" to discover and add to the system some hidden causes of weaknesses' existence. The integration of supplementary tools is also encouraged by the guideline "use of intermediary systems for some actions". The guideline referring to "heterogeneous structure" strengthens this idea, but enhances it to the whole SWOT chart, not only to weaknesses. Increasing the "level of segmentation" encourages us to depict S, W, O, and T into affinity groups, if necessary. The challenging guideline "instead taking an action that is dictated by the specifications of the problem, implement an opposite action" lets us considering an innovative tool of I-TRIZ, called AFD [25], to "dig" more into the preliminary SWOT chart in order to discover potential gaps or shortcomings. The principle of "reconfigurable construction" recommends building the SWOT chart in a modular way such as the scalability of SWOT ("expansion or contraction of the system") to have no inconvenient for linking its elements with the design phase. The matrix format could be a solution to this issue. "Increasing the concentration of the state" is referring in our view to the possibility of seeing the system from several perspectives like, for example, both as relationships between inputs and SWOT elements (to define the relative weight of each element) and correlations between the SWOT elements (to define the relative impact of each element). "Multi-level interface" suggests linking each element of SWOT with the related elements when strategies are set up. Also, it indicates the use of more tools for approaching a certain complex problem, as long as each tool could reveal a different perspective of the same problem.

3.2. Roadmap of the Enhanced-SWOT

Indications from section 3.1 visualize the framework within which the roadmap of Enhanced-SWOT takes shape. Figure 1 (Fig. 1) illustrates the relationships between the SWOT elements (Spiral-model).

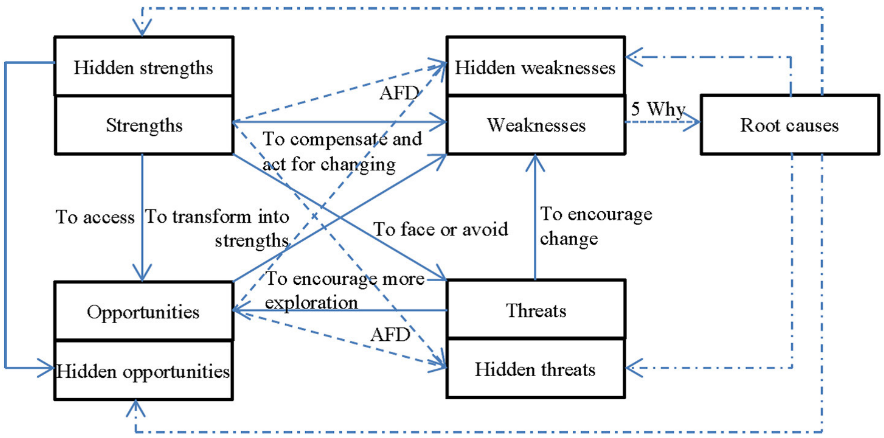

Fig. 1. Relationships between the SWOT elements (Spiral-model)

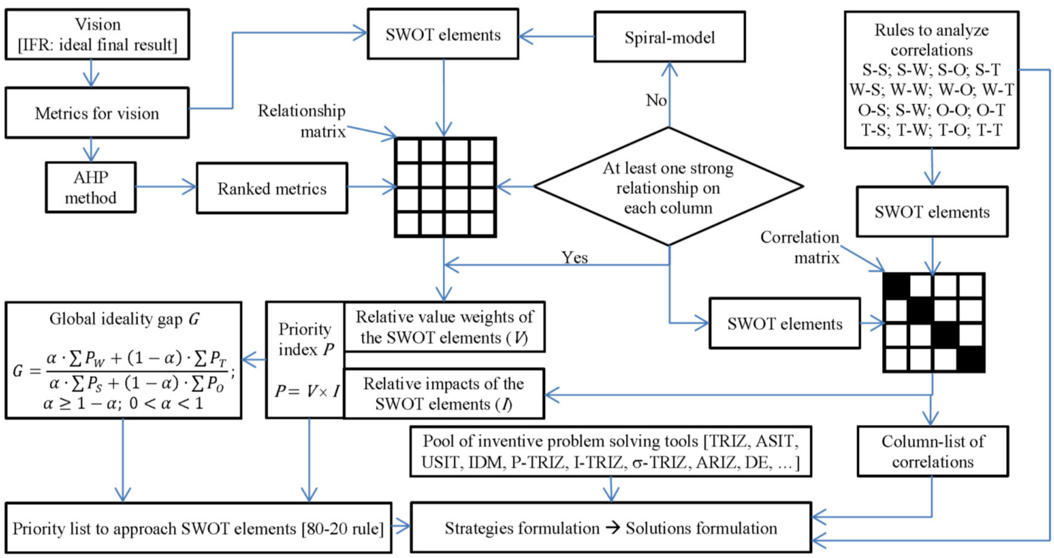

Fig. 2. Enhanced-SWOT roadmap

Continues arrows in Figure 1 show the effects between SWOT components. Dashed arrows show tools to be applied to reveal new information. Dash-dotted arrows show that root causes can reveal new information on SWOT components. Figure 2 visualizes the major blocks and steps of the Enhanced-SWOT methodology. From the standpoint of this research, a development project should start with the vision formulation. It actually reflects the "Ideal Final Result" (IFR) of the envisaged system over an envisaged time horizon (t). For example, if the system is an engine (a technical product), the vision is described by a list of measurable performance characteristics and their intended targets (e.g. gauge, weight, fuel consumption/100 km, power, noise level, etc.). If the system is a production process, the related metrics might be: the total monthly costs, the total quality costs, the cycle time, the workforce productivity, etc. If the system is a business process, the related metrics might include: turnover, profit margin, sales volume, operational income, return on assets, return on invested capital, etc. If the system is related to regional economic development, the metrics that describe the vision from an operational point of view could comprise: real gross domestic product per capita (GDP/CP), compound annual growth rate (CAGR), total-factor productivity (TFP), labor force participation rate (LFPR), foreign direct investment inflows (FDI), GDP deflator, gross enrollment rate (GER), capital account, gross fixed capital formation (GFCF), average Q-ratio, quality of life index, etc. Further, metrics should be ranked such as to provide a mean for balancing decisions if limitations in resources (money, time, people, technology, etc.) constrain the space of intervention. A very practical tool to solve this step is the AHP method [26], but several other methods could be considered in this respect.

SWOT elements have to be identified using the vision's metrics as reference. In this way, favorable premises exist to improve the quality of SWOT chart. The Spiral-model from Figure 1 has to be additionally used in order to enhance the SWOT chart. In particular, two issues from the Spiral-model are highlighted here, the "5 Why?" approach and the AFD method (anticipatory failure determination) [25]. "5 Why?" forces applicants to move beyond the effects (weaknesses), to the root causes. Thus, a set of critical points are brought to surface. They represent "harmful preconditions" to SWOT. If they cannot be removed, it might look difficult to overpass weaknesses. The basic of AFD is the change of the perspective when analyzing a system; in the sense you look at the system to destroy it [25]. This changes the vector of psychological inertia and leads to unexpected results (hidden weaknesses of the system). Application of AFD to strengths and opportunities may enrich the SWOT chart. A relationship matrix is further depicted. It deploys the metrics into SWOT elements. From the standpoint of this research, the following relationships could occur: no relationship (0); possible/weak (1); medium (3); clear above medium (5); somehow close to strong (7); strong/100% crucial (9). Numerical values are inspired from QFD practices [21]. Value weights are calculated by adding on each column the weighted relationships at the intersection cells between the ranked metrics and SWOT elements. Relative value weights (V) come up by expressing results in percentages.

The next step consists in determining the correlations between the SWOT elements. For the case of W and T, the following questions are considered: "How much a given W (or T) could increase the negative influence of another given W (or T)?"; and "How much a given S (or O) could diminish the negative influence of a given W (or T)?". For the case of S and O, the following questions are formulated: "How much a given W (or T) could block or diminish the benefic effect of a given S (or O)?"; and "How much a given S (or O) could support the achievement of a benefic effect of another given S (or O)?". A correlation level is thus established for each pair of SWOT elements. From the standpoint of this research, the following correlations could occur (+ or -): no correlation (0); possible/weak (1); medium (3); clear above medium (5); somehow close to strong (7); strong (9). Results (in absolute values) on each column are added, revealing the impact of each SWOT element. Relative impacts (I) come up by expressing results in percentages. In this point, a priority index can be calculated by multiplying I and V of each SWOT element (see Fig. 2). This index suggests the power (influence) of each SWOT element in the equation of competitiveness for the analyzed system.

In order to give an impression of the criticality (of the innovation effort) to meet the vision for the envisaged system, a global ideality gap (G) is proposed by this research work. The mathematical formula is revealed in figure 2 (Fig. 2), where $\sum P_S$, $\sum P_O$, $\sum P_W$, and $\sum P_T$ represent the sums of all Ps for the S elements, of all Ps for the O elements and so on. The coefficient α reflects the weight which is given to the current internal issues of the system (S and W) relative to the forthcoming/potential future external issues (O and W) in the equation of competitiveness for the analyzed system. Usually, α should be ≥ then $1 - \alpha$, but exceptions could occur (this strongly depends on the context, vision's metrics and time horizon). In comparison with the work of R. King [12] (see section 2.2), depiction of G into two indexes (CP and CV) is not seen so practical by this research, as long as solutions to a given problem cannot be designed and implemented instantaneously. Thus, in the time horizon associated to the vision, all four dimensions of SWOT will have to be taken aggregated into account (in a way or another each of them will play a role within the improvement projects; possibly with different intensities). The more G is closer to 0 the better, in the sense that the innovation problem is less critical. A more suggestive impression of criticality is given if G is multiplied with 100. Depending on the given context, a list of interventions is further set up (see the 80-20 rule [27]). To each SWOT element can be associated a chain of dependencies with the other elements (see the correlation matrix in Fig. 2). Thus, a particular strategy can be formulated in relation to each element from the priority list. Each link ("ring") of the chain is subject to a particular innovation approach. Therefore, the applicants can select the most appropriate tool from a pool of possible inventive problem solving instruments (see Fig. 2: TRIZ, I-TRIZ, σ-TRIZ [5], IDM [6], ASIT [4], USIT [3], etc.). The aggregation of local ideas is the next step of the methodology. Various methods could be also considered for this task (e.g. [28]).

In most of the practical situations, the primary outputs that come up from the Enhanced-SWOT (or SWOT) analysis are actually projects; desirably, intelligent innovative projects (note: intelligent = well-defined, well-directed, cost-effective, high value-added, sharp-to-the-point). Solutions come up as outputs of these projects. Projects contain objectives, metrics and targets that are actually deployed from the vision of the overall system, as well as outputs and outcomes. They also contain activities that require adequate resources and management to be put into practice. Thus, innovations should continue during projects' implementation, too, as long as the environment in which the system operates is a dynamic one.

4. Case study

In the following an illustrative example of Enhanced-SWOT application is revealed. It treats a problem from the IT industry, specifically improvement of a software development process in a software service company. The vision is to have in one year an increase of the capability for the software development process from 3 Sigma to 4 Sigma (see the Six Sigma concept). Capability is measured in this case in percentage of total quality costs from the net revenues, in terms of delay to the deadline and in terms of software defects ("bugs") at a number of lines of code. The current level of process performance is 1 bug at 500 lines of code (1 bug at around 1.5 man-days), an average delay to meet the deadline of 12 days and about 22% total quality costs from the net revenues. The target is 1 bug at 1.1 man-days (R_1 = 35%), an average delay to meet the deadline of 6 days (R_2 = 20%) and about 15% total quality costs from the net revenues (R_3 = 45%). Results of the first iteration of SWOT Spiral model (Fig. 1) are shown in Table 2.

Table 2. SWOT analysis before and after 5 Why and AFD application, with relative value weights (V), impacts (I) and priority (P)

Strengths	V	I	P	Weaknesses	V	I	P
- Flexibility reallocation of resources (≈ 20%)(16)	2.2	3.2	7.0	- Delays in deliveries - internal teams (1 ÷ 2 days)	2.0	3.0	6.0
- Openness adaptation to customer requirements	2.1	3.2	6.7	- Frequent priority changing(4)	3.5	3.4	11.9
- Motivated staff to learn new things(3)	3.2	4.1	13.1	- Insufficient time for analysis and evaluation(14)	3.1	2.3	7.1
- Skilled programmers(1)	3.5	4.9	17.2	- Lack of know-how for analysis and evaluation	2.4	1.3	3.1
				- Poor effort estimations by teams (≈ 10% error)	2.0	2.0	4.0
				- Partial knowing of the software by the testers	3.2	1.8	5.8
				- Lack of stable developers(13)	3.0	2.5	7.5
				- Differences in efficiency between team members	2.2	1.5	3.3
Additional strengths after 5 Why and AFD				Additional weaknesses after 5 Why and AFD			
- Creative staff and rapid adaptable to new requests(5)	2.1	4.2	8.8	- Some persons do not know how to self-organize	2.0	1.4	2.8
				- Vague definition of the responsibility areas	2.0	1.6	3.2
				- Lack of accurate tools to assess people's work	2.7	2.4	6.5
				- The software dev. process is not documented	3.3	1.0	3.3
				- Lack of tools for good monitoring and control(10)	2.1	3.8	8.0
				- Lack of historical data to quantify project effort	1.3	2.7	3.5
				- Gap in acc. effort estim.- very early pj. phase	1.7	3.6	6.1

Opportunities				Threats			
- Growing number of local programmers	1.7	1.8	3.1	- Changes by the client (2 wks; 20%/prj)[6]	3.4	2.6	8.8
- Local consultancy on organizational issues[15]	2.2	3.2	7.0	- Lack of some resources (u ≈ 1 pers./cycle)	3.4	1.5	5.1
- Local consultancy on software project management[2]	2.1	7.0	14.7	- Unexpected evolutions in customer behaviour	1.7	2.0	3.4
				- Bad estimation by the client (10 ÷ 30 % error)[12]	3.4	2.3	7.8
				- Complex and large applications, hard control[7]	3.3	2.5	8.3
				- Wide variety of technologies[8]	2.5	3.3	8.3
				- Lack of stable key developers / experts	2.8	1.1	3.1
Additional opportunities after 5 Why and AFD				Additional threats after 5 Why and AFD			
- Managers more conscious ("learning from past mistakes")	1.7	0.8	1.4	- Some processes of the customer are immature	2.1	2.3	4.8
				- Deadlines imposed by the client	3.0	1.8	5.4
				- Technologies - extremely high dynamics[9]	2.5	3.3	8.3
				- Facile migration of highly qualified work force	1.6	1.6	2.6
				- Difficulty to interfere in the work of colleagues	3.5	1.4	4.9
				- Process dependent by staff creativity[11]	3.7	2.1	7.8
				- Accumulated tiredness at the key persons	2.6	1.5	3.9
				- Non-attractive tasks for a longer period of time	1.6	1.4	2.2
				- Growing number of local IT companies	1.7	2.6	4.4

Results after the application of the Spiral model's procedure (5 Why and AFD) are shown in Table 2, too. They reveal a high number of new issues relative to the first iteration. The exemplification of the "5 Why" instruction is further illustrated on the weakness "Lack of know-how for analysis and evaluation": 1st why: Lack of accurate tools to assess people's work; Lack of historical data in quantifying effort in the project; …; 2nd why: Some processes of the customer are immature; Software technologies have an extremely high dynamics; …; 3rd why: Wide variety of technologies; Non-attractive tasks for a longer period of time; …; 4th why: The software development process in not documented; …; 5th why: Deadlines imposed by the client (minimal time for QA tests); … and so on. Application of AFD on the strength "Motivated staff to learn new things" is further exemplified. It means to destroy staff's motivation. This vector of "aggressive thinking" led to the idea of giving them boring tasks. Automatically, a hidden threat was revealed: Non-attractive tasks for a longer period of time. The results of relationship matrix and correlation matrix are shown in Table 2, too (V and I). With this information, the global ideality gap G was calculated (see Fig. 2), by considering $\alpha = 0.5$ (both threats and opportunities are already happening). The result is $G = 2.2$ (220%), where $\sum P_S = 52.8$, $\sum P_O = 26.2$, $\sum P_W = 82.1$ and $\sum P_T = 89.1$. This means, company is facing with a very high challenge to overpass the current state for meeting the intended targets. Because of space limitation, from the priority list of 16 items (elaborated on the P basis; $P = V \times I$ (see Fig. 2) and Table 2 (see the items with (no.) (80/20 rule))), strategy and solution formulation is shown only for the case of weakness "lack of stable developers". Strategy formulation for this example comes up from the correlation matrix (not shown in this paper) and looks as follows: improve "stability of developers" or overpass "instability of developers" by more intelligent use of "skilled developers" and "creativity of the team" with a focus on reducing also "delays" and improving "effort estimation". In TRIZ language, the strategy is interpreting as: improve stability/overpass instability (13) without increasing pressure on other people (11). The related inventive principles are: composite structures (40), separation of disturbing part from the system (2), and transformation of system's properties (flexibility, concentration, volume, conditions) (35). Thus, a first priority for the company in relation with the weakness "lack of stable developers" is to implement the "agile software development model/extreme/scrum programming" [29], which offers also opportunities for higher diversity of tasks, better effort estimation and monitoring, flexibility in team formation/reformation, robustness to change requests, backup for critical tasks. To this, company should ensure competitive salary package and contractual clauses. To implement an advanced agile programming process, the company may use the opportunity "local consultancy on software project management".

5. Conclusions and future researches

This research proposes an architectural roadmap for improving SWOT design and exploitation of its results. One focus is on displaying as much as possible "hidden" SWOT elements such as the quality and robustness of analysis to be improved. The second focus is on quantifying the implications of each SWOT element in solving the improvement task of the envisaged system. Using quantitative indicators, the innovation challenge can be better visualized. Based on the links between the SWOT elements, comprehensive improvement strategies that use inventive problem solving tools (e.g. TRIZ) can be formulated. A guidance or initial training for the first application of the algorithm is required because of its complexity. However, complexity compensates for accuracy, which is an important issue when company faces with limited resources to invest in innovation projects. Researches for refining the methodology for multi-sector strategic development are taken into account. Challenges on optimizing and balancing multiple target functions are envisaged in this respect.

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