

Developing the evaluation framework of technology foresight program: lesson learned from European countries

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Abstract- Foresight activities are valued in many countries since 1990s due to their long term strategic planning. These governments consequently allocate most resources in these foresight activities. As a result, the paper mainly develops the evaluation framework of technology foresight program, by integrating the concepts of evaluation and logic framework with the experience of foresight evaluation from developed countries, for instance European Union, Britain etc., to realize the outcomes of implementing foresight activities. Taking Sweden as a case study, the paper is also proposed to show the effectiveness of this new framework.

Keywords- Technology Foresight, Foresight Evaluation, Logic Model

incorporated S&T policies and foresight analyses, becoming a top-down decision-making mechanism.

The implementation of foresight activities extend opportunities for innovation so as to set priorities for investment, guide the direction of the science and innovation system responding to its original goals, and even broaden the range of actors engaged in science and innovation policy. Foresight exercise is a valuable instrument for the government to monitor the impact of its science and innovation policy. However, how to measure the outcome and impact of foresight activities is hard to define. So the study mainly develops the evaluation framework and presents the outcome perspectives of technology foresight program through generalizing from the experiences of European countries.

I. INTRODUCTION

“Foresight” was first introduced in ‘Foresight in Science: Picking the Winners’ by Irvine and Martin in 1984 [1]. There are many European countries putting into large resources in “Foresight” activities since 1990s, such as European Union, United Kingdom, Netherlands, Sweden, etc., and some scholars have also attached greater importance to the impacts and influences since 2000 [2, 3, 4, 5, 6]. At the moment, more than 40 countries have carried out sustainable national foresight studies including United States, Japan, Germany, South Korea, China etc. Japan in particular has already finished its 8th technology foresight in year 2005, and has

II. LITERATURE REVIEW

Foresight activities provide future long-term opportunities and potential benefits for society, economy and scientific innovation. Looking back at the related studies on Foresight such as Martin (1995) and Georghiou (1996) etc [7, 8]. They all agree that foresight is a fully involved, future-orientated systematic operation. As the current basis for decision-making process, the development of the evaluation technology is definitely a systematic approach that will bring about tremendous impact on competition among industries, social welfare and living standard.

A. Process v.s. Le Prospective Foresight

In general, the study divides the foresight activities into two dimensions according to Martin (1995) : (1) “Process” is an interaction process that contains feedback mechanisms ,and (2) “le prospective” refers to output & outcome, which develops potential future, and provide current decisions [7]. This study will use the two dimensions to organize foresight activities related studies:

(1) Process evaluation

Mainly a future-orientated process, most of the related studies on process evaluation [2, 4, 9, 10] emphasizes on the management process of the foresight activities for example, whether the involvement of stakeholders is appropriate, whether the experts have gained full support during operation process, whether the management process is effective etc.; and the approach used, for instance, whether Delphi methodology is appropriate, whether methods like scenario writing and workshops are helpful etc. Both management process and approach used need to be considered and assessed immediately to ensure that the foresight result will not be distorted.

(2) Output & Outcome evaluation

Mainly an evaluation of the output, outcome and impact of the foresight operation for example: number of participants, level of report distribution, number of meetings held, level of government intervention etc. Related researches include Georghiou, & Keenan (2006); Destatte (2007); Da Costa, Warnke, Cagnin & Scapolo (2008) [6, 11, 12].

B. European Experiences

(1)United Kingdom

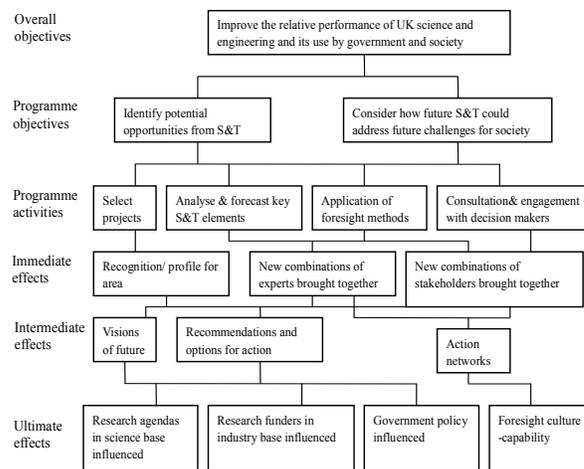


Fig. 1. UK foresight program logical model

aSource: PREST, 2006.

UK government had begun the implementation of the Foresight program since 1993 and is now moving into Phase three. Miles (2005) suggested that in its first phase, UK has benefited from competitive advantage in its S&T policy with the emergence of innovative operation system; as for the second phase, despite the non-correlated relationship between UK’s foresight planning and innovation policies, the planning did not last long; in phase 3, UK’s foresight planning put more weights on fewer key areas [13]. In 2006, Manchester Institute of Innovation Research, PREST has provided a forecast report through interviewing 8 foresight team members and 28 stakeholders using the logic framework diagram shown in Fig.1 as standard [5]. As a whole, the third phase of UK’s foresight planning is widely encouraged and appreciated mainly because it brings about new initiatives and prospects and also it applies scientific evidence and foresight technology to policy agendas etc.

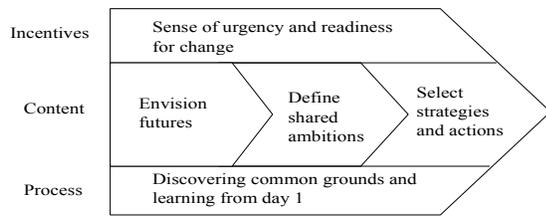


Fig. 2. Netherlands foresight program's ambition-driven strategy

aSource: Van der Meulen, de Wilt & Rutten, 2003.

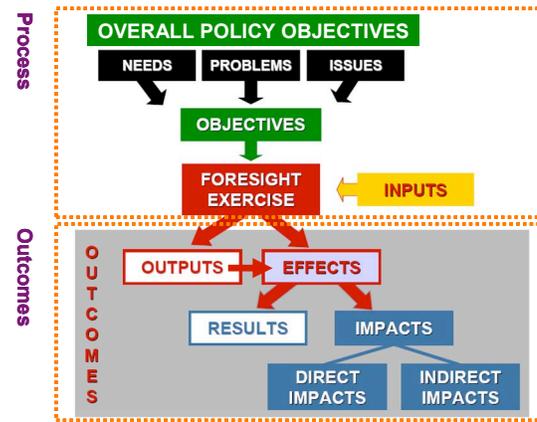
(2)Netherlands

Van der Meulen, de Wilt & Rutten (2003) have once carried out the Foresight evaluation for Netherlands's Ministry of Agriculture and Nature & Food Quality department. Agricultural foresight research is executed by National Council for Agricultural Research (NRLO). The findings discussed 3 main objectives: (1) Develop future opportunities, give priority to essential technology innovation activities investment; (2) Structure social network, encourage interaction among stakeholders; (3) enhance stakeholders consent towards action planning. These three objectives have helped in pointing out the value and importance of Foresight impact analysis, as shown in Fig. 2 [3].

(3)European Commission

This study will explore the main focus of the activities from the whole national policy system based on the idea of Rationale by Georghiou & Keenan (2006) and EU Joint Research Centre (JRC) [11, 14]. They look from the view of the decision-making system and propose 6 prerequisites for the foresight evaluation process as follows: building advocacy coalitions (to build new allies) ; improve innovation system quality (to improve cooperation and interaction) ; providing policy advice(to provide decision-makers long-term ideas) ; providing social forums (to increase participation); fostering policy dialogue (to expend the participation of the community) ; and supporting policy definition (to change the outcomes derived from same procedures into policy definition). These prerequisites will be altered due to the nature of the foresight activities and that differences in scopes

Fig. 3.



Foresight evaluation logical model

aSource: Destatte, 2007.

will cause the main focus of the evaluation to differ as well [11, 14].

Destatte (2007) once proposed a foresight evaluation framework at the 'FOR-LEARN Mutual Learning Workshops' event hosted by the EU [12]. As we can see from Fig. 3, the logic framework is based upon the two dimensions, process and output & outcome, and is formed through a combination of input, objective, effect, output, outcome and impact etc. The main element of the logic model can be divided into 7 evaluation rules, these include, effectiveness, efficiency, utility, relevance & appropriateness, sustainability, fairness and behavioral additionality. This type of logic model and evaluation rules is applied both in many European countries and also the United States. For instance, the logic framework was used in UK during their second foresight's impact analysis.

III. RESEARCH METHOD

The study applies the concepts of evaluation and logic model with the experience of foresight evaluation from developed countries, for instance European Union, United Kingdom, Sweden, etc., to develop the framework of foresight evaluation. Also combining with foresight implementation [15], the process in the framework mainly includes eight elements, overall policy goals, inputs, strategic objectives, foresight activities, outputs, effects, outcomes, and impact. The efficiency, appropriateness, relevance and effectiveness of

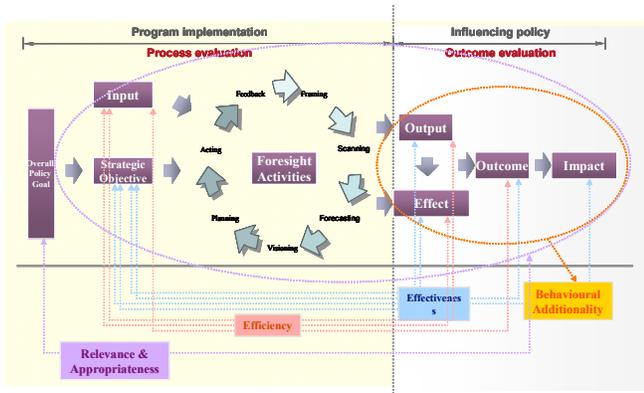


Fig. 4. Foresight evaluation framework and its perspectives

foresight process have been considered as main viewpoints of evaluation, as shown in Fig. 4 and Table 1. And during the process, it is divided into several phases: (1) between strategic objectives and outputs; (2) between strategic objectives and outcomes; (3) between strategic objectives and effects/impact; (4) effects, outcomes, and impact; (5) between inputs and outputs; (6) between overall policy goals, foresight activities, and outcomes. Each phase has its own focus of evaluation and consideration. Based on the four perspectives and six phases, we can further develop various items of evaluation and indicators.

IV. FINDINGS

This study uses Destatte's these 4 perspectives in order to develop evaluation indicators such that the linkage between dimensions and perspectives can be assessed, see Fig 5. Fig 5 summarizes evaluation dimensions from the seminar held by the EU in 2007 on 'For Learn Mutual Learning Workshop'; it also refer to the online manual provided by the EU on foresight evaluation [16] and related studies [17, 18, 19]. As shown in Fig.5, the study also further develops various measured items according to the four perspectives.

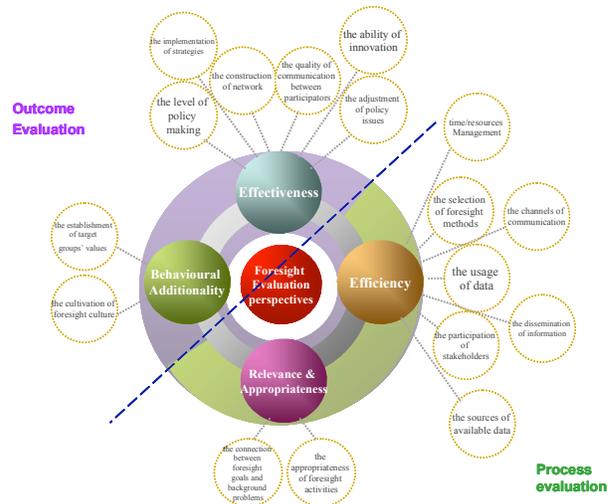


Fig. 5. The measured items of Foresight evaluation under perspectives

TABLE I
EVALUATION RULES IN EACH STAGE OF THE FORESIGHT EVALUATION FRAMEWORK

Evaluation rules	Evaluation type	Main issue	Questions
Efficiency	Process evaluation (Between input – outcome/impact)	1. Organizational management 2. Methodology	<ul style="list-style-type: none"> • How to carry out foresight activities management and the design process? • How to turn input into gain, output and impact? • Do experts receive enough supports? • Are the methods chosen during the foresight implementation process helpful?
Relevance & Appropriateness	Process evaluation (Between the mission statement, implementation process and outcome)	1. Relevance of Objectives/ problems 2. Government support	<ul style="list-style-type: none"> • Appropriateness and relevance of objectives, positioning, methodology etc. • Whether governments support industries to enter emerging technology market in order to overcome the phenomenon of market failure?
Effectiveness	Result evaluation (between objectives – outcome/impact)	Focus on the level of target completion, that is measures of outcome/ impact	<ul style="list-style-type: none"> • Level of differences between the actual and expected impact. • What is the actual outputs reached ?
Behavioral Additivity	Result evaluation (specifically outcome/ impact)	Changes occurred due to government intervention	<ul style="list-style-type: none"> • If there is no government intervention, how will foresight be operated? • What difference does government intervention make to foresight? • Will foresight implementation improves the end result? • Will the foresight culture be introduced and continuously maintained?

Based on the evaluation perspectives and dimensions aforementioned, this research utilizes logic framework to further build the evaluation indicators for the foresight research activities, for detail please see Table 2. Table 2 mainly use the idea of logic framework as mentioned above to penetrate through the 4 measures (Relevance & Appropriateness, Effectiveness, Efficiency and Behavioral Additionality), each stage is then monitored for instance between objectives and outputs, between objectives and outcome, between objectives and impact, between input and outputs and between policy's mission statement and implementation process and outcome etc. in order to further embrace the evaluation key points in each stage under different measures, the item measures preferred, indicators and the focus upon the foresight implementation.

Taking effectiveness as an illustrated example, as shown in Table 2, it will include six measured items: (1) the level of policy making; (2) the ability of innovation; (3) the quality of communication between participators; (4) the implement of strategies; (5) the construction of network; (6) the adjustment of policy issues. And in above phases, effectiveness is emphasized between strategic objectives and outputs, between strategic objectives and outcomes, and between strategic objectives and effects/impact. Furthermore, we will extend to define indicators for these measured items, such as the influence of government funds' inputs (to measure the level of policy making), or the influence of S&T policy's funds (to measure the level of policy making), or the commitment of participators (to measure the quality of communication between participators), or the number of network formation (to measure the construction of network). Each indicators' measurement and categories are also mentioned.

Just like what Georghiou & Keenan (2006) had suggested, the prerequisites for foresight implementation can be differentiated into 6 categories, therefore when the prerequisites differ, the key areas that need to be focused on

will also be different for example when the prerequisites is to provide policy advice, then the evaluation key points will be direct output and decision-making; if the prerequisites is to create supportive alliance, then, the corresponding evaluation key areas would be network system [11]. Similarly, the research method (impact analysis concept and logic framework) is also used and evaluation items, which include additionality, efficiency, relevance & appropriateness etc., preferred item measures and the prerequisites for foresight implementation are focused in Table 2 (located before references).

V. Case Study

The study takes the evaluation experience of technology foresight from Sweden as a case study to show how the framework of foresight evaluation is workable. Swedish Technology Foresight identifies improvement areas in the Swedish innovation system which is a good example for this research. Swedish Technology Foresight is a national project conducted in 1998-2001 and 2003-2004. It aimed to create insights and visions about technological development in the long term (10 to 20 years) in order to identify worthwhile strategies in education, research and development to promote the development of Swedish society. Its objectives are to strengthen a futures-oriented approach in companies and organizations; to identify areas of expertise with potential for growth and renewal in Sweden; to compile information and design processes for identifying high-priority areas in which Sweden should build expertise [20].

Unlike most studies in other countries, Swedish Technology Foresight was not carried out on behalf of the government, although it has enjoyed strong government interest and support. Swedish Technology Foresight was headed by a Steering Committee. The work of the project was carried out by eight specialized panels: (1) health, medicine and care; (2) Biological natural resources; (3)

Society's infrastructure; (4) Production systems; (5) Information and communications systems; (6) Materials and materials flows in the community; (7) Service industries; (8) Education and learning. Each panel comprises up to 15 experts with different perspectives, formed the core of the Technology Foresight project. An Advisory Committee composed of representatives of different organizations ensured that vital aspects of Swedish community life were integrated into the work of the Technology Foresight project. Swedish Technology Foresight was evaluated by an international team in 2005. The evaluation report states that organizations (research organizations, consulting agencies, and foundations) appear to be the main winners and users of the results.

In the first round, an evaluation committee was set up to continuously monitor and evaluate the implementation of the foresight exercise. Its evaluation focuses on the actual process, but not the findings of the project's work, such as mission definition, risk analysis, panel recruitment procedure, etc. Björn & Lübeck (2003) indicated that there are some critical problems in the first round [21]:

- The mission definition was too vague;
- The time given to the panels was too short (no time for analysis) ;
- No “scientific guidance” of the process took place;
- Societal problems were defined under way, and were not professionally treated;
- No mechanism was established to prevent dominance by eloquent participants;
- The risk analysis, which was conducted, should have been more extensive;
- The interchange between panels was too limited;
- Some practical problems in the production of reports (guidance, logistics);
- The panel recruitment procedure was not very transparent;

- The internal project management structure should have been more strict.

However, Björn & Lübeck also indicated that there are some advantages in the first round:

- Wide acceptance in the Swedish society of Foresight as a powerful process;
- The “mind setting” and networking among participants was highly appreciated;
- The industrial participation in the project was very satisfactory;
- The reaction was good;
- The action was better than expected, in particular regarding the R&D priorities set by government - and many lessons were learned.

In the second round, Schartinger & Weber (2007) enumerated some characteristics which Arnold, Faugert et al (2005) mentioned in their research report¹. At the individual level nearly everyone found that participating in the second round of the Swedish Technology Foresight was an immensely enjoyable and learning experienced and that their personal networks were greatly expanded, in a number of cases they also argued that this would boost their careers. There is little sign of direct influence at the decision-making or political level. On the other hand, indirect effects on foresight capabilities were more marked than the anticipated impacts of foresight results on policy-making. The most obvious impact of the second round of the Swedish Technology Foresight was a series of fora for young people to debate the future [22].

In terms of Amanatidou & Guy (2007), the organizers regarded the results of the first round as a starting point for wider discussion of more social orientation. This meant, however, that “everyone” became the audience, and the

¹ E. Arnold, S. Faugert, A. Eriksson and V. Charlet, “From Foresight to Consensus? An Evaluation of the Second Round of Swedish Technology Foresight, “ *Technopolis Report*, 2005.

second round exploited less formal and rigorous methods and produced results of potential interest to multiple parties. The first round included an extensive dissemination phase, lasting for about two years, and received a lot of publicity, with the Prime Minister giving the keynote speech at its conference. On the other hand, the second round, which echoed political discussions that were occurring more widely in Sweden at the time, did not manage to attract the same level of publicity and its dissemination phase was not as impressive. The evaluation was critical of the intervention logic, which was not well worked out, and the objectives of the exercise, which were not clearly articulated. The evaluation suggested that foresight might need to be done in parallel at different levels with different customers. Important factors in Sweden were the fact that the value of a consensus view is considered higher than in other political systems (a positive factor); and the existence of a certain degree of fragmentation in the Swedish policy system (a negative factor) [23].

As mentioned above, in efficiency aspect, we can find that participant mechanisms of two round Swedish Technology Foresight were both so well-functioned that they contributed to creating several networks (effectiveness). Concerning dissemination of activities, it was not only promoted extensively but received a lot of publicity. Otherwise, in the first round, it didn't give sufficient time for the panels' function and had no time for analysis. In addition, the interchange between panels was too limited to receiving resources. Similarly, the second round exploited less formal and rigorous methods and produced results of potential interest to multiple parties. These negative reasons diminish efficiency.

In effectiveness aspect, because participants attended Technology Foresight activities actively and the second round Technology Foresight provided a series of fora for young people to debate the future, a lot of networks were formed. There is little sign of direct influence at the

decision-making or political level. The existence of a well developed range of other policy support mechanisms made foresight one instrument among others, and without gaining priority, it left much less room for impact. We can judge its effectiveness really worked.

In relevance/ appropriateness aspect, although Swedish Technology Foresight has received strong government interest and support, it was not carried out on behalf of the government. The involvement of industrial organizations as sponsors was perceived by government as just a lobbying device. For this reason, the legitimacy of the exercise of Technology Foresight was also questioned. On the other hand, the mission definition was too vague. These factors reduced the degree of relevance/ appropriateness.

In behavioural additionality aspect, as the "mind setting" and networking among participants was highly appreciated in the first round Swedish Technology Foresight, it would be helpful to create foresight culture. As a result, the second round Swedish Technology Foresight was launched and brought about national innovation systems being established.

VI. Case Study

Within these past few years, related governments and organizations in Taiwan has helped to promote many important foresight researches and that since 2000, which provide Taiwan with background information on technology development in order to create a common view on the technology development and promote industrial renovation. By following these evaluation trends of most countries, the outcome and impact of the foresight researches have also being paid great attention upon gradually.

As a result, this study generalized studies from Destatte (2007), which had suggested the evaluation framework and evaluation perspective through combining the 4 perspectives including relevance & appropriateness, effectiveness, efficiency and behavioral & additionality

with two dimensions, which are process evaluation and result evaluation. It also consults research studies from Georghiou & Keenan (2006) under different objectives for the foresight activities, appropriate foresight evaluation perspectives should be supplemented by the concept of impact analysis and logic framework, evaluation items, evaluation key points, item measures and evaluation indicators in order to create a better foresight impact analysis framework.

By developing the evaluation framework of foresight exercises, the study hope not only to provide the reference of appropriate measured items for foresight evaluators, but also assist foresight executors to clarify the focuses and perspectives of evaluation so as to the implement of foresight activities responding to initial overall policy goals.

TABLE II
FORESIGHT EVALUATION FRAMEWORK'S MEASUREMENT

Evaluation Rules		Outcomes			Process		Prerequisites for foresight implementation
		Effectiveness	Behavioral additionality	Efficiency	Relevance & Appropriateness		
Evaluation Phases Between Objective – outputs	Meanings	Whether Output, Outcome and Impact are suitable to the initial target set	Through the implementation of the foresight activities, provide guidance about changes on the behaviors of the stakeholders	Whether the allocated resources is efficient compared to the output, effect and impact produced, implies the emphasis on the quality of the foresight implementation process	Whether foresight activities have done the right thing under the predefined conditions	Provide policy advice, improve quality of innovation system and facilitate policy dialogue	
	Evaluation key points (indicators)	1.Direct output 1-1. Number of dissertations, patents, reports, minutes etc. produced under foresight result				1.Create supportive alliance 2.Improve innovation system quality	
	Evaluation key points (indicators)	1.Network system 2. Innovation ability (refer in particular to innovation system)				1. Provide policy advice 2. Provide social forum 3. Promote policy dialogue (Integration) 4. Support policy definition	
	Item measures preferred (indicators)	1-1. Network formation 2-1. The impact of industry-science networks formation 1. Decision- making 2. Participants' communication quality 3. Reproritization of policy fields 4. Strategy implementation					
Between Objective – outcomes	Evaluation key points (indicators)	1-1. Policy impact 1-2. Impact from government expenditure 1-3. Impact of R&D expenditure 1-4. Impact of industry expenditure 1-5. The improvement towards living standard 2-1. Promise from participants 2-2. Quality advisory 2-3. Communication between experts 3-1. Impact of government coordination 4-1. Implementation of FS input strategy					
	Item measures preferred (indicators)						
Outcome/ impact (include short/ medium and long term)	Evaluation key points (indicators)	1. Change in perspective 2. Build in foresight culture 3. Innovation ability (refer in particular to innovation system)				1&2. Create supportive alliance; Provide social forum; Provide policy dialogue; Improve innovation system quality 3. Improve innovation system quality	
	Item measures preferred (indicators)	1-1. Moving towards cross-fields way of thinking 1-2. Establishment of long term perspective 2-1. Level of increase in foresight culture and cognition 3-1. Level of increase in foresight culture and cognition					
Between Input – outputs	Evaluation key points (indicators)			1. Management 2. Information management 3. Methodology and implementation 4. Interest groups to participate in an appropriate level 5. Information distribution 6. Communication channel		1&2. Support policy definition 3. Provide social forum 4. Provide social forum; Provide policy dialogue	
	Item measures preferred (indicators)			1-1. Participants and policy positioning 1-2. Resource management 1-3. Time management			

Between Policy's mission statement – implementation process and outcome	Evaluation key points			<p>2-1 .Accuracy of source of information</p> <p>3-1 .Appropriateness of the methodology</p> <p>3-2 .Appropriateness of method of execution</p> <p>4-1 .Suitability of the participants</p> <p>5-1 .Quality of information flows</p> <p>6-1 .External communication strategy</p>	<p>1. The degree of relevance of the foresight objectives and issues that need to be clarified during foresight</p> <p>2. Appropriateness of the activities carried out during foresight</p> <p>1-1 .Linkage between objectives and policies</p> <p>1-2 .Degree of relevance of the objectives and issues that need to be clarified by the government</p> <p>2-1 .Whether the areas and topics chosen are appropriate</p> <p>2-2 .Suitability of the methods chosen</p> <p>2-3 .Suitability of the system faced</p> <p>2-4 .Learning orientation</p>	1&2. Support policy definition
Item measures preferred (indicators)						

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