

Chapter 2

Strategic Analysis

Abstract In this chapter, we present four basic concepts of strategic analysis as they are used in the business sector, as well as their adaptation for the case of STEM education. The four concepts are: a strategic analysis model, SWOT analysis, Delphi Method, and Risk Management.

Keywords Strategic analysis model • SWOT analysis • Delphi method • STEM education • Risk management

2.1 A Strategic Analysis Model

A business strategy addresses organizational objectives and the examination of actions needed for their actualization. The actions are based on the available resources and the evaluation of the internal as well as the external environments in which the organization operates (Nag et al. 2007).

This Brief describes a study which implemented a strategic analysis for STEM education in general and specially for the secondary school STEM education in Israel; accordingly, it refers to the strategic actions that should be taken in order to improve the achievements in STEM education on both the individual level and the national level. The study implemented a strategic planning process as is used in business organizations.

The model we used is based on three stages (described below based on Godet 2008) which sometimes, are intertwined in each other.

A. Pre-active—preliminary thinking—phase. At this stage, the organization's vision, which describes the desirable future reality of the organization, is determined. In order to foster an organizational change and to plan the desirable future changes, a wide variety of diverse ideas related to the future of the organization are suggested at this stage. Specifically, possible future scenarios are constructed based on experts' insights, both from within and outside the organization, who work together on forecasting the future of the organization and identifying threats and opportunities. The thinking on and planning for the future prepares the organization

toward the implementation of the actions that should be taken, motivate the employees, and provide a meaningful direction towards the future.

B. Proactive—preparation for the future—phase. In this stage, based on the analysis of the targets identified in the previous phase, the strategy how to achieve these targets is selected by a small team, comprises usually of managers. In addition, at this stage, the organization lays out its desirable reality, as well as its desirable quantitative measurable achievements for the future.

Then, under uncertainty conditions, several scenarios are created, which describe how to achieve the desirable change. Among the possible scenarios, one scenario is selected. This scenario should layout a flexible strategy that has the potential to exploit opportunities for the promotion of the organization's targets.

C. Appropriation—task-oriented—phase. At this stage, the change process is launched and promoted by a collective effort of all the employees of the organization. Specifically, strategic moves and detailed courses of action are determined for the realization of the vision and of the strategy formulated in the previous phases.

2.2 SWOT Analysis

SWOT—Strength, Weaknesses, Opportunities, and Threats—analysis is a methodological examination of the environment in which an organization operates. It is based on the examination of (a) internal characteristics of the organization (strengths and weaknesses) and (b) characteristics of the external environment of the organization (opportunities and threats). SWOT analysis allows the organization choosing operational strategies that foster its strengths and opportunities and protect it from its weaknesses and threats (Barney 1995).

Though the origin of SWOT analysis is at the business sector, it has been used also for the analysis of public sector organizations, e.g., schools and hospitals (Rego and Nunes 2010). For example, in the field of education, institutions of higher education carried out SWOT analysis for the evaluation of educational initiatives, such as the integration of information technologies (Sabbaghi and Vaidyanathan 2004).

SWOT analysis was applied in the case presented in this Brief for the identification of risks that the system of STEM education in Israel should prepare itself to face with (see Chap. 4). In our case, risks represent

- *conflicts* STEM teachers face while working in the education system;
- *barriers* with which other stakeholders of STEM education (representatives of the education system, academia, industry, military, and NGOs) face when they wish to promote changes and reforms in the education system.

2.3 Delphi Method

Delphi Method is based on expert evaluation of the topic under discussion. The process takes place in several rounds, in each of them a set of questions is answered by a group of experts. The Delphi procedure was first introduced by Olaf Helmer (1966) and included the following steps (usually called rounds):

- First round
 - Gathering a group of experts from the said field
 - Presentation of a set of questions about future trends to each expert separately
 - Each expert answers the questions individually and confidentially without any direct contact with the other experts.

This stage is usually implemented by interviews or questionnaires, which, in most cases, include open questions relevant to the study. The participants are asked to identify topics that will be discussed in the next rounds.

- Second round
 - The experts' answers gathered in the first round are presented to each expert, who is now asked to express his or her opinion about each of them.

Sometimes, a Delphi survey also included participants who are not considered experts in the field. Hussler et al. (2011) argue that heterogeneity is important, even if it slows down the process of reaching an agreement. Participant's heterogeneity and diversity bring up a variety of opinions, elevate opinions which are not considered as a main stream, and avoid the bias that can occur if only experts participate in the survey.

- Additional rounds take place in a similar manner until an agreement with respect to the desirable directions is reached.

The working assumption is that each round decreases the level of disagreement between the experts and eventually it is possible to formulate a strategy which is agreed upon all experts. The Delphi method attempts to avoid group thinking in which one expert opinion affects the other experts' perspective as it sometimes happens during brainstorming sessions (Linstone and Turoff 1975).

Delphi surveys are implemented in different research fields. Here are three examples.

- **Science policy.** Butts et al. (1978) describe a study which aimed to rate topics relevant to science education research in order to recommend topics for academic research. A large group of experts, who judged the topics and expressed different views, prioritized the topics by a Delphi survey.
- **Future forecasts, mainly technological forecast.** Since 1992, the Japanese National Institute of Science and Technology Policy (NISTEP) has been conducting large-scale surveys to identify medium to long-term directions for a

broad range of science and technology fields. For the ninth survey (2010), NISTEP combined three methods of Delphi, scenario and workshops, to form a vision of the “ideal” society and then study science, technology, and social systems that can help realize the vision.¹

- **Software projects.** Nakatsu and Iacovo (2009) present a study that ranked possible risks for software projects that can be outsourced to organizations either within the country or abroad.

The original Delphi procedure, as was presented by Helmer (1966), has been changed significantly since then, and today, the Delphi method is implemented in a variety of ways. Therefore, Delphi surveys may differ in their different characteristics, such as the sample size—the number of experts who participate in the survey, and the number of rounds carried out till an agreement is achieved (usually, the first round aims to identify the factors relevant for discussion and additional two rounds are applied for their rating).

However, several features of the Delphi survey are always implemented: anonymity among participants; participants’ feedbacks between rounds; attempt to reach consensus among participants; and use of open and closed questionnaires (Rowe and Wright 2011; Hussler et al. 2011; Hasson and Keeney 2011).

In the case described in this Brief, the Delphi method was used in the three phases of the strategic analysis process of STEM education in Israel. It included experts from five stakeholder groups, who have different expertise and interests. However, the importance attributed to the different attitudes of all participants enabled to lay out a comprehensive picture related to risk management of STEM education in Israel.

2.4 Risk Management

Risk is an internal or external event that has the potential to affect the implementation of the organizational strategy and the achievement of the objectives it sets for the future. The risk severity level is determined according to its (a) likelihood—the probability of its realization and (b) impact—the damage that the risk realization can cause (ISO Guide73 2009). The event, that is, the risk realization, may deviate the organization from achieving its desired orientation, either positively (upside) by enabling the organization to exhaust an opportunity, or negatively (downside), by threatening the achievement of the desired results.

The following events are commonly conceived as risks for different kinds of organizations: natural disasters, security holes (e.g., cyber-attacks), shortage or failures of human resources, financial crisis, unstable business environments, and project failures. On the one hand, in the field of accidents and safety at work, for example, only events that have negative consequences are considered as risks, and

¹See http://www.nistep.go.jp/en/?page_id=56.

therefore, risk management as the field of safety focuses solely on the prevention of damage and the reduction of the intensity of the risk impacts. On the other hand, events which are recognized as an opportunity for the organization reflect a positive future. For example, an unexpected business opportunity may evolve as a result of a change introduced into the tax policy that may enable the organization to expand its markets.

Risks are classified in different ways, e.g., by different organizational concerns: strategic risks, financial risks, operational risks, political risks, and hazard risks (related to facilities or human lives) (IRM 2002). Based on Mikes and Kaplan's (2014) terminology, our examination categorized risks according to three resources: operational risks, strategic risks, and external (political and financial) risks (see Chap. 6).

Bruckner et al. (2001, in Hosseinzadehdastak and Underdown 2012) defines risk management as follows:

Risk management refers to strategies, methods and supporting tools to identify, and control risk to an acceptable level. Additionally, all events that may prevent an organization from realizing its ambitions, plans, and goals are known as **risks**. In other words, **risks are potential problems that might happen**. As a result, identifying risks, assessing them, and estimating their impacts can help to mitigate negative their effects (p. 2).

Bruckner et al.'s definition (2001, in Hosseinzadehdastak and Underdown 2012) has been adopted for our research. Specifically, in the process of risk management, we used methods and tools to identify and control risks; e.g., SWOT analysis was applied for the risk identification. Thus, the identified risks represent weaknesses and threats for STEM education in Israel, that their existence in the future endanger the desired achievements of STEM education (for example, the need to increase the number of high school graduates in the STEM subjects on the highest level and, respectively, the number of qualified STEM teachers). The risk rating according to their severity level led to the formulation of a response plan which lays out thirteen courses of action to alleviate (mitigate) the negative impact of the highly ranked risks, in order to reduce the severity of their impact on STEM education in Israel (see Chap. 6).

In the process of risk management in the business sector, organizations adopt practices and methods in accordance with changes occurring in their internal and external environments. Therefore, risk management is an ongoing process. Though organizations and companies choose different risk management techniques which are suitable for their professional activities, a review of the relevant literature shows that organizations adopt a similar process of risk management (IRM 2002; ERM 2004; Curtis and Carey 2012). The accepted steps of a risk management process, as applied by business organizations, are described below, as well as their application for the risk management process described in this Brief, which was applied for STEM education in Israel. Additional details about the research process are presented in Sect. 3.2.

- (1) **Formulation of the strategic objectives of the organization.** In this step, the organizational goals and objectives, as well as the risk management policy suitable for the organizational culture, are decided upon. The organization senior management usually presents this policy to all the employees of the organization.

The adoption of a risk management process for STEM education requires the identification of the goals and objectives that the system wishes to achieve. The following review of relevant documents (Ministry of Education 2011; Ministry of Education, Culture and Sport 1994) summarizes the *objectives* of STEM education in Israel:

- Building human resources in the STEM fields to maintain the position of the high-tech industry in Israel as an important component of the nation's economy.
- Promotion of equal opportunities for all groups in the Israeli society: STEM education should propose each individual a variety and diverse ways for self-fulfillment and excellence.
- Science and technology are considered as part of the general and basic education needed today (and in the future will be required even more), for anyone who wishes to contribute to society (Ministry of Education, Culture and Sport 1994, p. 9).
- Development of 21st century learning skills, such as higher order thinking strategies, deep understanding, teamwork ability, sense of competence, and self-regulation. These skills are currently demanded due to the enormous changes that took place in the past decade in the global economy, job markets, and business environments (Casner-Lotto and Barrington 2006; Duderstadt 2010; Greenhill 2010; Male et al. 2010).

Accordingly, the stated *goals* for STEM education in Israel are defined as follows (Ministry of Education 2012):

- Establishment of an excellence program in STEM education that will increase the number of graduates who complete their high school studies with a diploma which includes an advanced level (5 units²) studies of English, Mathematics, and two science subjects (Physics, Chemistry, Biology, and Computer Science). In the technology education, one of these science subjects can be replaced by an engineering subject.
 - Within five years, doubling the number of excellent graduates in the above STEM excellence program (the basis year specified in the report is 2010).
- (2) **Event identification.** At this stage, the organization identifies external events (opportunities and threats) and internal events (strengths and weaknesses) that may have either positive or negative impacts on the achievement of the

²In Israel, the number of units of each subject matter represents the level of learning of the subject in the high school: One (1) represents the lowest level and five (5) represents the highest level.

organizational objectives and goals, as defined in the previous step. A distinction is made between:

- an event with a negative impact (a downside) which represents a risk, and should be treated by a relief program (mitigation);
- an event with a positive impact (upside) which represents an opportunity that the organization management can channel for the achievement of the objectives set in step # 1.

This phase, the risk identification phase, when implemented for STEM education in Israel was carried out by a SWOT analysis. The SWOT analysis identified risks (internal weaknesses and external threats) as well as opportunities (internal strengths and external opportunities) faced by this education system (see Pahse A: Risk Identification, Chap. 4).

- (3) **Risk assessment.** Risk assessment is carried out by the examination of the risk probability (likelihood) and their implications (impact). The likelihood represents the probability that an event, which can damage the organization, will occur; the implication represents the potential damage that the event can cause.

For STEM education in Israel, the phase of risk assessment process (of internal weaknesses and external threats) was implemented by a Delphi survey in which practitioners in STEM education—who hold different roles and belong to different sectors—estimated the risk implications (see Chap. 5). Since we also included in this stage the risk prioritization, this phase is referred in this Brief as Phase B: Risk Rating.

- (4) **Risk response.** At this stage, the organization decides on actions whose aim is to reduce the intensity of the risk implications, in order to minimize the harm that the risk may cause to the achievement of the organizational objectives. This is done by applying one of the risk response strategies, including:

- **Avoid:** remove the risk;
- **Mitigate:** reduce the risk likelihood and/or its impact;
- **Transfer:** transfer the loss that a negative event may cause to a third party, such as an insurance company;
- **Share:** share the risk implications with a third party;
- **Accept:** accept the risk implications and do not take any action to lower the probability of the risk likelihood and its impact.

In addition, in this step, organizations also consider strategies by which opportunities will be addressed, including:

- **Exploit:** search for ways how to realize the opportunities;
- **Enhance:** examine how to increase the effect of opportunity;
- **Sharing:** transfer part of (or all) the treatment of the opportunity to another party;

- **Accept:** accept the uncertainty of the opportunity and do not take any proactive actions to exhaust its potential.

As can be seen, overlap exists between the strategies for addressing risks and for addressing opportunities, which can be combined if needed.

In the case described in this Brief, Phase C: Risk Response for STEM education in Israel examined how to approach the risks, as well as the opportunities, by one of the above strategies (see Chap. 6).

- (5) **Control Activities.** In this stage, procedures and control activities are established to ensure that the response plan determined by the organization is followed properly.
- (6) **Information and Communication.** The target of this stage is to ensure the ability to identify and collect relevant information at any time in order to enable the various parties of the organization to perform their jobs successfully. It is important to ensure information flow in all directions in the organization: top-down, bottom-up, and across organizational levels.
- (7) **Monitoring.** This stage ensures that the risk management process continues smoothly over time, including (a) continuous assessment of the risks that have already been identified and are treated continuously, and at the same time, (b) the identification of new risks as well as how they should be treated by one of the above mentioned strategies.

As can be seen, risk management is a repeated, ongoing process of identification-assessment-response, applied both for risks that have already been identified in the past as well as for new risks which are identified by the organization during this process.

2.5 Summary

One of the key documents in the field of risk management is ISO 31000 Risk Management (ISO Guide73 2009) which describes the principles and guidelines of the risk management process. According to this document, the process can be used for any organization, regardless of size or sector in which the risk management process is implemented.

The literature review conducted for the purpose of our study showed that risk management is not implemented commonly in the field of education. Muehlbach (2008), who describes the application of a risk management process in continuing education and training, claims that leaders of educational institutions do not understand yet the need for risk management in education. Clearly, in order to prepare the graduates of the education system towards the unknown future, a risk management perspective is needed in education in general and mainly, in STEM education in particular.

This Brief illustrates this approach. In the next four chapters, we describe our examined educational field, that is, STEM education in Israel (Chap. 3), laying out the three stages of risk management applied in our study—risk identification (Chap. 4), risk rating (Chap. 5), and risk response (Chap. 6). We hope that this description illustrates the suitability of risk management processes also for education organizations.

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Risk Management of Education Systems

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