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Dynamics of Organisational Capability of Japanese Construction Firm towards Open and Service Innovation through PPP/PFI arrangement

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FOREWORD by EDITOR-in-CHIEF

We are very pleased to inform the readers that Journal of *Science, Technology, & Innovation Policy and Management* (STIPM Journal) Vol. 5, No. 1, July, 2020 is now ready for public reading and views.

STIPM Journal is an online research journal managed by the Research Center for Science, Technology, Innovation Policy and Management, Indonesian Institute of Sciences (P2KMI-LIPI). This journal in fact provides scientific information needed mostly by the research scholars. As a peer reviewed journal, STIPM provides free access to research thoughts, innovation, and original discoveries.

In this edition, the STIPM Journal contains six articles dealing with science, technology and innovation policy and management written by scholars from Japan and Indonesia.

The first article, entitled *Dynamics of Organisational Capability of Japanese Construction Firm towards Open and Service Innovation through PPP/PFI arrangement* was written by **Taeko Suehiro**, **Kumiko Miyazaki**. This study examines the influence of Public-Private Partnership (PPP)—or, more specifically, Private Finance Initiative (PFI)— arrangements in relation to open and service innovation in construction firms in Japan.

Second article was composed by **Pratiwi**, entitled *The Role of Local Community Associations as Intermediaries: A Multiple Case Study in a Rural Area.* This study investigates the role, capabilities, and the outcome of the engagement of local community associations as intermediaries in different sectors such as agriculture, food processing, and tourism product. This study describes the way innovation promotes rural development.

Erman Aminullah et al., present the third article, *Policy Role in Innovation Network: Case of Indonesian Food Processing Firms.* The objective of the study is to reveal internal and external factors that affect the use of network relations for innovation, with a focus on mapping the policy role in innovation networks. The study was undertaken through case analysis in four different firms in Indonesia.

The fourth article entitled *Potentials of Research Activities in Medicines at the Indonesian Institute of Sciences (LIPI)* was by **Hadi Kardoyo et al**. This article reveals the findings of research priority setting (RPS) in the field of medicine and health at the Indonesian Institute of Sciences (LIPI) in 2017. The RPS stage had been conducted with the Delphi Method and produced five major issues.

Next article entitled *What We Learn from Innovation Failure: A Review of Clean Water Postpaid Service in Remote Island Indonesia Using Sea Water Reverse Osmosis (SWRO) Technology* was presented by **Rendi Febrianda and Nur Laili**. Final article was compiled by **Syukri Yusuf Nasution and Yovita Isnasari** with the title *Valuation IP of Nano Technology to Make a Nano Tea Based on Mangosteen Peel as a New Product Development.* This article analyses the potential of nano technology in developing new

product, such as how much the potential of the turn over if the technology is used to produce a nano tea based on mangosteen peel, how much the royalty rate, and how is the positioning of the technology in in relation with legal aspects, technological readiness, market condition and finance.

In addition to all articles presented in this volume, we also would like to thank the authors, editors, and reviewers who have worked very hard in this edition. We hope that all articles featured in this edition are useful for the readers.

Jakarta, 16 July 2020

Editor-In-Chief

JOURNAL OF STI POLICY AND MANAGEMENT

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Dynamics of Organisational Capability of Japanese Construction Firm towards Open and Service Innovation through PPP/PFI arrangement

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ABSTRACT

This study examines the influence of Public–Private Partnership (PPP)—or more specifically, Private Finance Initiative (PFI)—arrangements in relation to open and service innovation in construction firms in Japan. The expectation of the PPP/PFI procurement arrangement is that Japanese construction firms will provide a broader range of services (service innovation) through expanded cooperation with various other firms (open innovation) compared to the conventional procurement scheme.

Our in-depth case study of a Japanese construction company shows the dynamics of project-based firms' capability accumulation through a PPP/PFI arrangement. The study identified a model of capability development for construction firms towards service and open innovation. It consists of three organisational capabilities: technological capabilities, project capabilities and collaborative capabilities. The model can be seen as an ideal approach for understanding and comparing cases of long-term capability accumulation of project-based firms, especially regarding provision of services that meet the public's needs.

I. INTRODUCTION

The Japanese government has increasingly required Public–Private Partnership (PPP) and Private Finance Initiative (PFI) arrangements for procuring and managing public infrastructure, such as airports, public facilities (e.g. government offices, schools and public housing) and waste treatment facilities, owing to pressure to reduce the financial burden of central and municipal governments. In 2013, the Cabinet Office set a goal for introducing PPP/PFI projects (from 2013 to 2022) totalling JPY 12 trillion, which was almost twice the amount set in 2013 (Japan

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Cabinet Office, 2013 and 2018). Guidelines for prioritising the introduction of various PPP/PFI arrangements were introduced in 2015 (Japan Cabinet Office, 2015). These guidelines recommended that local governments, which represent populations of more than 200,000, consider utilising PPP/PFI to build and operate public facilities.

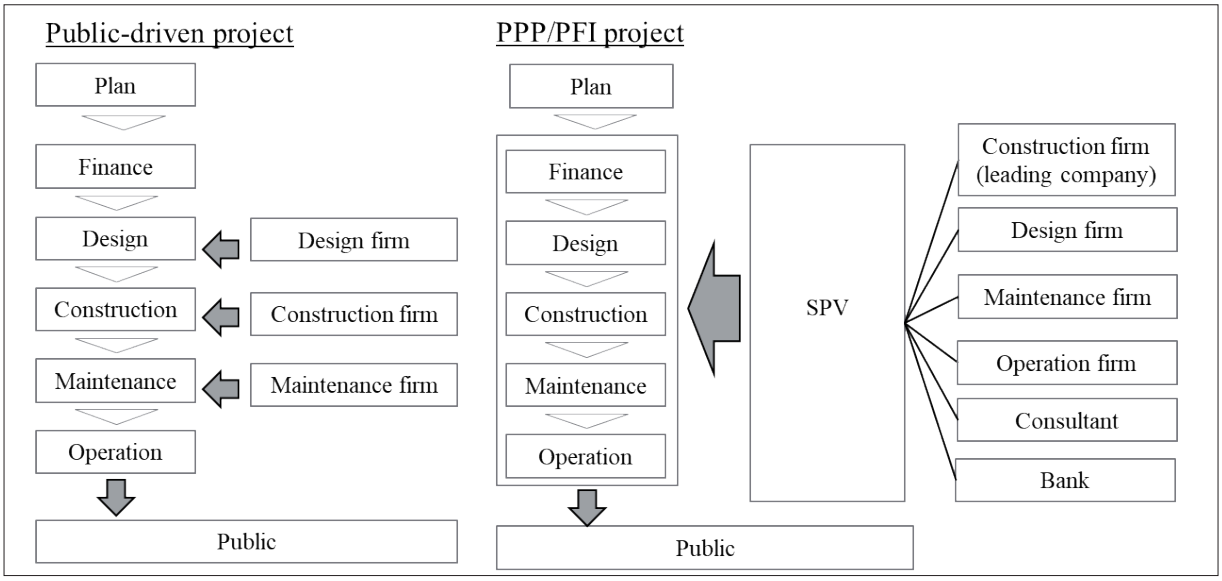
PPP is loosely defined as cooperative institutional arrangements between public and private-sector actors. PFI is a type of PPP collaboration that is based on long-term infrastructure contracts led by private actors. PFI was first introduced in the United Kingdom in 1992 and in Japan in 1999 to harness the management skills and commercial expertise of the private sector and bring discipline to the delivery of public infrastructure (The United Kingdom, HM Treasury, 2012). PFI-type PPPs involve many forms of contractual arrangements, such as Build-Own-Transfer (BOT), Build-Transfer-Operate (BTO) and Build-Own-Operate (BOO) (for more details, see Savas, 2000).

In this study, however, the researchers simply define PPP/PFI as a 'project that generally involves the design, construction, financing, and maintenance and operation of public infrastructure or a public facility by the private sector under a long-term contract' (Campbell, 2001). In addition, PFI is distinct from the Design-Build-Operate (DBO) type of PPP, which is financed by the public sector.

PPP/PFI arrangements foster the involvement of private companies, such as construction companies, in roles conventionally assumed by public authorities, such as investment, project management and operation, and maintenance service management. Such PPP/PFI arrangements are expected to improve public service quality and reduce costs. As shown in Figure 1, PPP/PFI projects include a wide range of services from private firms based on long-term contracts.

In conventional public projects, the public sector manages the entire life cycle of the public facilities, including planning, design, finance, construction, operation and maintenance. Private firms are partly involved at some stage in this life cycle, such as design, construction and maintenance, separately. Once construction companies have completed their work and have passed the final inspection stage, they will usually only take minimal responsibility for the facility in question. Although some maintenance and operation works are outsourced to private firms, the roles of private contractors are generally strictly assigned according to the specifications of the arrangement.

On the contrary, in PPP/PFI projects, the service-related life cycle of public facilities is included in a long-term PPP/PFI contract, such as design, finance, construction, operation and maintenance. A long-term commitment to a



Source: Author's modification based on Japan Cabinet Office (2014)

Figure 1. Difference in the Scope of a Public-Driven Project and a PPP/PFI Project

PPP/PFI contract based on output procurement encourages private companies to undertake innovative actions towards improving the life of the infrastructure project. Furthermore, PPP/PFI projects have forced suppliers—in many cases, construction companies—to set up Special Purpose Vehicles (SPVs). These act as key coordinating agencies, taking on financial, design and operational responsibilities for the public facilities. Figure 1 shows the difference in the scope of a public-driven project and a PPP/PFI project.

From the innovation studies perspective, construction firms need to foster both service and open innovation to bring about the institutional changes required for PPP/PFI arrangements. In terms of service innovation, since the scope of PPP/PFI projects is much wider than that of conventional construction projects (Japan Cabinet Office, 2014), the role of a construction firm as a leading company in a consortium is normally wider too. To undertake these PPP/PFI projects, construction firms must conduct open innovation by collaborating with other companies, such as design and maintenance firms, to deliver a wide range of services through SPVs (Japan Cabinet Office, 2014). This research defines open innovation as the firm conducts innovation in collaboration with other firms, not just technological activities of a particular firm doing technical projects with other firms.

However, studies on the effects of PPP/PFI arrangements have mainly focused on evaluating projects—that is, determining whether PPP/PFI is effective for providing public services, which depends on the project (Hodge and Greve, 2007; The United Kingdom, Treasury Committee, 2011). Although some studies have focused on the capability development of construction firms through PPP/PFI arrangements, most of these studies have also conducted short-term and project-based analyses (e.g. London Heathrow Terminal5 project (Davies and Brady, 2016; Davies, Dogson, & Brady, 2016) and the London Olympics (Worsnop, Miraglia, & Davues, 2016)). There is still little understanding of the long-term dynamics of capabilities evolution of a project-based firm itself and the partner-companies influence in the business eco-system.

Davies and Brady (2016) defined project capability, which is distinguished from the dynamic capability of a project-based organisation. There are various ways for a project-based firm to accumulate capabilities, such as through project-to-project learning or within groups of firms in the business ecosystem. This paper highlights bringing project capabilities from outside firm as collaborative capability to examine the capability for open innovation more clearly.

The purpose of the present study is to examine the evolution of Japanese construction firms' organisational capability to provide a broader range of services (service innovation) through expanded cooperation with various other firms (open innovation) under the PPP/PFI procurement arrangement.

The study was aimed at filling the aforementioned knowledge gaps by addressing the following questions:

- (RQ.1) How have construction firms' project and technological capabilities evolved to provide PPP/PFI services for the public sector?
- (RQ.2) How has the collaboration between construction firms and other firms changed through the PPP/PFI arrangement?

To address these questions, we conducted an in-depth case study of a Japanese construction company (Company A) which is one of the most experienced companies in the field of waste management PPP/PFI projects. This research analysed Company A's capability accumulation based on the tendering information of 43 PPP/PFI projects from 2002 to 2018 and patent data from 1996 to 2018. The authors interviewed nine people who have experience of PPP/PFI project including two members of the PPP/PFI department of waste-to-energy in Company A. As such, this research focused on the dynamics of the capability accumulation of this project-based firm through PPP/PFI arrangements.

From the point of view of capability development through government's strategic procurement, Suehiro and Miyazaki (2019) found that governments' capability development through the PPP/PFI arrangements can create space for

private companies to provide better service by accumulating tacit knowledge within the projects.

This study analyses the construction firms' capability accumulation in terms of open and service innovation when entering a long-term PPP/PFI arrangement. Based on previous research related to open and service innovation through PPP/PFI arrangements, this research focuses on three capabilities in a construction firm: project capability, collaborative capability and technological capability.

Consequently, this research proposes a model of capability development towards service and open innovation consisting of three particular organisational capabilities: technological capabilities, project capabilities and collaborative capabilities in the case of a construction firm which is a key actor in PPP/PFI. The model can be seen as ideal for understanding and comparing cases of long-term capability accumulation of project-based firms, especially with regard to providing services that meet the public's needs.

This paper is structured as follows. In Section 2, this paper introduces the theoretical framework explaining construction firms' organisational capability towards open and service innovation through PPP/PFI arrangements. Section 3 outlines the methodology of this research. The key findings are presented in Section 4. This is followed by a discussion in Section 5. Finally, the authors conclude with directions for future research in Section 6.

II. ORGANISATIONAL CAPABILITY DEVELOPMENT THROUGH PPP/PFI

2.1 Evaluation of PPP/PFI Projects

Although PPP/PFI arrangements have been introduced in many social infrastructure projects in Japan and other countries, both researchers and governments have pointed out that the benefits of PPP/PFI are still subject to debate, and the evaluation of PPP/PFI has delivered contradictory evidence as to its real effectiveness (Hodge and Greve, 2007; The United Kingdom, HM Treasury, 2012; The United Kingdom, National Audit Office, 2018).

Hall (1998) suggested that the early PFI projects in the UK had achieved significant savings overall for road projects and two prison contracts that generated about 10% savings compared to publicly financed prisons. Similarly, the analysis of 29 business cases conducted by Anderson and Enterprise LSE (2000) identified 17% cost savings. Moreover, recent reports from Mott-Macdonald (2002) and The United Kingdom, National Audit Office (2003) identify PPPs as delivering on time and on budget far more often than traditional procurements.

Conversely, The United Kingdom, Treasury Committee (2011) presented evidence that out-turn costs of construction and service provision are broadly similar between PPP/PFI and traditionally procured projects. Further, in terms of quality, according to the Royal Institute of Architects in the UK, the quality of buildings delivered through PFI-type PPPs in many cases has been lower than traditionally procured ones (The United Kingdom, Treasury Committee, 2011). Such poor design has caused various issues, such as rising maintenance costs. Furthermore, Boardman, Poschmann, and Vining (2005) presented evidence from five projects including transportation, water-supply and waste-disposal in the United States and argued that these represent a series of 'imperfect' partnership projects with high complexity, high asset specificity, a lack of public sector contract management skills and a tendency for governments to be unwilling to 'pull the plug' on projects once they are underway. As Hodge and Greve (2007) concluded, the value-for-money (VFM) benefits of PPP/PFI are still subject to debate because of their considerable uncertainty. Moreover, it is difficult to obtain clear evidence of this in the absence of an accurate and uncontroversial public sector comparator (Hall, 1998).

Studies on the effects of PPP/PFI have mainly focused on projects evaluation and, as in the cases of those examples above, have determined that the effectiveness of PPP/PFI for providing public services depends on the project (Hodge and Greve, 2007; The United Kingdom, House of Commons, Treasury Committee, 2011; The United Kingdom, HM Treasury, 2012; The United Kingdom, National Audit Office, 2018).

2.2 Evolution of Organisational Capability under the PPP/PFI Arrangement

Brady, Davies, and Gann (2005a; 2005b) studied the evolution of construction firms' organisational capability through PPP/PFI arrangements. They introduced the concept of integrated solutions which capture the combinations of products and services that address a customer's unique requirements throughout the life cycle of development and design to systems integration, operations and decommissioning.

Brady et al. (2005a) mentioned that PPP/PFI projects potentially provide a supportive climate for a collaborative way of working between the suppliers of design, construction, operation and maintenance services, and this may lead private actors to exploit opportunities for innovation by creating a virtuous circle of learning between different stages of the capital goods innovation process. To foster system integration under the PPP/PFI arrangement, Brady et al. (2005a) also mentioned that construction firms need four capabilities: system integration, operational service, business consulting and financing capabilities.

However, Brady et al. (2005a) concluded that the accumulation of these capabilities to provide innovation in PPP/PFI projects is limited. This is because few PPP/PFI projects had been conducted at the time and the repeatability of PPP/PFI projects had not yet emerged during the period under study, according to the research of Gann and Salter (2000). They also concluded that in the construction industry, the process of shifting towards integrated solutions is not easy and takes time. Thus, long-term research is needed to capture the capability-building towards more service-enhanced and integrated solutions in construction firms.

2.3 Capabilities of Construction Firms

Several studies have been conducted in firms as project the last 20 years on the capabilities of construction-based companies (e.g. Davies & Brady, 2000; Gann & Salter, 2000; Brady & Davies, 2004; Davies & Brady, 2016; Davies et al., 2016; Zerjav, Edkins, & Davies, 2018). Davies and Brady (2016) defined project capability, which is distinguished from the dynamic capability of a project-based organisation, as follows: 'The concept refers to the distinctive managerial knowledge, experience and skills, which are located within a single organisation (a firm) and which are required to establish, coordinate and execute projects'. However, as mentioned in the Introduction, most studies have focused on project-based analyses (e.g. London Heathrow Terminal5 project (Davies & Brady, 2016; Davies et al., 2016) and the London Olympics (Grabher & Thiel, 2015; Worsnop et al., 2016)). Therefore, there is still little understanding of the long-term dynamics of the evolution of project-based firms' capabilities. There are various ways for a project-based firm to accumulate capabilities, such as through project-to-project learning or within groups of firms in the business ecosystem.

Grabher and Thiel (2015) analysed the 2012 London Olympics to present how project capabilities are mobilised in complex projects. They found that the Olympic Delivery Authority had to mobilise specialised knowledge and project capabilities embedded in a network of firms and individual project professionals that brought their experience from previous projects. The present study underlines the importance of the wider ecosystem of project capabilities distributed among a community of firms and professionals in the sector. This paper highlights bringing project capabilities from outside the firm as collaborative capability to examine the capability for open innovation more clearly.

From the point of view of service innovation in firms, a firm's technological capability often influences innovation in its service. As Djellal, Gallouja, & Miles (2013) mentioned, innovation in public services has long been preoccupied with the introduction of new technologies, and especially with the introduction of new IT technologies, and the changes in business organisation associated with the use of these technologies.

From the point of view of capability development through the government's strategic procurement, Suehiro and Miyazaki (2019) found that governments' capability development through the PPP/PFI arrangements can create space for

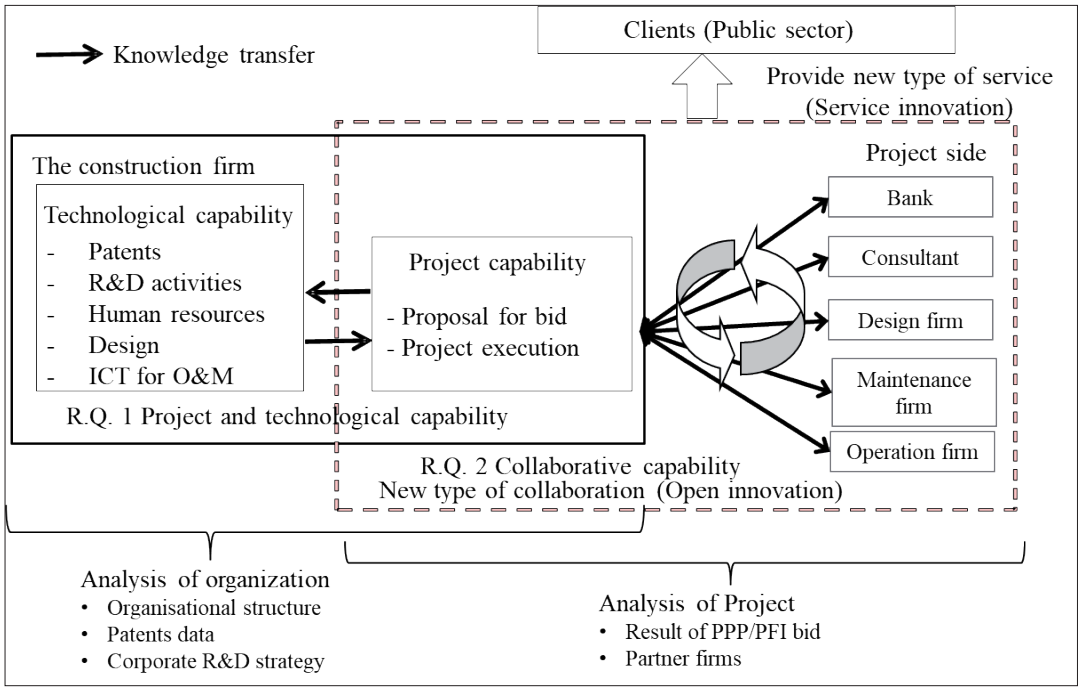


Figure 2. Analytical Framework

private companies to provide better service by accumulating tacit knowledge within the projects.

In this study, the authors analyse construction firms' capability accumulation in terms of open and service innovation when entering along-term PPP/PFI arrangement. Based on previous research related to open and service innovation through PPP/PFI arrangements, this research focuses on three capabilities in a construction firm: project capability, collaborative capability and technological capability (see Figure 2).

III. METHODOLOGY

3.1 Method and Data

First, the authors researched the trends in the PPP/PFI projects by reviewing public reports from the Cabinet Office, Ministry of Environment and Ministry of Land, Infrastructure, Transport and Tourism. This included public documentation such as tendering documents and publications related to PPP/PFI projects in Japan. The authors also interviewed nine people from private sector firms, including construction firms (plant engineering and civil works) and waste management companies, and public sector firms, including a municipality and waste management association. The authors asked the questions presented in Table 1.

Secondly, the authors conducted quantitative and qualitative analysis for the case study of Company A (see 3.2 for a description of Company A). As part of the quantitative analysis, the authors analysed the results of 43 bids for PPP/PFI projects by Company A. The bidding information was collected from tendering documents in the PPP/PFI project database presented by PFI Informationand Japan PFI/PPP Association. Bidding information included project detail based on contracts, a list of member companies and their roles, results of evaluations by a selection committee and a summary of the proposals.

The authors also investigated Company A's corporate strategy and R&D strategy based on their annual reports from 2000 to 2017, medium- and long-term plans, patents, publications and internal technical reports. A patent analysis was conducted using four-digit IPC codes to capture shifts in trends in their R&D results.

Finally, the authors conducted a detailed interview of a member of the PPP/PFI department of waste-to-energy in Company A. The interview lasted four hours and focused on such issues as company strategy in PPP/PFI projects,

Table 1.
List of Questions in Interviews

- Reasons for introducing PPP/PFI projects
- Advantages and Difficulties of PPP/PFI projects
- Tendering and selection process of PPP/PFI project
- Organisational change to adapt PPP/PFI projects
- Collaboration with other companies in PPP/PFI projects
- Risks of PPP/PFI projects
- Accumulation of capability of firms and municipalities through PPP/PFI
- Technological change through PPP/PFI project

process of proposal and execution of PPP/PFI and organisational change over the last two decades.

3.2 Case Study: Company A

From among construction companies experienced in PPP/PFI projects, the authors selected Company A as a case for this study. Company A is a plant engineering and construction company and one of the most experienced companies in the field of waste management PPP/PFI projects.

For the last two decades, over 1,000PPP/PFI projects have been procured in the various fields of public service in Japan (e.g. schools, sports facilities, hospitals and waste management facilities). In the field of waste management, in particular, PPP/PFI procurement has been actively introduced, and 159 projects have already been delivered.

Company A participated in 43 bids for PPP/PFI projects and succeeded in procuring 21 projects from 2002 to 2018, based on the tendering information collected by the authors.

Company A's main business is environmental plant systems (mainly a waste-to-energy plant), which accounts for more than 60% of their total sales. Their environmental plant system sales have almost doubled in the last 10 years, from 120 billion yen in 2010 to 250 billion yen in 2016, driving the rapid growth in total sales. Their total sales significantly increased after late Phase 2, from 290 billion yen in 2011 to 400 billion yen in 2016.

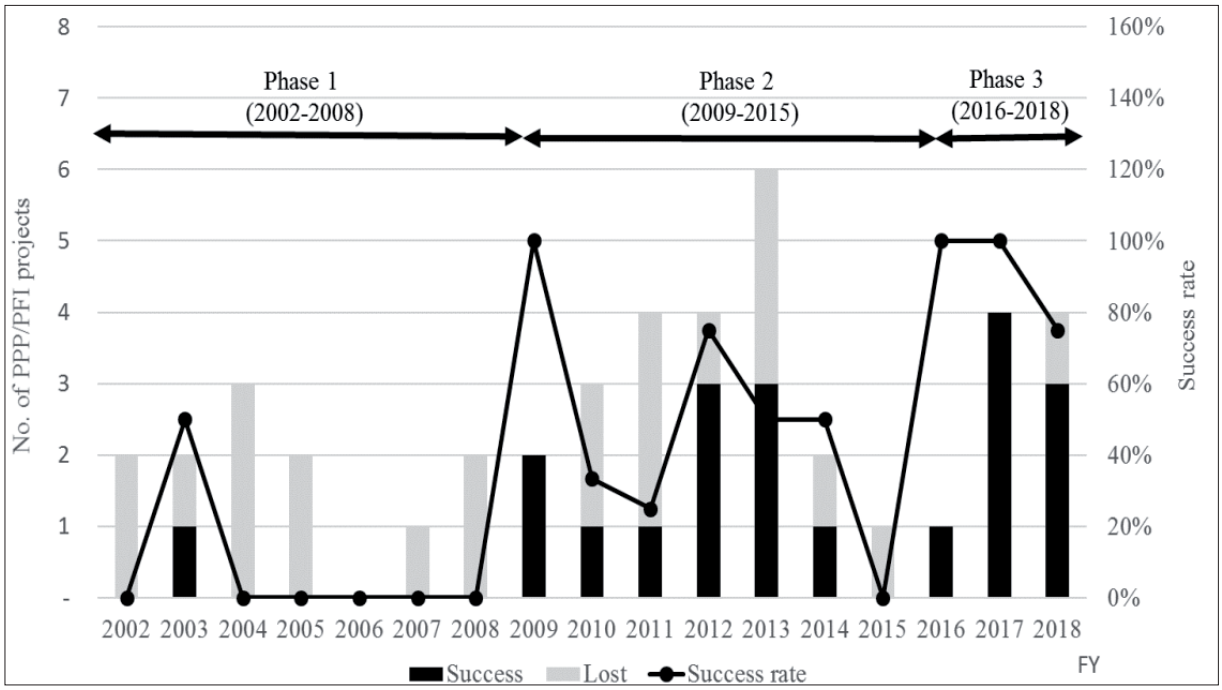
IV. FINDINGS

4.1 Shift in Success Rate of PPP/PFI Project Bids

Company A has accumulated their project capability through their 16-year project experience since the beginning of the PPP/PFI project participation period. The change in Company A's success rate of PPP/PFI project bids is shown in Figure 3. The bidding information was collected from tendering documents available from PPP/PFI databases.

From 2002 onwards up till March 2018, Company A had participated in bids for 43 PPP/PFI projects and had succeeded in procuring 21 projects (with an average success rate of 49%). The success rate is growing, as shown in three phases in Figure 3. In the initial stage (Phase1: 2002–2008), Company A was struggling to win bids for PPP/PFI projects, and they only won one project out of 12 bids in seven years. During this period, they participated in the bidding for various projects, not only for waste management but also for water treatment, parking lots and container terminals. Most PPP participation projects were of the PFI, which require business investment and have to compete with not only engineering companies but also consortiums led by various investors.

After they won two waste treatment facility projects in 2009, their success rate dramatically increased. In Phase 2 (2009–2015), they participated in 22 bids (twice as many as those in Phase 1) and won 11 projects (average success rate: 50%). In Phase 2, they mainly participated in waste management projects and DBO-type projects, where investment is by the government and private companies and financing is not necessary. In terms of competitive environment,



Source: Own elaboration based on tendering documents

Figure 3. Shift in Success Rate of PPP/PFI Projects Based on Results of Tendering

Phase 2 had fewer competitors. Only three firms participated per bidding project, on average, which was much less than in Phase 1, where the average was 5.6 firms. It is mainly because construction firms have become to select projects to participate in later phase.

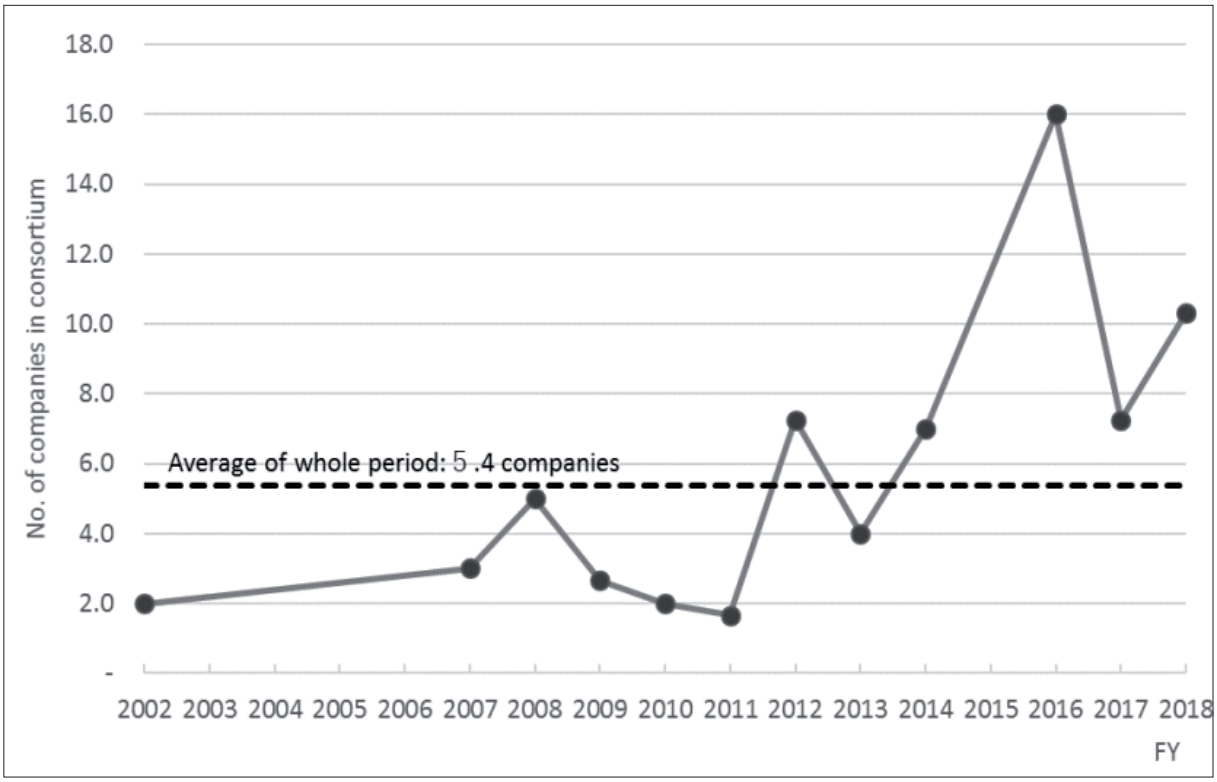
After 2016, when Phase 3 began, the success rate increased further. Company A won eight projects out of nine bids between 2016 and early 2018 (success rate: 89%). Competitiveness was slightly less than in Phase 2, and only 2.6 companies participated per bidding project, on average. In Phase 3, the project business scheme changed slightly to a wider project scope, and Company A collaborated with a larger number of companies (see Section 4.2 for details). Company A also played the role of representative company for all projects.

The strengthening of tendering capability for PPP/PFI procurement had a positive impact on the entire performance of the firm. As noted from the interview, around 70% of the waste-to-energy plants that they built in the last 10 years were procured as PPP/PFI projects, and PPP/PFI sales have a significant impact on total sales. Total sales have significantly increased after late Phase 2, from 287 billion yen in 2011 to 399 billion yen in 2016.

4.2 Collaboration with Other Companies within a Project

In order to participate in the tender and delivery of PPP/PFI projects, Company A has collaborated with other companies and created a consortium. These other companies include construction and civil engineering companies, plant engineering companies, operation and maintenance (O&M) companies and waste management companies. Company A normally selects partner companies project-by-project, based on the tendering requirement from government.The number of member companies in a consortium has tended to increase year by year, especially after late Phase 2, and Company A often collaborates with over 10 companies in one project (Figure 4.). Of the companies that Company A collaborated with, shown in Table2, there are four main types of collaboration in delivering waste management PPP/PFI projects.

Firstly, Company A always collaborates with several local construction and civil en-



Source: Own elaboration based on tendering documents

Figure 4. Average Number of Member Firms in a Consortium

gineering companies (for example, with 48 companies in 44 projects). This is because civil works require local networks to acquire human resources and material on site. These relationships between Company A and its partner companies have mostly been one-off over the 17 years. This implies that the field of civil works is highly standardised, that it is relatively easy to build collaborative relationships and that there is an abundance of companies to choose from.

Secondly, Company A has often collaborated with waste management companies which own facilities for waste treatment in recent years, especially after late Phase 2. This is mainly due to public sector demand to widen the scope of projects. Municipalities require the addition of ash treatment to the scope of the PPP/PFI project due to lack of capacity at their landfill site. This is a recent trend in Japanese waste management PPP/PFI projects, and Company A has already participated in 10 projects which include ash treatment. Company A collaborates with, on average, 2–3 ash treatment companies and 2–3 waste transport companies per project for ash treatment. This is one of the main reasons for the increase in the number of consortium member companies. The project risk for ash treatment is normally separated from main waste-to-energy incineration PPP/PFI projects, and co-working between the operation of the incineration plant and ash treatment is limited.

Thirdly, Company A has had a robust collaborative relationship with O&M companies over the entire period. Company B, which is a subsidiary of Company A, has participated in half of Company A's PPP/PFI projects as an operation and maintenance company. Originally, Company B was divided into two companies by geographical area, but in 2015 these two companies were merged into one in order to enhance the operation management technology and service.

Finally, Company A collaborates with plant engineering companies (such as Company C), which potentially can be competitors. Company C deals with the design, construction and operation of recycling facilities which use relatively simple technologies and systems. Company C

Table 2.
Summary of Collaboration with Other Companies in PPP/PFI Projects

Type of Company	Collaboration Characteristics
Construction and civil engineering companies	48 companies/projects collaborated with 37 companies for only one time
Waste management companies	28 companies/projects Their main role is ash treatment
Operation and maintenance companies	27 companies/projects Mainly collaborate with subsidiary (Company B)
Plant engineering company	7 companies/projects (Company C) Their main role is to design, construct and operate recycling facilities

Source: Own elaboration based on tendering documents

also invests in Special Purpose Vehicles (SPVs) and manages recycling facilities throughout the project life cycle. Although Company C has sometimes competed in the bidding for the recycling facilities of PPP/PFI projects over the last two years (Phase 3), they have collaborated on waste-to-energy incineration PPP/PFI projects in the period.

4.3 Transition of Patent Registration and R&D Strategy

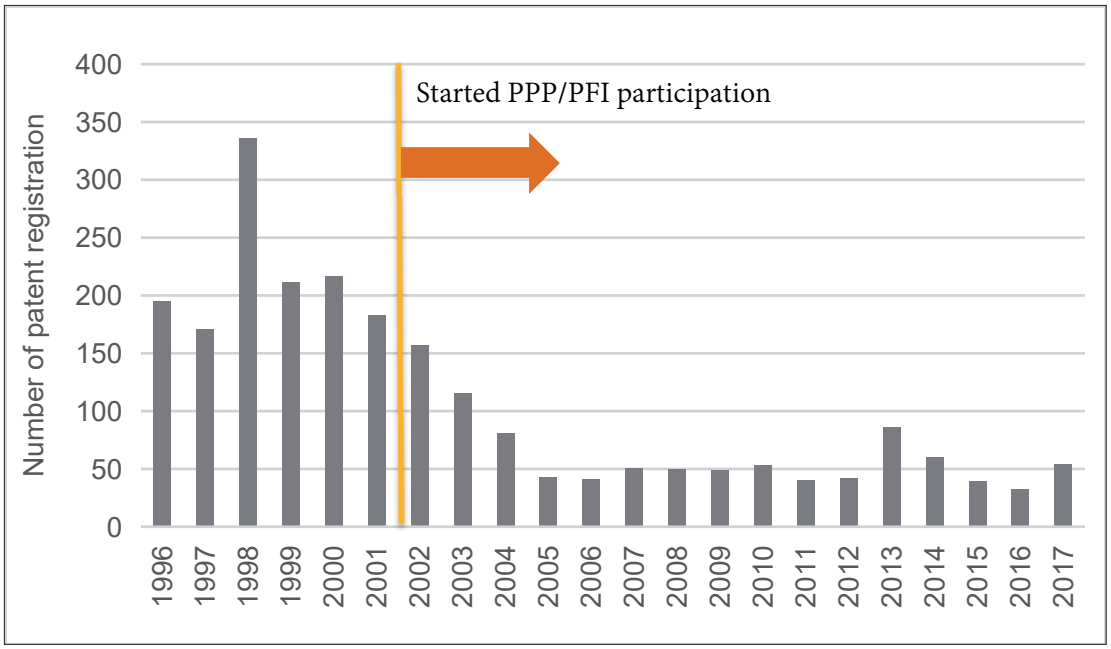
In order to understand the accumulation of technological capability, the results of the analysis of Company A's patent data are shown in Figure 5. Figure 5 also shows the trend in the number of patents related waste-to-energy technologies, based on the four-digit IPC code. The analysis shows a shift in Company A's patent concentration over the last 20 years.

First, a large number of patents were registered before 2002 when Company A started participating in PPP/PFI projects. As mentioned in the interview with Company A, they actively developed recycling technology in the period from 1996 to 2001 in order to capture business opportunities to the significant institutional change towards recycling-oriented society under the Basic Act on Establishing a Sound Material-Cycle Society founded in 2000.

The number of patents which related to the solid waste treatment technology then significantly decreased after 2002. This implies that participation and execution of PPP/PFI projects is not directly related to number of patents registered. In the interview, Company A representative mentioned that they tend to use robust technology for PPP/PFI projects in order to lessen risks of operation and maintenance. For PPP/PFI projects, Company A has to take on the risk for 15–20 years of operation and maintenance of waste-to-energy facilities, based on the long-term PPP/PFI contract. They therefore do not have a strong motivation to introduce leading-edge technology, which may have led to the reduction in the number of patent registrations by Company A, especially those related to waste management technology.

Company A's recent publications such as academic papers, internal technical reports and the financial annual report indicate that they have recently invested more in R&D for operational technologies and information technologies. For example, they were building a remote monitoring system centre in their head office in 2011 to collect operating information from each plant in their PPP/PFI projects to ensure stability and efficiency in sharing information and resources. They will further expand the remote monitoring system centre in 2018 to adapt to the increasing demand of the operating system. In addition, they are improving their automated operations system in order to lessen the burden of operations by codifying tacit operating knowledge.

Furthermore, technologies contributing to operations efficiency, such as technologies for power generation efficiency, for prolonging the life of components and for automatic clearing



Source: Own elaboration based on tendering documents

Figure 5. Number of Patent Registration (Solid Waste Treatment Related Technologies)

system, are being developed. Some of these technological developments are delivered by collaboration with external companies, such as IT companies or a subsidiary.

There are no joint applications for patent with partner companies in PPP/PFI projects except with Company A's own subsidiaries. This clearly shows that collaboration in projects does not directly influence the R&D activity and technological capability of the firm.

V. DISCUSSION

5.1 Change in Role: Accumulation of Project Capability

Analysis of Company A's participation in PPP/PFI projects shows that its role in projects has gradually changed (Table 3). In Phase 1, Company A participated in the PPP/PFI project mostly as a consortium member, not as a leading company of the consortium. This means that they did not play the role of project manager nor did they manage the proposal and bidding. They provided the design, construction and operation work of the facilities under the control of representative companies such as construction companies, trading companies and leasing companies.

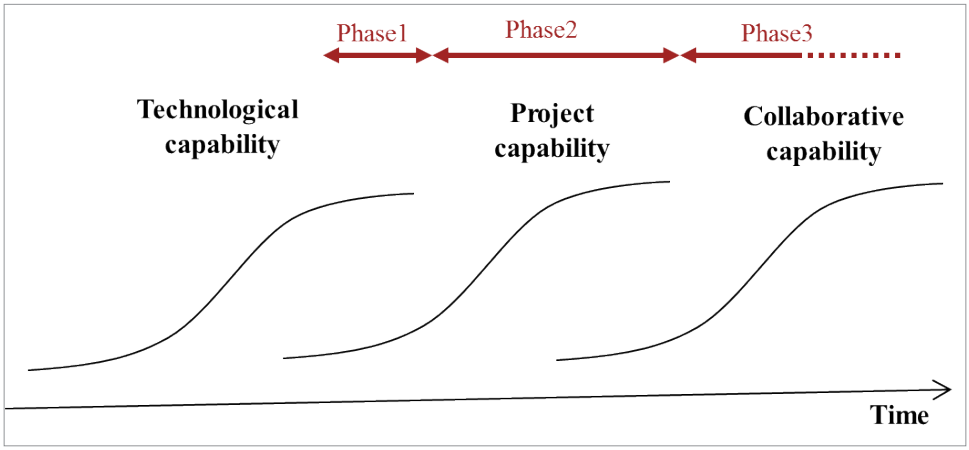
In Phase 2, Company A came to manage the entire PPP/PFI project as the leading company. However, their scope of work became narrower than that in Phase 1. For example, they started to collaborate with O&M companies (or subsidiaries such as Company B), entrusting O&M work which they had delivered in the previous phase to these companies. Building construction work also was completely undertaken by other construction companies. Ash recycling, which is added to the project scope in Phase 2, was entirely delivered by other companies.

Company A's role became further limited in Phase 3. Company C, which is a plant engineering company, began to deliver the construction and operation work for the recycling facilities. Company A only played the role of project manager and took care of construction of the incineration plant. The interview with Company A indicated that the main purpose of collaboration was to lower business risk and release unprofitable projects to other specialised companies in order to allocate human resources for their main business of incineration facilities.

Table 3.
Shift in the Role of Each Member Company

Type of service			Phase1	Phase2	Phase3
Project management			Others/Company A	Company A	Company A
Construction	Plant	Incinerator	Company A	Company A	Company A
		Recycling facilities	Company A	Company A	Company C
	Building		Others/Company A	Others	Others
Operation/ Maintenance	Plant	Incinerator	Company A	Company B	Company B
		Recycling facilities	Company A	Company B	Company C
	Building		Company A	Company B	Company B
Ash recycle	Transportation		-	Others	Others
	Recycling		-	Others	Others

Source: Own elaboration based on tendering documents



Source: Own elaboration based on tendering documents

Figure 6. Capability Development Model of PPP/PFI Arrangement

5.2 Shift in Type of Capability

This study reveals that, in order to respond to the institutional shift towards PPP/PFI arrangements, Company A has accumulated three types of organisational capabilities: technological capability, project capability and collaboration capability. These capability dynamics of Company A have changed over time through waste treatment PPP/PFI projects, as shown in Figure 6.

5.2.1 Accumulation of Technological Capability

First of all, technological capability related to the waste treatment facilities was mainly built before Company A entered the PPP/PFI market.[1] The development of new technologies (radical innovation) necessary for building and operating the waste treatment facilities were carried out before participation in the PPP/PFI projects.

The difficulty of fostering technological innovation is pointed out in some PPP/PFI literatures (The United Kingdom, House of Commons, Treasury Committee, 2011; Boardman et al., 2005). A possible reason for this is that the public sector tends to prefer robust and stable technologies which have been introduced in many other facilities.[2] In addition, because waste treatment facilities are large and complicated product systems, the company does not want to introduce

[1] Based on the interview with Company A and Association of Waste Management

[2] Based on the interview with Association of Waste Management

drastically new technologies, as these are risky. Our interviewees also mentioned similar issues:

> Technologies in the field of waste management are already mature, and most municipalities prefer 'normal' technologies with 'low cost'. (Association of waste management)

> Although we make various proposals about technological innovation, we have a tendency to avoid risks by introducing real leading-edge technologies. (Company A)

However, this research found that even after participating in PPP/PFI projects, Company A actively invested in O&M by using information technologies such as remote monitoring systems and automated operating systems.[3] These technologies help save O&M costs, strengthen project capability for bidding and improve level of O&M service. Company A introduced a monitoring system in 2011 when they started to deliver operations for several waste-to-energy plants after construction work. Just after the monitoring centre was introduced, a large number of PPP/PFI projects were won by Company A.

Therefore, although there are examples of PPP/PFI projects hindering innovation, PPP/PFI projects can indeed foster incremental innovation and facilitate technological capability related to O&M service in construction firms, as in the case of Company A.

In summary, as shown in Figure 6, Company A moved up its capability ladders along S-Curve from basic to advanced capability through participating PPP/PFI projects.

In the early stage, Company's technological capability was radically increased based on their R&D activities related to the waste treatment facilities even before participating in PPP/PFI market. Then, Company A's technological capabilities were gradually increased through implementing PPP/PFI projects by collaborating with other companies.

5.2.2 Accumulation of Project Capability

Secondly, project capability improvement took place when Company A began to participate in bids for PPP/PFI projects, and this capability was accumulated mainly in Phase 2, alongside the organisational change. Although there are many types of project capabilities, as mentioned in previous research, the authors define capability of winning bids (proposal capability) and of delivering (project execution capability) PPP/PFI projects as project capability.

Based on this case study, the authors found that the transition of organisation structure for PPP/PFI project proposals had a positive impact on accumulation of project capability by emphasising both external and internal learning effects.

In the early period, from Phase 1 to the middle of Phase 2, the sales and marketing PPP/PFI department managed the entire proposal process. This department consisted of people from backgrounds other than sales and marketing, such as engineering and commercial banking.

PPP/PFI's procurement process also needed to improve in order to improve the different capabilities, unlike bidding for conventional projects. Company A had to apply comprehensive evaluation processes, including technical proposals and business feasibility, and build long-term business projects through contracts with consortium members and through arranging financial investment.

In the early period, the PPP/PFI department accumulated proposal capability by learning from mainly external resources, using close relationships with other players in the business eco-system, such as clients (public sector), consultants and other construction companies. For example, the PPP/PFI association provided simulative experience programme of feasibility study and bidding process of PPP/PFI projects for companies interested in the PPP/PFI business.[4] For creating proposals, a number of specialists on the proposal team of Company A had a positive impact on the proposal process by collecting information and managing other departments. For example, the sales and marketing specialists drove customer demand, the engineers communicated with design and project management departments to write the technical proposals and the finance department managed the project business plan with a financial consultant.

[3] Based on the interview with and annual reports of Company A.

[4] Based on the interview with Company A.

> Because there are experienced engineers in the PPP/PFI department, proposal making could be managed in the sales and marketing department. The PPP/PFI project proposal-making process is highly complicated and requires a broad range of knowledge of both the business and technologies of waste-to-energy projects (Company A).

In the later period (mid-Phase 2 to Phase 3), the design department became the centre of the proposal team. In this period, because both the construction firm side and the client side were experienced in PPP/PFI procurement and because the business scheme of projects was routinized, the proposal needed to mention more detailed technological issues. Company A's design team has a close relationship with both construction and the operational team, meaning that they can easily get feedback from current PPP/PFI projects to improve the proposal and project execution.

In terms of project execution capability, Company A has accumulated operational capability through its PPP/PFI projects. Although Company A operated waste-to-energy facilities for the public sector even before PPP/PFI began, the contract was normally only a one-year contract, and Company A's autonomy was limited. Under the conventional project scheme, it was difficult to manage the recruitment and training of employees for operations from the long-term view. Maintenance and procurement information was collected and managed by the head office based on the remote monitoring system. Comprehensive management of the entire life cycle of waste-to-energy plants became possible under PPP/PFI.

5.2.3 Accumulation of Collaborative Capability

Finally, collaborative capability would provide further project capabilities accumulation. As As previously mentioned, PPP/PFI arrangements foster collaborations with partner's local construction and civil engineering companies, the field of civil works is highly standardised, that it is relatively easy to build collaborative relationships and that there is an abundance of companies to choose from.

As shown in Table 3, Company A collaborated with other companies once they learned and managed these services, except for project management and construction of the incinerator plant, which are core services of waste management PPP/PFI projects[5].

Moreover, collaborative capability seems to also be related to the accumulation of capability in the business ecosystem. The interview indicated that the O&M company (Company B) and plant engineering company (Company C) were originally subcontractors, and their role was limited under the control of Company A in the beginning of the PPP/PFI project (Phase 1 and Phase 2). However, Company B's and Company C's capabilities have gradually improved through collaboration with Company A and others, and Company A has asked them to invest in the project and manage facilities with autonomy, as business partners.

Furthermore, Company A seems to recognise the importance of further collaboration with companies outside of their conventional business ecosystem in order to seek opportunities to enter emerging business fields such as the concession business of water treatment. The interview with Company A indicated that they are also aware of the need to collaborate with companies such as IT companies and asset management companies.

VI. CONCLUSION

This research analyses how construction firm's organisation capabilities evolved through the participation in PPP/PFI projects to provide open and service innovation. Although some studies have focused on the capability development of construction firms through PPP/PFI arrangements, most of these studies have also conducted short-term and project-based analyses. There is still little understanding of the long-term dynamics of the evolution of the capabilities of a project-based firm itself and influence of partner-companies in the business eco-system.

In this paper, the authors proposed a model of capability development towards service and open innovation consisting of three particular

[5] In regard to ash recycling treatment, Company A did not manage by themselves before collaboration. However, the business scheme of ash recycling is separate from waste treatment incineration facilities.

organisational capabilities: technological capabilities, project capabilities and collaborative capabilities in the case of a construction firm which is a key factor in PPP/PFI. The model can be seen as ideal for understanding and comparing cases of long-term capability accumulation of project-based firms, especially with regard to providing services that meet the public's needs.

The results highlighted that the collaborative capability could be a key factor for construction firms to expand their service field. Japanese construction firms traditionally have strong relationship with other companies in same business, which is relatively easy to build collaborative relationships. Although previous PPP/PFI arrangement foster construction firms to provide wider range of service, the collaboration with different types of companies are still limited.

There are more various type of projects in the current PPP/PFI market in Japan compared to 20 years ago. Number of O&M-oriented projects (i.e. airport, road, water and sewage) are increasing rather than construction-oriented projects (i.e. waste-to-energy, government office and public housing). Also, not only for the PPP/PFI, the business field of construction firm are also becoming wider, such as renewable energy development, commercial complex development, operation and maintenance of complex facilities (i.e. hospital) and energy management of facilities. In order to capture opportunities in these new markets, exploration through appropriate collaboration with companies outside of current eco-system would be necessary for Japanese construction firms from the view of long-term strategy.

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