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Integrating models of projects, business ecosystems and layered infrastructure markets

Pekka Leviäkangas

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University of Turku

Turku School of Economics
Department of Marketing and International Business
Operations and Supply Chain Management
Doctoral Programme of Turku School of Economics

Supervised by

Professor Lauri Ojala
Turku School of Economics
University of Turku
Turku, Finland

Professor Juuso Töyli
Turku School of Economics
University of Turku
Turku, Finland

Opponent

Dr. Timo Välilä, Economic Advisor
European Investment Bank
Luxembourg, Luxembourg

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ABSTRACT

Infrastructures, such as roads, railways, and water supply networks, require investment, upgrades and maintenance throughout their life-cycle. Often the funding of these through public budgets is considered insufficient. The deployment of private capital for infrastructure finance – public-private partnerships (PPP) – is seen as one solution. PPPs have also been regarded as a manifestation of neoliberal policies that comprise privatisation of public assets or transforming the assets into market-oriented entities.

PPPs should be regarded neither as privatisations nor transformations, but primarily as projects where private investors invest their capital in the *project asset*, make commercial use of the asset and generate returns on their investment. The often politicised nature of PPPs calls for more holistic and objective tools to appraise PPPs that on one hand have a pure profit-motivated nature, and on the other hand are investments with significant socio-economic and environmental impacts.

This thesis provides an integrated and holistic view on public-private partnership projects in terms of their distributional effects within the entire PPP ecosystem context. The result presented is an analytical framework: an integrated model that can be used as a 'debate platform' by the actors within the PPP ecosystem, so that the prerequisites to find where sharing of goals and risks make sense, and to bring fairness to the entire PPP project lifecycle. PPP projects are in fact business ecosystems that interact with the surrounding society and markets in a variety of ways. Therefore, the stakeholder view in PPP investments and business is crucial. The main beneficiaries of the model are the

investors in PPP projects and the infrastructure managers and public financing bodies that may consider if a PPP is a viable option to realise a project.

This thesis is built on three models: the PPP project model, the PPP ecosystem model, and the market model. The fourth model, the integrated model for infrastructure PPPs, is a synthesis of the other three models. Each article following this compendium details the corresponding model. The first article uses the first PPP road project in Finland as an empirical case and forms the base project model that shows a project's cash flows and how project valuation is done, mainly focusing on two stakeholder segments: the investors and the state. The second article shows how an infrastructure PPP market is structured, thus distinguishing different market 'layers'. It also analyses the returns of different infrastructures to their owners and discusses the PPP prospect in ownership and governance contexts using Finnish data sets from 2002-2009. All main infrastructures were covered by the analysis of this article. The third article on the PPP ecosystem model widens the project model and involves stakeholders from different market layers, resulting in a financial statement model for the entire ecosystem. The final article integrates the market layer and ecosystem views and hence it is named as the integrated model.

The constructive and inductive process based on the four models allows the formulation of four main postulates that conclude this thesis: 1) PPPs revenue logic should rely mainly on market-based funding; 2) PPPs are risky with respect to their social sustainability, which is due to many potential and complex spill-over effects; 3) PPPs must also be considered as ecosystems, where the stakeholders are actors in the ecosystem with sometimes conflicting and sometimes coinciding interests; 4) it is more logical to draw market specific policies rather than PPP project policies.

This type of integrated model has not been presented earlier, which is the main scientific contribution of this thesis. The practical contribution is that the model can be used as an instrument particularly at the early development stages of an infrastructure project to assess if both commercial and societal goals can be achieved with a PPP arrangement. The model requires further empirical testing and must be validated for usability in varying infrastructure PPP cases.

Keywords: public-private partnerships, finance, funding, infrastructure, investment, business ecosystem, market

TIIVISTELMÄ

Infrastruktuurit, kuten tiet, radat, satamat ja johtoverkostot vaativat rakentamiseensa merkittäviä pääomia ja niiden ylläpitoon sitoutuu pitkäaikaisia menoja. Infrastruktuurien, eli perusrakenteiden rakentaminen ja ylläpito perustuvat perinteisesti julkisten varojen käyttöön - valtion, kaupunkien ja kuntien budjettien kautta. Useissa maissa näitä budjetteja pidetään alimitoitettuina rakentamisen ja ylläpidon tarpeisiin nähden. Tästä syystä yksityisen pääoman käyttö on yleistynyt perusrakenteiden investoinneissa ja elinkaaren rahoittamisessa. Englanninkielinen termi public-private partnerships (PPP) on yleistynyt hyväksytyksi käsitteeksi, ja PPP-mallien käytöllä onkin pyritty kuromaan umpeen julkisten infrastruktuuribudjettien vajetta. PPP:t on myös nähty uusliberalistisen politiikan ilmentymänä, jossa julkista omaisuutta on siirretty tai siirtynyt yksityiseen omistukseen, ja jonka tarkoituksena on voiton tavoittelu markkinaehtoistamalla julkista palvelua ja omaisuutta.

PPP-hankkeet, joita usein kutsutaan myös elinkaarihankkeiksi, eivät kuitenkaan ole suoraan rinnastettavissa yksityistämiseen tai julkisten palveluiden markkinaehtoistamiseen. PPP -hankkeiden ensisijainen tarkoitus on mahdollistaa suurten ja pääomavaltaisten hankkeiden toteuttaminen tuomalla yksityinen pääoma rahoittamaan hankkeita tarjoamalla pääoman sijoittajille mahdollisuus tuottoon. Toisinaan hankkeiden käsittely johtaa prosessin politisoitumiseen ja ideologisiin keskusteluihin, joiden yhteydessä itse hankkeen tarpeellisuus ja yhteiskunnalliset hyödyt saattavat jäädä toisarvoiselle huomiolle. Tästä johtuen onkin tarpeen kehittää PPP -hankkeiden arviointimalleja, jotka auttavat hankkeiden kiihkottomassa arvioinnissa, mutta toisaalta ottavat huomioon eri osapuolten ymmärrettävät ja luonnolliset tavoitteet. Infrastruktuurihankkeissa esimerkiksi ympäristöön kohdistuvat vaikutukset saattavat näytellä suurta osuutta hankkeiden hyötyvaikutuksissa, mutta vaikutusten arvottaminen sekä markkinaehtoisesti että yhteiskuntataloudellisesti on usein haasteellista.

Tässä väitöskirjatutkimuksessa kehitetään PPP-hankkeen kokonaisvaltainen arviointimalli. Mallissa eritellään PPP-rahoituksella toteutettavien infrastruktuurihankkeiden raha- ja hyötyvirrat sekä niiden jakautuminen eri toimijoiden kesken. Yhtiömuotoista PPP-hanketta lähestytään liiketoimintaekosysteeminä ja menetelmänä käytetään klassista rahavirta-analyysia. Malli soveltuu monenlaisille infrastruktuurihankkeille. Erityisen hyödyllinen malli on PPP -hankkeiden alkuvaiheen arvioinnissa, jossa on oleellista hahmottaa hankkeen hyötyjen ja kustannusten

jakaumavaikutukset sekä mahdollisuus rakentaa hankkeelle ansaintalogiikka, joka houkuttelee myös yksityisiä sijoittajia. Hankkeeseen liittyvät liiketoimintariskit, ulkoisvaikutukset ja muut laajemmat sosioekonomiset vaikutukset tulee kyetä hahmottamaan jo varhaisessa vaiheessa, jotta toimiva rahoitusjärjestely saadaan rakennettua. Kehitetty malli voidaan nähdä 'keskustelualustana' ja 'vuorovaikutustyökaluna' joka avaa eri osapuolten intressit läpinäkyvämmällä tavalla ja auttaa löytämään rahoitus-, riskinjako- ja toteutusratkaisuja jotka ovat elinkaareltaan kestäviä, yhteiskunnallisesti ja poliittisesti hyväksyttäviä sekä markkinoita vääristämättömiä - kansanomaistaen, tavoitteena on siis reiluus kaikkia oleellisia osapuolia kohtaan.

Väitöskirjatutkimuksen malli rakentuu kolmesta osamallista: projektimalli, ekosysteemimalli ja markkinamalli. Neljäs osamalli, kokonaismalli, on synteesi näistä osamalleista ja oleellisin tutkimuksen tulos. Tämän kokonaismallin kehittelyn aineistona on käytetty Suomen ensimmäistä PPP -hanketta (Järvenpää-Lahti moottoritie), sekä analysoitu eri infrastruktuurien omistus-, hallinto- ja tuottorakenteita käyttäen empiirisenä aineistona suomalaisten infrastruktuurien omistus-, hallinto- ja taloustietoja vuosilta 2002-2009. Tutkimus jakautuu neljään tieteelliseen vertaisarvioituun artikkeliin, joissa kolmessa esitetään osamallit ja viimeisessä, neljännessä, synteesinä kokonaismalli.

Käytetty tutkimusote on yhtäältä konstruktiivinen ja toisaalta induktiivinen. Kyseessä on mallin rakentaminen, joka muodostuu askeleittain rakennettavista osamalleista, joista kukin perustuu edeltävään osamalliin. Tuloksena esitetään myös neljä postulaattia, jotka ovat looginen seuraus mallinnustyöstä: 1) PPP -hankkeiden ansaintalogiikka tulee rakentaa pääasiassa markkinaehtoisiin rahavirtoihin; 2) infrastruktuurien PPP -hankkeet ovat kuitenkin riskisiä erilaisten ulkois- ja jakaumavaikutusten suhteen; 3) PPP -hankkeita tuleekin käsitellä liiketoimintaekosysteemeinä, joissa tyypillisesti toimijoiden intressit ovat yhteen nivoutuneita eivätkä erillisiä, vaikkakin toimijoilla on myös keskenään ristiriitaisia tavoitteita; 4) PPP -hankkeiden toimivuuden edellytys on, että markkinaympäristö ja -vaikutukset ovat soveltuvia kulloisellekin hankkeelle; täten PPP -hankkeiden sääntelyssä kannattaa kiinnittää erityistä huomiota markkinoiden toimivuuteen ja tehokkuuteen, yksittäisten projektien ja rakenneuudistusten sijasta.

Avainsanat: yksityisrahoitus, elinkaarihanke, infrastruktuuri, investointi, liiketoimintaekosysteemi, ulkoisvaikutus, markkinat.

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I was privileged to have one of the world's leading PPP experts as my opponent, Dr. Timo Välilä from the European Investment Bank. I am truly grateful that he made himself available for this academic debate.

No achievement is indebted to a single person, no goal reached alone, as is witnessed by the above acknowledgements. And this goes beyond the academic and professional community. My wife, Kirsi, has travelled with me for more than 35 years. This is just a minor milestone on our shared path, and the time spent with the paper and thesis writing has never felt lonely. I hope this milestone also serves, one way or the other, as an example to our wonderful, beautiful and smart children: Anniina, Aleksi and Alvari.

I humbly express my thankfulness to the abovementioned mentors, contributors and love ones. To this last mentioned group belong my dear mother Tyyne, my beloved sister Anna, and my always supportive in-law parents Leena and Martti.

[And the final question remains: why another PhD thesis (previous one in technology), in a 'mature' age? The answer is simple: it is fun - well,… most of the time at least! And as long there is enjoyment in learning and discovery, there is no reason not to take pleasure out of it. Besides, any other activity would have probably had a much bigger carbon footprint so the externalities in this respect were well managed. ☺]

TABLE OF CONTENTS

List of Figures

List of Tables

1 INTRODUCTION

1.1 Background

Public infrastructures are essential elements in all societies as they provide the conditions and services that allow the modern state to function properly and create value for citizens and organisations. These infrastructures – roads, railways, ports, telecom networks, water and energy supply, to name the most relevant ones – require substantial finances to be built, maintained and finally dismantled when reaching the end of their service life. The World Economic Forum (2013) estimated that the world runs an increasing infrastructure funding deficit of at least USD 1.0 trillion per year. In other words, this amount is accumulating annually. However, this news is not unexpected since infrastructure investment deficits were recognised much earlier, for example, by Munnell (1990) in the United States in the late 1980s. Infrastructure investments were observed to contribute to regional economy in terms of jobs and overall economic activity.

But since infrastructures do require investment, upgrading and maintenance throughout their life-cycle and since the funding for these beneficial investments through public budgets is considered insufficient, new sources of funds are needed. To bridge the funding gap, that seems to be chronic, the deployment of private capital for infrastructure investment has been seen as one prospective solution for financing[1]. The projects and arrangements where this has been taking place have been named as *public-private partnerships* (*PPP*). PPPs have been affecting politics and policy-making and they have been also regarded as a manifestation of neoliberal policies. The early steps were taken by Margaret Thatcher's United Kingdom (UK) government, and one line of

[1] *Funding* is paying back the upfront cost of the infrastructure that is *financed* either by public or private capital. So, for example, private financed toll road is ultimately funded by the users of the road (Source: Institute for Government, https://www.instituteforgovernment.org.uk/explainers/financing-infrastructure; read September 11, 2018).

her privatisation policies was the Private Finance Initiative (PFI; House of Commons Treasure Committee 2011, p. 4) that paved the way for the UK and from thereon for European PPPs.

PPPs and project financing methods have emerged not only in most industrialised countries but also in developing economies: the former suffering from ageing infrastructure that requires more investments, and the latter with governments' inability to raise necessary funds from their treasuries. At the same time new lines of thinking regarding the public sector's role and management philosophy have paved the way for doctrines such as *new public management* (see e.g. Gruening 2001, Hood 1995) and *value for money* (see e.g. Grimsey & Lewis 2005, Tsamboulas et al. 2013) both of which entail the idea of private sector involvement and business-like management in public service delivery.

However, the road from concepts to practical decision tools in policy (and project) appraisal has been fraught with pitfalls and contradicting views. Therefore it is not surprising that experiences in many countries are controversial (see e.g. Witz et al. 2015). There is a substantial set of literature identifying the potential pros of PPPs; however there is smaller, but equally important volume of negative experiences reported in different fora. Transparent, objective and analytical comparison of PPPs versus traditional carry-outs of infrastructure projects is scarce. The project-specific nature of PPP investments makes it difficult to obtain such data that would make the comparison genuinely unbiased and valid: two identical investments that are carried out in identical circumstances, one as a PPP and the other as a traditionally procured project, would be required for such a comparison. For statistical reliability, such comparisons should be multiple.

1.2 Public-private partnerships as a delivery method

Public-private partnerships emerged as an alternative to public delivery of infrastructures, largely following some of the other sectors' evolution paths where public service could be also offered by the private sector. There are several variants of delivery / procurement methods all which have been tried in practice since the introduction of PPPs.

First, it was possible to separate design and construction from the mandate of the public sector; later also maintenance, and finally the financing and ownership. All these links in the value chain of delivering an infrastructure pose the crucial question of whether to provide the service or carry out the task in-house or to contract out (Estache et al. 2004). There are a number of motivational factors for both the public and private sector to drive PPPs (Meunier & Quinet 2010, Tsamboulas et al. 2013), and not only have they been on the agendas of national governments, but also on those of local governments (Koch & Busch 2006). A variety of contractual variants can be included in PPPs: Build-develop-operate (BDO), Design-construct-manage-finance (DCMF), Buy-build-operate (BBO), Lease-develop-operate (LDO), Build-own-operate-transfer (BOOT), Build-rent-own-transfer (BROT), Build-lease-operate-transfer (BLOT), Build-transfer-operate (BTO) (Carmona 2010).

Table 1 highlights some of the essential variants and how they cover the infrastructure delivery value chain. All except the first (in-house model) may entail elements of a public-private partnership. It must be emphasised that all the shown variants can be realised within a number of contractual frameworks, which in reality means that PPPs assume an 'organic' nature that can be fitted and modified to a number of contexts, organisational architectures and regulatory environments. Therefore the models in Table 1 must be regarded as representative examples of delivery variants, not an exhaustive list. There is no section in the infrastructure delivery value chain that could not be covered by either the private or public sector or in partnership.

Thousands of PPP projects have been carried out all over the world which signifies the reality of their need and the vast empirical base how different variants can be incorporated and projects procured.

Table 1. Infrastructure delivery models

Type of procurement / contract	Value chain function in delivery				
	Finance	Design	Construction	Operation	Ownership
Public project in-house	Public	Public	Public	Public	Public
Public procurement	Public	Private	Private	Public / Private	Public
BOT	Public / Private	Public / Private	Private	Private	Private
DBFO	Private	Private	Private	Private	Public
BOO	Public / Private	Public / Private	Private	Private	Private

1.3 The PPP market

As PPPs gained popularity, institutional investors became increasingly interested in them as a new form of investment, and quite quickly the PPPs could be regarded as a market of their own right.

The World Bank data base report recorded that the total PPP investment in transport with private participation was US$69.9 billion in 2015. Europe and Central Asia (ECA) captured the largest share of the recorded project, with US$44.9 billion, 64% of the total. Following ECA was Latin America and Central Asia (LAC) with US$21.7 billion (31%). Minor market shares were recorded for South Asia (SAR; 3%), East Asia and Pacific (EAP; 1%), Africa (AFR; 1%), and the Middle East and North Africa (MNA; less than 1%).

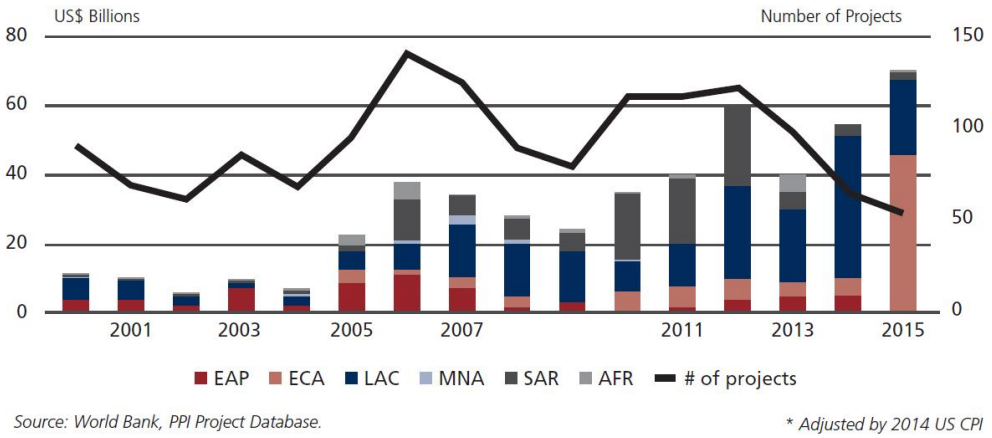

Figure 1. The PPP market records from the World Bank's PPI Project Database[2]

The European Investment Bank recorded 69 PPP transactions that reached financially close to an aggregate value of EUR 12 billion in 2016 (European Investment Bank 2017). In volume terms this was an increase of the market by 41% compared to 2015. In value terms, the market shrunk by 22%. The most active market was the UK by both value and number of projects. Transport was the largest sector in value, whilst the education sector recorded the highest number of projects. Over 80% of the transactions closed were government-pay PPPs, meaning in other words that direct user-financing was not used, and the recovery of the capital investment and operation was provided from public funds.

Both the above statistics show how significant to the market the PPP has become, and PPPs may well be considered as a market of their own, with dedicated investors, specialised contractors and operators, and national expert units that advise governments – both national and local – on how to make best use of PPPs as part of their investment programs and policies.

In Finland, a total of four national PPP projects have been realised, all of them road infrastructure investments in the southern part of Finland: E18 Hamina-Vaalimaa (under construction), Highway 4 Järvenpää-Lahti (contract expired), E18 Muurla-Lohja (in operation), E18 Koskenkylä-Kotka (in operation), as of December 2017. One railway project (Kokkola-Ylivieska) was considered but the procurement was aborted. The

[2] Reprint with the permission of the World Bank.

absolute number of PPPs is not high in Finland, but in fact they represent a fair share of the capital projects carried out when compared with some other countries (Witz et al. 2015).

To summarise these first chapters, it can be concluded that private financed infrastructure started from the need to deploy alternative capital sources for investments that were deemed necessary for economic development. When this need was combined with somewhat ideological directions where formerly public good projects could be carried out as private investments, the real story of PPPs came to be. Soon, and alongside with these motivations, PPPs became quickly popular and drew specialised investors to finance infrastructure investments. Thus PPPs became a competitive market segment for investors. Today, there are many specialised infrastructure PPP funds in the market (Preqin's database contains 213 unlisted funds; Preqin 2016)[3], most of them in Europe, but for example major Canadian and Australian pension funds are estimated to hold 10 percent of their investments in infrastructure funds (Déau and Touati 2014).

Hence it is obvious that successful PPPs deliver both public and private good: benefits, growth, jobs to the public good and returns to private investors and the two aspects are so intertwined in the history and motivation of PPPs that they must be considered side-by-side and in congruence.

1.4 Key concepts of this research

1.4.1 Public-private partnerships (PPP)

The doctrines of new public management and value for money are often manifested by *asset restructuring, i.e. outsourcing, commercialisation and privatisation of infrastructure*. International institutions such as the World Bank, EIB, and the OECD have extensively studied the issue (Thompson et al 2001 for railways and Heggie & Vickers 1998 for the road sector). However, a clear-cut normative research on the actual benefits is not that common. In some cases the asset restructuring has been done in sections, e.g. UK's railway infrastructure as a part of larger asset restructuring package

[3] http://docs.preqin.com/reports/Preqin-Infrastructure-PPP-PFI-July-2016.pdf; read 10.9.2018.

(Welsby & Nichols 1999; Nash 1993) and in some cases it has been done on project-by-project basis. The latter directly then refers to PPP (public-private partnerships) and project finance (Leviäkangas 2007, Välilä 2005, Blanc-Brude et al 2006) where typically the private investors assume the piece of infrastructure to be financed, built and operated by them.

PPP has no universally accepted standard or definition. A range of agreements and arrangements between the public and private sector fall under the umbrella of public-private partnerships; however, usually it is considered that PPP is a long-term contract between a private party and a government (local or national) body in order to supply a public asset or service with private financing. In many cases, there is a bundling of both the physical asset and the service. In typical PPPs the private party or parties bear a significant share of the risks and management responsibility (see e.g. World Bank 2015).

The OECD gives the following definition to PPPs: "*long term contractual arrangements between the government and a private partner whereby the latter delivers and finances public services using a capital asset, sharing the associated risks"*. Implicitly, the OECD mainly refers to state projects, but the government could of course be local or regional government, too.

PPPs must be distinguished from privatisation, since the last mentioned refers to the selling or transferring of public assets to private investors. Changing the legal status of a public asset into, for example, a limited liability company or some other type of more commercially oriented vehicle where the owners' liabilities are defined in a different manner and the operating logic of the asset becomes more market-oriented, is corporatisation. This is not synonymous with privatisation if the state or local government continues to hold the asset. PPPs should be regarded neither as privatisations nor transformations, but primarily as projects where private investors invest their capital in the *project asset*, make commercial use of the asset and generate returns on their investment. These project assets may take several different forms, where the cash flow logics, both incoming and outgoing, can vary in equally different ways. Furthermore, partnerships between the public and the private sector may vary from a pure procurement technique to shared holdings in the asset. PPPs can be regarded to fill the space between traditionally procured public projects and full privatisation (Grimsey & Lewis 2005).

One of the most common governance structures for PPPs is a *single-project company*. A company is established to finance, build and operate the asset in question. Private investors establish the company by providing necessary equity and debt capital so that

the project company may assume the tasks of building and operating. It is also possible that the construction and operation are separated into two different project companies or *special purpose vehicles*.[4]

1.4.2 Business ecosystems

PPP single-project companies are often referred to as special purpose vehicles. However, they can equally well be defined as business ecosystems since they work for mutual benefit, while, at the same time and possibly in competition, advancing their business. There are several definitions for business ecosystems, with some of the most cited ones being Moore (1993) and Iansiti and Levien (2004). They have slightly different wordings but essentially deliver the same message. Moore's (1993) definition is widely used and goes as follows:

> "*An economic community supported by a foundation of interacting organizations and individuals—the organisms of the business world. The economic community produces goods and services of value to customers, who are themselves members of the ecosystem. The member organisms also include suppliers, lead producers, competitors, and other stakeholders. Over time, they coevolve their capabilities and roles, and tend to align themselves with the directions set by one or more central companies. Those companies holding leadership roles may change over time, but the function of ecosystem leader is valued by the community because it enables members to move toward shared visions to align their investments, and to find mutually supportive roles.*"

Ecosystem thinking rests on companies' proactive responses to increased competitive pressure through mutually beneficial relationships with customers and suppliers (Iansiti and Levien, 2004). Business ecosystems tie different actors together through the flow of knowledge and shared value creation processes.

[4] A special purpose vehicle (SPV) is in this context the project company. However, the definition of an SPV is more generic and entails more than just project companies built for PPPs. See e.g. https://ec.europa.eu/eurostat/statistics-explained/index.php/Glossary:Special-purpose_entity_(SPE).

This being the rough definition, it is evident, again by definition, that in a PPP context the business ecosystem must include regulators, investors, partners up and down the supply chain, and stakeholders subjected to PPP projects' impacts (including externalities); all must be regarded as ecosystem actors (Leviäkangas et al. 2016). Yet how we define a business ecosystem depends on how we define our system under analysis and draw the boundaries for it. Hence, as is PPP, also ecosystem is a contextually flexible concept. Ecosystems can be seen as an extension of or an alternative view to preceding concepts such as clusters, value chains and value networks. A description of the ecosystem for an infrastructure asset is shown in Figure 2. The asset may be a network, a part of the network, or a node. In the context of this research, it can be regarded as a project, or more precisely, a PPP project, and it frames the 'system' under analysis.

For PPP project ecosystems, the common grounding is the shared fate of the involved actors and their need to understand their role in the ecosystem. A single-project company's ecosystem works for a (more or less) predictable project over its life-cycle, including execution and operation, and does not differ very much from the ideas of having common platforms or common market segments where ecosystem actors can work together towards a shared goal. The ecosystems of infrastructure PPPs are extensive and cut through a number of different markets (Leviäkangas et al. 2015).

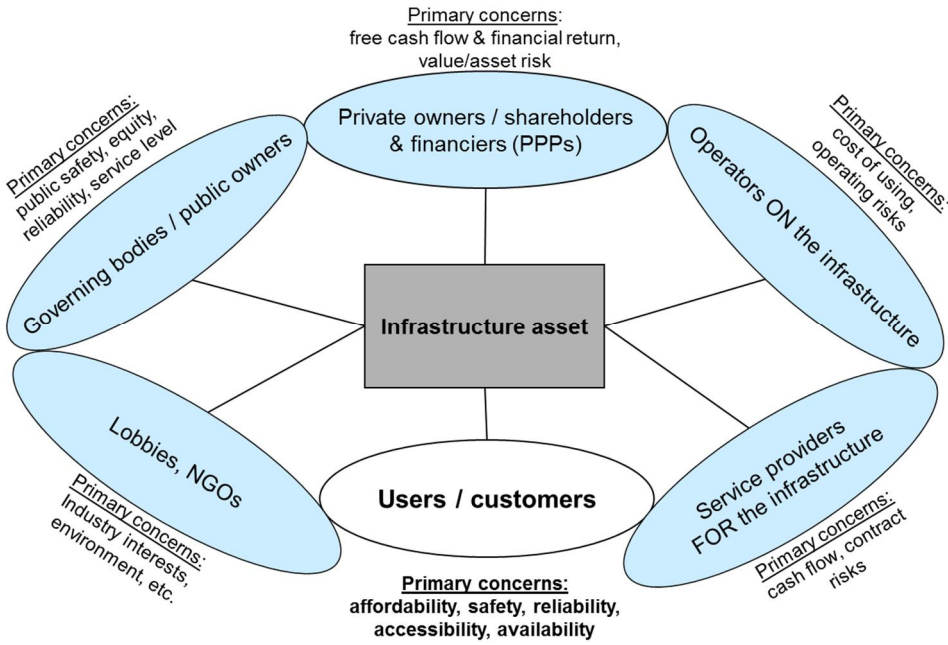

Figure 2. The infrastructure asset ecosystem (PPP ecosystem)

1.4.3 Infrastructure PPPs and their socio-economic contexts

Infrastructures in this thesis are defined as the *networks and nodes* of our *built environment*. These networks and nodes include roads, railways, ports, airports, telecom lines, energy and electricity networks, water supply and waste management, and the utilities associated with these.

Infrastructures serve several market layers and there are several types of organisations involved as market actors (Leviäkangas et al. 2011; Leviäkangas et al. 2015). For example, electricity networks can have multiple electricity producers, they have multiple clients in the corporate and consumer segments, and they may compete with other networks for the transferring of electricity. The networks may be public, semi-public (e.g. municipality or city owned companies) or entirely private firms. Entities with different legal forms may have different business rationales.

Infrastructure developments (i.e. projects) have multiple and extensive economic, social and environmental impacts. These impacts, when not priced by the markets, are considered as *externalities*. Infrastructure PPPs entail these externalities that may, and usually do, have significant effects on a project's acceptability and profitability. Therefore, the appraisal of a project cannot be limited to single-actor-single-viewpoints but must be a holistic appraisal of the impacts covering all necessary stakeholders. The more extensive the appraisal context, the more weight must be given to the externalities.

1.5 Key questions in PPP implementation

1.5.1 Contradicting views on PPPs

Some evidence indicates that PPPs have been rather unsuccessful in countries with lesser institutional maturity and stability (Witz et al. 2015). Also in countries where there is already a long tradition of PPPs, the opinion regarding them is not always encouraging. The UK House of Commons Treasury Committee report (2011) stated bluntly that "We have not seen clear evidence of savings and benefits in other areas of PFI projects which are sufficient to offset this significantly higher cost of finance". Also, the lack of innovation and general performance of PFI projects was criticised by The Committee. Some other assessments in the UK have concluded that the whole perception of PPPs bringing in additional benefits is overly optimistic (Shaoul et al. 2013). Cruz and Marques (2011) published their assessment of Portuguese PPP projects which resulted in a heavy financial burden for the public economy. Semiatycki (2009) reported unsuccessful cases of PPPs in the UK, US and Australia. Hodge and Greve (2007) provide an international review with contradicting results in terms of the effectiveness of PPPs. One of the very recent critical views comes from the European Court of Auditors who studied 12 EU co-financed PPPs in France, Greece, Ireland and Spain (European Court of Auditors 2018).

Yet PPPs are seen to provide positive effects in infrastructure delivery. Despite their critical assessment, also the European Court of Auditors (2018) found that PPPs enabled faster policy implementation. It does not require references or evidence to realise that deployment of private capital can contribute to the development of infrastructures,

particularly when the public budget constraints are severe. PPP projects in Finland are considered by and large successful, even if solid analyses have not been performed (Leviäkangas 2013; Finnish Transport Agency 2013). The Arlandabanan project – the train link between the airport and City of Stockholm – has been completed and operated without major problems (Nilsson et al. 2008). Many of the Norwegian toll roads were built before the term 'PPP' came into existence, or at least common usage, and have been operating for decades (Leviäkangas 1996; Odeck 2008). Although the Norwegian toll roads cannot be considered as pure PPPs because the local authorities are often the sole shareholders of the toll companies, no doubt they are public investments that utilise private capital, major banks being the debt investors.

Since the evidence and experiences are contradictory, and whilst there is a clear 'market push' for PPPs (Leviäkangas et al. 2016b), the need for balanced, transparent and objective approaches is apparent.

1.5.2 To partner or not? Guidelines for implementing PPPs

There are general guidelines on how to construct PPP implementation contexts at both an institutional and project level. Guidelines are provided, for instance, by the Asian Development Bank (undated), The United Nations (UNESCAP 2011, United Nations 2008) and The World Bank (2014). Apart from general directions, these guidelines in the best case offer references to other guides and examples of how to conduct a PPP project appraisal or what prerequisites should be in place to have successful PPPs. However, these guidelines are very generic in nature and, for practical purposes, technical, simple-to-use and hands-on tools are harder to find.

Another set of standards has been prepared by the United Nations Economic Committee for Europe. These standards have a particular emphasis on the sustainable development goals (SDG) of the United Nations (UNECE (2016). These standards are also at a very general level. For example, the draft standards for railway PPPs focus on political acceptability, processing of capital investment programmes, and ensuring the viability of processes (UNECE 2017). The UNECE standard also adopts the view of Sustainable Development Goals (SDG) and People First Objectives according to the United Nation's 2030 Agenda (United Nations 2015; UNECE 2016). The standard covers the following main elements: A) project selection and baseline requirements, B)

financing requirements, C) legal requirements, D) feasibility for low and middle income countries, E) other issues related to the rail sector. The UNECE rail PPP standard appears to be more of a policy guideline than a technical standard.

The European PPP Expertise Centre (2015) justifies PPPs by the following statement: "One of the main, if not the most important motivation for using PPPs, is their potential to improve value for money (VfM). Although the definition and scope of VfM varies, improving VfM in its broadest sense means using PPPs where they can improve the delivery of benefits relative to the associated costs across a range of alternatives." The Centre also lists a number of more detailed arguments from harnessing more innovation to budget certainty. Beyond some examples and case stories the report stays at a very general level when making recommendations regarding how and when PPPs could and should be used. The Centre concludes the key requirements for a successful PPP project are as follows:

- a supportive and stable policy, institutional and legal framework for PPPs;
- strong political support and strategic intent;
- a technically competent public sector client;
- effective public sector governance and project management capability so that the preparation, procurement and contract management stages are well managed;
- the establishment of credible and coordinated project pipelines;
- a responsive private sector market that is potentially capable and willing to support a PPP programme;
- strong management of and support from project stakeholders; and
- effective communications capability.

One of the motivations to incorporate PPPs is transferring the investments off the balance sheet of the government party. This can be done, and in Europe the Eurostat identifies "risk and reward" criterion and "control" criterion. The party that assumes the main risks related to the investment, should record the asset in its balance sheet. If this principle is not conclusive, it could be recorded by the party that has *de facto* control over the asset. In order not to record the asset on government balance sheet, i.e. the national accounts, European System of Accounts 2010 lists a number of detailed conditions how to apply the criteria. (European PPP Expertise Centre and the European Investment Bank 2016)

Replacing public financing with private capital does not alter the overall socio-economic viability of a project. However, introducing private investors to the project

requires understanding of how the costs and benefits are to be shared between ecosystem actors. Without this reflection it is hard to justify the project to all actors. Therefore, the statement of costs and benefits of the project needs to cover the ecosystem actors with enough detail so that the project becomes acceptable to the public, private investors, contractors and suppliers and different market actors affected by the project (Leviäkangas et al. 2016a).

Models that are able to capture the rationale of value co-creation in a PPP project ecosystem are needed to de-politicise and neutralise ideological loadings that are often present in PPP projects.

1.5.3 Other issues with PPPs

The list of challenges as well as opportunities regarding PPPs is as long as the criteria for successful projects and successful policies. To be a successful project and investment, the project needs to be carried out on time, within budget and provide good quality for the money spent. The time, quality and cost criteria is a traditional 'iron triangle' of good project management (Atkinson 1999). Positive expectations are also loaded on PPPs regarding more innovation and the adoption of modern technologies. (Li et al. 2005; Akintoye et al. 2003; Parker and Hartley 2003). Negative expectations and experiences include high administration and transaction costs, and potential conflicts of private and public interests (Hampton et al. 2012; Li et al. 2005; Akintoye et al. 2003; Parker and Hartley 2003). The project performance aspect has been widened in a number of studies with regard to stakeholder perspectives, project phase and nature, and country location, which affect cultural factors, institutional capabilities, and transparency of the administrational context (Liyanage and Villalba-Romero 2015; Ng et al. 2012; Leviäkangas et al. 2016a; Cheung et al. 2012; Jamali 2004; Koen et al. 2015).

PPPs are a manifestation of a policy, and a deliberate attempt to find alternative ways to finance and deliver infrastructures, as well as many other services, such as health care and education (Acerete et al. 2012; Willems and Van Dooren 2016; Richter 2004; Sinisammal et al. 2016; Hodge and Greve 2007). National PPP policies have been issued (or drafted) by, for example, Australia, UK, and India (Australian Government 2015; HM Treasury 2012; Government of India 2011), but many countries have been satisfied by building specialised units to advise on PPPs (for an overview, see World Bank's

Public-Private Partnership in Infrastructure Resource Center https://ppp.worldbank.org/public-private-partnership/overview/international-ppp-units; Dutz et al. 2006; OECD 2010).

1.6 Aims of this research

The aims of this research build on

- the obvious need to find congruent views and approaches to PPPs that recognise the varying motivations and drivers of the key stakeholders, which can be regarded as ecosystem actors;
- the obvious contradictions related PPPs and experiences on them: PPPs are seen as a part of the investment gap solution by supplying capital needed for these investments, and yet in many instances PPPs have failed to deliver results that are better than with traditional public financing;
- the clear recognition that PPPs are on one hand a market in their right, while being also an ecosystem comprising public bodies, investors, the construction and service companies, the wider society, such as NGOs and civil society organisations, and last but not least the users of supplied infrastructure.

The first aim of this research is to provide an integrated and holistic view on public-private partnership projects in terms of their distributional effects within the entire PPP ecosystem context. The second aim is to provide an analytical framework, an integrated model that can be used as a 'debate platform' by the actors within the PPP ecosystem, so that the prerequisites to find where sharing of goals and risks make sense, and to bring fairness to the entire PPP project lifecycle. A multi-perspective appraisal framework is needed in order to make PPPs a win-win arrangement for all stakeholders.

The contradicting views undermine an objective and de-politicised societal debate on PPPs and how PPPs could and should be utilised in the provision of infrastructures. Furthermore, the apparent lack of easy-to-use technical tools does not contribute to PPP appraisal. It may well be possible that some of the contradicting views - which may partly be ideological, of course – are due to lack of understanding of the different views and priorities of the stakeholders involved. If the stakeholders all perform their project appraisal in isolation and there is no integrating synthesis to build consensus, it is hardly surprising that arguments from one side are not fully appreciated by the other side.

This research goes through an inductive and constructive process by presenting a set of models that are inter-related with each offering a distinctive perspective to PPP investment projects. Also, there is clearly a lack of integrated views as much of the existing literature focuses on the specifics of PPPs, such as risk allocation, stakeholder engagement, financial aspects, etc., however relevant these may be in their own right.

2 THEORETICAL AND METHODOLOGICAL UNDERPINNINGS

Management accounting and *investment analysis* are touched on as the strategic behaviour of investors and project sponsors are considered and PPP projects feasibility is assessed. Management accounting (Burns & Scapens 2000) offers one framework to capture and communicate PPPs, since it translates the 'institutional' structure of a PPP into accounting information. Investment analysis is in turn an operationalised management accounting tool to serve and aid the managers to make investment decisions based on accounting information. *Public accounting* principles affect the funds flows between institutions, e.g. rail administration receiving budget funds for track construction and maintenance and conversely rail administration receiving track use charges from rail operators. *Transport economics* studies the equilibrium between demand and supply of mobility services, including the infrastructures (which can be considered as one form of service that has a demand and supply), and for example the allocation of internal and external costs to the users of infrastructure (OECD 2007).

2.1 Theoretical grounding

The theoretical grounding of this thesis relies on established theories on institutions and organisations (Hamilton 1919, Commons 1931) and the theory of investments (Jorgensen 1963, Modigliani & Miller 1963). The theoretical continuums and paradigms that are derived from the established theoretical foundation comprise new institutional economics (Williamson 2000, Coase 2004, Menard & Shirley 2005) and models of investor behaviour such as shareholder value maximisation (Blyth et al. 1986) and balancing between risks and returns (Sharpe 1964). These in turn have led to operational tools for investment decision analysis, such as asset pricing and cost-benefit analysis.

Wider disciplines that include these types of tools can be identified as well, such as engineering economics and decision analysis.

Much of the work in this research is about modelling, and this is discussed more in depth in chapters 2.3 and 2.4. Some additional elements to the theoretical basis are evident. For example, *economic systems*, *business ecosystems,* and *business models* represent the emerging theoretical contexts, whether considered as just research themes or even as new propositions for theories or paradigms (Moore 1993; Iansiti & Levien 2004; Osterwalder et al. 2004).

The term 'system' also brings forth the elements of *systems sciences* (Checkland 1999; Checkland and Poulter 2010; Checkland 2012) to the topical and contextual collection interfaced by this research. PPPs are mainly organisational and social systems, new types of systems perhaps, but abundantly being implemented. As a social system, the considerations of how PPPs are witnessed by surrounding stakeholders and how they are managed to pursue the goals that have been set for them, incorporates the perspectives of *stakeholder and stewardship theories* (Freeman et al. 2010; Freeman et al. 2004; Donaldson 1990; Donaldson & Davis 1991) which are also emerging theoretical constructs, the former assuming that a firm (in this case, the PPPs) must consider wider expectations of the stakeholder community, whereas the latter is narrower in its assumptions, mainly expecting managers to focus on the overall performance of the firm.

The theoretical bases and methodological approaches that are drawn from in this dissertation are depicted in Table 2. The overarching theoretical structures – theories on institutions and investments - lay the foundation for paradigms and theoretical continuums that follow from 'source' theories: new institutional economics and shareholder wealth maximisation principle. Although the exact evolution path of the theoretical contexts may not be explicit (at least without more extensive literature research), there is a clear logic in terms of semantics and publication times of the most relevant literary works.

Table 2. Theoretical underpinnings

Field of science:	Economics		Economics & Systems sciences
	Established theories		Emerging theories and other approaches
Theory basis:	Theory of institutions and organisations (Hamilton 1919, Commons 1931)	Theory of investment (Jorgenson 1963, Modigliani & Miller 1963)	Theory of business ecosystems and models (Moore 1993, Iansiti & Levien 2004; Osterwalder et al. 2004)
Paradigms or other theoretical continuums:	New institutional economics (Williamson 2000, Coase 2004, Menard & Shirley 2005)	Shareholder value maximisation (Blyth et al. 1986), risk-return trade-off (Sharpe 1964)	Stakeholder theory (Freeman et al. 2010, Freeman et al. 2004), stewardship theory (Donaldson 1990, Donaldson & Davis 1991)
Methodological techniques or approaches:	Conceptual and visual modelling of the organisation; valuation of the firm	Investment analysis, cost-benefit analysis, decision analysis, asset pricing	Stakeholder analysis, social systems analysis, system dynamics, case studies, descriptive modelling

2.2 Modelling elements

2.2.1 Models as constructs

This thesis is built around three distinctive models: the PPP project model, the PPP ecosystem model, and the market model. The fourth model, the integrated model for infrastructure PPPs, is a synthesis of the other three models.

All the phenomena and objects included in the models are observable and measurable, and indeed factual. This is in line with the inductive model building which leads to postulates or conjectures that can be further tested and which hopefully bear practical relevance. Hence there is a strong reliance on constructivism. The models presented are in fact management accounting constructs (Kasanen et al. 1993), built on other constructs such as cash flow analysis and benefit-cost analysis. The elements of practical relevance, practical functioning, while at the same time having theory connection and being able to make theoretical contribution, are crucial for constructive research (Kasanen et al. 1993).

If the partial models (project, ecosystem, market) and the integrated models are empirically adequate - i.e. they make sense, they can be used for real world problems and situations – we can say that the model building is based on constructive empiricism (van Fraassen 1980).

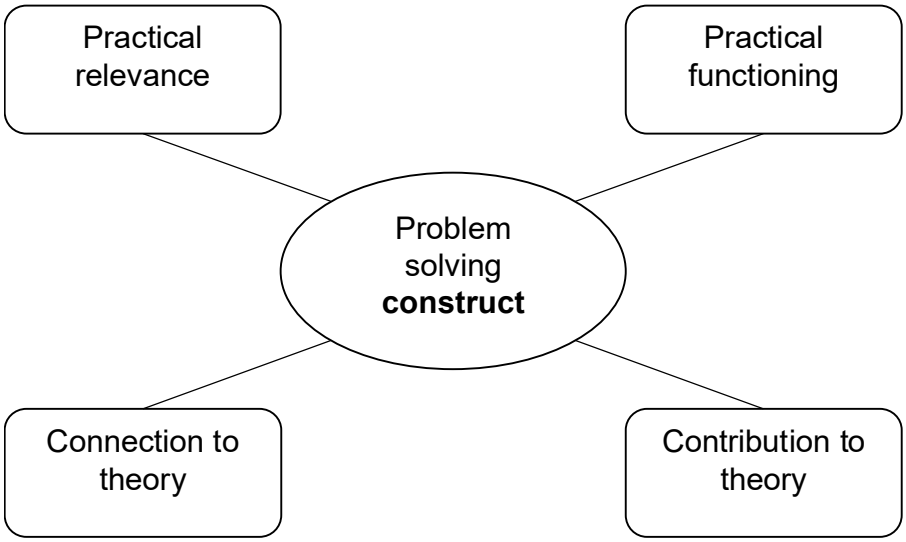

Figure 3. Elements of constructive research[5]

[5] Redrawn and modified from Kasanen et al. (1993).

2.2.2 The constructed models

The PPP project model is a descriptive and mathematical representation of a PPP project. This model is built on the basis of an empirical case project, not on the basis of any single theory. There is no single "theory on PPPs" and therefore the model is a building block for postulates that may be used to construct conjunctures or theorems. As the model is analytical (mathematical), it is able to be set in different project contexts (where it can be used to describe other projects). The model was also validated in the first article "Financial anatomy of E4 Helsinki-Lahti shadow toll PPP-project" (Leviäkangas et al. 2013) and the results of the validation are used also as a starting point for postulates.

The PPP project model is basically a cash flow -based systems model that was empirically validated using a single case project. However, if the accounting of financial and economic flows is correctly constructed in the model, or they can be modified when the project context is different, then the model is generic and acceptable and requires no testing. The mathematical logic is the decisive factor. The PPP project model is furthermore clearly a systems model, where the system is conceptually visualised and then analytically formulated with the help of financial equations.

The second model, the PPP ecosystem model (Leviäkangas et al. 2016), has some similar characteristics to the project model and can be viewed as an extension of the project model. Also the system the ecosystem model describes is extended from the project model. It contains more agents (stakeholders or actors) and extends over several markets stretching the boundaries of the project model. The same tools of model presenting, the financial equations, are applied and hence the ecosystem model has essentially the same theoretical properties – it is a mathematical model. Evidently, both the ecosystem and project model rely on management accounting theory, where financial and economic properties of a system are described with the help of accounting concepts.

The third model, the PPP market model, is a conceptual system description that again extends the two aforementioned models but does not yet include any mathematical representations. The market model construction (Leviäkangas et al. 2015) starts with empirical analysis on the ownership and governance structures of technical infrastructure networks and nodes in Finland. There is no financial modelling, but instead there is financial analysis of the profit generating capacity of different networks and how different ownership and governance structures seem to affect this capacity. The actual market model is built on the basis of qualitative analysis of the ownership and

governance structures. The market model was preceded by research efforts that included financial analysis of infrastructure returns and investor value capture (Leviäkangas et al. 2011).

The integrated PPP model fits the PPP ecosystem model (extended and derived from the project model) into the market model that can be used, either as such or in a modified form, to appraise and evaluate any type of PPP infrastructure project. This integrated model is the final outcome of this thesis.

The models, both the integrated model and its components on the basis of which it was constructed, allow postulation and theorem building. The models in themselves cannot be built on any particular theories, as said, but that is the nature of bottom-up, inductive model building that has a degree of independence for any theory (Zalta 2012). Whether the integrated model or other models fit into any theory, is in fact irrelevant. All the models presented here have already established roots in management accounting theory and systems theory. Management accounting presents the laws of financial and economic analysis, and systems theory offers the foundation of presenting conceptual structures that can be regarded as systems and/or system of systems. The semantic view of theories declares that theories do not require formal calculus; rather they should be viewed as 'families of models' (Zalta 2012).

Scientific models represent a phenomenon or phenomena, objects or features of the world (Frigg and Hartmann 2012). The models in this research represent different views for public-private partnerships, at different levels of resolution. The models have different semantics, but for the most part they are a combination of equations (mathematical models) and visual representations of these views (analogical models). A PPP project or ecosystem is not physically representable (except the outcome, which is the physical facility) since it is a social model, first and foremost, and hence lacks an observable physical form. However, as the model of an atom, PPP projects, ecosystems and markets can be represented by visual analogies.

The market model is slightly different, since it has more of a qualitative nature and the construct of the model is based slightly on intuition but mainly on observation of the market structures and ownership and governance structures of Finnish technical infrastructure networks. Still, all the elements of the model have empirical representations in the real world and therefore the model is reasonably reliable. A sample of 30 different networks, nodes and utilities were studied while constructing the model.

The sample coverage was considered good, and in some cases involved 100% of the population (e.g. railways and national roads).

The integrated model is valid provided the partial models used for its construct are valid and there is logical congruence between different models. The building of the integrated model follows an inductive and constructive process. There is no generally accepted 'integrated PPP model' yet; instead this thesis proposes one. Figure 4 shows the inductive logic and progress from the individual project model towards the integrated model which combines the views of infrastructure market layers and PPP ecosystems.

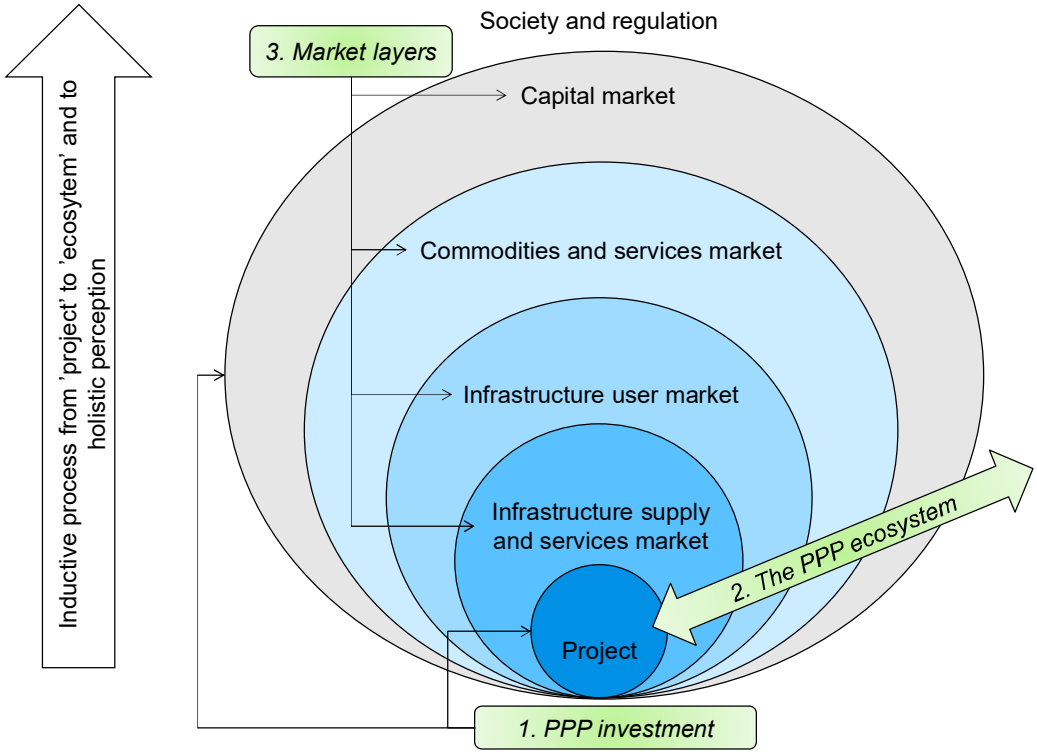

Figure 4. The inductive steps of the modelling

2.3 Research process and carry-out

This research was carried out during 2013-2017 in Finland and Australia. The research received no direct external funding. However, some of this work benefitted indirectly from the research carried out in the European Union COST (European Cooperation in Science and Technology) program, especially COST Action TU1001 Public-Private Partnerships in Transport: Trends and Theory (http://www.cost.eu/COST_Actions/tud/TU1001). Also project BENEFIT (Business Models for Enhancing Funding & Enabling Financing for Infrastructure in Transport) under the Horizon 2020 program of the European Union contributed to the body of knowledge that is partly utilised in this research. This research also benefitted from the C-Business project that was funded by the Finnish Funding Agency for Innovation (Leviäkangas et al. 2011).

The model integration is done step-by step, on different resolution levels of analysis: 1) PPP project level, 2) PPP business ecosystem level, 3) market level, and 4) societal level. The level of resolution is represented by each article, and the process is an inductive one. The articles are as follows:

Article 1: "Financial anatomy of E4 Helsinki-Lahti shadow toll PPP-project" (Leviäkangas et al. 2013) constructs and demonstrates the *model for a single-project company* or special purpose vehicle. The derived model is used as a starting point for more generic model building. This article provides the first step on the inductive process and serves as a springboard for the first set of postulates of this thesis.

Article 2: "Infrastructure public–private partnership project ecosystem – financial and economic positioning of stakeholders" (Leviäkangas et al. 2016a) constructs a generic *PPP ecosystem model* showing the distribution of cash flows, costs and benefits within the PPP ecosystem consisting of the most relevant stakeholders. This article provides the second set of postulates.

Article 3: "A slice or the whole cake? Network ownership, governance and public-private partnerships in Finland" looks into the *structure and dynamics of infrastructure markets* and contextual characteristics affecting PPP projects (Leviäkangas et al. 2015). This article provides additional postulates.

Article 4: The last article "Understanding infrastructure PPPs – the project, the ecosystem, the markets and the societal economy" (Leviäkangas et al. 2016b) builds a synthesis on the basis of the first three articles. It presents an *integrated PPP infrastructure project model* that is fitted into market context and possesses the ecosystem aspects. The final postulates are derived from this synthesis.

Table 3 depicts the contribution of articles to each abovementioned level of resolution and Figure 5 shows how the articles are positioned in the inductive process.

Table 3. Build-up process towards the integrated model (presented in Article 4 as a synthesis built on Articles 1-3)[6]

Level of model resolution	**Article 1**	**Article 2**	**Article 3**	**Article 4**
Project	X			
Ecosystem		X		
Market			X	
Integrated				X
Contribution	*Developing the project model*	*Developing the ecosystem model*	*Developing the market model*	*Developing the integrated model*

[6] The candidate's contribution to all articles was about 80% and he acted as corresponding author.

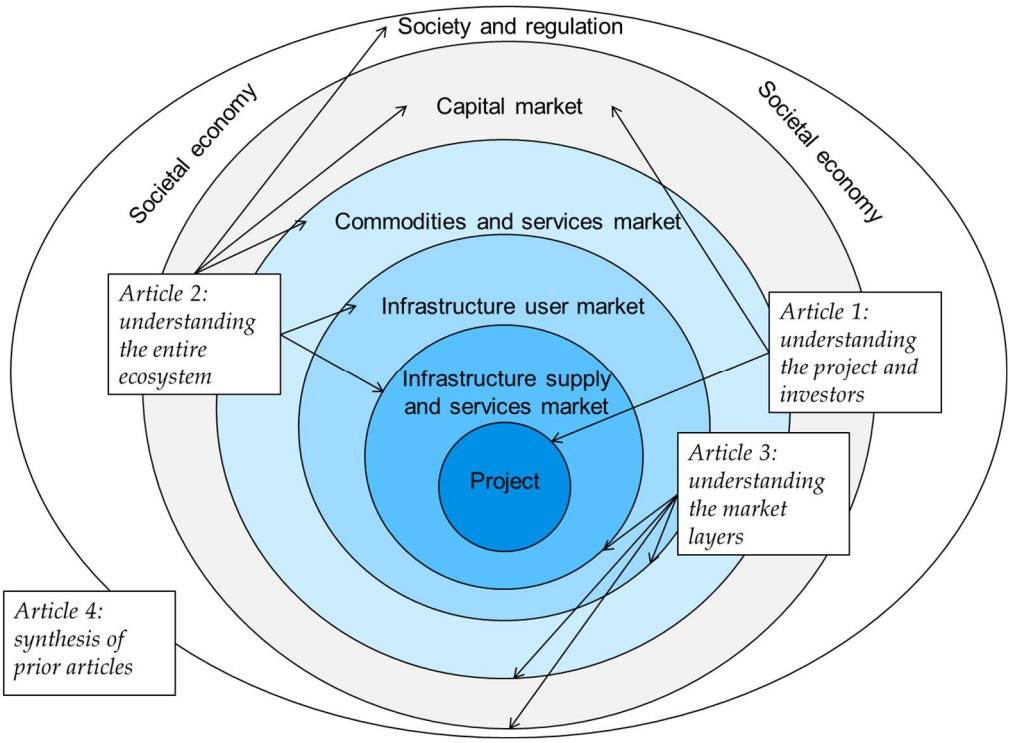

Figure 5. Positioning the articles in the inductive process from individual project towards the integrated view

3 RESEARCH OUTCOMES

3.1 PPP Project Model

The project model starts with visualising the key stakeholders of a PPP project organised as a single-project company; a special purpose vehicle. It simplifies the cash flows into easily manageable units that can be incorporated by management accounting tools, such as cash flow analysis of a capital investment. The empirical case on the basis of which the model was constructed was the Helsinki-Lahti semi-motorway upgrading project (Leviäkangas 2013).

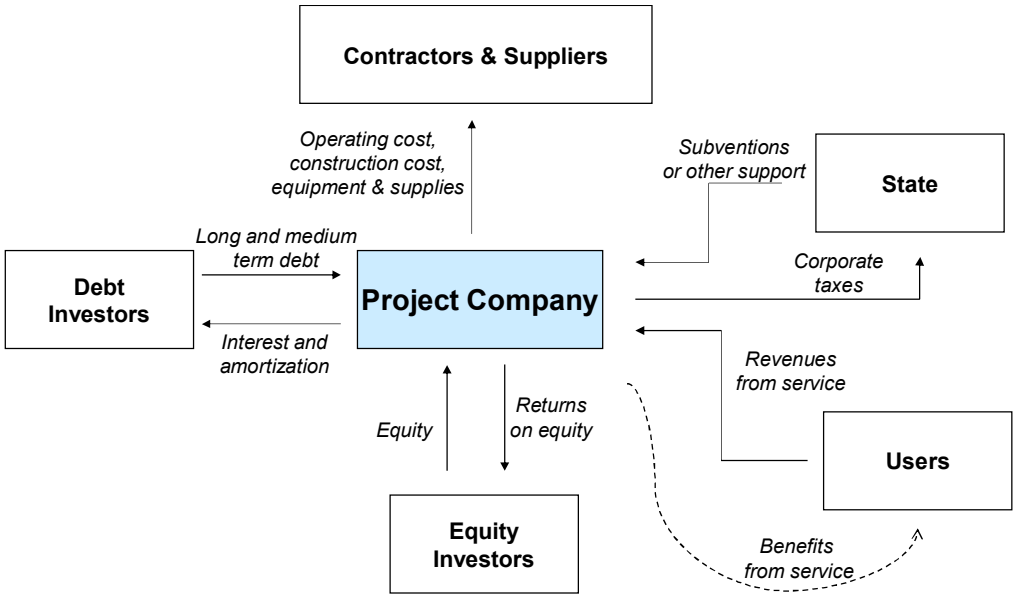

Figure 6. PPP Project model (single-project company model) (Leviäkangas 2016b, 2013)

From the visual concept model it is possible to move towards a mathematical cash flow model of the PPP project. The following notation is used:

Rev = revenues of the project company coming as service payments from the users
Sub = subventions and different forms of support from the public sector (note that some forms of support might not be liable to tax; here it is assumed that they are)
Ope = operating costs of the project company
C = construction cost, i.e. the expenses of building the asset
Tax = corporate taxes paid by the project company
E = equity capital invested in the project company
D = debt capital raised by the project company
iD = interest on debt capital
A = amortisation of debt
Dep = depreciation of the asset
T_c = corporate tax rate
FCF = free cash flow of the project company
TCF = total cash flow of the project company; subscripts identify if the cash flows are directed to equity investors (E) or debt investors (D).

All the above flows are expressed in present value terms. Depending on the actor and their preferences of time value of money (interest), the flows are discounted with different rates accordingly. Thus, the same flow paid by e.g. the state, may have different present value when received by the project company. Therefore also the term iD refers to the present value of the interest payment stream in absolute terms.

The project company is subject to taxes after costs, interest payments, and depreciation expenses have been subtracted from its revenues:

$$Tax = T_c\,(Rev + Sub - Ope - Dep - iD) \qquad (1)$$

In a simplified setting, construction cost C equals depreciation Dep, even if they, in practice, occur at different times. Therefore, here these are assumed to be equal since C is spread over time to allow the company fair tax planning and full utilisation of deductions.

The free cash flow (FCF) for the project company can be expressed as:

$$FCF = Rev + Sub - C - Ope - Tax$$
$$= Rev + Sub - C - Ope - T_c\,(Rev + Sub - Ope - Dep - iD)$$
$$= (1 - T_c) \times (Rev + Sub - C - Ope) + T_c Dep + T_c iD \qquad (2)$$

defining that the cash available for the project company's owners is after-tax net cash flow plus tax benefits from depreciation and interest. For debt investors, the total cash flow (*TCF*) is the amortisation payments and interest less the initial debt investment:

$$TCF_D = A + iD - D \qquad (3)$$

For the equity investors, the net total flow is the free cash flow minus the amortisation and interest paid to the debtors less the equity they initially invested in the company:

$$TCF_E = Rev + Sub - C - Ope - Tax - A - iD - E \qquad (4)$$

When the total net flows for equity investors and debt investors are aggregated, the aggregate cash flows for the project company investors equal to:

$$TCF_E + TCF_D$$
$$= Rev + Sub - C - Ope - Tax - A - iD - E + A + iD - D$$
$$= Rev + Sub - C - Ope - Tax - E - D = FCF - E - D \qquad (5)$$

stating that investors receive free cash flow minus their capital outlays. The market value of the project company V_P should equal the expected present value of free cash flows. This in turn equals the total net cash flow to the project company, plus the capital outlays. The market values of equity and debt lead to the expectation of the market value of the project:

$$V_P = FCF = TCF_E + TCF_D + E + D = (E + TCF_E) + (D + TCF_D)$$
$$= E_m + D_m \qquad (6)$$

The users and members of the society provide cash flow in the form of revenues from user charges, subventions (grants), or financial support from the state or local government, but receive taxes from the project company:

$$TCF_S = Tax - Rev - Sub \qquad (7)$$

If this flow of cash is positive, the public sector will have a financially profitable project, excluding the externalities, which are usually relevant in infrastructure projects.

This model was also applied with real-world (or reasonably close to the real world) data. The Capital Asset Pricing Model (CAPM) was applied in the determination of the risk-adjusted discounting rates of the project cash and economic flows. When a shadow toll[7] scenario combined with different revenue, cost and pricing scenarios was simulated for the case project used in constructing the project model, the conclusions were that it was difficult, if not impossible, to find win-win situations for both the state and the private investors. The scenario analysis included scenarios for

- different levels of traffic growth
- different pricing scenarios, i.e. level of shadow tolls paid by the state to the concessionaire (company commissioned to finance, build and operate)
- a higher PPP efficiency by lowering the comparator estimates for construction and operating costs
- different capital structures for the project company, i.e. different weighting in the levels of equity and debt capital invested in the project company.

It was found that traffic growth was crucial in generating cash flows. This is not surprising, since the unit of payment was a vehicle kilometre of travel. Changing the unit price for the shadow toll also played an important role in the project's financial outcome. The project company's capital structure had only minor, if any, impact on the project's net present value for the investors and the state. Cost scenarios regarding the construction of the road, and assuming that PPP may have efficiency impacts resulting in lower construction cost, indicated a moderate impact on investors' (state and private) returns.

[7] The state was paying a 'shadow toll' to the project company for each vehicle kilometre of travel. The road users paid no tolls.

3.2 PPP as a Business Ecosystem Model

The project model cash flows can be allocated in an ecosystem matrix that is generic for any type of infrastructure PPP. The business ecosystem model simply distinguishes the actors or stakeholders and allocates the payments between actors (for each 'debit', there is also a 'credit') so that the cash flows become apparent for each actor. The matrix indicates that it is fairly straightforward to calculate each stakeholder's net financial position, column by column.

Two additional items are added to the project financial model, representing the non-cash items that are often relevant in socio-economic cost-benefit analysis:

Ben = Benefits accrued to the users in socio-economic cost-benefit analysis (CBA)

Ext = External costs related to the project, included in the CBA

The benefits and external costs generated by the project can usually be monetised according to standard cost-benefit analysis (CBA). The problem may be that an agreed standard does not exist for some services. For example, there are some non-cash items such as meteorological services which are regarded as highly beneficial for society and users of services, including both private citizens and organisations, but their benefits have only recently been studied seriously (see e.g. Leviäkangas 2009; Leviäkangas and Hautala 2009).

Furthermore, what is typical for these types of PPP projects is that some of them involve the direct collection of revenues based on the users of the service and possibly also on the public client – here it is referred to as 'the state', but it could be any public agent working on behalf of the community and/or society. It is an inescapable fact that without these hard cash revenues from end users and/or the public sector any PPP is impossible to implement and the business case for private investment is missing.

The rules to satisfy the economic rationales for different stakeholders follow. The shareholders of the project company must receive enough cash flow in order to cover their initial equity capital investment plus the interest they have placed on their equity:

$$(1 - T_c)(Rev - C) + T_c Dep + T_c iD - E > 1$$
$$\Leftrightarrow (1 - T_c)(Rev - C) + T_c Dep + T_c iD > E \Leftrightarrow FCF > E \qquad (8)$$

This states simply that after-tax net cash in present value terms (discounted by required return on equity) after all costs in the project, and after interest and depreciation tax benefits (because these are tax deductible) must be greater than the initial equity placement.

Table 4. PPP Project Ecosystem Financial Model

Debt investors	Equity investors	Project company	Users	The state	Contractors& suppliers	Notes & explanations
	$-E$	$+E$				Equity investors invest E in the project company
$-D$		$+D$				Debt investors invest D
		$-C$			$+C$	Project company constructs the facility and pays to the contractors Cn
		$+Rev+Sub$	$-Rev$	$-Sub$		Project company receives revenues from the state or from the users
		$-Ope$			$+Ope$	Project company pays contractors for operating and suppliers for deliveries (e.g. maintenance & equipment)
$+iD$		$-iD$				Project company pays interest on debt
$+A$		$-A$				Project company amortises the debt
		$-Tax$		$+Tax$		Corporate taxes after expenses, depreciation and interest (assuming that Sub is tax liable)
			$+Ben-Ext$			The state accounts for benefits of users and third parties, i.e. the external benefits, as well as external costs
Σ	Σ	Σ	Σ	Σ	Σ	
$-D+iD+A$ $=TCF_D$		$E+D-C+Rev+Sub-Ope-iD-A-Tax$ $=E+[Rev+Sub-C-Ope-Tax]+[D-iD-A]$	$Ben-Rev$	$Tax-Sub-Ext$	$C+Ope$	The surplus cash flow available for share and debt holders, paid by the project company; payments to suppliers and contractors; benefits and costs for users and public sector client (society)
	$=-E+E+FCF-TCF_D = FCF-TCF_D$		$Ben+Tax-Rev-Sub-Ext$			
$TCF_D + FCF - TCF_D = FCF = V_P$						Market value of the project equals free cash flow available for investors

In fixed period concessions, the project company is left in the end with empty pockets and liquidated after it has fulfilled its task of delivering the service. When the project company is expected to continue its existence over an indefinite period of time, the shareholders must consider the liquidity position of the company and other long-term obligations, such as pensions and re-investments.

For debt investors the rule is equally simple: the debt allowed to the project company must be paid back in full with required interest. Hence the interest and amortisation cash flow in present value terms, discounted with required return of the debt holders, must exceed initial debt outlay:

$$iD + A - D > 0 \Leftrightarrow iD + A > D \qquad (9)$$

For suppliers and subcontractors, the case of a project's profitability is of secondary importance as long as their contracts with the project company are economically worthwhile and their receivables reasonably guaranteed.

The conclusions of the ecosystem model imply that few infrastructure PPPs can in fact be purely market and user driven in terms of their finances. There is always at least the connecting infrastructures that must entail some sort of public engagement in the form of co-financing or subsidies, since the market-based demand for these elements, which generate indirect benefits, just might not exist. Also, there is an apparent need to consider the willingness of other ecosystem actors to pay for or participate in the investment. Typically, for example, the road hauling industry benefits from road investments and its willingness to pay for some investments could be higher than private car users and bus service operators, but in many cases when real tolls are collected the heavy-goods vehicles already pay a higher toll.

Different behavioural patterns of the investors result in different preferences for the time value of money and risks that will be reflected by the required returns (discounting rates) of different ecosystem actors. With the help of the ecosystem model, the actors are able to better position themselves regarding the project and understand the preferences of other actors.

3.3 The Market Model

The market is modelled as 'layers' that robustly present the value chain from institutional planning of the infrastructure to execution and operation of the project asset (Leviäkangas et al. 2015). Regulations and standards set the base for any infrastructure design and how it is (or should be) processed if steps are taken towards implementation and realisation. In a PPP context, the capital market offers the financing resources for the infrastructure. If the design is processed without major problems - making necessary decisions and commitments on political and administrative levels – and the project enterprise is also able to raise enough capital from the investors the process takes steps to engineering design, procurement and the actual commencement of the project. Once completed, the project asset starts to serve the consumer, industries and those service providers that operate the infrastructure or provide services on the infrastructure, such as transport and logistics operators. These layers as well as the functions within each layer are presented in Table 5.

The sample data from Finland consisted of 30 infrastructure-related companies and utilities, some of which can be regarded as pure operators (e.g. the national railway company), some as infrastructure owners (electric main grid) and some as utilities (power supplying and infrastructure companies). A municipality or state-owned enterprise (MOE, SOE) is a special-type of entity that is under municipality or state government control, but not subject to corporate legislation or taxation. A municipality or state-owned company (MOC, SOC) is a standard limited liability (ltd.) company that is subject to corporate regulation and taxation. A private company (P) is a privately owned limited company.

Table 5. Market contexts of an infrastructure PPP

Market 'layers'	**Functions**
End user market (commodities market)	Consumption and use of produce (goods and services)
Infrastructure user market	Use of infrastructure, services ON the infrastructure (e.g. logistics services, public transport, smart mobility services, etc.)
Infrastructure services & infrastructure supply	Management & operating of infrastructure; services FOR the infrastructure (e.g. design, maintenance, etc.); construction
The infrastructure layer	
Capital market	Supply of capital
Regulatory and administrative system; the society	Administrative processes, project appraisal, policies and public and global interests

The conclusions drawn on the basis of the market model and financial analysis performed on the sample companies and enterprises imply if PPPs are needed to ensure adequate infrastructure development and level of infrastructure investment, there is a need to widen the scope from a project-level perspective to view the market layers in their entirety. Put simply, this would mean that considering PPP-type of arrangements for market layers, for example, for entire networks or entire service segments, rather than considering only 'bits' of infrastructures, might be an option in some cases. The revenue and return-making potential is evident as was shown particularly in the cases of energy networks and ports (Leviäkangas et al. 2015). The returns provided by the different infrastructures and utilities to their owners were immune to market return movements, meaning that the volatility risk of returns was very low, and risk-adjusted returns were higher than the risk-return trade-off would suggest. Especially the municipal owners of ports, water supply utilities (including the distribution infrastructure) and energy utilities received high returns. This implies the high return potential of infrastructures and the investors' interest in them.

3.4 The Integrated Model

The integrated model brings the market, project, and ecosystem models into a single framework that can be described as a financial and economic system model. It is a mix of several model types: a construct, an analytical approach, and a descriptive model. None of these model characteristics is dominating, however.

The integrated model is shown in Table 5. Market layers, ecosystem actors and the flows of cash, benefits, and costs are allocated to the model in a manner identical to the ecosystem model. It makes it possible to simultaneously view how the project serves or impacts the different market layers and functions beyond simply viewing the ecosystem actors. For clarity, one new parameter is added to the model: *Ser* denotes the service revenues collected by providers and operators from users (as in the case of passenger and freight fees of railway operators). These cash flows are usually the focus when, for example, the transport market is considered. The transport market is treated as a market where consumption of transport services are demanded and supplied. Depending on the type of PPP arrangement in question, these markets may or may not be included in the arrangement. If they are, they may play a significant role in the PPP, and hence they must be recognised.

In the integrated model the upper level flows can be seen as market transactions, namely the capital supply, and transactions between contractors and suppliers and the SPV, whereas the lower level flows often comprise a complicated set of investments. Thus, the state must simultaneously consider multiple issues, such as the need for subventions and how the critical elements of socio-economic benefits and externalities are distributed within the community, economy and society.

$Ben = Ben' + Ben'' + Ben'''$ and $Rev = Rev' + Rev'' + Rev'''$ denote the distribution of benefits and revenues between the ecosystem actors.

Table 6. The integrated PPP model

ECOSYSTEM ACTORS								
Society	The State, Fiscal Government	Debt investors	Equity investors	Project company	Contractors and suppliers	Operators and producers	Users	Consumers, industries
		-D	*-E*	*+E+D*				
		+A+iD		*-A-iD*				
				-C	*+C*			
				-Ope	*+Ope*			
	-Rev'			*+Rev*		*-Rev''*	*-Rev'''*	
	-Sub			*+Sub*				
	+Tax			*-Tax*		*+Ser*	*-Ser*	
+Ben'							*+Ben''*	*+Ben'''*
-Ext								
Regulatory system, policy		Capital market		PPP market	Infrastructure supply & services	Infrastructure users		End user market
MARKET LAYERS, FUNCTIONS								

4 IMPLICATIONS

4.1 Implications for practice

Public-private partnerships continue to be on the agenda of practically all governments across the globe. However, the debate on the ability of PPPs to solve long-term financing gaps of infrastructure is very keenly debated. This research falls in the very midst of both academic and political debate.

From a practical perspective, this research contributes to decision-making processes when considerations on capital projects and their financing are undertaken. From a theoretical angle, the proposed models contribute as such to the evaluation of PPP projects and the assessment of societal benefits these projects are meant to deliver. The models can also be used by practitioners as tools to aid with decision-making. The basic frameworks of the project, ecosystem, market and integrated models apply to virtually any type of PPP project or investment, provided that the analyst has the skill and ability to tailor the frameworks for the project at hand, and that the decision-maker has an equal capacity to critically evaluate the analysis.

The model construct, in fact, resembles an input-output matrix with the difference that input-output matrices represent the sale and purchase of goods and services within the context of an entire economy or region, whereas the derived construct shows transactions and value added within the context of an infrastructure PPP project. The developed construct is novel and has not been introduced in its current form before, except for the articles compiling the model from elements into the integrated model.

Perhaps the most significant contribution to the practice can be described as increasing PPPs' transparency. With the proposed framework and integrated model any PPP can be transparently described, not only using prose and qualitative and subjective assessments, but in a fully analytical and non-biased manner. PPPs can

thus become more than just 'value for money': they become – or at least they can potentially be regarded as – non-ideological and de-politicised investment decisions that can be rational rather than emotional. Also, the distributional effects, costs and gains, are better understood across the PPP ecosystem.

Figure 7 shows where in the project cycle the integrated model provides assistance in assessing the feasibility of the PPP. First, the economic and financial pre-analysis that is needed in the project screening and identification phase can make use of the model by having the initial perception on the distributional effects of the project and understanding the context and potential impacts on the ecosystem. The model also serves as the economic and financial flows start to get quantified in the feasibility analysis phase. The technical scoping will also have implications on financing and economics and from thereon on ecosystem's actors. Second, as this understanding is increased and in the best case quantified, the negotiations can be carried on a better informed basis and with better perception on different stakeholders' interests and priorities. In short, the model serves as an information and transparency platform that is able to put stakeholders' positions on the table in an objective manner.

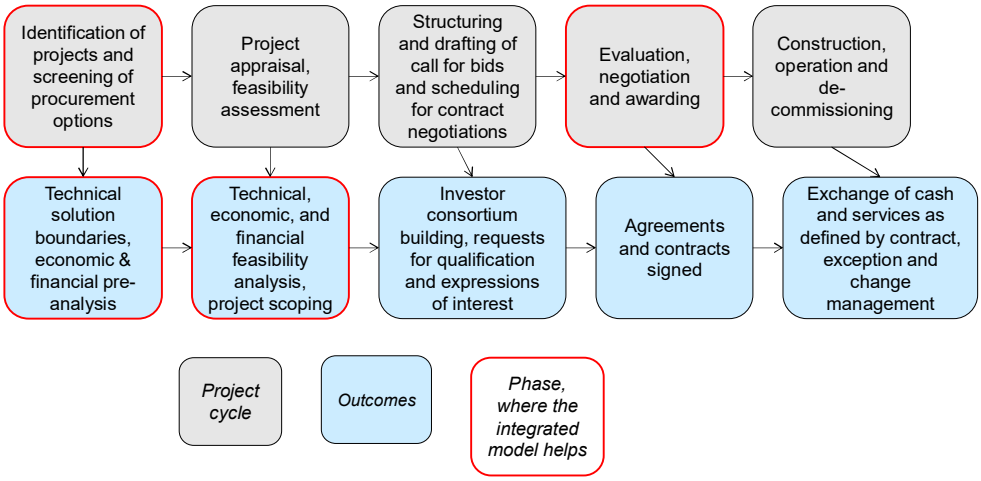

Figure 7. Practical contribution of the integrated model

4.2 The theoretical implications

Assuming that the integrated PPP model incorporates the multiple aspects different stakeholders must or should consider in order to evaluate PPPs from a private investment, public good investment or any other perspective, the explicit conclusion is that decision-makers follow the behavioural patterns recognised in the stakeholder theory. Stakeholder theory assumes essentially that business and ethics must work together in the minds of managers, and that the managers must be able to translate the objectives of their businesses to be congruent with other values prevailing in the surrounding society (Freeman et al. 2004). The managerial behaviour according to the stakeholder model may contradict the assumed behavioural models of the stewardship theory, in the latter of which the ultimate goal of managers is the maximisation of shareholders' wealth. This way, the steward (manager) becomes the agent of the principal (shareholder). The maximisation of shareholders' wealth has been one of the dominant paradigms in management science for many decades (see, for example, Ross 1973, Jensen & Meckling 1976).

It is evident that on the brink (or in the middle) of climate change, resource scarcity, and over-population, any investment decisions need to take into account wider societal and environmental implications. The integrated PPP model proves that without these wider considerations the chances of creating successful PPPs may be reduced. Concentrating only on investors' wealth (i.e. private returns) will not create the infrastructures societies and people need – nor will the corporate sectors and different markets be served adequately if the investment does not work for all the market layers impacted by the investment. It appears as if the whole appraisal and analysis of PPPs draws similar conclusions, as has been the case in the debate between theorists of the firm and researchers of the behavioural patterns of managers of those firms. Indeed, there are wider and more extensive interests to be taken into account by those managers and investors who engage themselves with PPPs, if they wish to be successful in their business.

The doctrines often associated with PPPs – greater efficiency, more innovation, better value for money, etc. – may be partly true, but it seems that these benefits have more to do with the institutional context of the project and managerial skills within the ecosystem surrounding the project, as suggested by the BENEFIT project that

studied several PPPs across Europe (Roumboutsos et al. 2016). BENEFIT was a major European research effort to assess critical factors affecting infrastructure project delivery performance. It analysed 55 PPP projects and 32 traditionally public financed projects. The research was rich in empirical data and application of different analysis methods, and hence its findings can be regarded significant. Apart from identifying institutional factors, project characteristics and competences as relevant factors for project success than methods of procurement or sources of financing, BENEFIT also concluded that no single factor combinations as such could be found to determine projects' successful outcomes.

The entrepreneurial approach and action alone may not be enough to accomplish all the good sides of a PPP project. However, the doctrine could possibly work if the shared goals were there and the common good was adequately recognised. Essentially the conclusions support the stakeholder theory while at the same time the doctrine of shareholder value maximisation is challenged as a means to ensure long-term sustainability in the economy (Lazonick & O'Sullivan 2000; Stout 2012).

The integrated model suggests that if the stakeholders within the ecosystem strictly focus on their own interests instead of understanding the entire ecosystem and the interests of all stakeholders, it is harder to introduce, recognise and acknowledge beneficial spill-overs, be they novel technicalities, less time in construction improving overall efficiency, better environmental sustainability, or cost savings in general.

4.3 Methodological implications

Methodological techniques from which the integrated model has been derived include asset pricing (value of a single-project company), cost-benefit analysis (the ecosystem calculus and the integrated model) and market modelling in the value adding process of the infrastructure development. These techniques were all necessary in order to assess how different stakeholders view the project and which of their interests would be represented when infrastructure PPPs are planned and implemented. The outcome of the research process indicates also that no single method or technique is adequate if a holistic, wider perception of the PPP is pursued.

This was demonstrated also by BENEFIT project when using a larger sample of projects and multiple analysis methods (Roumboutsos et al. 2016). Equally so, if the abovementioned methods and techniques are used in isolation to defend the views of a limited stakeholder segment, the acceptability of the project may well be questionable in the eyes of the other stakeholders.

As the valuation and assessment techniques vary for different purposes and different stakeholders, so do the basic parameters affecting the subjective value. This is mostly evident in the discounting rate that can be different for the same cash or economic flows. For example, the revenues received by the project company and paid by the state or by the users may be discounted at different rates depending on who is doing the discounting. Investors, state officials, users, suppliers and service providers all have their own unique risk premium and time value for money, benefits and costs. If the integrated model's equilibrium, where all stakeholders are reasonably satisfied, does not work, then the project is likely to encounter criticism or even difficulties. It is noteworthy that the magnitude of returns is not perhaps the key question, but rather the distributional effects within the ecosystem. If this is the conclusion, then there are many other interests to be considered than just those of the shareholders or investors or even the public client authorities.

The integrated model utilises mainly traditional discounted cash flow and benefit-cost analysis as a first-choice valuation technique. However, the model does not exclude the use of more refined valuation techniques, such as multi-criteria analysis (e.g. Korhonen et al. 1992) or real option analysis (Trigeorgis 1993; Amran & Howe 2003), both of which have a vast number of alternatives. In fact, the integrated model should make the application of more refined methods easier when interpreting the outputs of the analyses.

4.4 Postulating on the basis of findings

The constructive and inductive process based on the four subsequent models of public—private partnership projects result in the postulates presented in Table 6. Without postulating, the modelling process would not allow further empirical testing which is always needed for any derived model, if its validation is seen necessary.

For practical testing of the model, it is possible to use either simulation or testing with real-world projects and data.

Table 7. Postulates derived from findings

	Postulate	Based on the finding and rational
P1	PPPs revenue logic should rely mainly on market-based funding (i.e. direct revenues from the users and beneficiaries of the facility or project)	When revenue logic of the PPP is based on public-source funds, the win-win situation for public and private investor is hard to find (Articles 1 and 2). The pay-back for the investment through private investment and privately financed SPV leads to higher or only marginally lower life-cycle cost; this is due to appropriate risk pricing of the private sector and high project-specific transaction costs.
P2	Project-form PPPs are risky with respect to their economic and financial sustainability due to many potential and complex spill-over effects	PPPs are usually within the public domain, and yet they partly follow private investment logic that may not be in congruence with interfacing market layers (Articles 3 and 4). The PPPs are not isolated investments but projects in a network and/or market system, where different parts of the system are in dynamic interaction.
P3	PPPs must be considered also as ecosystems, where the stakeholders are actors in the ecosystem with sometimes conflicting and sometimes coinciding interests	PPPs share the conceptual features of a business ecosystem (Article 2). PPPs engage multiple actors involved in the project, in the forming of the special purpose vehicle, and finally as users and stakeholders influenced by the spill-overs.

P4	It is more logical to draw market layer specific policies than PPP policies	Infrastructures are logically networks or connected nodes and there are likely to be wider effects for any project or investment (Article 4). The market will be probably more efficient when, for example, a network comprises uniform market characteristics across the network rather than a set of varyingly constructed PPPs and SPVs.

5 CONCLUSION

5.1 Summary of findings

The project model was built on a real-world empirical case, the first PPP project in Finland, and it applied traditional cash flow analysis and asset pricing methods to assess and verify the model (Leviäkangas et al. 2013). The Capital Asset Pricing Model (CAPM) was applied in the determination of the risk-adjusted discounting rates of the project cash and economic flows. When a shadow toll scenario combined with different revenue, cost and pricing scenarios were simulated for the case project used in constructing the project model, the conclusions were that it was difficult, if not impossible, to find win-win situations for both the state and the private investors.

Reducing the project analysis scope to two main ecosystem actor groups – the state and the investors – it was possible to see that it was challenging to find a win-win- space for these groups. Implicitly, the result pointed in the direction of the urge to have a more holistic, wider PPP project appraisal framework in place, where the different actors within the PPP business ecosystem are included.

The next step in the inductive and constructive model building process was to include the aforementioned ecosystem actors, and an upgraded, more holistic model was introduced in Leviäkangas et al. (2015). The conclusions regarding the ecosystem model suggest that few infrastructure PPPs can in fact be purely market and user driven in terms of their finances. There are probably always interfaces of some nature that call for some level of public engagement in the form of co-financing or subsidies. The ecosystem model further suggests there is an apparent need to consider other ecosystem actors' willingness to pay for or participate in the investment.

Different characteristics and patterns in investor behaviour affect the investors' preferences for the time value of money and risks. These, in turn, will be reflected in the required returns (discounting rates, but also the nature of returns that may be

non-monetary) of different ecosystem actors. With the help of the ecosystem model, the actors are able to better position themselves regarding the project and understand other actors' preferences.

The conclusions presented on the basis of the market model suggest that while PPPs may be needed to ensure active enough infrastructure development and level of infrastructure investment, there is a need to widen the scope from a project-level perspective to view the market layers in their entirety. In other words PPP-type arrangements could be considered for entire market layers; for entire networks or entire service segments, rather than considering only 'bits' of infrastructures, such as single stretches of roads or rails. The Finnish data suggests that there is a good revenue and return making potential, particularly in energy networks and ports (Leviäkangas et al. 2015).

The integrated model tied up all the previous models into an integrated framework, with on one side, the market transactions (capital supply and transactions between contractors and suppliers and the project company), and on the other, the external-type of benefits and cost, contribute to the wealth and well-being of the PPP project ecosystem. Those ecosystem actors, that by the definition of their roles must take these complex distributional effects into account, are assisted by the application of the integrated model. At least that is one of the main aims of this research. Such frameworks have not yet been publicly available.

5.2 Further research prospects identified

The first obvious research need is the validation of the integrated model by using real-world data or simulated data. The latter option should probably be attempted first since real-world PPP contracts in their final forms are quite extensive and heavy documents which contain a number of detailed clauses that have financial or economic implications. Using simulations, it would be straightforward enough to assess whether the model provides meaningful and usable results for initial decision-making. The model is unlikely to work for very detailed analysis unless it is tailored for that purpose and developed further. The second natural step would be to use real-world projects in their initial stages for validity testing.

Further research would also be needed to set up PPP policies, strategies, guidelines and standards if the integrated model seems to contribute to the analysis and appraisal of PPPs. So far the recommendations and guidelines – political, strategic and technical – are at a very general level and give limited practical tools for decision-making and project selection. Combining the integrated model and benefit-cost appraisal could be a fruitful attempt to support decision-making, or even to construct some decision support tools. There is no immediate conflict between the traditional benefit-cost analysis and the suggested integrated PPP model (nor the sub-models), hence supplementing traditional benefit-cost analysis can be a potential application option for the integrated model.

From the purely technical side of analysis, the use of different discounting rates for ecosystem stakeholders and different mixes of financial flows and non-financial flows (e.g. externalities) would be interesting to see how different project attributes and characteristics contribute to the decision-making of the stakeholders. Identifying most potential conflicts of interest and more importantly, the potential congruence between stakeholders' objectives regarding the projects, would be relevant information for public sector decision-makers, investors and civil society stakeholders whose voices need to be equally heard. These more technical analyses would possibly be significant in the search for congruence of stakeholder objectives in PPP projects.

Finally, the developed models – on PPP projects, ecosystems, market layers and the integrated model - have been constructed utilising some empirical contexts of transport infrastructures. For a wider application across other areas, such as energy, utilities, and even some services (e.g. healthcare), further research would be needed. The *a priori* assumption is that the models work at least for other infrastructures apart from transport, but this would need to be tested and validated.

PPPs are a product of their time, when governments have adopted new doctrines regarding how to provide public services, rearrange public assets and assume new ways of thinking and *modus operandi*. Therefore, PPPs and different manifestations related to them are not permanent, but follow the developments of the surrounding society in which they appear.

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This thesis provides an integrated and holistic view on public-private partnership projects in terms of their distributional effects within the entire PPP ecosystem context. The result presented is an analytical framework: an integrated model that can be used as a 'debate platform' by the actors within the PPP ecosystem, so that the prerequisites to find where sharing of goals and risks make sense, and to bring fairness to the entire PPP project lifecycle. PPP projects are in fact business ecosystems that interact with the surrounding society and markets in a variety of ways.

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