学位論文

# Examining the Secondary Effects of Technological Politics in Infrastructure Development

## 技術の政治性が及ぼすインフラ整備における副次的効果

Pitch SUTHEERAWATTHANA

ピッチ　スティラワッタナ

**Examining the Secondary Effects of Technological Politics in Infrastructure Development**
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by

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# ABSTRACT

## Examining the Secondary Effects of Technological Politics in Infrastructure Development

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This thesis focuses on the characteristic of technological politics that imposes secondary effects on infrastructure development. Technological politics refers to the notion that the use of technology transforms, orders, and adapts peoples' decision to choose a particular course of action without question or because it is unavoidable . The application of one technological solution sometimes masks profound and problematic consequences in the social order. For example, modern IT technologies may lead to the destruction of human relationships that have a distinctive cultural cast. Or, an Official Development Assistance dam project for a developing country may influence the way people use water resources, go to work, and even protect themselves from natural disasters over a very long time. However, within conventional categories for analyzing technological capacity, the notion of technological politics is not generally considered in engineering implementation.

This research begins with an examination of the philosophical concepts that explain how peoples' decisions are dominated by technology in general, both consciously

and unconsciously, deliberately or inadvertently. Instead of successfully applying the findings of previous research to infrastructure development, the case study investigation reveals the common phenomenon that there exists a series of actions subsequent to the initial impacts of infrastructure development projects. This is one form of technological politics, indicating that effects gradually spread and cause several other events to occur as consequences. Accordingly, this idea is developed into the concept of the solution "chain" in this thesis. The chain here refers to the cyclical phenomenon of needing to implement remedial solutions one after the other. Thus the purpose of this research is to demonstrate the evidence for the developed concept in infrastructure development. To do this, two case studies of dam constructions at Mt. Merapi in Indonesia and Bang Pakong in Thailand are analyzed to depict the series of additional engineering, economical, and legislative deliberations needed as remedies due to the impacts arising from the initial dam construction. The outcomes of such disturbing orders have a wide range of influences on both animate and inanimate objects such as local people, the government, and the environment.

The theory of technological politics in this thesis consists of two notions: 'who governs' and 'what governs'. This thesis clarifies how a society is influenced by construction, who are the relevant stakeholders, and what unequal degrees of power and levels of awareness they may have. The output of this research not only presents a way to view infrastructure development projects through the lenses of disciplines other than engineering and economics, but also provides compelling evaluation criteria that should be considered in project planning, design, construction, and even operations.

# 論文内容の要旨

## 技術の政治性が及ぼすインフラ整備における副次的効果

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本論文は、インフラ開発がもたらす社会への副次的影響の構造を「技術の政治性」の観点から明らかにしたものである。ここで言う技術の政治性とは、ある問題解決のために導入された技術が、気づかぬうちに社会の共通の関心事や利益と関わるような人々の行動を変化、制限、あるいは馴化する過程を秩序化する、媒介としての性格を意味する。例えば、現代の情報通信技術は人間関係の崩壊を引き起こすかもしれない。あるいは、発展途上国におけるダム開発プロジェクトは生活者の水資源利用方法、労働形態、さらに、長期的視点でいえば行政や制度にも影響を及ぼす可能性がある。これらは、技術を機能性や効率性からのみ捉える従来からの直接的な視点とは異なり、技術が社会秩序に及ぼす副次的影響に言及したものである。このような技術の政治性の議論は、社会科学分野における概念的な理論にとどまっていたが、本研究ではそれを援用することにより、インフラ開発で観察される技術の政治性の様態の一つをその副次的影響とともに明らかにし、その影響に起因する価値の埋め込み構造に考察を加えた。

本研究では、まず、日常生活において人々が意識的あるいは無意識に影響を受ける技術の政治的特性について、技術哲学分野の先行研究を整理し洞察を得た。先行研究から得られた知見は、ある技術システム(この場合はインフラ開発)の社会への導入が、無秩序に生じるの

ではなく一定の方向性をもち、個々の行動をある種の秩序に置き換えていく過程についての議論である。本論文では、そのような過程を「連鎖(chain)」と呼ぶことにした。連鎖とは、言い換えると、ある問題への解決策が必要とされた結果、次々と解決策の循環が発生する状況を表す。そこで、インフラ開発における連鎖による悪循環を検証するために、メラピ山(インドネシア)およびバンパコン川(タイ)における２つのダム建設の事例研究を行った。その結果、更なる追加工事や経済投資を引き起こす当初のダム建設の技術的要因とともに、環境や行政などに及ぼす影響の連鎖、さらには連鎖の悪循環における現地住民や政府など関係者の価値の埋込み構造が明らかにされた。

本論文の特徴は、社会科学における技術の政治性に関する概念的な研究をインフラ開発に適用し、技術が及ぼす副次的影響の構造に現実の問題を用いた考察を加えた点にある。ここで示された「連鎖」の構造は、誰がステークホルダーとなるのか、ステークホルダー間にはどのような権力の不均衡が存在し、人々がその事に対してどのように意識的にふるまったかなどを分析する新しい視点を提供したものである。本研究の貢献は、インフラ開発の循環において、「誰が支配するか」そして「何が支配するか」という側面からの技術の政治性の具体的事例の提示であり、建設事業が社会秩序に及ぼす影響を、工学や経済学といった分野を超えた視点から考察した点にある。本研究の成果は、インフラ開発を分析する新しい視点を提供しただけでなく、事業計画、設計、施工、実施に応用可能な評価規準に関する示唆を含むものである。

## DEDICATION

*To my father and mother*

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# CHAPTER 1

# INTRODUCTION

## 1.1 INTRODUCTION

In many situations, technologies impose impacts that are not easily recognized by the users of technology or even by the developers of technology. These impacts are known as secondary effects. Many attempts have been made in the field of the philosophy of technology to understand the secondary effects of technology. These attempts have mainly focused on devices and scientific knowledge.

Recently, infrastructure development projects involving the combination of various technologies have been observed to impose a number of secondary effects, including degradation of the environment, the uneven distribution of benefits and costs, and so forth. These secondary effects have in many cases been subverting the benefits of developments. These situations indicate shortcomings in our knowledge relating to the design and evaluation of infrastructure development projects.

The central premise of this thesis is that gaining the ability to identify secondary effects will reveal more clearly the scope of the negative impacts caused by technology. This ability is expected to contribute to better decision-making in the design and evaluation of infrastructure development projects. Therefore, there is a need for a clarifying concept that offers a new means for identifying secondary effects.

## 1.2 OBJECTIVES OF THESIS

This study has three main objectives. The first objective is to develop a concept that is insightful for identifying the secondary effects of infrastructure development projects. This study elaborates the concept of chain solutions on the basis of philosophical research. The findings suggest the chain structure as a means of understanding the sources of secondary effects.

To establish the significance of the chain concept, the second objective is to examine chains of solutions and their implications through empirical research using case studies. Examining a series of solutions reveals that two types of secondary effects occur during the development of a chain: effects created by individual solutions and effects underlying the whole chain. Accordingly, secondary effects are redefined.

Theoretical explorations in the field of the philosophy of technology provide many insights in the consideration of the phenomena related to the use of technologies. However, the typical education path for project engineers and decision makers does not emphasize such knowledge. Therefore, the third objective is to demonstrate the effect of employing such theoretical investigations on predicting the secondary effects of infrastructure development projects. With the effectiveness of such insights demonstrated clearly in this study, it is hoped that project engineers and decision makers will adopt them as a serious consideration in the project design and evaluation of future projects.

## 1.3 MOTIVATION FOR RESEARCH

In general, technology improves our living conditions and makes things previously beyond imagining into realities. As examples, a television allows the dissemination of information in the form of graphics and moving objects. A typewriter increases the speed of writing and improves its readability. A bridge provides a convenient connection between communities located on different sides of a river. Household appliances provide conveniences for domestic tasks at home such as cleaning and cooking. A mobile phone on a global network makes communication between two persons in different continents possible with just a few touches of the fingertips. Technology is almost everywhere: at home and at work, on the ground and under it, on land and on the ocean, on earth and in space, and so forth. Its applications include clothes, instant foods, eyeglasses, refrigerators, electricity, cars, railways, printing machines, telephones and faxes, medicines, industrial robots, biological cloning, satellites, rockets, and so forth. It is almost impossible to name all of the technologies that are present in our lives; the list seems never ending.

However, despite the careful efforts and good intentions at the time of their development and assessment, the application of many technologies has brought about both unprecedented harm as well as benefits. Humans make use of technologies and, at the same time, experience their secondary effects. As examples, a television becomes a baby sister in modern families [Winner, 1986]. The typewriter influenced the change of gender expectations for secretarial workers from male to female [Ihde, 1993]. Bridges at Long Island enabled discrimination against the black and the poor because they were

used to prevent their access to the beach [Winner, 1986]. Household appliances create more work for mothers [Cowan, 1983]. A mobile phone makes it difficult for us to escape from works and friends [Arnold, 2003]. History demonstrates that humans are unable to foresee the whole scope of secondary effects that may be imposed by a given technology. Humans can only learn by doing.

Many attempts have been made in the field of the philosophy of technology to understand the secondary effects of technology. Good examples include, although are not limited to, studies on the phenomena of authority and subordination [Engels, no date], social domination [Marcuse, 1964], technological imperatives [Winner, 1977], device paradigms [Borgmann, 1984], the social construction of technology [Pinch and Bijker, 1987], human and nonhuman actors [Latour, 1987], background relations [Ihde, 1990], revenge effects [Tenner, 1996], and Janus faces [Arnold, 2003].

These attempts in the field of the philosophy of technology have mainly focused on devices and scientific knowledge. Infrastructure development projects, involving the combination of various technologies, have not been paid much attention. However, infrastructural technologies such as roads and dams deserve closer attention for several reasons. First, they come to form the background of our daily lives. Second, unlike other devices, their cancellation or removal is not easy at low cost; if they have impacts, they will be felt for decades. Last but not least, infrastructural development processes involve high investment – on the scale of billions of dollars – and involve and affect a wide spectrum of stakeholders, including government agencies, beneficiaries and other

affected persons, vulnerable groups such as the poor, international financial aid institutions, NGOs, and so forth.

It should be noted that the distinction between positive and negative impacts is not a focus of this study. This is because an impact can be perceived as positive for one person and negative for another at the same time. It depends on the values of the individuals concerned. In some cases, an impact which is negative today may become positive tomorrow, and vice versa. Furthermore, the tradeoff between them is not a concern in this thesis either. Rather, this thesis presents an attempt to provide an alternative view for considering secondary effects. However, due to various constraints, most of the discussions in this thesis involve impacts which have been perceived negatively from the viewpoint of affected local communities.

### 1.3.1 UNFORESEEABILITY OF SECONDARY EFFECTS

Rendering something unforeseeable into something foreseeable is always a challenge. Not only infrastructure development projects but also other applications of technology generate unpredictable impacts. Humans still do not have complete understanding of many factors relating to the application of technologies. However, unlike an electrical appliance for example, an infrastructure development project involves the well-being of the public. Its unpredictable impacts can create difficulties for many people, not simply individuals. In most circumstances, those people affected did not initiate the project, nor do they receive any benefits from it. This study on the unpredictability of secondary effects of technology, therefore, should set a high priority

on determining the secondary effects of infrastructure development projects, because they can potentially disadvantage huge numbers of people.

### 1.3.2 IRREVERSIBILITY RELATING TO INFRASTRUCTURE

The lifespan of most infrastructures is quite long, being on the scale of 30 to 50 years, or even longer. Since it is likely to be very costly to cancel an infrastructure's usage or to remove it after it has been constructed, its impacts will probably continue until the end of its life. Given this long period of time, the potential irreversibility of any related damage must be considered.

Dams in the United States provide clear evidence of this issue. For instance, unacknowledged during their planning and construction phases, the impact of fish species becoming extinct due to the obstruction of their migration patterns was only revealed decades later. Currently, many efforts are being devoted to the removal of a number of dams, both non-functioning and functioning ones. The recovery of fish migration is under the close observation of scientists and non-government organizations.

Looking at both our current surrounding infrastructures and future ones to come, what kind of irreversible impacts may they bring about? Without the ability to identify secondary effects in advance and to predict what irreversible damage they may case, it is difficult to describe such so-called 'developments' as sustainable.

### 1.3.3 METHODOLOGY FOR EXAMINING SECONDARY EFFECTS

It is unquestionable that theoretical explorations in the field of the philosophy of technology can provide valuable insights into the interrelations between technology and society. It is possible that such explorations are neglected in either the education for or practices of engineers, project planners, and decision-makers. One plausible reason for this is that such theoretical explorations are undertaken with a high level of abstraction. They are not developed sufficiently for practical implementation. In other words, they lack rigid methodologies. Thus, the ultimate goal of the research theme is to provide some concrete methodologies to aid in the practical implementation of such theoretical explorations in examining the secondary effects of technology.

## 1.4 RESEARCH METHODOLOGY

In this study, the two initial research activities involved the review of literature on the philosophy of technology and that on cases of infrastructure development projects (see figure 1-1). These two activities were undertaken simultaneously so that relevant cases could be selected for further detailed observation. The selected case studies include the Sabo Facility Project at Mt. Merapi in Indonesia and the Bang Pakong Diversion Dam Project in Thailand.

Project reports, articles and media reports related to the case studies were reviewed for basic data. This basic data was used as a basis for the development of a conceptualization of technological politics and for setting up a proposition. Detailed

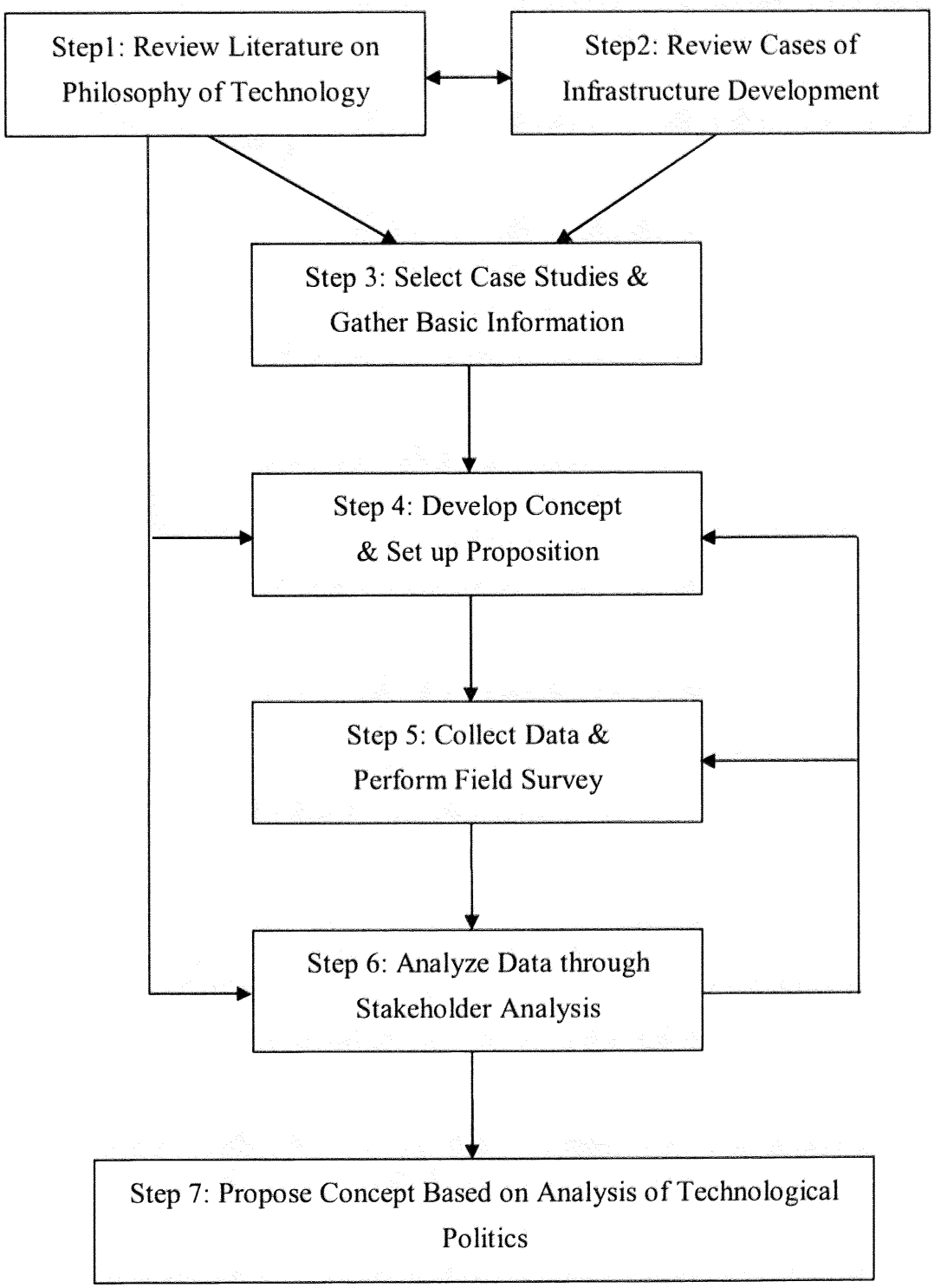



Figure 1-1: Flowchart of Research Activities

information was gathered through data collection from relevant organizations, field surveys, and interviews.

Then, all data was analyzed in order to elaborate the developed concept, and a stakeholder analysis was performed in order to revise the proposition. For a comprehensive analysis, it was necessary to repeatedly undertake steps 4 to 6 (see figure 1-1). Finally, this study presents the developed concept based on an analysis of technological politics, and puts forward speculative discussions related to the application of this concept.

## 1.5 RESEARCH OUTCOMES

### 1.5.1 CHAINS OF SOLUTIONS AS A POLITICAL PHENOMENON

In this study, the chain solution concept is developed on the basis of philosophical explorations related to the non-neutral powers of technology in association with two notions of technological politics. Non-neutral powers of technology are apparent in situations in which a technology imposes impacts other than its intended purposes. The theory of technological politics consists of two notions: who governs (the achievement of political power by the elites through the use of technology) and what governs (the generation of a new social order by technology itself). Winner (1977) extended the meaning of technological politics from 'who governs' to 'what governs'; thus the definition of politics was extended to have a greater meaning.

The chain solution concept involves the cyclical phenomenon of needing one solution after another, such that solutions continue to occur in a series of actions for a

long time. This technological trap is a form of technological politics that influences people to make decisions in a certain way. With respect to the findings of this study, the political phenomena associated with the chain of solutions not only provides a potential means of determining how society is dominated by technology from the viewpoint of the second notion, but also suggests some insights regarding the advantage-taking behaviors of key actors from the viewpoint of the first notion.

Chains of solutions relate to the second notion of technological politics because it addresses the capacity of solutions to self-generate impacts. During its evolution, a chain of solutions by itself generates two important types of secondary effects: (i) effects created by individual solutions and (ii) effects underlying the whole chain. The first type of secondary effect is the effect that is generated by an individual solution within the chain structure. An individual solution within a chain can generate consequential effects in three patterns which will be described later in this dissertation. Importantly, both the solutions and their generated effects enhance the extension and expansion of the chain of solutions. The second type of secondary effect is the effect that emerges in such a way that the longer a chain is, the greater the effects are. Throughout the chain, this type of effect continues to subvert the benefits of development.

Chains of solutions include the first notion of technological politics because they involve many stakeholders. Analyzing various stakeholders' behaviors throughout a chain provides some insights. This study asserts that, inseparable from whatever threat it may present, an infrastructure development impact also presents an opportunity for advantage-taking behavior by an individual or a group of persons, either through the impact itself or

through its successive solutions. The advantage-taking behaviors are demonstrated in the stakeholder analysis. As a result, some speculative discussions are put forward.

The following paragraphs provide summaries of discussions in this dissertation. Figure 1-2 and 1-3 illustrate overviews of the chain structures and secondary effects in the two case studies. Figure 1-4 illustrates an overview of this dissertation in relation to the philosophical explorations used for elaborating the chain solution concept, identifying the two types of secondary effects, and discussing advantage-taking behaviors. More details of the chain solution concept and arguments for its importance can be found in the following chapters of this dissertation.

### 1.5.2 SECONDARY EFFECT TYPE I: EFFECTS CREATED BY INDIVIDUAL SOLUTIONS

Within the chain structure, several new effects have arisen due to the implementation of various solutions. Some examples of such effects in the case of the Sabo dams at Mt. Merapi are as follows. As the solution for the conflict between local sand miners and large private sand-mining companies, the establishment of the GORO Association resulted in frustrated people acting as a violent mob, which was the very opposite to solving the conflict. As the solution for preventing environmental destruction, the establishment of the National Park has resulted in protests and lawsuits between indigenous communities and the Ministry of Forestry. Also, it will probably create the additional impacts of massive illegal logging, the large-scale theft of biological resources, and the granting of legal permits for mining inside the National Park.

Examples of similar effects in the case of the Bang Pakong Diversion Dam are as follows. As the solution for the erosions and flooding, the release of capital water as one of the requirements of the new operation rule is expected to lead to the necessity of constructing new upper dams in the river basin. Instead of reducing the current proposed cost of 669 million baht for the construction of erosion-and-flooding prevention structures, the new operation rule will most probably demand a much higher future cost – several billions of baht for the construction of new dams.

### 1.5.3 SECONDARY EFFECT TYPE II: EFFECTS UNDERLYING A SOLUTION CHAIN

Examples of effects occurring underlie the whole chain of solutions in the case of the Sabo dams at Mt. Merapi are as follows. First, in addition to the project costs of the Sabo dams, some funds have already been spent on the implementation of solutions, yet more funding seems to be necessary. It is noteworthy that the success of solutions is uncertain, but what is certain is that the Indonesian government must continue to spend money.

Second, the threat of disaster from Mt. Merapi has actually not disappeared; it has simply changed its form – from volcanic disaster to private sand-mining companies. Considering the Sabo facilities at Mt. Merapi from this point of view, it is hard to agree that the project has eliminated the threat to villagers' lives.

Examples of effects occurring underlie the whole chain of solutions in the case of the Bang Pakong Diversion Dam are as follows. First, the development of more and more

jobs in engineering and construction firms is likely to enhance the industry rather than alleviate the suffering of local communities affected by the development project.

Second, for a series of unsuccessful solutions tackling the impacts of degraded water quality, the situation appears to demand some kind of regular solution for maintaining a good water quality. This solution will mean regular effort in both time and money for local administrations, and therefore it will accordingly result in difficulties in balancing budget priorities for local administrations who have very limited budgets each year.

Third, in this particular case, most of the previous and current funds for the solutions have been allocated to the government agency – the RID – that is also responsible for the ongoing performance of the dam. It can be expected that the same pattern of distribution will occur for future budgets for impact-solving. What is of major concern is that, for bureaucrats and technocrats, the boundary of interests which should exist between 'implementing a successful project' and 'making an unsuccessful project in order to be awarded prospective budgets for future solutions' might be blurred.

### 1.5.4 ADVANTAGE-TAKING BEHAVIORS

Examples of advantage-taking behaviors in the case of the Sabo dams at Mt. Merapi are as follows. First, the executive members of the GORO Association received benefits from private sand-mining companies in various forms. Second, the Governor of Yogyakarta used the National Park plan to achieve other goals; these included becoming a status symbol in the region, generating income from tourism, and gaining access to

reforestation funding. Third, some logging companies may seek mining permits inside the proposed National Park. Fourth, companies that sell fertilizers and pesticides will potentially gain a market from the implementation of the agricultural loan. Fifth, private sand-mining companies would actually be the real free-riders of such an agricultural loan program because the local sand-miners may turn their attention to reaping the benefits of the loan program, instead of continuing their confrontation with the private sand-mining companies.

Examples of advantage-taking behaviors in the case of the Bang Pakong Diversion Dam are as follows. First, the Office of Natural Resources and Environmental Policy and Planning (ONEP) included other programs in order to further promote interest in environmental conditions and other concerns in the area during the period of the ex-post evaluation; in contrast, NGOs tried to convince the public that the diversion dam should be permanently suspended or totally removed, so that it would become a symbol or a recognized example of an unsuccessful project. Second, the RID made an attempt to propose the construction of technically unnecessary prevention structures on the riverbank, probably to gain the benefit of additional funding. Third, overloaded trucks began using the local roads along the irrigation canals to avoid a weight-checking station located on a nearby highway. Fourth, it is likely that RID may utilize the predicted shortage of capital water to justify the construction of new dam projects in the river basin. Fifth, engineering and construction firms continue to benefit more and more jobs due to work on the various solutions to the project's impacts.

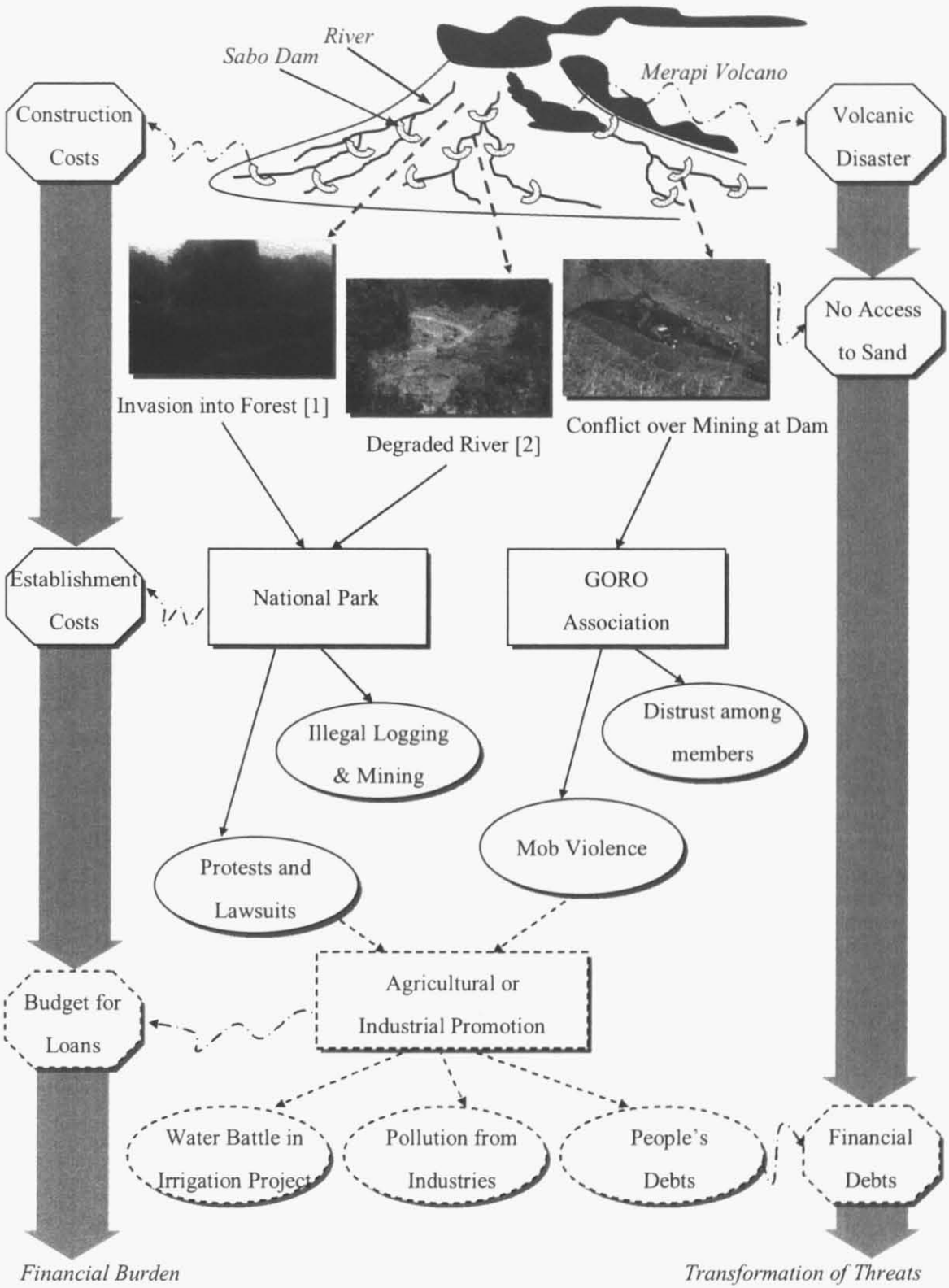



Photo Source: [1] & [2] from Hartono (2004); [3] from JBIC (2003)

Figure 1-2: Overview of Chain Structure and Secondary Effects in the SBDM Case

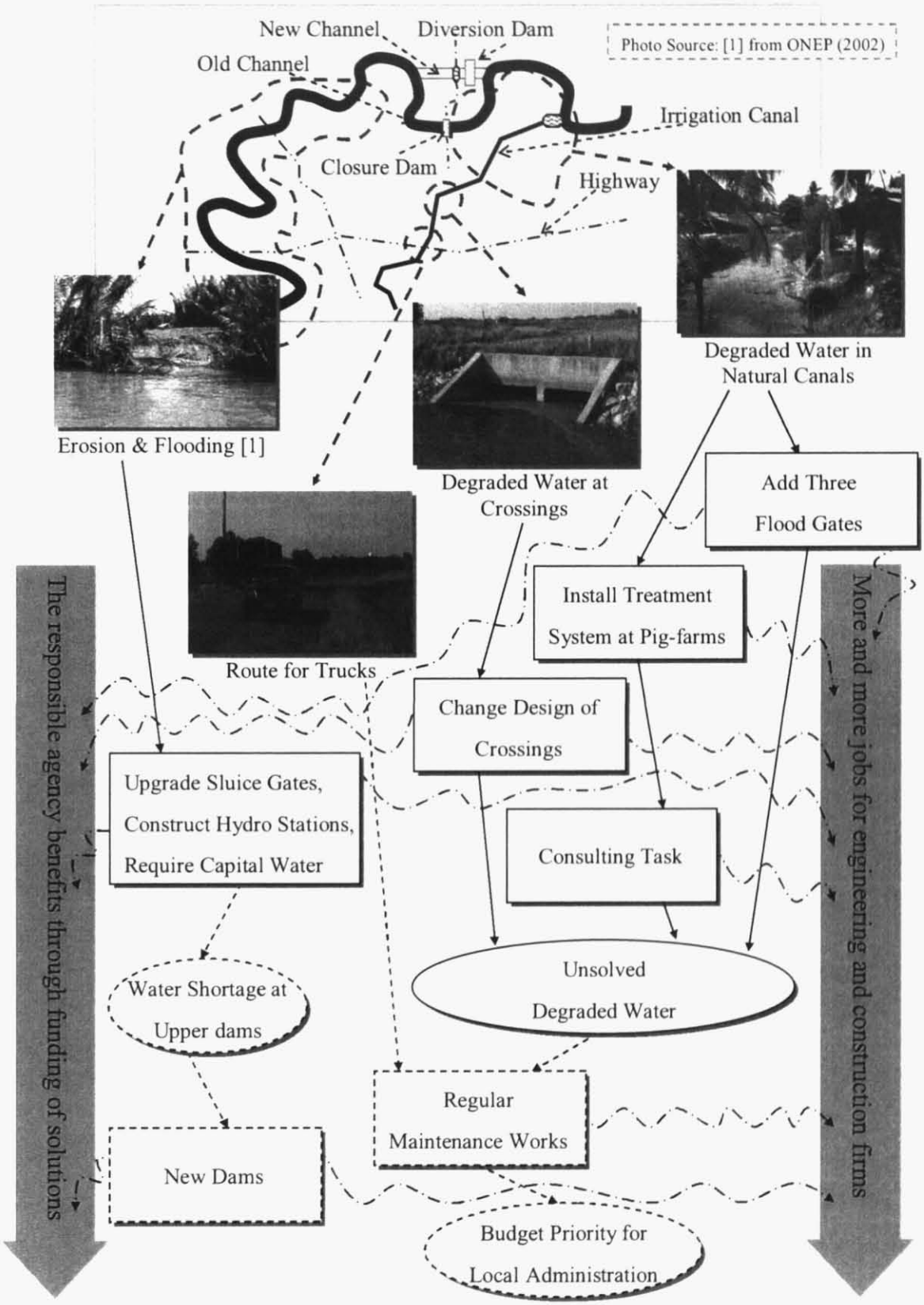



Figure 1-3: Overview of Chain Structure and Secondary Effects in the BPKD Case

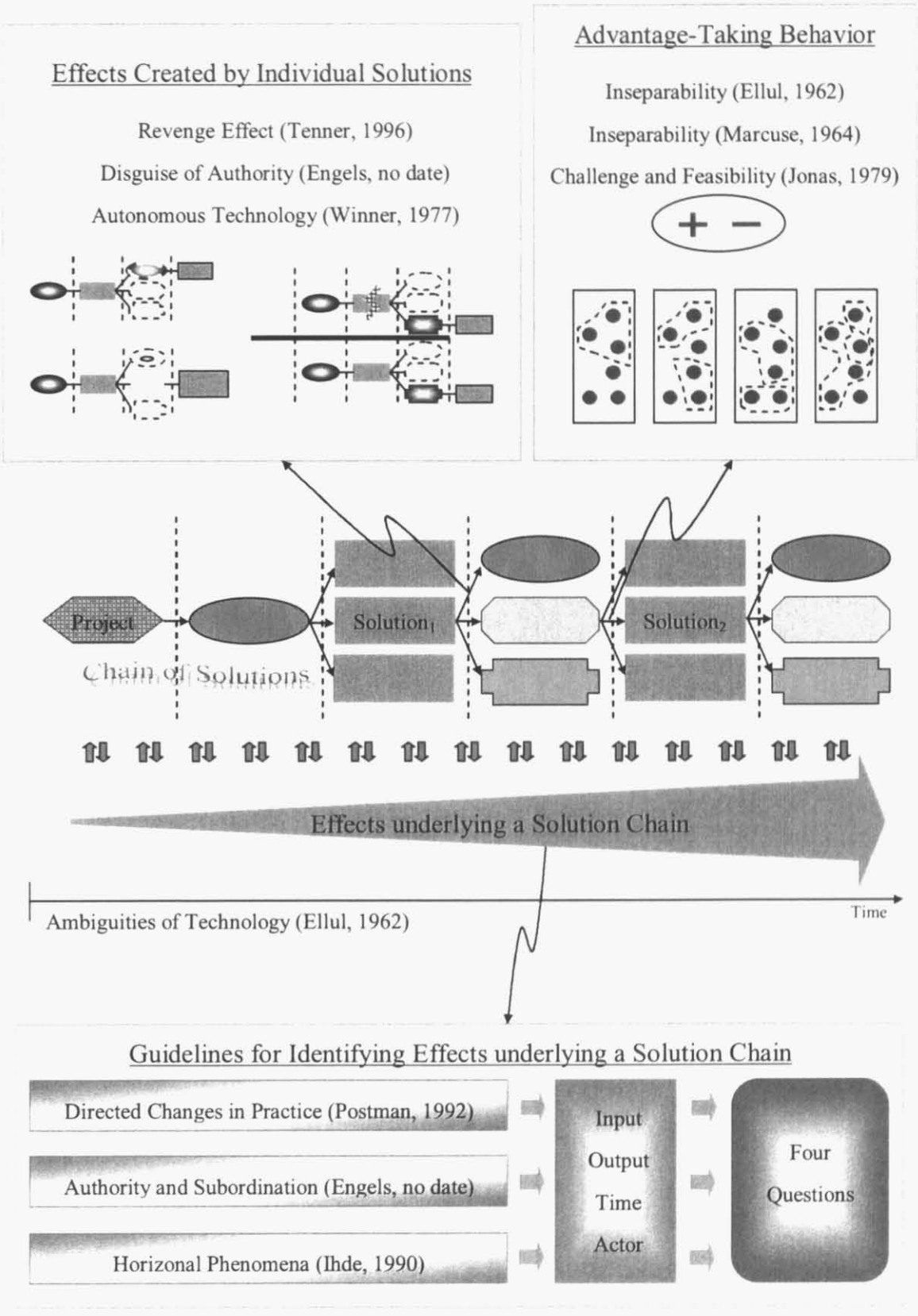



Figure 1-4: Chain of Solutions and Related Philosophical Research

## 1.6 ORGANIZATION OF THESIS

This dissertation consists of six chapters. Chapter 2 introduces a background review of previous studies on the philosophy of technology. Three main streams of research in the philosophy of technology are described. Various concepts relating to the non-neutral powers of technology are extracted from these streams, as they contribute to the development of this dissertation. It is noted that non-neutral powers of technology are apparent in situations in which a technology imposes impacts other than its intended purposes.

Chapter 3 contains the central ideas of this dissertation. It illustrates how the concept of the chain solution is developed from theoretical explorations in the field of the philosophy of technology, and it demonstrates the potential contributions of the chain solution concept to the identification and clarification of new secondary effects. Then, a proposition regarding to the advantage-taking behavior in technological impacts and solutions is asserted.

Chapters 4 and 5 demonstrate applications of the chain solution concept and proposition in two case studies; the Sabo Dams at Mt Merapi in Indonesia, and the Bang Pakong Diversion Dam in Thailand. In each chapter, the background of the case study is described. The resolution of several related issues involving chains of solutions is explained. Secondary effects are identified through chain solutions. Then, advantage-taking behaviors of some actors during the development of the solution chains are discussed.

Chapter 6 summarizes the content of this dissertation, and demonstrates its particular contributions. Then, various issues remaining for future research related to project evaluation and decision making are discussed.

# CHAPTER 2

# A REVIEW OF STUDIES ON THE PHILOSOPHY OF TECHNOLOGY

## 2.1 INTRODUCTION

This chapter provides a background review of previous theoretical studies on technology. Three main streams in the philosophy of technology are described. Some concepts related to the non-neutral powers of technology are extracted from these streams, and these make a particular contribution to the development of this dissertation. The categorization of a number of concepts is undertaken by using a basic cause-effect relationship in order to demonstrate a simple picture of their contribution.

## 2.2 PHILOSOPHY OF TECHNOLOGY

Theoretical critiques on technology, by many scholars, can be grouped into at least three main views; these include instrumentalism, substantivism, and social constructivism.

### 2.2.1 INSTRUMENTALISM

In the view of *instrumentalism*, technology is neutral. It is a means to an end. The benefits and harms resulting from a particular technology depend on how humans use it. The story of the McCormick reaper in the United States is a classic example. In the nineteenth century, at a time when skilled craftsmen were demanding better wages and

forming a union, the McCormick Company installed a set of mechanical grain reapers which required only low-skilled workers for its operation. Because the mechanical process was slower and more expensive than the earlier labor-oriented process, the mechanical grain reapers were decommissioned three years after their installation; however, by then the machines had served their purpose: the destruction of the labor union [Winner (1986), Ihde (1993)]. In the early days of the industrial revolution, many managers adopted this tactic to control the labor force [Ihde, 1993].

The story of Robert Moses' bridges at Long Island [Winner, 1986], one of the most famous references in this field, also falls into this view. These bridges were intentionally designed and built at a particular low height so that buses – the vehicles typically used by the poor black population at that time – could not pass under the bridges. Consequently, only the private vehicles owned by the middle and upper classes were able to access the beach.

### 2.2.2 SUBSTANTIVISM

In contrary to instrumentalism, the view of *substantivism* considers that technologies are not neutral. The development trajectory of a technology has its own logic. A technology generates unpredicted consequences in addition to its original designed purposes. The influential philosophers in this view are Martin Heidegger and Jacques Ellul [Feenberg, 1999].

Technologies are not always used for the purposes they were designed for [Ihde, 1993]. The typewriter was originally intended to offer blind persons a writing aid, to

replace handwriting, and to increase the speed of writing. After its introduction to the market, one reason for resistance was that secretaries – who were mostly male at that time – objected to using typewriters because they believed their jobs were being threatened [Ihde (1993), Dierkes *et al* (1996)]. Ihde (1993) claimed that the typewriter influenced the change of gender expectation for secretarial positions from male to female because of a women's character: – women were considered to be more familiar with musical-type keyboards. He further claimed that this change led to a total reorganization of today's business offices. Another example is television. The television often becomes a baby sister in modern families, and it has also become a powerful tool in presidential election campaigns [Winner, 1986].

Jacques Ellul was the first person to introduce the concept of 'autonomous technology' [Feenberg, 1999]. The term 'autonomous technology' means that technology is out of control. Humans do not know everything about the technologies they create. Feenberg (1999) noted that in modern societies technologies shape our way of life, whereas Winner (1986) used the term 'forms of life' to describe impacts of technologies. Some examples of such formative technologies include the snowmobile, buses and buildings, the mechanical tomato harvester, the mobile phone, and transportation and communication systems. The snowmobile, studied by Pertti J. Pelto (1973) as cited in Winner (1977), could shape an entire society, and a particular example is the relationship between the Skolt Lapps of Finland and the reindeer who live in their region. The Lapps used snowmobiles as a replacement for dogsleds and skis in their reindeer herding. Changes in their society resulting from the use of the snowmobiles include a decline in the number of reindeer, the transformation of the Lapps from herdsmen to wage laborers,

inequalities in their society, and so on. The original designs of buses, buildings and sidewalks – several types of infrastructures – made it impossible for many disabled persons to move freely [Winner, 1986]. Winner (1986) also provides the story of the use of the mechanical tomato harvester in California. The machine was only compatible with larger-scale farms, and thus rural agricultural farmers were put in a disadvantageous position. However, this effect of the tomato harvester was not foreseen by the research team at the time of its early design. Arnold (2003) offers a critique on the effects of mobile phone technology. He remarked that, if using a mobile phone, a person might not be able to escape from work and friends. Chandler (1977) presents stimulating stories about the operation requirements of various technologies. For instance, the operations of transportation and communication systems require large-scale, centralized, and hierarchical organizations which are administered by skilled practitioners and managers.

### 2.2.3 SOCIAL CONSTRUCTIVISM

Whereas instrumentalism and substantivism mainly focus on the effects of technology on society, *social constructivism* also considers how society influences the technological development or design process. Constructivism argues that decisions made regarding technological alternatives not only depend on technical requirements and economic efficiency, but also depend on the interests and beliefs of the various social groups involved in and affected by the technology.

Social Construction of Technology (SCOT) is a well-known descriptive model explaining how a technology is socially constructed. Bijker (1995) demonstrated the model through stories about bicycles, bakelites, and bulbs. The story of bicycles seems to

be the most frequently cited. In brief, the initial designs of the bicycle can be categorized into two main types: the high-wheeled bicycle, and the equal-sized low-wheeled bicycle. The racers favored the high-wheeled bicycle because of its higher speed, whereas women and other users were concerned about its safety. This showed that different social groups can have different interpretations of the same technology. Finally, the safety bicycle won the design victory, and this design informs the current look of our bicycles today [Pinch and Bijker (1987), Bijker (1995)]. The SCOT model consists of four components: relevant social groups, interpretative flexibility, closure and stabilization, and the wider context (Pinch and Bijker, 1987). Another no less famous model is the actor-network theory developed in the works of Callon (1986), Law (1986), and Latour (1987, 1999). One of the unique features of the actor-network theory is that it argues for the analysis of both human and nonhuman actors; these are called actants.

## 2.3 CONCEPTS RELATING TO THE NON-NEUTRAL POWERS OF TECHNOLOGY

The aim of this study is not to clarify whether one theory – instrumentalism, substantivism, or social constructivism – is more superior, but to extract some key non-neutral powers of technology in order to develop an alternative means of discerning the secondary effects of a technology. Some examples of secondary effects of technology which probably emerge due to the non-neutral powers of technology include the following: the rearrangement of human relations, such as in a society with a feudal lord changed by the development of the hand mill and in a society with divisions of labor changed by the development of the steam mill [Marx and Engels republished in Scharff

and Dusek (2003)], the accelerated revolution in horseback fighting methods in battle due to the innovation of the stirrup [White, 1962], a cooperation between Bengali and Non-Bengali Pakistanis due to the establishment of the Karnaphuli Mill in Pakistan [Hirschman, 1967], the replacement of cash with credit transactions due to a telecommunications project in Ethiopia [Hirschman, 1967], the poverty and hardship of manufacturing laborers due to the middle class's ownership of cars [Linhart, 1968], the wide-reaching changes in the Skolt Lapps communities in Finland due to the introduction of the snowmobile machine [Pertti J. Pelto (1973) cited in Winner (1977)], the necessity of large-scale, centralized, hierarchical organizations for transportation and communication systems [Chandler, 1977], the changes in roles of parents and children in setting the dining table due to the adjusted height and design of new standard wall cabinets with doors [Cowan, 1983], the inspiration provided for engineers by the achievements of the Pyramids, the nuclear bomb and large rockets [Pacey, 1983], the new role of the television as baby sister in families [Winner, 1986], the disadvantaged position of small-scale farms in California resulting from the development of the tomato harvester [Winner, 1986], the changes in gender expectations for secretarial positions from men to women due to the introduction of the typewriter [Ihde (1993), Dierkes *et al* (1996)], the asymmetric dependency relationship between computer programmers and users [Rochlin, 1997], the prevalence of on-line chatting in search of amusement and sex in France resulting from the development of telecommunications devices [Feenberg, 1999], the difficulty of escaping from work and friends resulting from the use of the mobile phone [Arnold, 2003], and so on.

Inherent to the views of both substantivism and social constructivism, the non-neutral powers of technology are the most interesting. They encompass a capacity for self-generation, as well as remaining open for flexible interpretation. There have been attempts by many scholars to explain the non-neutral characteristics of technology; these have included, but are not limited to, authority and subordination [Engels republished in Scharff and Dusek (2003)], ambiguous technological progress [Ellul, 1962], inseparable alien values [Marcuse, 1964], technological imperatives and reverse adaptation [Winner, 1977 and 1986], new needs suggested by technology [Jonas, 1979], value incompatibility [Pacey, 1983], device paradigms and focal things [Borgmann, 1984], background relations and horizonal phenomena [Ihde, 1990], directed changes in practice [Postman, 1992], revenge effects [1996], technological dependency [Rochlin, 1997], technical mediation [Latour, 1999], Janus faces [Arnold, 2003], and so forth.

It is possible that the insights offered by these concepts are what is missing in current understandings of the secondary effects of infrastructure development projects. In this study, two infrastructure development projects are examined to verify the application of these philosophical concepts in identifying secondary effects.

## 2.4 SUMMARY

In this chapter, a number of studies on technology have been described. In the field of philosophy of technology, there are three main streams; these are instrumentalism, substantivism, and social constructivism.

In the view of *instrumentalism*, technology is neutral. It is a means to an end, and the benefits and harms of a technology depend on how humans use it. The view of *substantivism* considers that technologies are not neutral. The development trajectory of a technology has its own logic. A technology results in other unpredicted consequences in addition to its original designed purposes. The view of *social constructivism* considers how society influences the technological development or design process. Constructivism argues that decisions made regarding technological alternatives not only depend on technical requirements and economic efficiency, but also on the interests and beliefs of the various social groups who are stakeholders.

Various concepts related to the non-neutral powers of technology are extracted from these streams or views. These concepts will be further used in the development of an alternative means of discerning the potential secondary effects of infrastructure development projects.

# CHAPTER 3

# DEVELOPMENT OF CONCEPT

## 3.1 INTRODUCTION

The initial intention of this research was to apply the findings of previous philosophical explorations in identifying secondary effects in two case studies. As this investigation was pursued, it was found that the two case studies exhibited the commonality of the phenomenon of a series of solutions, and this phenomenon became the main focus of research. The observed phenomenon is a series of solutions subsequent to the initial impacts of the infrastructure development projects under investigation. A series of solutions is described as a 'chain' phenomenon in this study.

There is no single previous philosophical concept that can fully explain the chain phenomenon. However, a number of philosophical concepts do account for details in some parts of the chain. However, what is more important is that analyzing a chain reveals two types of secondary effects in infrastructure development projects, and the chain phenomenon is actually a form of technological politics.

This chapter opens with some background discussion of the theory of technological politics. Then, it demonstrates the main idea of the chain solution concept and its contributions to identifying and redefining secondary effects. Later on, a

proposition regarding to the relationship between advantage-taking behaviors and technological impacts and solutions is asserted.

## 3.2 TECHNOLOGICAL POLITICS

### 3.2.1 NOTIONS OF TECHNOLOGICAL POLITICS

There are two notions in the theory of technological politics. The first notion, the conventional one, is about technocracy and involves discussions about the power of elite or expert persons in the design and planning of machines and systems of modern artifacts. The second notion of technological politics involves the capacity of technology to generate impacts on society by itself, regardless of the persons who hold power during its design and planning. Winner (1977) extended this second meaning of technological politics from 'who governs' to 'what governs'. He declared that "technological politics, in this manner of seeing, encompasses the whole of technology's capacity to transform, order, and adapt animate and inanimate objects to accord with the purely technical structures and processes"(p. 237). In this thesis, the term 'politics' indicates the influencing of people's decisions by their relationship with something or someone.

### 3.2.2 FORMS OF TECHNOLOGICAL POLITICS

A number of previous studies can be interpreted as presenting various forms of technological politics. They include, but are not limited to, reverse adaptation (Winner, 1977), alienation in technological society (Marcuse, 1964), new needs or desires due to challenge and feasibility (Jonas, 1979), and directed changes in practice (Postman, 1992).

Winner (1977) asserts his hypothesis of the theory of technological politics that "as large-scale systems come to dominate various areas of modern social life, reverse adaptation will become an increasingly important way of determining what is done and how" (p. 251). The concept of *reverse adaptation* argues that in many circumstances means do not serve particular ends, but instead the ends are adapted to match the available means. In his writing (pp.242-250), five patterns of reverse adaptation are proposed as follows: (1) the system controls markets relevant to its operations; (2) the system controls or strongly influences the political processes that ostensibly regulate its output and operating conditions; (3). the system seeks a 'mission' to match its technological capabilities; (4) the system propagates or manipulates the needs it also serves; and (5) the system discovers or creates a crisis to justify its own further expansion.

Marcuse (1964) points out the sense of alienation which is generated by our advanced industrial society. He defines an advanced industrial society as a society with the mass production of radio and television, transportation and communication, food, clothing, commodities, lodging, and so forth. Marcuse's notion of alienation can be interpreted as a form of technological politics, and there are two interesting areas of discussion in his writing. The first one considers that our advanced industrial society gives rise to alien needs and values. For example, "people find their soul in their automobile, hi-fi set, split-level home, and kitchen equipment (p.9)". Similarly, Jonas (1979) proposes that technology suggests or generates new needs and desires by offering new challenges and feasibilities. Plastics, with properties not found in any natural materials, can not only effectively substitute for previously natural materials, but can also open up possibilities for new applications. Other examples of technologies include a

plastic cup of coffee, heart surgery, artificial insemination, test-tube babies, host pregnancies, cloning, and so on. The question that Marcuse puts forward is whether these alien items and practices are true or false needs, and he suggests that the answer depends on each individual.

The second notion Marcuse has put forward concerns the influence of alienation on freedom of choice. He argues that "whether or not the possibility of doing or leaving, enjoying or destroying, possessing or rejecting something is seized as a need depends on whether or not it can be seen as desirable and necessary for the prevailing societal institutions and interests (p.4)". The productivity, efficiency and benefits made available for the majority become alien necessities, and all contradiction seems irrational. The alien items and practices as portrayed in the needs, attitudes, and rhetoric emerging from advanced industrial societies are the real source of domination, and they imply the irrationality of 'technological rationality'.

Postman (1992) demonstrates changes in medical practice due to the application of medical instruments and equipment such as monitors. He discusses the survey result of an unnecessarily high number of X-rays and surgeries conducted in American medical practice, which can result in cancer and death, respectively. When using medical instruments, doctors take the data provided by the machine more seriously than that from patients, and thus the doctor's experience becomes less valuable than the calculations of machinery. He deduces that "doctors themselves feel restricted and dominated by the requirement to use all available technology (p.104)", and "technology changes the practice of medicine by redefining what doctors are, redirecting where they focus their

attention, and reconceptualizing how they view their patients and illness (p.105)". This encouragement to use machines can be interpreted as a form of technological politics.

In this thesis, the main concept is that technologies have been imposing certain politics on societies. Under such politics, a person will at times make decisions or choose a course of action without question or because it is unavoidable. If human decisions are examined objectively, various forms of technological politics can be found. The concept of the *solution chain*, developed here, could be a new form of technological politics. This concept is elaborated through the examination of a series of solutions implemented following the initial impacts imposed by infrastructure development projects which involved a combination of various technologies. It therefore incorporates both notions of technological politics. The following sections explain the development of the concept.

## 3.3 THE CONCEPT OF CHAIN EFFECTS

One of the ambiguities of technology identified by Ellul (1962) is the notion of unforeseeable effects. The notion of the side effect in Hirschman's work (1967) on development projects identifies a similar ambiguity. An infrastructure development project, like other applications of technology, generates unexpected impacts; these can be both positive and negative. Some are immediate, while others take time to emerge. Usually, a serious negative impact requires some kind of solution.

In many cases a solution cannot fully resolve a particular unexpected impact. In addition, the solution, itself an application of technology, may then generate further impacts – either expected or unexpected ones. Thus, further solutions will be required for

either the remaining impacts, or new but expected impacts, or new and unexpected impacts, if any. The cyclical phenomenon of needing to devise one solution after another may continue to occur in series for a long time, in which case they develop into a chain (see figure 3-1). Accordingly, a chain of solutions is the outcome of having unexpected impacts.

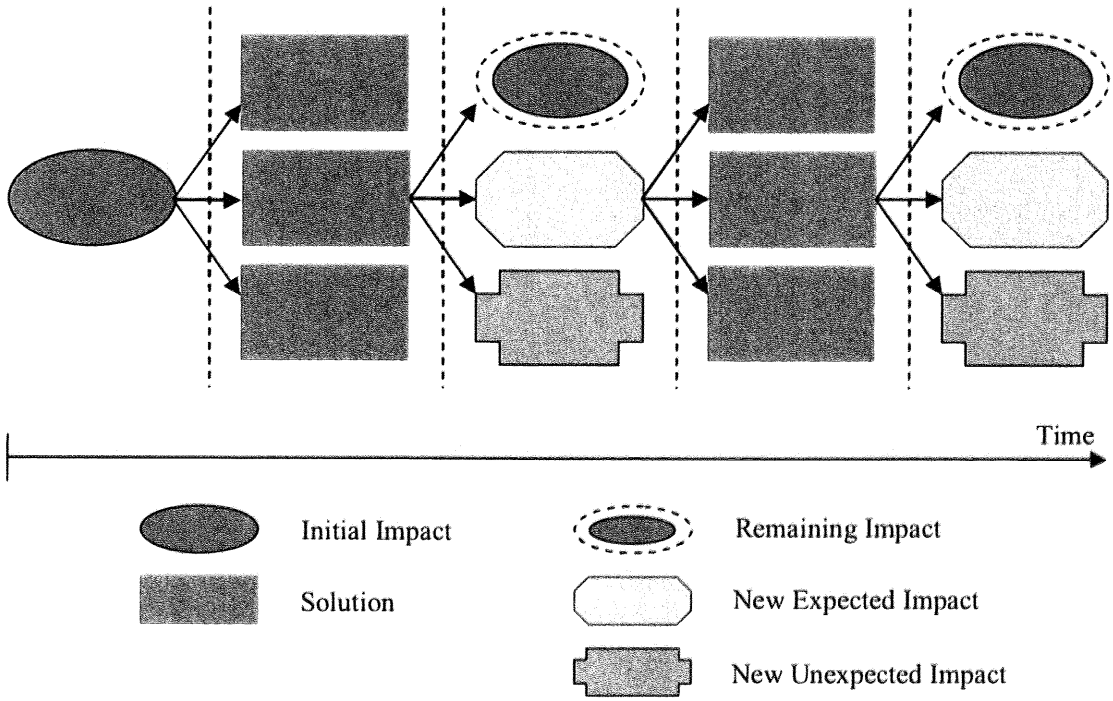



Figure 3-1: Chain of Solutions

This technological trap, created by the unexpected negative impacts of an initial infrastructure project, is a form of technological politics. The chain of solutions is a potential means of determining how societies are being dominated by infrastructure development. The phenomena related to chains of solutions have not been taken into consideration in the development of infrastructure projects. The present research has

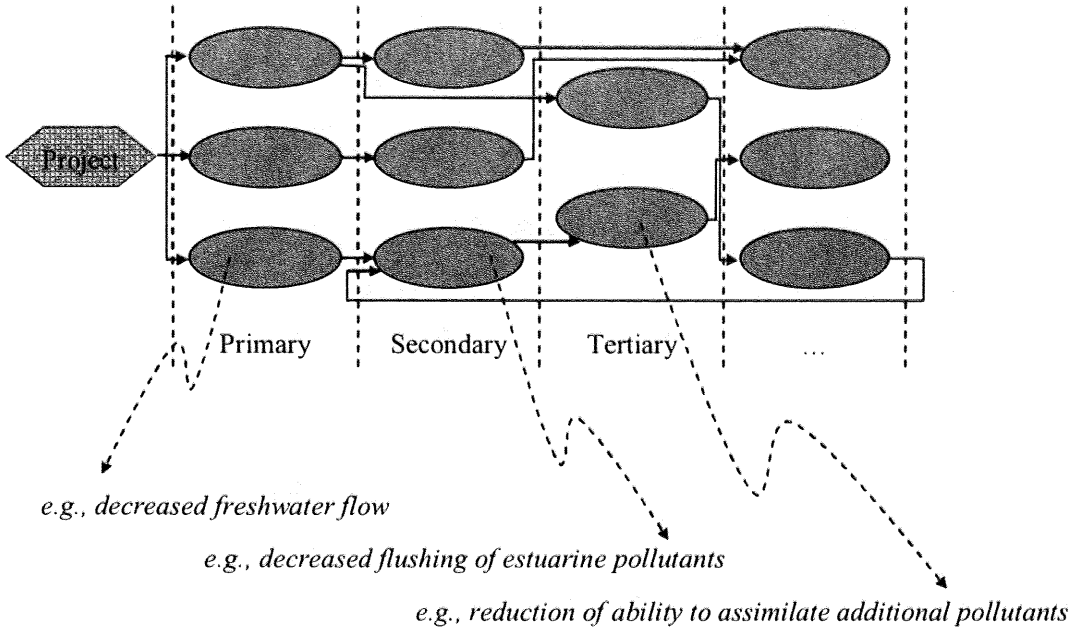
involved an empirical study which has sought to identify examples of such chains of solutions and their importance through case studies.

## 3.4 REDEFINING SECONDARY EFFECTS

Conventionally, a secondary effect means the impact that is subsequent to the initial impact of an infrastructure project. Subsequent impacts arising from an initial impact are not limited to secondary effects; they also include tertiary and higher order impacts [Bisset (1987), Lohani and Halim (1987)]. The following is an example of conventional secondary and higher order impacts given by Bisset (1987). An initial impact of a dam is the decreased flow of freshwater. Its secondary impact is the decreased flushing of estuarine pollutants. Then, its tertiary impact is a reduced ability to assimilate additional pollutants, and so forth (see figure 3-2).

The major benefit of analyzing a chain of solutions is that it provides an alternative means of identifying the secondary effects of infrastructure development projects. Here it is appropriate to propose a new definition of 'secondary effects.' Secondary effects are those impacts that emerge during the development of a chain of solutions; there are two types of such effects: effects created by individual solutions and effects underlying the whole chain. The former type of secondary effect incorporates the capacity for the self-generation of impacts that is characteristic of technological solutions; this capacity is what conventional impact analyses do not explicitly refer to. Meanwhile, it is also clear that the latter type of secondary effect has not been predicted by conventional impact analyses either; this is the obvious advantage of the chain solution concept.

- Conventional Definition [Bisset (1987), Lohani and Halim (1987)]




- Proposed Definition [Chain of Solutions]

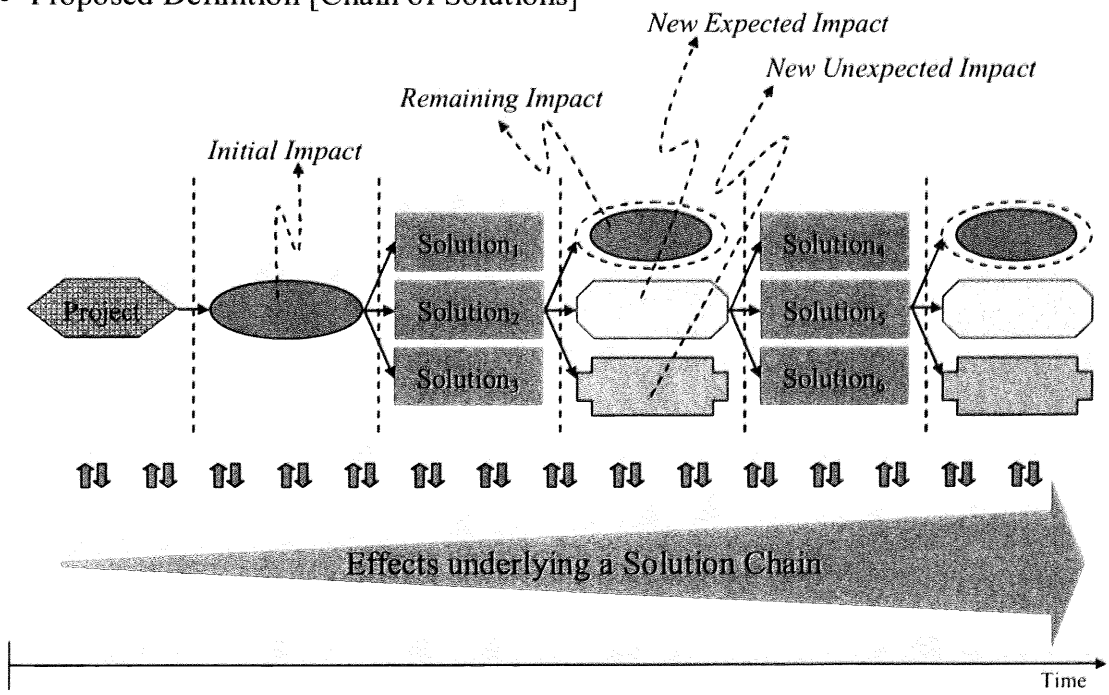
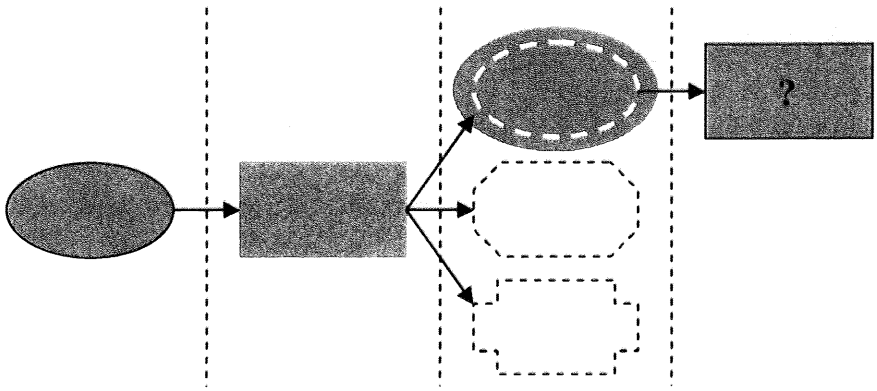



Figure 3-2: Differences between Conventional and Proposed Definition

## 3.5 EFFECTS CREATED BY INDIVIDUAL SOLUTIONS: EVIDENCE FOR THE REVENGE EFFECT

In many cases, a solution itself can generate new impacts; these can be either expected or unexpected. This kind of situation results in the first type of secondary effect. This section describes a number of ways in which a solution can generate secondary effects.




*Instead of achieving its own purpose, a solution sometimes expands the impact.*

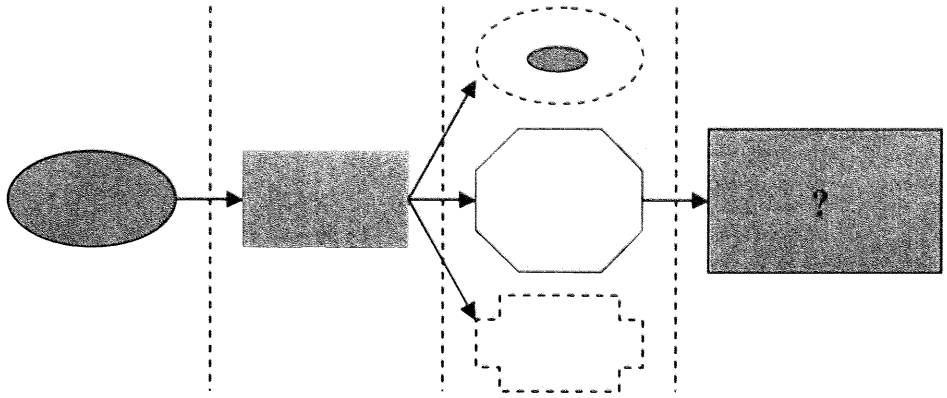
Figure 3-3: The First Link in the Chain Solution Pattern

First, instead of achieving its own purpose, a solution sometimes enlarges the impact (see figure 3-3). The purpose of a solution is to resolve an impact that has arisen from either an initial project or a previous solution. However, instead of resolving an impact, a solution could either increase an impact's severity or expand its scope. After an impact has been expanded, a further solution is expected. This conditioning happens because some solutions, themselves an application of technology, are able to create a revenge effect as noted by Tenner (1996). The observation of chains of solutions

indicates that a revenge effect could mean either an increased severity or an expanded scope of the impact.

In the case of the Sabo dams at Mt. Merapi, the GORO Association was established with the purpose of resolving conflict between the local sand miners and the private commercial sand-mining companies. However, instead of resolving the conflict, the establishment of the GORO Association brought about revenge effects in two different dimensions. First, its failure escalated the conflict situation into mob violence, which caused approximately 13 million rupiah of damage. Second, the actions of its administration expanded the scope of conflict by creating distrust among members of the association who had previously been united.

Second, the new impact a solution creates can be more severe than the one it was designed to resolve (see figure 3-4). Although a solution can effectively solve an impact, at the same time it can generate a new impact which is totally different from and more serious than the one it resolved. Most probably, the new and more severe impact will require a successive solution, which will demand more time, funding, or other efforts. Interestingly, in this way the initial impact has already been transformed into a new one. Given that this situation occurs in a series pattern, the disguise or transformations of impacts can occur repeatedly with increased severity. Therefore, the degree of effort involved in the successive solutions tends to increase along the solution chain. This conditioning happens due to a combination of two non-neutral powers of technology; the disguise of authority critiqued by Engels (no date) and the revenge effect noted by Tenner (1996).




*The new impact a solution creates is more severe than the one it has resolved.*

Figure 3-4: The Second Link in the Chain Solution Pattern

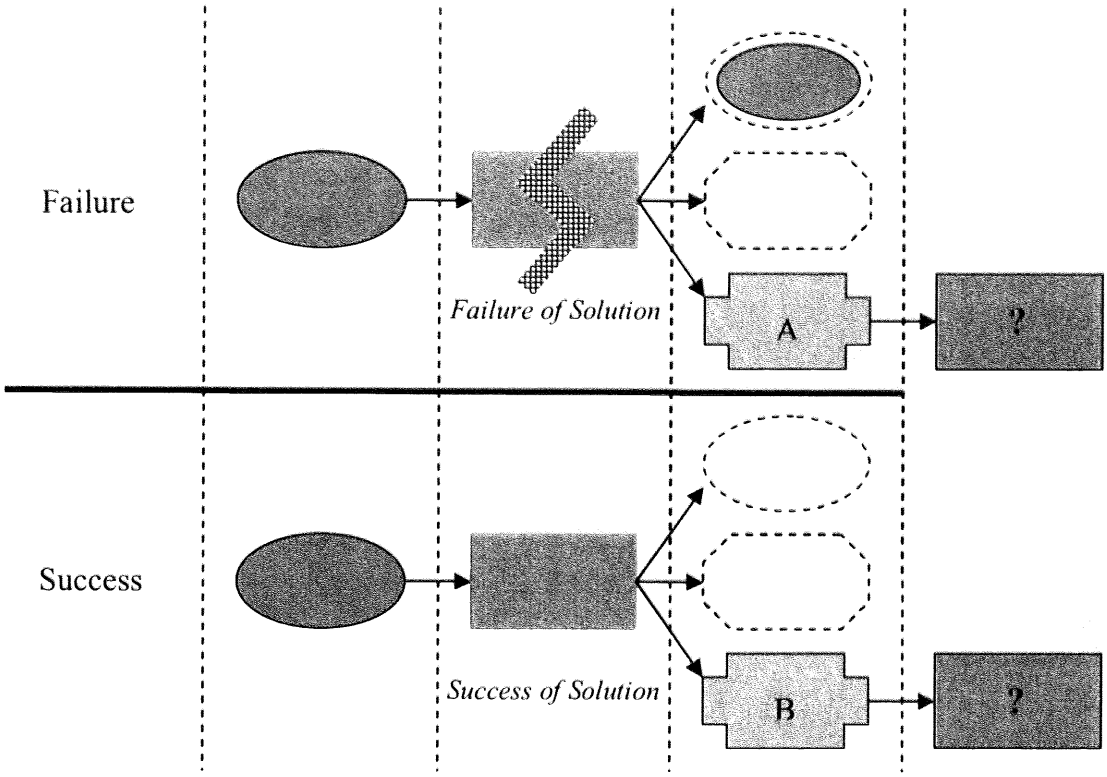
In the case of the Bang Pakong Diversion Dam, the dam caused the impacts of riverbank erosions and downstream flooding. To solve these impacts, a plan was proposed involving the construction of prevention structures along the riverbank, with an estimated cost of 669 million baht. However, the plan was rejected because of its high projected cost. Instead, a modified dam operation rule was proposed to resolve the impacts. The new operation rule required additional associated systems, such as upgrading of the function of the sluice gates at the diversion dam, the restoration or new construction of fifteen hydrology stations, and the release of 130 million cubic meters of capital water from two upper dams. These requirements involved an additional cost of only 70 million baht, a very much lower figure than that estimated for the construction of the prevention structures. However, while this solution is very appealing at the present time, in the near future it may not be viewed so positively. Since the two upper dams each have their own irrigation areas with an annual growth rate, the release of such a large amount of capital water would mean that their water supplies could not last long.

Therefore, the situation will like lead to a proposal for constructing a new upper dam, which would typically cost several billion baht. Obviously, the cost of resolving the shortage of capital water – the new impact – is much higher than the cost for solving the impacts of erosions and flooding – the initial impact.

It is noteworthy that in this particular case the increased effort and expense of resolving the new impact – which is influenced by the powers expressed in the notions of the disguise of authority and the revenge effect – do not occur as a result of the successive solution itself, the new operation rule, but of its requirement, the release of capital water. This situation demonstrates another application of the technological imperatives proposed by Winner (1977).

Third, a solution can generate a new impact whether it achieves its own purpose or not (see figure 3-5). Some solutions have such a degree of autonomy that they always generate a new impact, regardless of their success in resolving an impact. In cases in which the impact has been effectively resolved, a solution generates one kind of new impact. On the other hand, in cases in which the impact could not be resolved, the same solution will generate other kinds of new impacts. This conditioning occurs due to the autonomous characteristic of technology noted by Ellul (1962) and Winner (1977).

In the case of the Sabo dams at Mt. Merapi, the GORO Association was established with the purpose of resolving conflict between the local sand miners and the private commercial sand-mining companies. The failure of the association resulted in privileges for executive members and distrust among the members of the association. However, if the GORO Association had succeeded without principal-agent problems,




*A solution generates a new impact whether or not it achieves its own purpose.*

Figure 3-5: The Third Link in the of Chain Solution Pattern

possibly it could have resulted in other kinds of impacts. The association may bring about a coalition between the locals and private companies, and thus they may cooperate in the quarrying of sand not only at the dam sites, but also illegally by invading forest areas and the upper reaches of the rivers. Therefore, the environmental destruction will be accelerated. Regardless of its success with respect to conflict, the GORO Association could generate new impacts as a result of either the privileges granted to the executive members, the distrust among members of the association, or cooperation among interest groups leading to accelerated environmental destruction.

As demonstrated in this section, solutions are also an important source of impacts in infrastructure development projects, and this source should not be neglected. Importantly, both solutions and their generated impacts advance the extension and expansion of a solution chain.

## 3.6 EFFECTS UNDERLYING A SOLUTION CHAIN

What is more interesting is that some impacts occur under a solution chain in such a way that the longer a chain is, the greater the impacts are. This kind of impact is the second type of secondary effect. Throughout a solution chain, they continue to subvert the benefits of development.

To identify such impacts, a set of questions has been developed on the basis of a number of theoretical reflections in the field of the philosophy of technology (see figure 3-6). This study recommends a consideration of four components of solutions – input, output, time, and actor – from the viewpoints of encouraged usage, disguise of authority, and horizonal phenomena.

### 3.6.1 ENCOURAGED USAGE OF TECHNOLOGICAL SOLUTIONS

The first question is drawn from the concept of directed changes in practice pointed out by Postman (1992). He demonstrates the restricted feelings of doctors in using medical instruments more than seems necessary, using as examples the unnecessarily high numbers of X-rays and surgeries in American medical practices. Such unnecessary practices can result in cancer and death, respectively. As an extension to his argument, the unnecessary and repetitive use of certain resource inputs such as

investment and engineering work may be encouraged as well. Accordingly, a suitable question is: which resource input is the same for most of the solutions in a solution chain?

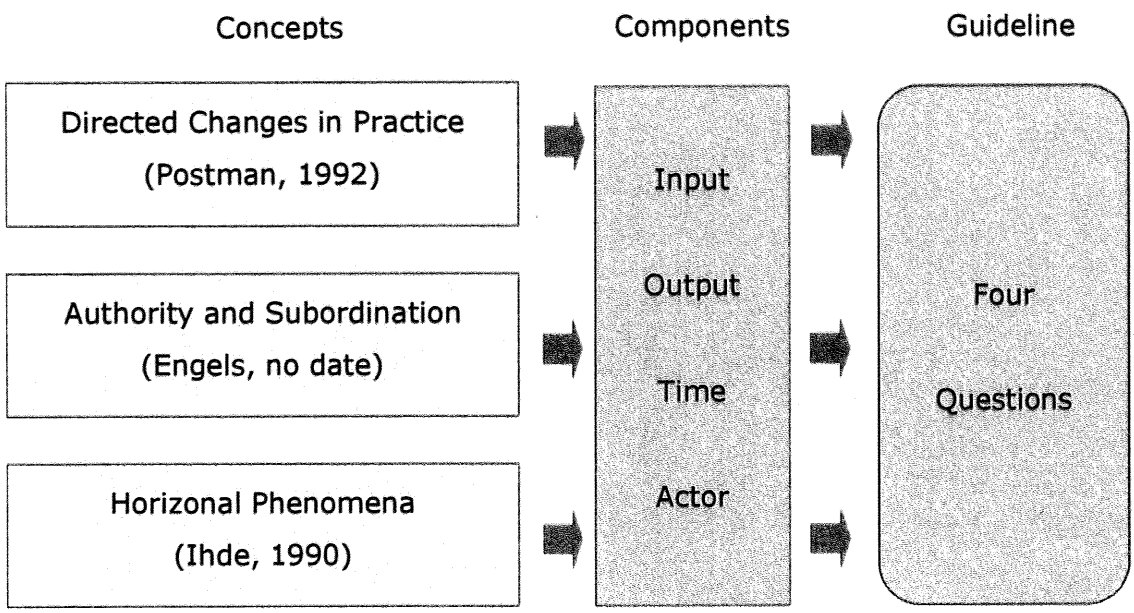



Figure 3-6: Development of Questions

### 3.6.2 DISGUISING OF THREATS THROUGH CHAIN SOLUTIONS

The second question is developed on the basis of the concept of authority and subordination critiqued by Engels (no date). He argues that authority does not disappear no matter how a social system is created, or whether it is democratic or socialist. Some examples include the cotton-spinning mill and a sea-going ship. In a cotton-spinning mill in a democratic society, the action of the steam dictates the timing of the work, and workers must adhere to this timing. On a sea-going ship, crews must obey the command

of a captain. Therefore, the effects of authority are everywhere; at best, it simply changes its form.

A solution is implemented to resolve an earlier impact, but in many cases it creates a new impact at the same time. Accordingly, a useful question is: do the new impacts created by a series of solutions have a similar foundation to the initial impacts they aimed to resolve? If so, the initial impact does not disappear, but is transformed into new impacts.

### 3.6.3 HORIZONAL PHENOMENA OF CHAIN

The third and fourth questions for identifying effects underlying a solution chain are developed on the basis of the concept of horizonal phenomena noted by Ihde (1990). Horizonal phenomena recognize the blurred boundary between what is experienced and the person who experiences it. Chemical transformations associated with edible technologies, such as the birth-control pill, are good examples. They cause a blurred boundary between real and artificial life on the borderline between human bodies and edible technologies. The effects on the human body can be permanent.

In some circumstances, a solution does not achieve its intended purpose. For a difficult impact, a one-time solution is usually not sufficient. Once an unsuccessful execution of a solution has been carried out, a further solution will almost certainly be necessary. If the further solution is also unsuccessful, yet another successive solution will be required. This is because such an impact has the quality of permanence. After a series of different unsuccessful solutions for the same impact, the situation tentatively results in

the implementation of a regular-type solution. A regular-type solution is a solution that is implemented on a regular basis, such as every month, every year, every few years, and so forth. Accordingly, the third question to be considered is: does a chain of solutions develop into a permanent impact, which can be alleviated but only by a permanent or regular solution?

The phenomenon of a blurred boundary between real life and artificial things involves the boundaries of physical things; for example, the human body and edible technologies. However, what is more interesting is the blurred boundaries of non-physical factors such as attitudes. There are many actors with a variety of interests involved in providing solutions; these include the government, the state, a group of local people, academics, NGOs, international bodies, and so forth. To consider an actor's interests in a particular solution, the fourth question is: are the boundaries of an actor's interests blurred by a series of solutions?

In summary, the four questions are as follows;

(1) Which resource input is the same for most of the solutions in a solution chain?

(2) Do the new impacts created by a series of solutions have a similar foundation to the initial impacts they aimed to resolve?

(3) Does a chain of solutions develop into a permanent impact, which can be alleviated but only by a permanent or regular solution?

(4) Are the boundaries of an actor's interests blurred by a series of solutions?

## 3.7 THE INSEPARABILITY OF GOOD AND BAD ASPECTS OF IMPACTS

This study argues that an impact arising from a solution chain is actually an opportunity or advantage for some actors. This proposition is derived from two kinds of non-neutral powers of technology.

First, a technology itself contains both good and bad aspects which are inseparable from one other. Ellul (1962) and Marcuse (1964) use the mass media as an example to demonstrate this characteristic of technology, claiming that the mass media disseminates both knowledge and propaganda.

Second, as indicated by Jonas (1979), a technology itself can suggest or generate new needs and desires by offering both challenges and new feasibilities. Plastics – with their special properties not found in any natural materials – are not only an effective substitute for older materials, but also open up possibilities for new kinds of use.

This study points out that not only a technology itself but also its impacts contain such characteristic. The proposition – elaborated here on the basis of critiques of the work of Ellul, Marcuse, and Jonas – is that, apart from any threat it may pose directly, an impact caused by an application of technology may also present an opportunity of advantage-taking for an individual or a group of persons, through either the impact itself or its successive solutions.

Stakeholder analysis can be used as a tool for identifying such advantage-taking behavior. It is a methodology for assessing the actors in the decision-making or implementation phases of a project or policy, in order to understand their interests,

positions, interrelationships, behaviors, influences, and so on [Brugha and Varvasovszky, 2000]. A good literature review on stakeholder analysis can be found in Brugha and Varvasovszky (2000). Examples of its application can be found in Varvasovszky and Brugha (2000), Elias *et al.* (2002), Buanes *et al.* (2004), Pan (2005), Mushove and Vogel (2005), and Srivastava *et al.* (2005).

Prior to analyzing stakeholders' behaviors, the relevant key stakeholders should be identified. There are many tools for identifying stakeholders. Some examples can be seen in Mitchell *et al.* (1997), Ravnborg and Westermann (2002), and Kaler (2002). However, the research question of this study places a greater emphasis on the kinds of powers of technology that cause impacts in infrastructure projects and how their successive solutions can present opportunities for certain stakeholders; therefore, the key stakeholders in the case studies presented in this study are simply identified.

After the key stakeholders were identified, an event analysis was performed for the purpose of analyzing two features: the coalitions and opportunities among key stakeholders. Accordingly, a number of diagrams and tables illustrating these coalitions and opportunities are presented. Detailed illustrations of the possible opportunities presented by impacts and their solutions, developed using the stakeholder analysis approach, are shown in the chapters relevant to each case study.

## 3.8 CONTRIBUTIONS OF PREVIOUS RESEARCH TO THIS THESIS

Although there has been no single previous philosophical exploration that can explain the entire solution chain phenomenon, a number of studies have provided insight

for explaining some elements of the solution chain, and also for elaborating the proposition regarding advantage-taking behaviors. This section describes the contributions of previous philosophical explorations to this study.

### 3.8.1 ON MOTIVATION FOR DEVELOPING THE CHAIN SOLUTION CONCEPT

One initial motivation for this study has been the notion of the unforeseeable effects of technology mentioned in Ellul's work (1962). For an extension of his work, an interesting question that arises from the notion of unforeseeable effects is to ask what would be the outcomes of such unforeseeable effects. An infrastructure development project imposes an unforeseeable or unexpected impact, which is the starting point of a solution chain. As described in section 3.3, a chain of solutions is the outcome of having an unforeseeable or unexpected impact.

The concept of autonomous technology in the works of Ellul (1962) and Winner (1977) provides an impressive and unique perspective on technology. Winner (1977) extends the notion of technological politics from 'who governs' to 'what governs'; the notion of 'what governs' is the basis for the development of the chain solution concept. An explanation of these two notions of technological politics is provided earlier in section 3.2.1 of this chapter. Although it is found later that the chain solution concept will be a more comprehensive concept when both the first notion (who governs) and the second notion (what governs) are incorporated into it, it must be noted that the notion of 'what governs' has made a significant contribution to the initial development of the chain

solution concept. With respect to the inspirations for this study, the writings of Ellul (1962) and Winner (1977) have been the most influential.

### 3.8.2 ON EFFECTS CREATED BY INDIVIDUAL SOLUTIONS

With respect to the identification of the effects created by individual solutions, three patterns of links in the solution chains are found during case study observations. These patterns of links can be explained in relation to three avenues of philosophical exploration (see section 3.5); they include the revenge effect [Tenner, 1996], the disguise of authority [Engels, no date] and autonomous technology [Winner, 1977]. The first link of a solution chain can be explained well by the revenge effect concept; a revenge effect could mean either the increased severity or expanded scope of an impact. The second link cannot be explained solely by the concept of either the revenge effect or the disguise of authority. The concept of the disguise of authority provides a wider perspective on various forms of authority, but it does not account for the increased severity or expanded scope of an impact. However, a combination of insights from these two concepts together can be helpful in explaining the second link of a solution chain. The third link of a solution chain is formulated on the basis of the concept of autonomous technology, according to which a solution can always generate further impacts regardless of its success in resolving a previous impact.

### 3.8.3 ON EFFECTS UNDERLYING A SOLUTION CHAIN

For the identification of the effects underlying a solution chain, a set of questions is developed on the basis of three areas of philosophical exploration; they include

directed changes in practice [Postman, 1992], authority and subordination [Engels, no date] and horizonal phenomena [Ihde, 1990]. Postman (1992) discusses changes in medical practice due to the way in which the use of medical instruments is unnecessarily encouraged. As an extension to his work, this study argues for a consideration of the way in which the use of resource inputs for a technology is unnecessarily encouraged, in addition to simply considering a technology in isolation. For example, it is also interesting to consider the incentives to use particular materials for producing X-rays films, in addition to simply considering the unnecessarily high rate of application of X-rays machines. This extended notion is used as a basis for developing the first question used for identifying the effects underlying a solution chain.

Engels (no date) discusses the existence of authority in many contexts; these include democratic and socialist societies, cotton-spinning mills, and a sea-going ship. Although the discussion in his work concerns only authority, it provides deep reflections on the foundation of technological impacts. Different technological impacts may share a common factor or foundation, and this study argues that such a commonality could be a threat to human life, income or well-being, or some similar risk. This perspective on technological impacts is used as a basis for developing the second question for identifying the effects underlying a solution chain.

Ihde (1990) discusses the horizonal phenomenon with respect to its (i) existence and (ii) the permanence of the blurred boundary between real life and artificial factors. The permanence of such phenomena is used as a basis for developing the third question for identifying the effects underlying a solution chain. For considering the existence of

such phenomena, this study extends Ihde's work from 'the blurred boundary between real life and artificial factors to 'the blurred boundary of attitudes'. This extended notion is used as a basis for developing the fourth question in identifying the effects underlying a solution chain.

### 3.8.4 ON THE PROPOSITION ON ADVANTAGE-TAKING BEHAVIORS

The proposition on advantage-taking behaviors is elaborated on the basis of two areas of philosophical exploration; these are inseparability [Ellul (1962), Marcuse (1964)] and challenge and feasibility [Jonas, 1979]. Ellul (1962) and Marcuse (1964) point out that a technology itself contains both good and bad aspects which are inseparable from one other. Examples of these are the knowledge (a good aspect) and propaganda (a bad aspect) disseminated by the mass media. Jonas (1979) considers that a technology itself can suggest or generate new needs and desires by offering both challenges and new feasibilities, for example, creative uses of plastics in various products and activities. In addition to these two notions, this study further argues that not only a technology itself but also its impacts contain such aspects. Accordingly, this extended notion is used as a basis for elaborating the proposition.

## 3.9 SUMMARY

The concept of the chain solution describes the series of solutions necessary to resolve the serious impact of an initial infrastructure development project. Analyzing chains of solutions has a contribution to make to the identification of the secondary effects of infrastructure development projects. There are two types of secondary effects

that arise from chains of solutions; these are the effects created by individual solutions, and the effects underlying a solution chain.

Effects created by individual solutions can occur in several ways due to the revenge effects of technology. First, instead of achieving its own purpose, a solution sometimes enlarges the scale of the impact. Second, the new impact a solution can create is sometimes more severe than the one it has resolved. Third, a solution can generate a new impact whether it achieves its own purpose or not.

Effects underlying a solution chain can be observed through applying a set of questions derived from the viewpoints of encouraged usage, disguise of authority, and horizonal phenomena. The four questions are as follows. (1) Which resource input is the same for most of the solutions in a solution chain? (2) Do the new impacts created by a series of solutions have a similar foundation to the initial impacts they aimed to resolve? (3) Does a chain of solutions develop into a permanent impact, which can be alleviated but only by a permanent or regular solution? (4) Are the boundaries of an actor's interests blurred by a series of solutions?

Finally, this research argues that an impact arising out of a chain is actually an opportunity or advantage for some actors. The proposition – elaborated on the basis of critiques on inseparability and feasibility – is that, apart from any threat it may present, an impact arising from an application of technology also presents a possibility of advantage-taking for some individuals or groups, either through the impact itself or its successive solutions.

This chapter has described the central concept and proposition of this study. The following two chapters will demonstrate the applications of the concept and proposition through two case studies, namely, the Sabo Dams at Mt. Merapi in Indonesia, and the Bang Pakong Diversion Dam in Thailand.