A Study on Establishing National Technology Strategy of Fusion Energy Development: Combining PEST-SWOT Methodologies

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1. Introduction

Nuclear fusion, the joining of light nuclei of hydrogen into heavier nuclei of helium, has potential environmental, safety and proliferation characteristics as an energy source. It can also, provide an adequate amount of fuel to power civilization for a long time compared to human history. It is, however, more challenging to convert to an energy source than nuclear fission [1].

To overcome this, Korea enacted a law to promote the development of fusion as an energy source in 2007. In accordance with this law, the government will establish a promotion plan to develop fusion energy, including policy goals, a framework, strategies, infrastructure, funding, human resources, international cooperation and etc. This will be reviewed every five years.

This paper is focused on the combining PEST (political, economic, social and technological) method with SWOT (strength, weakness, opportunity and threat) analysis, which is a prerequisite to form national fusion energy technology strategy.

2. Concept of national technology strategy

An important point to consider is that in the literature, 'national technology strategy' is not a well-known term and that authors use the term inconsistently. Some authors use of the term implies 'national technology policy', while others use the term to refer to national priorities of technologies.

The most important reason to differentiate strategy from policy is that 'strategy' is basically a synonym for 'path selecting'. When it comes to strategy one may select from the available options; however, for a policy, viable options may not exist. A policy does not operate selectively on different areas of technology; rather, it focuses on plans, tools or functional policies that aim at improving markets' functions [2].

On the other hand, if we consider 'national technology strategy' only as a country's priority, nothing new is defined and the term priority can convey the intended meaning by itself. This type of comparison of the two concepts of national technology policy and firm technology strategy [1] results in a third concept known as 'national technology strategy' which can be defined as follows:

"National technology strategy is a portfolio of desired related technology areas that receive governmental supports in the form of specialized goals for each branch of technology. This strategy assigns well-defined tasks and responsibilities for the pertinent government agencies that are responsible for implementing the goals for each technology areas." [2]

According to the above definition, a promotion plan of fusion energy development can be classified as not a national technology policy but a national technology strategy.

3. Methodology

SWOT analysis originates from the business management literature. It was adopted in the 1980s in public administration cases across such areas as regional development and municipal planning. There have been several examples of the successful application of SWOT analysis in the fields of energy planning and strategy [2, 3, 4, and 5].

The two main components of SWOT are indicators of the internal situation described as existing Strengths and Weaknesses, and indicators of the external environment described as existing Opportunities and Threats. SWOT list are developed in a participatory approach (from bottom-up components), complemented with a study of existing relevant strategic and planning documents, legislation and statistics (top–down components) [3].

However, to link indicators which derive from the internal and external environment to SWOT components is often controversial and sometimes illogical compared to the effort and time involved. To counterbalance these shortcomings, PEST[2], which is a typical methodology used with internal and external environmental analysis, is combined with the SWOT analysis. Previous research [2] applied STEEP (social, technical, economic, ecological and political), an extended method of PEST, in conjunction with SWOT analysis.

Fig. 1 shows the deduction process of SWOT components from a PEST analysis. PEST aspects of fusion are gathered for use in the PEST analysis. PEST indicators are classified into internal/external factors and positive/ negative factors simultaneously. The results of such studies can determine SWOT as it relates to the fusion sector. Then using the SWOT

[1] See [2] to clarify the concept of 'national technology policy' and 'firm technology policy'.

2 PEST is an acronym for political (P), economic (E), social (S) and technological (T). A PEST analysis is an analysis of the macro-environment referring to various macro-forces which have impact on a specific sector.

results, strategies of fusion energy development are extracted.

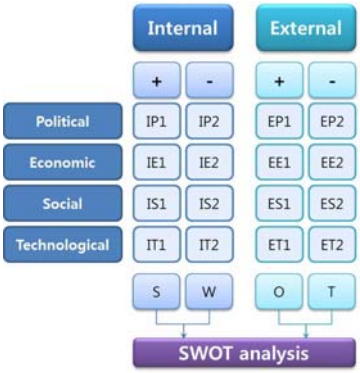

Fig. 1. SWOT components are derived from PEST indicators which are classified into internal/external and positive/ negative factors.

4. PEST and SWOT analysis of fusion sector

The initial diagnosis of the fusion sector can be summarized as shown in Table I. The indicators of the internal and external environments important in the fusion sector are rearranged by the PEST method.

Table I: PEST analysis of the fusion sector

Internal	Positive	Negative
Political	Strengthen the strategies of long-term low-carbon energy technology in the global world	Speed up the development of fusion energy in China, EU and Japan
Economic	Higher long-term potential of fusion energy	Low incentive of fusion from an industrial standpoint
Social	Increasing need for safe energy (e.g., after the Fukushima accident)	Delay of nuclear power plant construction
Technologic al	Limits of various alternative energies	Acceleration of DEMO R&D
	Strength	**W**eakness
External	Positive	Negative
Political	Well-established legal basis for fusion energy development	Policy risk of long-term investment in fusion energy
Economic	Efficient use of Korean resources in the fusion sector	Increasing the need for short-term benefits
Social	Higher needs for environmentally friendly energy technology	Insufficient public understanding of fusion energy
Technologic al	Successful operation of KSTAR devices	Long-lead time to realize fusion energy
	Opportunity	**T**hreat

SWOT analysis is used to generate strategies to improve the current situation. In this phase, it is useful to confront elements of internal indicators (S/W) with elements of external indicators (O/T). This confrontation leads to definitions of strategies, and generates four types of strategies: an offensive strategy (S-O), a reorientation strategy (W-O), a survival strategy (W-T) and a defensive strategy (S-T).

SWOT (Table II) summarizes the confrontation matrix as regards the strengths, weaknesses, opportunities and threats; thus, it offers a clearer view regarding a national technology strategy of fusion energy development.

Table II: SWOT matrix and strategies for the fusion sector

	Strengths	Weaknesses
Opportu nities	(S-O) Be the front-runner	(W-O) Foster basic research and human resources
Threats	(S-T) Vitalize international cooperation	(W-T) Strengthen technology licensing and PA

The peer review process is used to validate the four strategies derived from a SWOT analysis and to obtain qualitative estimates upon such strategies. It is also possible to generate new strategies in this phase or to correct current ones. The initial use of the SWOT technique as a tool for strategy selection allows us to reduce the number of rounds in the peer-review process, speeding up expert consensus as more structured information is provided to them.

5. Recommendations: strategies of fusion energy

The national technology strategies of fusion energy development are extracted by combining the PEST methodology and a SWOT analysis. Major strategies for fusion energy development are as follows:

Be the front-runner: to develop strength to take advantage of the benefit of an opportunity, Korea must be the front-runner in the field of fusion energy development.

Foster basic research and human resources: to offset weaknesses in order to take advantage of opportunities, Korea must foster basic research and develop human resource.

Vitalize international cooperation: to counteract the effect of a threat by means of harnessing strength, Korea must vitalize international cooperation.

Strengthen technology licensing and PA: to avoid the situation in which a weakness could lead to a threat, Korea must strengthen technology licensing and public acceptance.

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