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Managing Productivity in the Infrastructure Sector: A Case Study from Indonesia☆

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Abstract

This paper considers the nature of assessing productivity and effectiveness in infrastructure investment in the context of governments' increasing investment in new infrastructure. Taking the case of energy infrastructure investment within Indonesia, this paper makes three contributions: (i) develops a model for assessing infrastructure productivity based on landscape, regime and niche-level changes, (ii) suggests the interconnection between these levels based on sequencing multi-level changes over time, and (iii) shows the role of supply and demand side initiatives in enabling new infrastructure investment is evaluated.
Keywords: Infrastructure; Investment; Productivity; Multi-Level Perspectives Framework; Innovation

Abstrak

Artikel ini mempertimbangkan sifat dari penilaian produktivitas dan efektivitas pada investasi infrastruktur dalam rangka peningkatan investasi pemerintah pada infrastruktur baru. Dengan menggunakan kasus investasi infrastruktur energi di Indonesia, artikel ini menghasilkan tiga hal: (i) nembangun model untuk menilai produktivitas infrastruktur berdasarkan perubahan dari lanskap, rezim, dan perubahan di level yang tepat, (ii) menunjukkan interkoneksi antar level-level tersebut berdasarkan perubahan multi-level yang berurutan dari waktu ke waktu, dan (iii) menunjukkan peran dari inisiatif sisi penawaran dan permintaan yang memungkinkan investasi infrastruktur baru untuk dievaluasi.
Kata kunci: *Infrastruktur; Investasi; Produktivitas; Kerangka Perspektif Multi-Level; Inovasi*

JEL classifications: O25; O33; O38

1. Introduction

Over the next two decades, one of the most significant issues facing public sector managers and policy makers is the urgent need to increase investment in infrastructure assets. A recent McKinsey report, argues that between US$57 trillion and US$67 trillion is needed in economic infrastructure over the next twenty years to support trend rate economic growth (Dobbs et al. 2013). In developing economies such as Brazil, Indonesia and India, public sector managers face an especially acute challenge with committed spending lagging required infrastructure spending in the order of two to three percentage points of GDP.

Not with standing the pressure on national budgets worldwide, scholars have argued that the financing gap in infrastructure has not been created by a dearth of available private capital but by weak institutional frameworks in national economies to attract, absorb and retain private infrastructure investment (O'Neill 2009). For example, over the last decade, institutional investors have commenced building in-house capabilities for direct investment in infrastructure (Clark & Monk 2013a; 2013b) in response to the growth in pension capital seeking stable, long-term returns.

Whilst several studies have examined the availability of private capital to invest in infrastructure (Hebb

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& Sharma 2014; Knight & Sharma 2016), fewer have examined the market level settings to attract infrastructure investment. Specifically, although innovation frameworks account for how products attract new technology investment, less is known about how these apply to large, capital-intensive projects such as infrastructure. This is a gap since public sector managers are under pressure to justify the quality of public spending on infrastructure and ensure productivity.

This paper proposes a framework for assessing the productivity of project investment in infrastructure investment using an in-depth qualitative case study from an exemplar market: Indonesia and infrastructure investment in the geothermal sector. Indonesia has the world's largest geothermal power development potential at around 27 gigawatts (GW) (World Bank 2008), yet only 1.2 GW has been installed to date. This is in spite of growing population and rising electricity prices driving demand for electricity infrastructure. However, in 2014, following over a decade of public-private cooperation, Indonesia completed financing of its US$1.6 bn Sarulla geothermal project, making it the largest geothermal project in the world (Asian Development Bank 2010). This paper examines how market level changes have enabled this transition to take effect.

Building on a multi-level perspective in innovation economics, the aim of this paper is to contribute to the understanding of infrastructure finance and technology innovation in three specific areas. First, we propose a model for assessing infrastructure productivity in order to account for the transition towards greater and more efficient infrastructure spending. A multi-level perspective is applied to an infrastructure market setting to account for regime-level, landscape and niche changes. Second, we examine how multi-level changes are sequenced over time and the interconnection between changes at each level. Finally, a distinction between supply and demand side initiatives and their interaction in enabling new infrastructure investment is demonstrated. In doing so, we hope to extend our understanding of public sector administration of infrastructure investment.

1.1. Background

Management economists have long wrestled with the question of how new, innovative ideas are brought to market (March 1991; Thompson 2003). Some have argued that both exploitation and exploration were necessary in dynamic economics (Cameron & Quinn 1988; March 1991). Exploitation referred to concepts of efficiency, repetition, incremental improvement, and reduced costs. This is enabled by organizations and economic actors building consistent patterns around existing behaviors. Exploration, by contrast, is associated with search, discovery, innovation and change. This enables economic actors to pursue new activities that exist beyond business as usual activities. Although early management scholarship tended to focus on mechanistic structures for markets that privileged the ability of actors to pursue exploitation (Burns & Stalker 1966), March (1991) argued that both exploitation and exploration were essential for markets to flourish (O'Reilly & Tushman 2013).

In seeking to account for how economies respond to these tensions, traditional economic analysis prioritized equilibrium pricing models for inputs and outputs. The assumption underlying this model is that, in a perfectly competitive market, an equilibrium reached by trading between buyers and sellers at market prices is economically efficient and that, ceteris paribus, such an equilibrium could be achieved with any mix of resources (Arrow & Debreu 1954). An alternative, evolutionary model of change and stability argues that ceteris paribus assumptions need to be adjusted under certain conditions (Farjoun 2010).

A key text in this alternate approach is Nelson & Winter's (1982) *Evolutionary Theory of Economic Change*. Building on Schumpeter's (1976) work on innovation economics and Herb Simon's work on bounded rationality, Nelson & Winter (1982) argued that economic actors tended towards self-reinforcing routines which were capable of creating path dependence within existing regimes. These routines could be understood broadly to include technical, procedural, organizational and strategic processes (Nelson & Winter 1982). In accounting for the possibility of routine, management scholars focused on how these routines could be broken in order to enable regime change. These processes may be slow-moving and consistent (Eisenhardt

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1989), or proceed in fast-moving shifts or "punctuated equilibrium" (Benner & Tushman 2003). Whilst these models accounts for *why* economies were compelled by stasis or otherwise, they offers relatively little insight into *how* economies break out of these dependencies.

The theoretical framework applied in this in-depth case study builds on the multi-level perspectives (MLP) literature to account for the nature of regime-level change (Schot, Hoogma & Elzen 1994) (Schot & Geels 2008; Geels 2005; 2002). The MLP scholarship envisages socio-technical change taking place at three distinct levels: landscapes, regimes and niches (Geels 2002; 2005). *Landscapes* are the broadest level of change and refer to macro factors such as social trends, political values, and environmental issues. *Regime* changes refer to changes within particular social groups and communities within a given system. In the MLP literature this is taken to include user practices, scientific communities and emerging technologies. In this paper legislative and policy changes are also included. Finally, *niches* refer to micro changes that operate within specific local, project or site based variations.

MLP scholars argue that types of socio-technical change vary based on the levels being changed and identify three types of change (Geels & Kemp 2006). Firstly, *reproduction* refers to changes to the regime level only, with no changes at the landscape and niche levels. In these circumstances, organizations within the market may be reorganized but there is little shift in trajectory of underlying path dependencies. Secondly, *transformation* refers to changes at the regime and landscape level with no changes at the niche level. Here, institutional settings are adjusted but there is little change to the specific projects or organizations on the ground. Finally, *transition* is achieved when all three levels change in order to enable a major qualitative shift in the economic system. If successful, transitions enable changes to the underlying knowledge base and infrastructure of the economy.

Building on these MLP distinctions a theoretical model for 'transition' in the infrastructure sector within economies is proposed. As indicated above, infrastructure investment has been identified as a source of long-term economic growth and productivity, yet a disparity has emerged between the supply and demand for infrastructure investment. This suggests that infrastructure markets may be affected by path dependencies which impeded equilibrium. Yet, individual cases indicate that these path dependencies are not persistent in all cases.

An exemplar case is included to illustrate this proposed model for transition, followed by an extrapolation of the implications for innovations and management literature. This methodological approach is designed to offer theoretical elaboration based on rich, contextual detail of the policy settings. In the following section, the case context is set out, and changes at the landscape, regime, and niche level over four decades in Indonesia are examined. Interventions are then distinguished based upon whether they are targeted at infrastructure supply or demand. Supply refers to the financial, legal, and technical provisions to enable infrastructure construction whereas demand refers to the conditions for utilization.

1.2. Context

In developing this model for transition towards greater infrastructure investment, a market in which infrastructure financing pressures were acute and where some level of transitional success had been achieved was sought. The geothermal infrastructure investment market in Indonesia was suitable for two reasons.

First, Indonesia faces a striking gap between demand for energy infrastructure and supply. It has the world's largest geothermal power development potential with 40% of the world's known resource base, yet much of its capacity remains uninstalled (Polycarp, Brown & Fu-Bertaux 2013). By the late 1990s, only 527 MW of installed geothermal capacity was in operation across five fields. This discrepancy was in spite of rising electricity prices and a highly concentrated electricity market with almost 80% of supply coming from a single source: fossil fuels.

Secondly, Indonesia has subsequently achieved a measure of transitional success in securing public and private investment into the sector. In March 2014, the US$1.6 billion Sarulla geothermal project was finalized, making it the most important geothermal power project in Indonesia and the largest in the world to date. At a time when electricity prices are projected to grow in Indonesia by 8%

per year until 2029, the Sarulla project introduces 320.8 MW of installed capacity into the grid from 2018 (Asian Development Bank 2010; (Polycarp, Brown & Fu-Bertaux 2013).

1.3. Landscape Changes

Securing the Sarulla project was a culmination of interventions over three decades across numerous stakeholders. Early interventions by the Indonesian government and the multilateral banking community increased awareness of Indonesia's geothermal resources and assisted private sector stakeholders in project selection.

Supply side interventions. On the supply side, the government committed to conducting an extensive survey of geothermal resources in a 1972 inventory. This inventory was an important driver for development by bringing more attention to the country's assets and engaging the international community in technical assistance. Through the 1970s several international partners including the United States and Japan provided technical assistance to Indonesia to consolidate this inventory. This supported detailed engineering assessments of the country's geothermal potential, and helped build public sector management capability to vet projects.

The 1972 inventory formed the basis for Indonesia's early projects in geothermal. Through the early 1990s, Pertamina, the country's state-owned oil company, financed five geothermal plants which brought 527 MW of power into the grid.

In addition to this, the government reconfigured its policy settings to support industry development. A geothermal law was introduced in 2003 that produced a roadmap for future geothermal development in the country. A target was set to bring on 6,000 MW of capacity by 2020, and a number of restrictions inhibiting private investors were relaxed. Specifically, the new law allowed the private sector to bid for development projects in competitive tenders rather than forming joint operating agreements with Pertamina. This increased transparency in the commercialization process. Furthermore, responsibility for certain approvals and licensing were devolved to the regional government level (Polycarp, Brown & Fu-Bertaux 2013).

Whilst these reforms enabled supply side infrastructure development, there were several limitations. First, the 2003 geothermal law distributed construction risk solely to the developer. This impeded the ability of financial intermediaries to enter the market through novel risk-management instruments. Secondly, although delegated authority for approvals to regional government was intended to improve the approval process, in practice regional governments were under-resourced. Few governments had the capacity to run a successful tender process for the assets, and information on the asset potential was too limited to attract private investors.

Demand side interventions. Whilst supply side measures were progressively moving towards releasing supply capacity, separate policy levers were dampening demand for geothermal electricity. Specifically, the government continued to subsidize competing sources of electricity.

Electricity is a commodity product irrespective of source. Thus, subsidies to coal powered capacity distorted price signals in market relative to other sources of energy. In the early 2000s, for example, the Indonesian government responded to supply pressures by fast-tracking 10,000 MW of power generation capacity through coal power. This negatively impacted investor confidence due to a lack of a clear pricing structure for geothermal energy ((Polycarp, Brown & Fu-Bertaux 2013).

1.4. Regime Changes

Landscape-level changes helped improve the project selection process for geothermal projects. These have been estimated elsewhere to constitute up to 8% of the investment costs of infrastructure projects (Dobbs et al. 2013). Regime-level changes, however, helped translate improved project selection into a more systematic process for permitting and implementing major projects.

Supply-side changes. Project approvals and permitting of major projects can account for up to 15% of investment costs (Dobbs et al. 2013). However, these processes often sit on the 'critical path' and block the completion of major projects. An example is the US$4 bn 2,0000 MW Central Java Power Plan. There has been a delay of three years between the completion of the power purchase

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agreement and financial settlement due to difficulty in securing part of the land on the project site. Since the banks are unwilling to commit to finance until these land approvals are secured, projects can incur large costs in project delivery and execution.

In the geothermal market, a US$145 million geothermal fund was established in 2011 to assist with initial exploration, survey, and discovery costs. The purpose of this fund was to reduce some of the barriers imposed by large upfront costs, and significant delays in the early discovery stages. In addition the Ministry of Energy and Mineral Resources created a new Directorate General for New and Renewable Energy whereby approval processes could be expedited.

To assist in this process, the World Bank introduced a program with the Global Environment Facility in 2008 to help implement the 2003 geothermal law. A difficulty with the law was that many of the attending rules and regulations had not been clarified, thereby making it difficult for investors to commit to transactions. The World Bank program, together with subsequent programs from the international development community, supported 'project readiness' resources. This included international expertise on conducting feasibility studies, environmental and social impact assessments, and training of provincial governments on how to run tendering processes to attract private investment. These activities alone constitute between three to five percent of investment costs.

Demand-side changes. As part of the effort to stipulate regulations under the 2003 geothermal law, the Indonesian government introduced a pricing regime around geothermal electricity. Initially in 2009, geothermal was given a fixed maximum tariff of 9.7 cents per kWh. This was not financially attractive as it barely made geothermal projects profitable. In 2011, revised regulations introduced flexibility by allowing the winners of geothermal tenders to negotiate with Perusahaan Listrik Negara (PLN), Indonesia's state-owned utility, on a variable rate. However, PLN were not required to purchase this power (Crosetti 2012, Wahjosoedibjo & Hasan 2012). In July 2012, these regulations were changed again to introduce a variable feed-in tariff, ranging from 10 cents and 17 cents per kWh (Pramudatama 2012). This gave investors some certainty around geothermal pricing, without variation set by regional differences in the cost of production.

1.5. Niche Changes

Landscape and regime changes have only recently been consolidated in the successful financial closing of the Sarulla geothermal project. This is the first Greenfield geothermal project to be financed since the Wayand Windu Geothermal Power Project in 1997, and was syndicated between the government, private investors and the multilateral banking community. The project utilizes steam, brine and gas resources in the North Sumatra Province, and will be subject to a 30 year power purchase agreement. A number of project specific or niche commitments secured the financing for the project.

Supply-side changes. Although the equity for the project was put up by private sector project sponsors, the multilateral development banks offered variable loan terms to mitigate political risk. Specifically, the Japan Bank for International Cooperation extended a US$329 m political risk guarantee to cover potential scheduling, monitoring or approval delays caused by political factors. In the past, change of governments has posed a problem as project approvals have been reversed when new governments enter parliament. However, Indonesia's PT Sarana Multi Infrastructure (SMI), an independent unit responsible for syndicating public-private infrastructure partnership has sought to develop a special law that binds commitments of the central and the local government to realizing infrastructure projects notwithstanding a change in government. This has enabled the multilateral development banks to offer political risk guarantees that ease investor concerns.

Secondly, extensive support from the government and multilateral community enabled the Sarulla project to be proposed as a single, integrated project in which three separate power generating units are financed as a whole. Typically, large projects are segmented as project sponsors seek more detail of reserve analyses, technical and legal due diligence reports, and other independent advice. However, the supportive measure on this front enabled the commercial operation to be consolidated, thereby making the approval process simpler and more efficient.

Finally, the projected operating costs for the geothermal project were simpler than coal-fired power plants thereby making the financing less risky. Typically, power purchase agreements entered into with PLN required full pass-through of all fuel costs to the project owners (and, by extension, consumers). This can lead to some uncertainty about the projected profitability of the projects. This is especially the case for coal-fired power plants were input costs are significant and variable due to fluctuating commodity prices. In geothermal power, by contrast, all costs are accounted for upfront thereby removing pricing volatility.

Demand-side changes. In the Sarulla project, the Indonesian government agreed to guarantee certain payments made by PLN to the project owners under the energy sales contract via a Business Viability Guarantee Letter. This gave project owners greater certainty around revenue in the early years of the project. In addition, the introduction of global carbon pricing gave the project the possibility of additional credit-linked revenues in the future. Although the future of the CDM is uncertain, the project is structured in a way that means it may be eligible for earning future credits. It is currently expected to avoid 1.3 tons of carbon dioxide emissions per well.

1.6. Discussion and Implications

Governments around the world acknowledge that infrastructure investment has not kept track with the demand for new assets (Doornbosch & Knight 2008). In order to examine how governments close this gap, this paper examined the in-depth base of the geothermal market in Indonesia.

The findings of this in-depth study suggest that government initiatives may be categorized into three levels: *landscape*, *regime*, and *niche changes*. In the context of infrastructure investment, landscape changes give greater visibility and transparency to project assets. This includes initiatives that support project scoping, initial inventories, and feasibility studies of potential projects. Regime changes translate these transparency initiatives into detailed regulations and rules that detail how intended projects can be brought to fruition. This includes support regarding project approvals, environmental studies, as well as pricing arrangements. Finally, niche changes refer to project-specific conditions that enable counterparties to the project to enter into an agreement. **Figure 1** illustrates the proposed theoretical model for infrastructure transition.

This model advances the literature on technology innovation and infrastructure investment in three respects (Geels 2002; 2005; Schot, Hoogma & Elzen 1994). First, by applying an MLP framework to infrastructure investment, we give greater clarity to how infrastructure productivity may be assessed. The MLP framework has typically been applied to product markets, which differs from infrastructure investment because the investment timeframes are much shorter and the public sector has a less clearly defined role in market creation. By applying the MLP framework to infrastructure, we propose a framework for thinking through the productivity of public infrastructure investments. Cost/benefit models are difficult to construct across infrastructure sectors because of varying underlying assumptions to revenue (Torrance 2007; 2009). For example, the projected cash flow for hospital projects will differ significantly to rail or energy projects due to assumptions in pricing, demand volumes, and operating conditions that rely on government priorities. We therefore extracted a process-based model which takes into account these macro (landscape-level) factors, and highlighted the key project costs related to initial search activity, project due diligence, and completion facing infrastructure investment.

In the case of Indonesia, we found that there have been specific interventions targeted at each of these process barriers. Initiatives by the Indonesian government in the early 1970s reduced some of the search costs related to infrastructure finance, thereby laying the basis for market entry. Through the 1990s and early 2000s, detailed regulations and technical assistance made it easier for project sponsors to conduct project due diligence by setting clear parameters for investment and reducing project delivery costs. Finally, bespoke contractual arrangements such as the Business Viability Guarantee Letter in the Sarulla project assisted final project completion. Taken together, multi-level initiatives were crucial in readying the market landscape for infrastructure investment.

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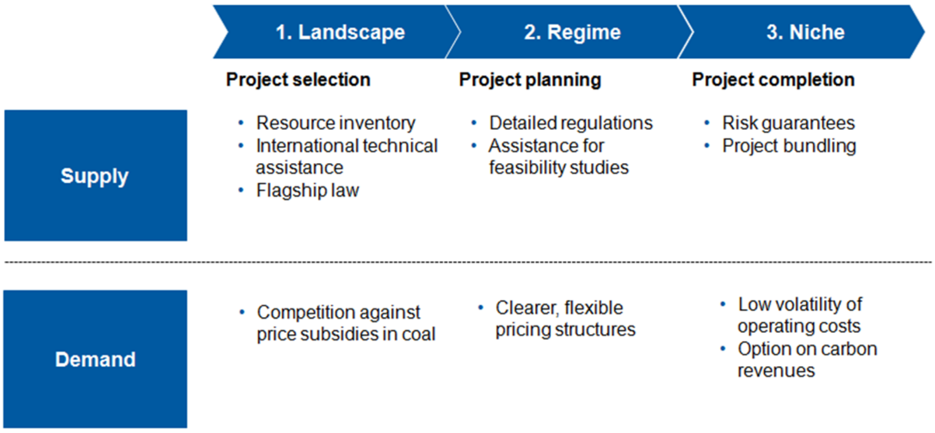

Figure 1: A MLP model of infrastructure investment in Indonesia

Secondly, the proposed model sequences the multi-level interventions longitudinally, following the logic of project selection, delivery, and completion. The current MLP perspective accounts for distinctions between 'reproduction', 'transformation', and 'transition' by accounting for the *number* of levels engaged at any one time (Geels & Kemp 2006; Geels 2005; Kemp 1994). For example, regime level changes without landscape or niche changes may result is minimal overall socio-technical change (Kemp 1994). By contrast, changes at all three levels enable socio-technical transition.

The proposed model is then extended by suggesting that the sequence of level change is significant. In the case of Indonesia's geothermal market, landscape-level changes were important before regime or niche level changes could take effect before project selection barriers precede completion barriers. Thus, initiatives to remove completion barriers early on (such as project support for the Sarullo project) may not be effective if they are introduced without sufficient change at the landscape and regime levels. Conversely, niche level changes for the Sarullo project in 2014 were only effective because of the long history of landscape and regime changes. The proposed model accounts for these changes by applying the logic of project development, from search, due diligence, and completion as outlined in Figure 1.

Finally, this paper asserts that both supply and demand side initiatives are important to change any one level. Previous studies of infrastructure tend to focus on either supply or demand side changes. For example, studies of sovereign wealth investment in infrastructure have tended to focus on investor capability to complete direct investment, or barriers to market transparency (Clark, Dixon & Monk 2013). Elsewhere, scholars examined demand-level price signals without considering the importance of non-price based initiatives that remove early stage barriers (Howarth 2012).

Further it is proposed that supply and demand initiatives are interdependent. Thus supply initiatives without demand initiatives lead to wasted resources as governments and the private sector pursue scoping studies for projects that are not economically viable. Conversely, demand initiatives without sufficient attention to supply constraints leads to a low number of viable projects. For example, in the clean energy sector, investment into clean energy projects remained low despite the introduction of a carbon price due to early stage barriers in energy infrastructure related to capital intensity of clean tech infrastructure (Knight 2012). In order to match supply and demand effectively over the long term, interdependence between these initiatives is needed in order to enable greater infrastructure investment.

While this proposed theoretical model addresses gaps in infrastructure financing, there are limitations to the approach used in its development. First, an exemplar case was used to highlight the elements of the proposed model but empirical evidence is needed to test the model. A challenge with market-level empirical studies in infrastructure is how to measure successful performance as performance may be inconsistent (Hebb & Sharma

2014). Future studies might take a longitudinal approach by following a single market (such as the geothermal market) over a long period of time, rather than taking a cross-sectional study across all infrastructure markets. A second limitation in this study is how the levels are defined. Lastly, the proposed model was applied to a specific infrastructure market setting to propose how the model might apply in the context of steps towards project completion. However, this may limit the generalizability to other markets or indeed other types of infrastructure, which should be an area for future research. Thus, in order to extend this research over time, we propose considering this model for other sectors.

2. Conclusion

Governments are under increasing pressure to close the gap between infrastructure supply and demand. Some have called on the G20 to be more productive in its approach to infrastructure investment and establish a global infrastructure productivity institute. Whatever the merits of the proposal, *how* governments encourage infrastructure investment at a time of growing government deficit remains a conundrum. This paper has sought to shed light on this problem by formulating a model by which infrastructure productivity can be analyzed, and used a successful exemplar to point the way to future public and private partnership in this area.

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