A Review on Evaluation Practice in Taiwan's Science and Technology Programs from the Perspective of a Logic Model Approach

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Abstract

The demand for evaluating the performance of public programs from their engaging stakeholders and involving social aspects continues to rise. Considering that Taiwan government has devoted its efforts to undertake the science and technology policy as the catalyst to boost up his economic advancement and social well-being, that the government financing a large amount of funding for the corresponding programs prompts us to wonder whether the current evaluation practice is an apt tool to monitor the change process and the expected outcomes of the programs. Hence, a logic model instrument is introduced in this study to examine the design of the planning and evaluation process. It also functions as a facilitator to revise the existing evaluation implementation. A logic model or a logical framework appeared in various forms in the 1960s, and in recent years are widely conducted in the practice of evaluation since it has the reputation of the efficient tool to conceptualize the program during the planning stage and help organizers to communicate with the participants.

A qualitative methodology was adopted. Document analysis is employed to systematically review government documents and reports to glean pertinent information. The results indicated that in spite of containing the elements delineated in the logic model, the arrangement of those is not well coordinated. In addition, the outcome section of program evaluation solely focuses on key performance indicators; namely measuring outputs rather than the effects a program may yield according to different stages of periods such as short-term, intermediate and long-term outcomes. Such designed evaluation practices may raise a doubt that whether the output-oriented approach of evaluating past program performance is well-designed enough to inform policy and management decisions. It is also concerned that the lacking a tracking system in the current evaluation practice may not be able to justify the spending on those programs. Accordingly, a coherent version of the evaluation mechanism in combination with the logic model is strongly suggested.

Keywords: government funding, key performance indicators, logic model, science and technology policy, Taiwan

I. Introduction

Program evaluation has received much attention in past decades, which has become an emerging issue in terms of government policy-making and performance management. Given the large amount of funding devoting to developing and implementing programs launched by various governmental departments, there exists a growing concern regarding whether the expenditures can in turn be translated into social, economic benefits, among others, for the citizens and stakeholders (Mayne & Rist, 2006; McLaughlin & Jordan, 1999; Zanakis, Mandakovic, Gupta, Sahay, & Hong, 1995). Thus, there is a shared perception that the role of evaluation is necessarily highlighted in the policy making and in an attempt to demonstrate accountability for the results of those implemented programs, government units have to design an appropriate evaluation mechanism to systematically and objectively assess the current or/and completed programs.

Utilizing a logic model has been regarded as an essential element in the evaluation process given that it can function as an integrated structure to connect resources from input to planned results such as outcomes (Cooksy, Gill., & Kelly, 2001; Wholey, Hatry, & Newcomer, 2010). Not only can this integrated framework articulate the relationships among inputs, activities, outputs and outcomes included in a logic model, it can also get program operators, evaluators and even stakeholders involved in a setting where they can communicate how the program is developed and undertaken and what outputs and outcomes will be yielded. Given its clear presentation of program elements by capturing the linkages among units, this tool can guide reviewers to break down the complexity of the programs and help them assess the feasibility of the program (Savaya & Waysman, 2005)

Taiwan government has strongly exhibited its inclination toward the development of science and technology policy to boost its economic development and address national needs. According to Ministry of Science and Technology (MOST) (2018), nearly 4 billion US dollar funding was approved and spent solely on science and technology policy in 2018; moreover, in 2019, the spending will be increased by 5.2%. From the annual expenditures on science and technology policy, the effective spending on the programs incurs interests among stakeholders and taxpayers, and MOST has also initiated evaluation protocol to oversee the implementation of the publicly invested programs in response to the accountability requested from the society.

However, the framework of evaluation format has been considered not integrated enough to fully analyze the performance of the programs; others even hold that the

current layout of evaluation format lowers the effectiveness of reviewing procedure since the components existing in the structure of program selection and evaluation format are so fragmented (Science and Technology Policy Research and Information Center, 2018). Accordingly, the use of present framework of evaluation forms to either conduct programs or assess the performance is likely lacking an efficient mutual communication between operators and reviewers. Hence, this on-going situation prompts the researcher to reconsider the overall function of the structure and further rebuild it by introducing a logic model to coordinate various components in the evaluation format.

II. Literature Review

Theory of change is widely adopted to explicate the application of a logic model. As Wholey, Hatry, and Newcomer (2010) indicated, theory of change is based on the assumptions that the input of resources is expected to result in the desired outcomes. Others also stressed that this theory builds up a casual chain connecting a series of units from the outset of program resources leading to the ultimate goals (Bickman, 1990; Connell & Kubisch, 1998; Pawson & Tilly, 1997). Accordingly, theory of change functions as a casual mechanism where an overall framework or picture is laid out and conceptualizes the program in a systematic way.

A logic model, also known as a logical framework, theory of change, or program matrix, is a tool used by funders, managers, policy-makers and evaluators of programs to evaluate the effectiveness of a program. It is a graphical depiction of the logical relationships between the resources, activities, outputs and outcomes of a program (Innovation Network, 2012) and utilizes diagrams or boxes to help uncover the underlying rationale behind the program and elicit the strategies to verify the hypothesis, even predict the relationship between observed components. In other words, a logic model provides details in sequential fashion so that each element is presented not only in the "if-then" (causal) relationships between them, but also displayed in a concrete and concise presentation. Aside from affecting the achievement of the intended outcomes, the development of a logic model also significantly impacts the feasibility of evaluation.

On the other hand, some researchers augured that a logic model could have varying versions or no unifying components of (Porteous, Sheldrick, & Stewart, 2002; Renger & Hurley, 2006; Savaya & Waysman, 2005). For example, Gervais, de Montigny, Lacharité, and Dubeau (2015) integrated two versions developed by the Kellogg Foundation (2004) and the United Way of America's (1996) to construct a more

comprehensive one to solve the research questions. Contrary to the aforementioned, this study only adopts a general logic model which encompasses two stage as proposed by Kellogg Foundation (2004) since its aim focuses on the feedbacks for the revision of program and evaluation document, rather than practically evaluates the on-going or accomplished programs. Kellogg Foundation's model (2004) refers the first sections the planned work, which describes what the program resources will be needed to implement the initiatives. Thus, this stage consists of two elements: resources (or input) and activities. Then, the second part of a logic model mainly emphasizes a program's expected results. From this standpoint, in addition to output, the outcome of the program is basically divided into three units corresponding to different lengths of the periods, such as short-term, intermediate, and long-term outcomes, as shown in Table 1.

Despite that the two stages are separately introduced, their arrows connecting the boxes logically present the relationship between two components, as shown in Figure 1. The delineation of each components constituting a logic model is provided as below. In terms of developing a graphic logic model, McLaughlin and Jordan (1999) suggested five stages to pay heed to the completion of a logic model. They mentioned that the first step for a program team to take is to collect relevant information from various sources as references to build up a comprehensive picture of the program. The collection of information helps shape the shared vision of the program scope, which, in the following step, allows a program team to identify the problems and define the extent to which the problems are resolved. Once the problem and solution are determined, the third step involves filling in the information collected in the former step into the columns, namely the components of a logic model. In this stage, the development of a logic model needs to focus on the accurate and full information contained in the table or figure. The linkages of the information are depicted in the fourth step to allow the audiences to visually understand the "story" of the program. Lastly, the assistance and involvement of stakeholders are indispensable after the presentation of a logic model belongs to a specific program, since the model needs to ensure that the connection of the information has been comprehended among stakeholders so that the verification process necessarily continues to be reviewed and checked by the representatives.

Table 1 The components and description of a logical model

Component	Description	Example
Inputs	Either financial or non-financial are needed for the program to reach the intended goals.	Public funding, human resources, equipment, etc.
Activities	The action(s) that a program operator undertakes to yield outputs and outcomes. Hence, activities can be regarded as a sort of strategies to tell the team what steps a program team should take based within the limit of given resources.	Conducting research, hosting training sessions or conferences, etc.
Outputs	Tangible and countable products are directly yielded from activities conducted by the program.	• Training sessions completed, number of people trained • Position papers, research reports or studies
Outcomes	A way to compare the change(s) or the difference(s) before and after the program is implemented. Notably, outcomes are extended from outputs, thus outcomes are observed to demonstrate the "why" of the program.	• Improved collaboration and coordination among partners • Increased visibility of a certain issue
Short-term Outcomes	Short outcomes are identified in an immediate period when the benefits or changes are anticipated to experience or display as a result of the program activities especially targeted at the stakeholders.	Differences in awareness, knowledge, skills or access of a target population (e.g., increased knowledge of a certain issue)

Intermediate Outcomes	It can be regarded as the extension of immediate outcomes. Thus, the occurrence of intermediate outcomes has to rely on the latter.	Change in target population's behavior
Long-term outcomes	The scope of ultimate outcomes belongs to more distant changes or differences that can be reasonably and causally attributed to the program. In general, these are known as "impact" as well, meaning that the benefits are broader and more durable changes than short-term outcomes.	A change of state in a target population, e.g., social impact

Source: Revised from Government of Canada (2010). *Supporting effective evaluations: A guide to developing performance measurement strategies.* Retrieved from https://www.canada.ca/en/treasury-board-secretariat/services/audit-evaluation/centre-excellence-evaluation/guide-developing-performance-measurement-strategies.html

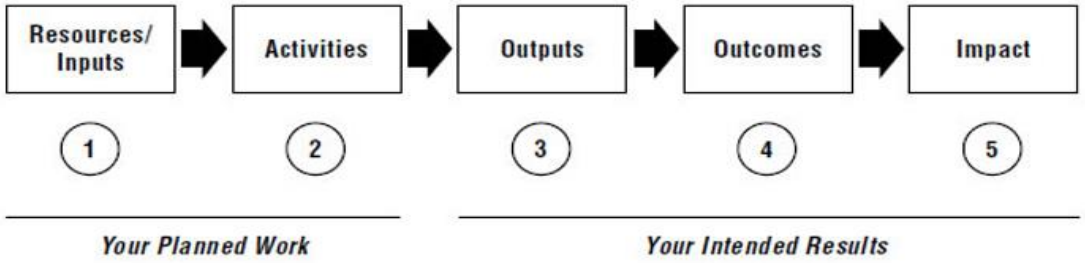

Figure 1 Basic logic model

Source: Kellogg Foundation (2004). *Logic Model Development Guide. pp. 3.* Kellogg Foundation: Battle Creek, MI.

Given the advantages of using graphic flow charts to articulate a program with clarity, a logic model has been extensively employed to help assess the performance and effectiveness of a program (Porteous, Sheldrick, & Stewart, 2002). For instance, Cooksy, Gill, and Kelly (2001) adopted a logic model as an integrative framework to evaluate a middle school curriculum program named Project TEAMS to facilitate the data collection and result interpretation. Holliday (2014), same as Cooksy, Gill, and Kelly's study (2001), used a logic model to assist the integration of qualitative data from focus groups in the first-year program aiming to addresses the problems the rural school program had encountered. Except for the application of a logic model on education-related programs, it can also be extended to various fields. In a program called Practice-Based Research Networks (PBRNs) was assessed by Hayes, Parchman, and Howard (2011) delineated the development of a logic model, in particular the process of involving stakeholders in the planning and evaluating the case. Cullen, Clapham, Byrne, Hunter, Senserrick, Keay, and Ivers (2016) evaluated a multi-site community-based aboriginal driver licensing program by constructing a logic model as an evaluation framework to understand the links within inputs, activities and expected outcomes. Helitzer, Hollis, de Hernandez, Sanders, Roybal, and Van Deusen (2010) utilized a logic model coupled with factor analysis as an evaluation instrument help develop the evaluation procedure. In a case study, Gervais, de Montigny, Lacharité, and Dubeau (2015) employed logic model as the core to demonstrate the practitioners how to develop the model based on program theory. Similar to the former study, Yampolskaya, Nesman, Hernandez, and Koch (2004) constructed a logic model as a means to assess the performance of the case.

Aside from academic, various government bodies also acknowledge the usefulness of a logic model to evaluate their invested programs. The Center for Disease Control (CDC), for example, has been widely utilized the concept of a logic model to facilitate the formation of evaluation questions, component linkages and so forth (Center of Disease Control, 2018). In Canada, to support its effective evaluation plan, a logic model is embedded into its evaluation framework to provide the relationship between each program and the department's strategic outcome(s) (Government of Canada, 2010). Moreover, the public sectors in Australia see a logic model as the fundamental elements in their evaluation process. For example, the Ministry of Health in New South Wales, the state on the east coast of Australia, has published *Developing and using program logic: A guide* as a teaching material to help public sectors design and implement evaluation process more easily (NSW Ministry of Health, 2017).

From the analysis of previously mentioned literature, originating from theory of

change, a logic model has been regarded as an efficient tool in cooperation with implementing evaluation process. Thus, ranging from academics and governmental departments, the operation of a logic model is rigorously embedded in the formation and execution of evaluation. In academics, a logic model can be applied to different fields of programs to yield the insights of the designated programs. Besides, using a logic model as the main approach to evaluate programs can help extend and sharpen the knowledge of itself as well. Practically, governmental departments are actively engaged in making use of a logic model to support their evaluation process and enhance the effectiveness of it.

III. Methodology

The main purpose of this study is to utilize logic model based on theory of change to examine the design and structure of current science and technology program selection and evaluation format in Taiwan. It opts to use qualitative research methodology by adopting document analysis to gain deeper and better comprehension on the issues. Document analysis or so-called documentary research method is considered as a form of qualitative research to assist the researcher to collect, review and analyze the documents ranging from the printed and electronic in a more systematic fashion. Given the purpose of this study is to provide suggestions for adjusting and reconstructing the framework of program selection and evaluation document, document analysis is appropriately chosen in support of addressing the research questions (Bardach, 2009; Bowen, 2009; Gaborone, 2006). Hence, via this method, the researcher collects the documents from the official website of MOST since it has been in charge of arranging and conducting program selection and evaluation process.

IV. Results and Discussion

In this section, the researcher is about to present the findings from the analysis of program selection and evaluation format. Furthermore, a logic model is utilized in the dialogue between the findings and implications. Based on the breakdown of the format collected from MOST, it encompasses three parts: selection form, evaluation form, and the document of reviewing both forms. To begin with, the selection form can be separated into two categories, one-year program and multi-year program respectively. Despite the difference, both include similar components starting from the demonstration of expected outputs, or key performance indicators (KPIs), the policy rationale a program builds on, the description of objective and activities, the funding, human resources and equipment a program needs, the analysis of external and internal surroundings. On the other hand, the self-report evaluation sheet is designated to have

the program manager annually assess the program's performance and cumulative measure its progress and accomplishments, which are filed as a report to submit to the review panel. The aim of reviewing sheet, lastly, is to determine whether the program should be funded and the performance of the program is expectedly achieved. Notably, in comparison with former format of program selection document, the current one restructures its organization by moving the unit of KPIs at the front in place of policy rationale. Moreover, it also adds the unit of policy relevance integrated into the unit of policy rationale so that the objectives of the program can be aligned with government priorities and complied with legislation. However, in terms of evaluation and review document, in spite of being slightly readjusted, the main framework of both remains same. The arrangement of each is presented as Table 2.

Table 2 The structure of program selection/evaluation/reviewing document

	The structure of program selection document	The structure of program evaluation document	The structure of reviewing document
1.			
2.	Layout of the expected key performance indicators	1. The accomplished objectives	1. The measurement of the performance of a one-year program
3.	Needs for funding, human resources and equipment	2. The implementation process	2. The review of a one-year program selection
4.	The policy rationale and purpose of the program	3. The use of funding, human resources and equipment	3. The measurement of the performance of a multi-year program
5.	The description of the program objectives and activities	4. The outline of achieved outcomes	4. The review of a multi-year program selection

Establishing on the system of logic model, the researcher firstly discusses the structure of program selection document. Despite that the outline is systematically distinctive from the logic model, it can be assumed that this arrangement aims to directly provide the reviewers with the expected achievements. In this respect, it indeed expresses the program’s significant improvements and services on its stakeholder; however, the connection of each unit existing in this structure seems lacking a coherent

and logic sequence. It is no doubt that presenting the achievements at the front page rather than filling in irrelevant information enhances the effectiveness of reviewing process, but the activities and strategies to demonstrate how the products of the program are yielded and the services of it are delivered are distantly supported. Meanwhile, the rearrangement of the structure makes examining whether the outputs generated by the program are in accordance with policy rationale and program objectives also require more time cross over the contents.

Another observation lies in the lack of products of relative long-term outcomes. For example, in program selection format, what emphasizes the significance of the program relies only on the "output" as proof to validate its performance and effectiveness. However, Kellogg Foundation (2004) argued that output represents nothing but the number and/or scope of the services and products generated and distributed by the program, which, on basis of logic model, fails to promise changes among the program's target population both at an individual and community, or even national level. Furthermore, Savaya and Waysman (2005) stated that each program contains varying and complicated activities to accomplish its goals, thus the invested program should exhibit its foreseeable outcomes or impact. However, in the program selection document, outputs are utilized to embody the value of the program's achievements. Although the outcomes are required to depict in the program evaluation format, this section lacks a detailed delineation of different outcomes in different period of time. Moreover, the design of this part does not entail program managers to list the data sources and methodology; namely, it is voluntary for program operators to report the kinds of data the program has collected and conducted to reveal its significant outcomes. From the standpoint of the logic model, either at the stage of applying or evaluation, a program ought to link outcomes with its related activities and process and further connect with the policy rationale even if the order of the element in a program is switched.

Aside from the lack of coherence between each component, another point worth discussing is that the current program selection and evaluation document are not closely tied with each other. That is, both documents are individually separated except that the input or resources invested in this program can be tracked. It is argued that the selection should be in line with evaluation given that program selection can act as a ground for an evaluator to assess what differences between before and after the activities are undertaken, as well as if the intended outcomes are accomplished. In this regard, lacking of coordination between selection and evaluation framework likely results in a less effective and efficacious operation. Despite that the reviewers who examine program selection document remain the same as the evaluation is implemented, the

inconsistence of two mechanism tends to inevitably cause the increase of intangible costs. Therefore, the evaluation mechanism based on theory of change is suggested that different stages of program development, including identification of problems, selection of research design, collection of relevant data, should harmoniously be incorporated with evaluation implementation (Rogers, 2014).

V. Conclusion

This study attempts to address the issue with respect to the existing Taiwan's science and technology program selection and evaluation implementation. It has been argued that the linkage between program selection and evaluation fails to build up a robust connection to enhance the effectiveness of reviewing process. The researcher utilized document analysis method to collect the relevant data from governmental materials and official websites to facilitate the examination of the information. Based on the breakdown of the collected data, it is found that program selection, program evaluation and document review are distinctively separated.

From the perspective of a logic model, the scale of outcomes can be divided into three different stages; however, in program selection, the requirement for developing a program simply focuses on the layout of outputs. Moreover, in the evaluation form, it extends the outputs into a more comprehensive scope of benefits. While each is systematically designed and can fulfill the designated function, the tie between program selection and ex-post evaluation is not robustly linked. The disconnection can be likely contributed to the cause behind the ineffectiveness. Hence, the recommendation lies in the utilization of a logic model based on the theory of change since it can not only guide the development of ex-ante and ex-post evaluation to yield a more coherent version of the evaluation mechanism, this approach can also function as a linkage to help resolve the gap between selection and evaluation mechanism to strengthen the performance and quality of reviewing process.

On the other hand, considering the key performance indicators only being applied at the output, it is suggested that the use of a logic model can help program managers early identify indicators between each two sequent components. This advantage allows them to design the method to collect baseline data before the program is initiated. In this regard, a logic model is likely to provide a program team with grounds to frame performance indicators within the context of maximizing public value. Another benefit to adopt the logic model is its flexibility. In spite of fixed aspects included in a logic model, it can be adapted to different purposes at different stages of the program cycle. For example, the function of a planning logic model mainly focuses on the strategy and

while the implementation one reflects the details of management and operation.

In short, a network-oriented logic model aims to direct a program toward a framework in which the team can track the performance and monitor the expected outcomes. Limitations also exist in the application of a logic model, especially a linear design failing to capture the dynamic variations. Nonetheless, in an attempt to solve the disconnection appearing in the science and technology program selection and evaluation, the utilization of a logic model is an appropriate conceptual tool for developing a more solid framework to improve the problem.

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