Generating impact chains

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Author(s):
Paschke, Melanie; Studer, Sibylle

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7 Generating impact chains

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Editors
Melanie Paschke
Manuela Dahinden

University of Zurich[UZH] | ETH zürich | University of Basel

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Zurich-Basel Plant Science Center
ETH Zürich
Tannenstrasse 1, TAN D5.2
8092 Zürich, Schweiz
+41 (0)44 632 23 33
info-plantscience@ethz.ch
www.plantsciences.ch

Editors
Melanie Paschke and Manuela Dahinden

Layout
Manuela Dahinden and Fabian Leuenberger

Illustrations
Fabian Leuenberger

Editing
Kaitlin McNally, Karina Oborune, Joseph Swann and Annina Ziltener

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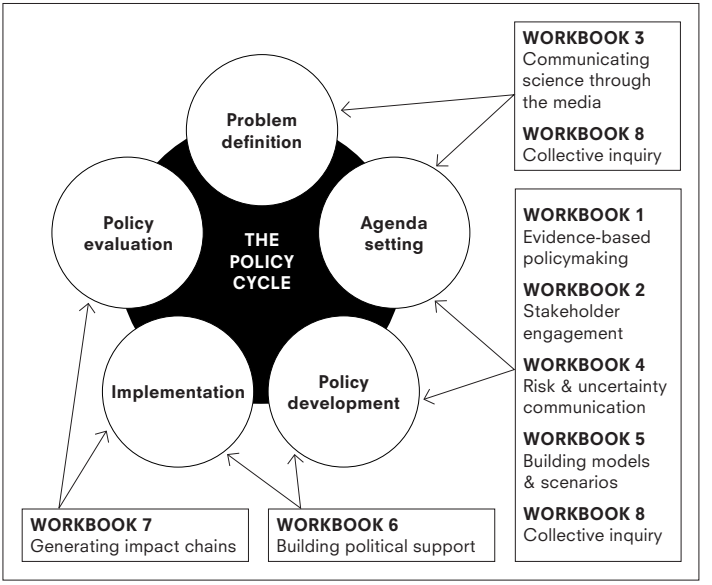
Editorial

> If we wish research evidence to be translated and absorbed in the social domain, it is necessary to understand how ideas about social change can be identified in policy programs and interventions. Generating impact chains is a common approach to make explicit *how change might happen* and provide a basis for policy evaluation.

This workbook is the seventh in a series of eight workbooks exploring the role of scientists in the science-policy dialogue. Workbook 7 reflects on how to generate impact chains. For the monitoring and evaluation of policies, it is useful to conceptualize impact chains in order to contrast the intended with observable impacts. 'Logic models' and 'theories of change' are commonly used tools to illustrate impact chains and to develop indicators for the assessment of the effectiveness of policies. Policy evaluation is seen as the last step of the policy cycle; however, policy evaluation can inform any step in the policy cycle and support ongoing planning, adaptation and learning.

FIGURE 1 — The policy cycle.



MORE READING
M. Paschke (2019). Introduction to science in policy. In: Paschke, M. and Dahinden, M. (eds.). Engaging in the science-policy dialogue. Workbook 1. Evidence-based policymaking. Zurich: Zurich-Basel Plant Science Center.

Guide to workbook 7

The aim

Workbook 7 introduces you to the generation of impact chains. You will learn how impact chains are developed and how they support the evaluation of policy programs.

Competencies

- You will understand the use of impact chains in the context of policy evaluation.
- You will understand the usefulness, as well as the limitations of impact chains.
- You will be able to design 'logic models' and 'theories of change' systematically in order to illustrate impact chains in policy programs.
- You will understand different strategies for developing impact chains (forward and backward mapping).
- You will be able to develop indicators to assess the effectiveness of programs (based on impact chains).

How to read this workbook

THEORY
We will introduce you to the idea of impact chains and their use in the policy cycle, their strengths and limitations. We will also discuss how and to what extent the context of a policy, as well as power asymmetries and unintended effects, can be considered when generating impact chains. Furthermore, we will show how impact chains support the generation of indicators for policy evaluation.
Throughout the workbook, we will present examples from different areas of expertise concerned with societal change: the need for healthy dietary choices, energy-saving through energy-efficient light bulbs, awareness of climate risks and enhancing wood-based bioenergy.

TOOLS

Logic models can be used to design and evaluate policy programs and interventions in a simple linear model. The focus of policy evaluation can be defined and indicators developed based on logic models. In the exercise, we will practice building a logic model.

Theory of change (TOC) allows you to build and evaluate programs, policies and interventions for complex problems. TOC aims at illustrating how meaningful societal change can happen. TOCs are often developed in a participatory process involving stakeholders.

TOC starts with a vision of intended societal changes and applies backward mapping to define the necessary strategy. It systematically plans the intermediate steps necessary in order to reach the ultimate goals.

EXAMPLES

We will present you with a logic model for research on powdery mildew effectors as analyzed by a participant in the *PSC Science & Policy training program* for graduate students.

1. THEORY of generating impact chains

Melanie Paschke
Director of education at the Zurich-Basel Plant Science Center, lecturer at the ETH Zurich and University of Zurich, Switzerland

Sibylle Studer
Scientific collaborator and project manager at INTERFACE Politikstudien Forschung Beratung GmbH, Lucerne, Switzerland

1.1. Impact chains in policy evaluation

1.1.1. Impact chains – a short definition

In generic terms, impact chains are visual representations of the expected change that a program, project, product or institution should bring about. Impact chains consist of several stages along which the effectiveness of a program evolves. An impact chain depicts causes (inputs, processes, actors) and effects (change in time and in target groups) of a program in a linear model (see figure 2). Prominent methods for conceptualizing an impact chain are the 'logic model' approach and the 'theory of change' (Balthasar, 2011; Kellogg Foundation, 2006; Montague-Clouse and Taplin, 2011).

FIGURE 2 — Simplified impact chain applied to the PSC Science & Policy training program for graduates.

Input	Process	Output	Outcome	Impact
• Concept • Resources	• Development of curriculum. • Invitation of speakers.	• PhD courses • Handbooks	• Participants have a better understanding of the science-policy interface. • Participants can apply the policy tools taught in the courses.	• More policy-relevant research. • More knowledge transfer from science to policy.

1.1.2. The use of impact chains in the policy cycle

Impact chains serve as a tool in different stages of the policy cycle (Balthasar, 2011; Stufflebeam, 2000):

Policy development
Impact chains help to clarify the objectives and target groups of a policy and to specify the inputs, processes and cooperation partners needed to implement the policy. Impact chains are used as a tool to conceptualize and steer policies. In federal public administrations like Switzerland, they can be powerful tools to align the implementation strategies of different actors involved in a program (Rieder, 2007).

Policy implementation
Impact chains are tools to monitor and manage policy implementation. They are useful sources for action plans, as well as for communicating project progress and accomplishments (Stufflebeam, 2000). Impact chains provide a basis for specifying the data to be gathered for monitoring purposes and for identifying aspects of the policy critical for attaining the desired goals (Kellogg Foundation, 2006).

Policy evaluation
Impact chains serve evaluation purposes. Indicators can be defined for each stage in the impact chain. Policy evaluators then collect and analyze data referring to these indicators. Or they focus on specific stages of the impact chain, taking resource limitation and practical constraints into account (Coryn et al., 2011; Funnell and Rogers, 2011).

There are two main types of evaluation:

> **Process evaluations** examine to what extent the implementation bodies have succeeded in delivering the intended products and services.
>
> **Impact evaluations** examine the intended and unintended effects of the process on the target groups, as well as on the public and environment (Donaldson, 2007; Balthasar, 2011; Rieder et al., 2014).

Impact chains can be applied in the stages of policy development (e.g., for strategy alignment), policy implementation (e.g., for controlling and communication purposes), as well as policy evaluation.

How can empirical scientists use impact chains?
Life scientists might draw an impact chain of the policy they want to influence in order to clarify at which stages in the impact chain their empirical evidence can make a contribution. Impact chains bring together different types of knowledge related to several stages of the policy cycle: **system knowledge** (agenda setting and policy development: What is the problem?) and **target knowledge** (policy development: What should change?) with **transformation knowledge** (policy implementation: How can change happen?) and **evaluation knowledge** (policy evaluation: Did it work? What can we improve?) (see 'Workbook 1: Evidence-based policymaking'). When rigorous analysis of these questions is necessary, evidence from research can inform the process.

Life scientists can also use impact chains to communicate, clarify and evaluate their own research projects or programs. An impact chain can support several stages of a research process by visualizing the following questions:

- During the preparation and implementation stage, you can ask: What do you want to achieve? What course of action do you want to take? What resources do you need? What limitations might you face?

- While running the program you can ask: What is the current state of the project? How does this compare with your objectives? What are the next steps to take? Should you adapt your goals or your activities?

- During a follow-up stage you can ask: What did you achieve? Did you achieve your initial goals? Were your assumptions realistic? What would you do differently next time?

1.1.3. The elements of impact chains

STAGES

Impact chains consist of different stages describing how a program develops from initial inputs to impact. These stages include:

- **Input**. Concepts, resources and actors who contribute to the implementation of the concept.
- **Process.** Activities to be realized in order to reach the output.
- **Output.** Products and services.
- **Outcome.** Effects on target groups.
- **Impact.** Long-term effects on the environment or society at large.

Traditionally, these stages are ordered in linear cause-effect-relations.

CONTEXT

In order to avoid isolation of the impact chain from other developments, contextual conditions and indirect effects that might affect the chain are generally reported in a context section. The context is not integrated as a specific stage in the linear model of input to impact, but often depicted as an extra box above or below the impact chain.

INDICATORS

In order to be able to monitor and evaluate a program, indicators are defined for each stage of the impact chain. Indicators are concrete, objectively measurable quantities to assess the effects of objectives (Braam, 2010). Based on these indicators, data is gathered with qualitative and quantitative methods that allow for assessing the goal attainment and effectiveness of a program. See 'Section 1.2. Indicators to measure impact'.

ASSUMPTIONS

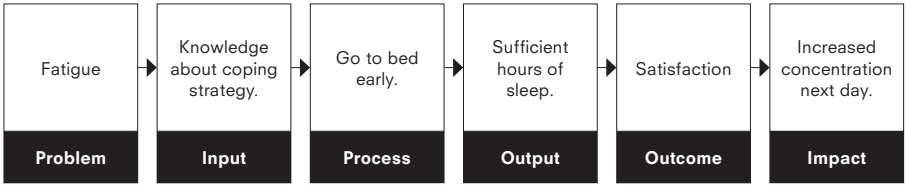
Last but not least, impact chains refer to underlying assumptions about cause-effect relations. These assumptions might be implicit or explicit. There are two strategies to increase the explicitness of the underlying assumption in an impact chain:

- **Forward mapping.** This strategy starts with the problem and develops the steps necessary to solve the problem.
- **Backward mapping.** This strategy starts with a vision and searches for the conditions necessary to achieve this vision.

1.1.4. Example of a simple forward mapping strategy

In impact chains problems, inputs, outputs, outcomes and impact can be linked by a chain of **if-then** relations: **If** I'm tired (problem) **then** I know (input) that I should not spoil my resources and should go to bed early (process). **If** I go to bed early **then** I can sleep for many hours (output). **If** I sleep for many hours **then** I will feel rested (outcome). **If** I feel rested **then** I will be more concentrated (outcome). **If** I feel more concentrated **then** I will get better grades on the test (impact).

FIGURE 3 — A simple example of a forward mapping.



Alternatively you can use the **reverse logic**, where you start at the impact stage of the logic model and then develop the logic model by asking 'but how'– questions. Your program components will then be created in reverse order. For example: I will feel concentrated and will get better grades in the test (impact), **but how**: If I feel rested (outcome), **but how:** If I sleep for many hours (output), **but how:** If I go early to bed (input), **but how:** If I'm tired (problem). The approach is useful to think beyond the already existing structures, processes, inputs and outputs of a program.

1.1.5. Strengths and limitations of impact chains

Impact chains support policy development, implementation and evaluation by providing visual representations of the aim of the program. They are powerful means for strategy development and promotion. Impact chains can be elaborated in a participatory process that helps to align different stakeholder interests. From impact chains, meaningful indicators for the accomplishment of a program can be derived. Besides their many strengths, impact chains also have limitations. Simplified models reduce complexity. They might describe linear cause-effect relations, but they are less suited to illustrating complex mechanism (e.g., nonlinear or mediating effects).

The main criticism of impact chains concerns their blindness to underlying causes, interactions, power asymmetries and unintended effects. With regard to stakeholder involvement, some argue that impact chains – even when developed in a participatory process – are prone to represent the ideology of the powerful rather than the consensus of all stakeholders, and therefore cement power relations (Bakewell and Garbutt, 2005). The most severe criticism concerns the simplifications necessary to depict a complex reality in a linear process. In impact chains, it is often difficult to integrate interactions with other programs (Rogers, 2008) or to represent adaptive systems and dynamics (Patton, 2010).
A response to the critics regarding the linearity of impact chains has been the more recent approaches of theory-driven evaluation (Coryn et. al., 2011). For example, Chen (2005) has developed nonlinear theory-driven evaluation models. It is in the responsibility of the evaluators to differentiate between the simplified representation of a program in a model and the complex[1] interactions involved in the unfolding of impact.

[1] Rogers (2008) distinguishes between complex and complicated problems.

EXAMPLE 1
Energy savings at the household level

Energy savings at household level are considered important by policymakers because they help to reduces greenhouse gas emissions. Several new technical developments and policies support households in energy saving. One example is the introduction of energy-efficient light bulbs. While energy-efficient light bulbs make lighting cheaper, they might also encourage people to illuminate larger areas over longer periods of time, which may result in lower energy savings than anticipated. This effect is called a direct rebound effect. Additionally, indirect rebound effects can arise when the savings gained due to more energy-efficient lighting are spent on other energy-intensive consumption. Please note: impact chains are not built to predict or explain unintended direct or indirect rebound effects.
Impact chains are used to monitor the success of programs and their policies: If we invest in technologies that save energy (such as energy-efficient light bulbs) will the energy savings be as high as predicted? Programs have only a partial control over results, as these are influenced by external factors: outcomes are generated by multiple causal chains.

FIGURE 5 — A simplified model for energy savings at household level.
Adapted from Hicks et al., 2015.

Output	Short-term outcome	Mid-term outcome	Long-term outcome
• Energy-efficient light bulbs introduced in all households.	• Energy savings increase. • **G**reen**h**ouse **g**as (GHG) emission decrease. • Energy costs decrease due to both longer lifetime and lower operating costs.	• High manufacturing energy consumption associated with each bulb not taken into account. • Light used to illuminate larger areas due to lower energy costs (direct rebound effect). • Savings in energy costs used for other GHG-expensive consumption (indirect rebound effect).	• Energy savings decrease. • GHG increases.

1.1.6. Dealing with the context of impact chains

The context of a program is often illustrated in an extra box above or below an impact chain, in order to illustrate contextual conditions that might mediate the implementation and effects of a program. In order to better understand causal mechanisms of a program, the classical tools for impact chain development 'logic model' and 'theory of change' (see 'Chapter 2. Tools') can be complemented by a realist matrix (Blamey and McKenzie, 2007). This matrix illustrates the conditions under which a specific target group will display the desired outcome of the program (Pawson and Tilley, 1997). To this purpose it exemplifies different combinations of **c**ontext, **m**echanisms and **o**utcomes, so-called CMO configurations. Table 1 illustrates a realistic matrix which specifies the expected effectiveness of climate change adaptation programs dependent on different contexts.

TABLE 1 — Realistic matrix concerning context-specific effectiveness of climate adaptation programs.
Adapted from Miyaguchi and Uitto, 2015.

CONTEXT		MECHANISM		OUTCOME
Specifically identified types of participant are well aware of climate risks. Specific types of skill that they need to acquire are clear to them.	+	Training and transfer of techniques and practices facilitate application and use of these skills, techniques and knowledge.	=	(+) High level of adaptive capacity. (+) High level of utilization of adaptive measures.
Relevant ministries and stakeholders are aware of climate risks and the importance of reducing vulnerability.	+	Provision of technical, policy and advisory support to relevant people (from government staff to rural farmers) facilitates its integration with their "business-as-usual" activities.	=	(+) Wide range of mainstreaming.
General citizens are relatively unaware or lack knowledge of **c**limate **c**hange and **a**ssociated (CCA) risks. Government officials do not see the actual need to integrate CCA issues into their business-as-usual activities.	+	TV, newspapers and symposiums attract attention and boost curiosity in citizens about CCA issues. Dissemination targeting government officials with convincing technical data and studies does not itself alter the behavior of government officials.	=	(+) Raised level of awareness among the general public. (–) Low level of awareness among government officials.

[2] "Under circumstances where the general public is known to lack awareness or knowledge of climate change and associated (CCA) risks, means of dissemination such as television, social media, internet or newspapers may be able to boost their curiosity and awareness. However, when it comes to raising awareness among government officials, this seemingly simple mechanism of dissemination has not been found to alter behaviour or mind-sets unless they see and understand the actual need to integrate CCA issues with their business-as-usual activities at the government level." — Miyaguchi and Uitto, 2015: 13.

1.1.7. The relevance of impact chains

Impact chains can fulfill an important role in public policy today, by defining, visualizing and monitoring good governance processes. Some principles ensuring that public policies are salient (relevant and timely), credible (accountable, believable and trusted) and legitimate (developed in a process that considers the values and perspectives of all relevant actors) are set out in table 2.

TABLE 2 — Governance principles guiding the formulation of widely accepted impact chains.
Geißel, 2007.

Governance principles	Applying these principles in the impact chain
Institutional context and stakeholder involvement: Are negotiation systems and networks with different actors in place?	Has the impact chain been established in a participative and consent-oriented process with different stakeholders?
Organizational form of the actors: Is it decentralized and transparent, and does it allow reflection?	Are the world-views, interests and powers implicit in the definition of the outcome transparent? Have different actors been considered in the impact chain, especially at the process stage?
Have different interests been coordinated?	Who guarantees this?
Agenda setting: Have problems been defined by the affected parties?	Do the outcomes address these problems?
Decision-making: Do state and non-state actors cooperate and negotiate multilaterally in decision-making?	Do governmental and non-governmental actors cooperate in decision-making? Who guarantees that outcomes are monitored and assessed in a timely and transparent manner?
Does the state play an active role in, e.g., balancing and implementing soft measures and incentive structures?	Do such interventions and measures serve to activate and balance rather than to command, control, and enforce?

1.2. Indicators to measure impact

Indicators are concrete, objectively measurable quantities that allow the assessment of outcomes. An indicator is an instrument for communicating information that is not directly measurable.

1.2.1. Types of indicator

- **Absolute indicators** measure only one aspect of the subject matter (e.g., number of minutes a light bulb is switched on per day).
- **Relative indicators** indicate relations (e.g., percentage of money savings through reduced energy consumption used for other consumption).
- **Complex indices** summarize several individual indicators (e.g., greenhouse gas emission index).

1.2.2. Approaches to generating indicators

Before indicators are generated, it should be clear who is doing what in this process (participatory approach *vs.* top-down approach). Three different approaches are possible (Noll, 2014):

- **Policy-driven approach** focuses on policy goals as the starting point and generates indicators to monitor goal achievement.
- **Concept-driven approach** develops indicators based on a theoretical measurement framework.
- **Data-driven approach** emphasizes data availability (e.g., of monitoring systems) and prioritizes already existing indicators.

The formulation of indicators is not only a technical challenge, but also includes considerations of cost-effectiveness, recognition, and applicability for the people involved. Table 3 illustrates some quality criteria for indicators.

TABLE 3 — Good indicators will include the following quality criteria. Feller-Länzlinger et al., 2010.

Support of several dimensions	For example, indicators measuring sustainability must consider the dimensions of ecology, economy and society.
Quality of measurement	Validity Reliability
Quality of indicator generation	Transparency (e.g., of aggregation). Quality of data. Availability of data. Option for periodical actualization. Efficiency.
Quality of recognition	Timeliness Acceptance
Legitimation	Legitimation of actors who utilize indicators for controlling.
Participation	Participation of all involved actors and affected stakeholders. Contribution of stakeholders to fostering acceptance.
Communication	Accessibility of information. Dialogue between science, policy and practice / application. Creation of appropriate interfaces to enable communication.
Definition of framework	Declaration of the framework used for controlling, monitoring and evaluation.
Declaration of stage	Declaration of the stage in the impact chain to which indicators refer.

A good indicator ought to be SMART (European Commission, 2004).

- **Specific**. The indicator must be unambiguous and clear.
- **Measurable**. The indicator must be measurable and the measurement costs appropriate.
- **Achievable**. The target value given by the indicator must be achievable.
- **Relevant**. The information provided by the indicator should be relevant for the target groups.
- **Time-bound**. The indicator must show when the objective ought to be achieved.

1.2.3. Example of a smart indicator for energy-efficient light bulbs

A smart indicator for the use of energy-efficient light bulbs in all households needs to define the quality, target population, baseline and threshold of the measure concerned, as well as the due date for measurement.

QUALITY – What is to be changed and why?
Exchange of generation I energy-efficient light bulbs by generation II light bulbs to significantly reduce gray energy.

TARGET POPULATION – Who will be affected?
Households.

BASELINE – How many will change? How much will it change? By when?
20% of generation I light bulbs have been exchanged by households in the first year.

THRESHOLD
90% of generation I light bulbs have been exchanged by households by the end of the third year.

EXERCISE 1
Logic model: An integrated approach to educating southern U.S. landowners about wood-based bioenergy

Figure 6 presents a logic model of the forest extension program discussed in the paper of Joshi et al. (2015). In order to exercise logic modeling, we have eliminated some elements from this model. These elements are listed below. The exercise involves attributing these elements to the different stages of the logic model in figure 6.
This model ends with the outcome stage. Think about adding an impact stage: What kind of long-term effects would the extension program have on society?

THEORY

TOOLS

EXAMPLE

Background

Utilizing wood resources for energy generation is often considered an opportunity to reduce and replace unsustainable fossil fuel usage. However, using agricultural products in energy production causes conflicts associated with food security. What factors influence landowner preferences for improved forest productivity in order to supply biomass for wood-based bioenergy industries?

FIGURE 6 — Logic model for the extension program. Joshi et al., 2015.

Situation (Context)	Inputs	Activities (Process / Implementation)	Outputs	Outcomes (Knowledge/ Actions/ Conditions)	Impact
• Strong federal and state policy support. • Extension professionals need science-based knowledge, resources, and local networks to effectively communicate benefits and market potentials of bioenergy.	• Extension professionals at land grant institutions. • Traditional and new technology transfer, science delivery materials, and systems for disseminating knowledge.	• Inform landowners about bioenergy and its market potentials. • Focus activities for underserved landowner groups.	• Educate extension community about potential benefits and market for wood-based bioenergy.	• Extension and outreach community will have new opportunities and resources [knowledge]. • Active forest management to meet the new demand from bioenergy industries [actions]. • Diversified employment and economic opportunities for rural landowners [conditions].	

Elements of the logic model

- Abundance of wood biomass in the southern regions of the United States.
- Decline in domestic timber market coupled with lack of awareness of new opportunities discourages landowners from adopting healthy forest practices such as thinning, thereby causing forest health issues (invasive species, forest fires etc.).
- Landowners are largely unaware of technical and economic feasibility as well as social acceptability of bioenergy.
- Federal, state, and local resources.
- Research facilities, equipment, supplies, and region-wide professional network.
- Knowledge dissemination concerning economic as well as social impacts of bioenergy on local and regional economy.
- Educate land-owners about potential negative impacts of wood-based bioenergy.
- Design multiple extension programs for best outreach to landowner groups.
- Extension/outreach resources for educated and younger landowners.
- Special program focus for underserved group of landowners.
- Increased knowledge base regarding bioenergy market.
- Increased knowledge about the logistics and economic feasibility of bioenergy.
- Landowners will consider supplying wood biomass.
- Active participation of landowners in outreach activities.
- Well-informed landowners with better understanding of the risks and possible impacts of market change.

Note: Distinguishing activities (as part of the implementation process) from outputs (as products of the implementation process) might be tricky. In the case of figure 6, it helps to identify (1) which elements serve to increase acceptance of the extension program and help to address the main target groups (implementation process) and (2) which elements contain target group specific products of the extension program (final product of the implementation process).

2. TOOLS for generating impact chains

Melanie Paschke
Director of education at the Zurich-Basel Plant Science Center, lecturer at the ETH Zurich and University of Zurich, Switzerland

Sibylle Studer
Scientific collaborator and project manager at INTERFACE Politikstudien Forschung Beratung GmbH, Lucerne, Switzerland

The development of impact chains for policy evaluation had its origin in the mid 1960s in the USA. First explicit notions of an impact chain can be found in the work of Daniel Stufflebeam. He defined **c**ontext (C), **i**nput (I), **p**rocess (P) and **p**roduct (P) as the core concepts of a comprehensive framework for evaluating a project, program, personnel, product, institution or system (Stufflebeam, 1966; 1976; 2000).[3] He called this framework the 'CIPP evaluation model'. The often-used label 'logic model' was introduced by Wholey (1979) and established by Chen and Rossi (1987) and Rossi et al. (1999). Since then, impact chains have been applied in various disciplines across the world (Coryn et al., 2011).[4] Weiss (1995) introduced the term 'theory of change' when expressing the need for being more explicit about cause-effect relations in impact chains. In the next section, we will elaborate on two approaches to developing impact chains: the logic model and theory of change.

[3] In the same time period, Suchman wrote about a 'chain of objectives' (Suchman, 1967: 55) examining three factors: program, objective and intervening process. Kirkpatrick already implicitly developed the idea of an impact chain by defining the four levels of learning evaluation: reaction to training, learning, behavior and results in terms of targeted outcomes.

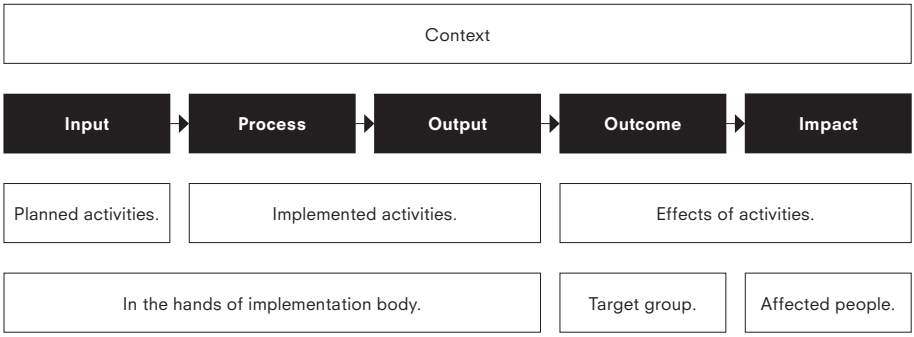
[4] Coryn et al. (2011) provide a comprehensive overview of publications on theory-driven evaluation, e.g., logical frameworks and theory of change.

2.1. Logic model

> A logic model is a systematic and visual way to present and share your understanding of the relationships among the resources you have to operate your program, the activities you plan to do and the changes or results you hope to achieve. — Kellogg Foundation, 2006: 1.

Impact chains as illustrated in figure 7 are called logic models. Logic models are characterized by a standardized sequence of stages (input, activities, output, outcome, impact). A considerable body of literature has elaborated on these stages and the processes involved in their development.

FIGURE 7 — Logic model. Adapted from Kellogg Foundation, 2006.



Purpose
For evaluators, a logic model defines the stages of a policy implementation process and clarifies its focus and limitations. It visualizes how effectiveness might be achieved and provides a basis for defining indicators and measurements of effectiveness. The development of a logic model might be part of a participatory process.
For practitioners, a logic model is a powerful tool for program planning, management, communication (with stakeholders), consensus-building on program objectives and implementation and development of a monitoring and controlling system, as well as for fundraising purposes (streamlining grant applications) (Funnell and Rogers, 2011).

Applications
Depending on the stage of the policy cycle the logic model will be applied in three different ways (Kellogg Foundation, 2006). **Outcomes approach** models focus on linking input with desired results and often differentiate between different outcomes (e.g., time phases, target

groups) and are most suitable for policy reviews. **Activity approach** models emphasize the implementation process and activities to be realized and are most suitable for monitoring and management purposes during policy implementation. **Theory approach** models focus on the reasons how and why a program will work, and are most suitable in the stage of policy development. Theory approach models can be considered as one type of theory of change; this will be discussed later.

Time needed
The time needed to develop a logic model depends on how participative (e.g., stakeholder-inclusive) it should be. Developing a basic logic model individually can be done in a few hours.

Implementation
Structure your project / program / research according to the stages of the logic model:

- **Input** includes the human, financial, organizational and community resources available.
- **Activities** are what the program does with the resources. Activities are the processes, tools, events, technologies and actions used to bring about the intended program results.
- **Outputs** are the direct products of program activities and may include types, levels and targets of services to be delivered by the program.
- **Outcomes** are the specific changes in program participants' behavior, knowledge, skills, status and level of functioning.
- **Impact** is the fundamental intended or unintended change occurring in organizations, communities or systems. — Kellogg Foundation, 2006.

The literature is not consistent about the terminology of the last two stages in the impact chain. Some authors (including us) use the term 'impact' for the last stage in the impact chain and 'outcomes' for the next to last. Others use 'outcome' for the last stage and 'impact' for the next to last stage. Irrespective of the terminology, authors generally agree with the content of the next to last and the last stage in the impact chain. We will use the term 'outcome' (next to last stage) to describe the effects on the target groups and 'impact' (last stage) to describe the societal effects of the program in interaction with the context.

Some authors distinguish between short-term and middle-term outcomes (i.e., those leading to long-term impact). Others differentiate outcome by target groups (e.g., institutions, households or individuals) or political entities (e.g., outcomes on community and national levels). The latter differentiation is especially helpful for policy evaluation, since it specifies amongst which target groups data on the program's effectiveness should be gathered.

Logic models can be conceptualized by applying both forward and backward mapping. When used for a policy review, forward mapping is more common, since the inputs have generally already been used (and are fixed) before the evaluation review process starts. In the early stage of the policy cycle or for a theory approach logic model, backward mapping can be applied.

Limitations

- Restricted to depiction of linear processes.
- Descriptive.

SOURCE – adapted from

Kellogg Foundation (2006). Logic model development guide. Battle Creek: W.K. Kellogg Foundation. Retrieved from:
www.wkkf.org/resource-directory/resource/2006/02/wk-kellogg-foundation-logic-model-development-guide

2.2. Theory of change

> Theory of change (TOC) is a rigorous yet participatory process whereby groups and stakeholders in a planning process articulate their long-term goals and identify the conditions they believe have to unfold for those goals to be met. These conditions are modeled as desired outcomes, arranged graphically in a causal framework. — Taplin and Clark, 2012.

Applications

TOC focuses on the expected mechanisms of change and is often elaborated in a participatory process, whereas a logic model highlights expected effects in a standardized and linear model. Table 4 contrasts the characteristics of a TOC with the characteristics of a logic model. The table refers to the most common manifestations of logic models and theories of change.

TABLE 4 — The most common manifestations of logic models and theories of change.

	Logic model	Theory of change
Content	Graphically illustrates policies according to the stages input > activities > output > outcome > impact.	Links outcomes and activities to explain HOW and WHY the desired change is expected to happen.
Format	Standardized (5 stages).	Less standardized.
Starting point	Program / policy.	Vision / goal.
Process	Often forward mapping, reduction of complexity to linear processes.	Backward mapping, stakeholder involvement is key.
Causality	Structures stages without analyzing causalities.	Causal model articulates underlying assumptions, preconditions for next stages, justifications, hypotheses.
Result	Descriptive representation.	Explanatory pathway.

Purpose

With a TOC, researchers can illustrate why and how a change is going to happen. TOC clarifies the preconditions for change, timing, how change will be achieved, who will induce it and how it contributes to the next step in the pathway. Assumptions are examined and indicators for testing them are developed. TOC is a powerful tool for practitioners to develop a common understanding of cause-effect relations in a participatory process. This understanding serves communication needs and fundraising purposes.

With respect to the above mentioned strengths and limitations of impact chains, theories of change are more likely to be able to depict complexity than classical, standardized logic models (e.g., TOC allow integrating feedback loops and simultaneous causal strands). In contrast, standardized logic models are easier to understand, relatively convenient to evaluate and allow for comparison between different programs: characteristics that are valued by policymakers and public administrators.

Time needed
The time needed depends closely on how participative (e.g., stakeholder-inclusive) the development of the TOC will be. Developing a basic TOC individually can be done in approximately one day.

Implementation
TOC starts with a vision of meaningful social changes and then defines the intermediate steps and the necessary strategy to reach the ultimate goals (Anderson, 2005). The most prominent approach to develop a TOC is backward mapping. You can use the Planning Triangle (NCVO, 2017) and follow these steps:

STEP 1
Start with defining the long-term goal / vision you want to achieve with your project / program / research.

STEP 2
Define the general preconditions.

STEP 3
Define what mid- and short-term objectives have to be met in order to reach your long-term goal. Explain how they will contribute to the long-term goal.

STEP 4
Identify the underlying assumptions of your project / program / research.

STEP 5
Define the interventions which are needed in order to fulfill the preconditions. Articulate assumptions linking the interventions with the preconditions.

STEP 6
Identify indicators to measure whether the preconditions are fulfilled.

Limitations
- Postulates context-specific mechanisms, but does not test for universal mechanisms.
- Little comparability between TOC of different programs.

THEORY

TOOLS

EXAMPLE

EXAMPLE 2
Developing a change map to adapt dietary choices

How could a TOC addressing the problem of the unhealthy diet of various social groups be formulated using backward mapping? What interactions could be useful? What are the necessary assumptions?

FIGURE 8 — TOC for healthy dietary choices using the Planning Triangle.
Adapted from NCVO, 2017.

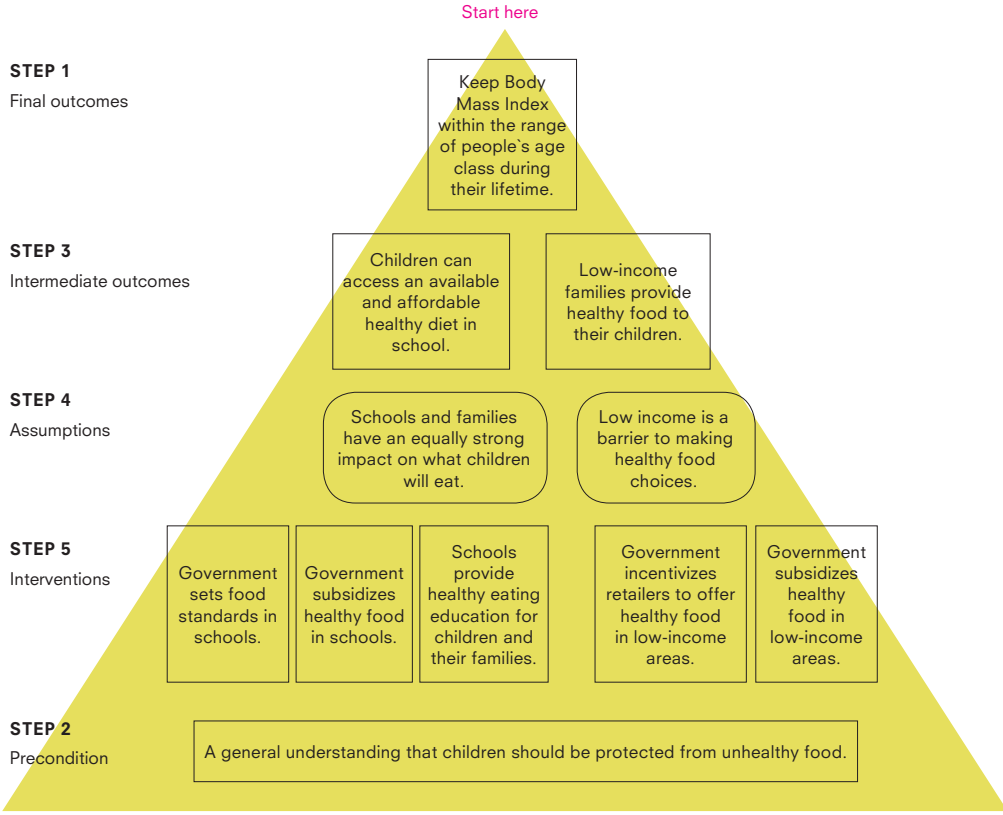
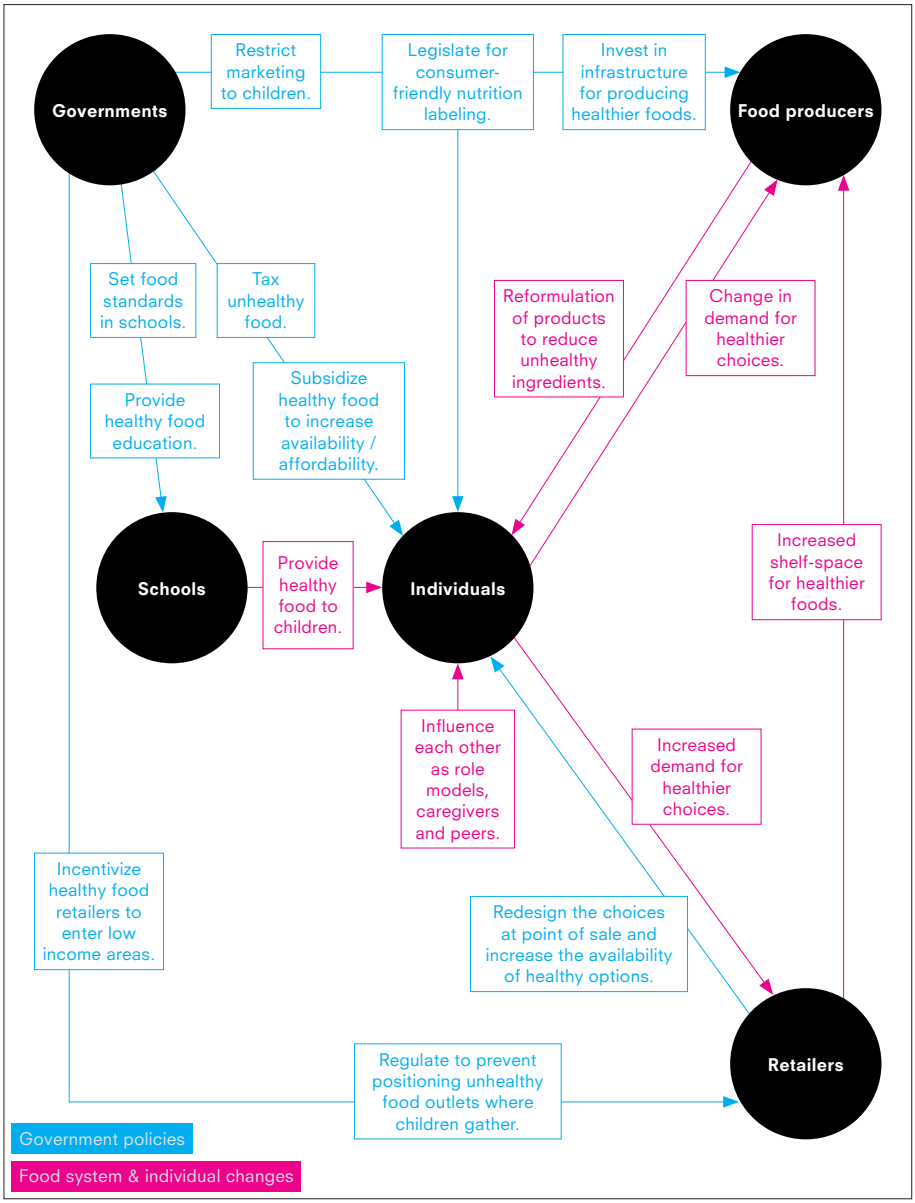


FIGURE 9 — How can governments support healthy food preferences. Adapted from *Lancet Obesity Series* infographic (2015). The food system is an interconnected network of producers, industry and institutions. But at its heart is the individual. Policy can affect all parts of the network, influencing a cultural shift toward healthier food preferences.



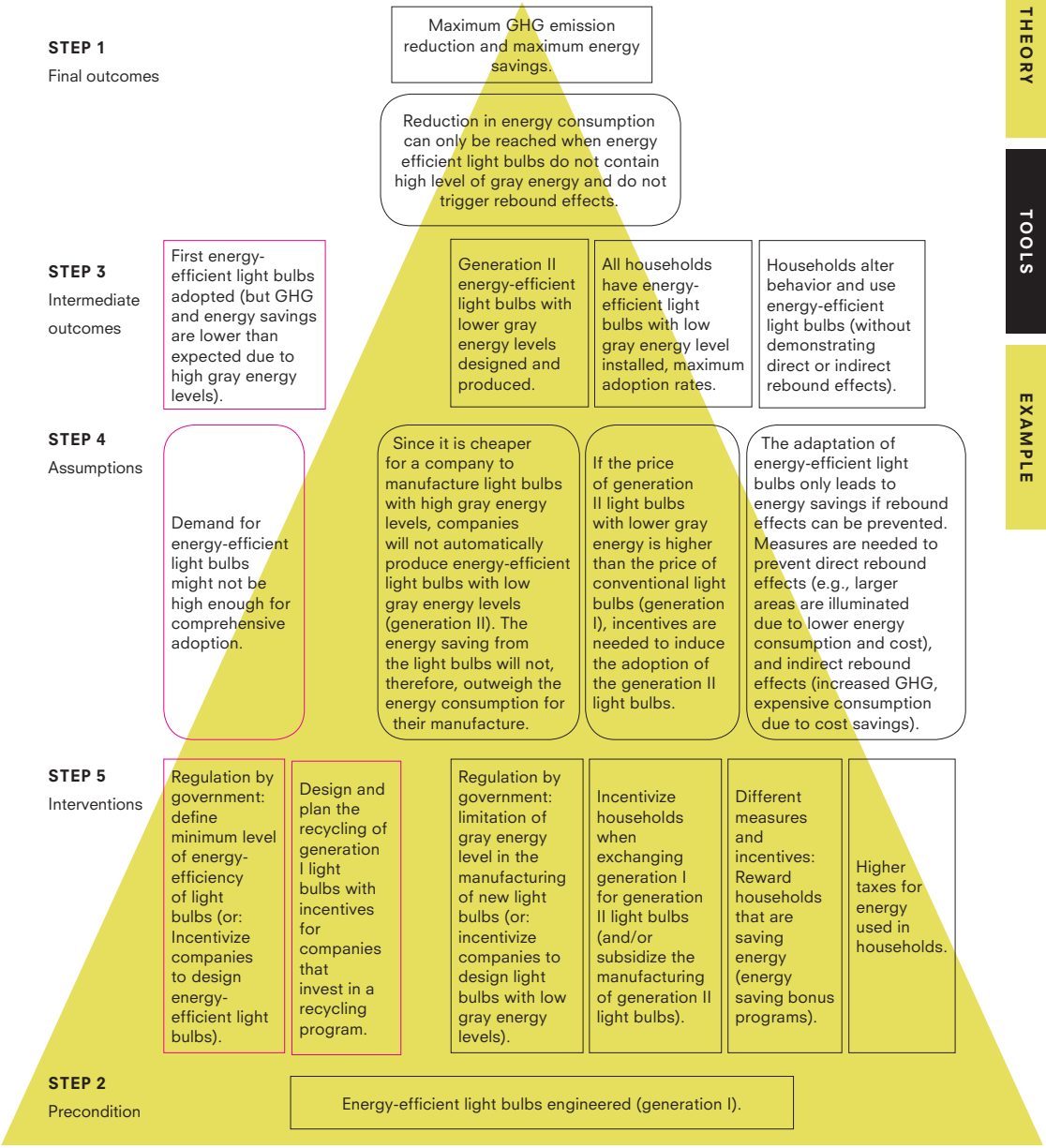
EXAMPLE 3
TOC for the use of energy-efficient light bulbs while minimizing rebound effects

In this example we show some of the steps that need special awareness during the introduction of energy-efficient light bulbs (with reference to Hicks et al., 2015). The increase in energy efficiency might be hampered by increased manufacturing energy consumption (gray energy) and /or rebound effects. What could a TOC look like?

MORE READING

Taplin, D., Clark, H. (2012). Theory of change basics. A primer on theory of change. Retrieved from: www.theoryofchange.org/wp-content/uploads/toco_library/pdf/ToCBasics.pdf

FIGURE 10 — TOC for the use of energy-efficient light bulbs using the Planning Triangle.
Adapted from NCVO, 2017.



3. EXAMPLE of impact chain generation

Kaitlin McNally
Former participant in PSC Science & Policy training program for graduate students and scientist at the Molecular Plant Biology / Phytopathology group, Department of Plant and Microbial Biology, University of Zurich, Switzerland

3.1. A logic model for research on powdery mildew effectors

As part of a case study, participants in the *PSC Science & Policy training program for graduate students* were asked to develop a logic model of their research. The focus of the following logic model is a study of resistance in wheat against disease caused by powdery mildew. The study is concerned with the production and acceptance of genetically modified seeds. The participant divided the individual elements of the logic model into four categories: scientific research (orange), international collaboration (pink), the science/policy interface (blue), and academic training (black).

The model assumes a linear process from genetically modified seeds to acceptance by consumers. However, this assumption underestimates rebound and unintended effects. Could you think of a more realistic model if you wanted to improve acceptance of transgenic wheat cultivars by farmers and consumers?

FIGURE 11 — Logic model for functional and evolutionary studies of powdery mildew effectors.

Evaluation questions

- Are transgenic wheat cultivars more resistant to powdery mildew than standard varieties?
- Can this knowledge be applied to long-term breeding strategies for durable resistance?
- Have state-of-the-art technologies been implemented and advanced?
- Has knowledge been generated?
- Has public acceptance of transgenics strengthened?
- Have public funds been used to promote public good, academic good and fostering international collaboration?
- Has a PhD candidate successfully been trained for a career in research?

Explanation

Possible unintended effects of this program might include consequences of the scientific process, including setbacks and unexpected discoveries, as well as conflicts of interest arising from public and stakeholder opposition to testing of **g**enetically **m**odified **o**rganisms (GMO). Additionally, if unforeseen faults are found in the transgenic seeds, there might be a backlash of opposition to further research and testing. To improve the logic model, the participant could add elements of outreach and education for the public and stakeholders (breeders, farmers and policymakers), and more activities to include stakeholders in the planning and acting stages. This would promote cooperation and a common vision of the intended outcomes. More research into the process of GMO testing and approval would assist in defining more realistic outcomes at the social and economic interface. For example, researchers could collaborate with breeders to integrate transgenic lines into popular local varieties, which until now has not been done in Switzerland. That the cultivars used for transgenic wheat have not been popular varieties with Swiss farmers has long been an argument against the need for testing and permitting genetically modified wheat in Switzerland.

Lessons learned

At first it can be difficult for participants to create a logic model, but ultimately they will find that this helps frame the elements and put a project into the bigger picture. It can also pinpoint gaps in the plan and it clarifies the final goals and impacts of the project. Imagining both positive and negative unintended outcomes is the first step in preparing for and avoiding potential pitfalls, which saves time and energy, particularly for long-term projects.

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