Implementation Framework for Procuring Municipal Waste Management Projects – The Case of Indian Public-Private Partnerships

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STATEMENT

I hereby declare that the work presented in this thesis is original to the best of my knowledge, except as acknowledged in the text. This material has not been submitted, either in whole or in part, for another degree at any University except for the award of degree Doctor of Philosophy (*Philosophiae Doctor)* in Civil Engineering to Indian Institute of Technology Guwahati.

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CERTIFICATE

This is to certify that the thesis entitled "**Implementation Framework for Procuring Municipal Waste Management Projects – The Case of Indian Public-Private Partnerships**", submitted by **Mr Dolla Tharun** bearing registration no. **146104027** in partial fulfilment of the requirement for the award of degree Doctor of Philosophy in Civil Engineering to Indian Institute of Technology Guwahati is a record of candidate's own work carried out under my supervision. The matter embodied in this thesis is original and has not been submitted for the award of any other degree.

Date: 28 February 2020

Laishram Boeing Singh
Thesis Supervisor

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Place: IIT Guwahati **(Dolla Tharun)**

Through Ghrist Alone .....
..... All Glory to God

ABSTRACT

Purpose

Indian Municipal Solid Waste (MSW) sector has been a crucial social sector that is connected to health and sanitation of the society, which is linked with achieving the millennium development goals. Public-Private Partnerships (PPPs) have been increasingly employed in the delivery of Municipal Solid Waste (MSW) projects of India in the past decade. This is due to the urgent need to comply with the MSW Rules. Though India is observed as a key proponent of PPP, indicated by its number of projects and investments, application to the MSW sector is quite obscure for the practitioners and policymakers. This requires an understanding of the crucial elements such as the motivations and perceptions of using PPP, appropriate risk allocation, and right methodology to craft the scope of the PPP project.

Hence, firstly, this study purposes to draw lessons on attractive factors and negative factors affecting PPP preference in Indian MSW sector. Secondly, appropriate risk allocation is key to the success of PPP projects. Typically, risk allocation has its bearing on the nature of the project, geographical location, and sector of application and policy of the government. Thus, risk management studies have heightened interest in the research community, given its importance and need. However, a study on risk management that qualifies to cater to the need of Indian MSW sector is still in a nascent stage for Indian PPP body of knowledge, especially from the perspective of practitioners and policymakers. To this end, the risk factors of Indian PPP MSW projects are studied. Thirdly, the performance of PPP projects depends on how the project has been structured. Bundled mode of public-private partnership (PPP) procurement has been a widely advocated governance structure of infrastructure delivery. But the traditional PPP option analysis for structuring project scope and size relating to the bundling of functions relating to a single component of the value chain will need to be extended even to include which components should be included in the project scope. This is currently missing in extant literature. This thesis sets out to identify the various aspects of how this bundling phenomenon has to be played out in practice and examines the implications of such decisions.

Abstract

Design/methodology/approach

A questionnaire survey, interviews with stakeholders involved in specific case studies, interviews with the stakeholders of the PPP projects in general, and with documentary analysis provided the necessary data for analysis. For knowing the motivations and hinderances of PPP in MSW, the respondents expressed their agreement to statements capturing the attractive and negative factors of adopting PPP in MSW sector using a mixed methodology of questionnaire survey and interviews. The results of the survey were analysed using factor analysis technique. For risk management, the results of risk intensity and allocation preference were obtained from the questionnaire survey and interviews with Indian stakeholders. Results are subjected to tests of reliability using Cronbach's alpha and then inferential techniques such as relative importance index and Kruskal-Wallis one-way analysis of variance to test whether the distribution of risk factor is same across different stakeholder groups.

For the objective of understanding the right structure of projects in MSW, this study develops a testable holistic framework that examines how various factors of bundling affects the performance of the PPP projects. Through a comprehensive literature review as the methodological backbone, using transaction cost economics, auction and agency theories, the review identified that innovation, maturity of markets, quality specifiability, scope economies, competition, information asymmetries, tendering to subsidiaries, and transaction attributes have a significant influence on this decision. They also affect the performance and success of PPP projects. To test the constructs which are deemed necessary in the decision making of bundling in PPP MSW projects, six longitudinal case studies of Indian cities having PPP in municipal solid waste (MSW) sector are carried out.

Findings

Though PPP is well sought and is also successful in many sectors and countries, its attractive factors and negative factors are highly contextual to the market, laws, and competency of the procuring agencies. Specifically, the 16 attractive factors for PPP in MSW sector can be grouped into Factor 1: Necessity and urgency of the services, Factor 2: Greater benefit to the public, Factor 3: Avoidance of financial stress on the public sector, and Factor 4: Achieving value for money and reduce transaction costs. The 13 negative factors can be grouped into Factor 1: Incompetent procurement, Factor 2: High transaction costs, Factor 3: Ineffective projects, Factor 4: Overexploitation by

the private sector. This meant that MSW services are primarily and importantly procured through PPP because PPP mode is more favoured on account of the dire need of MSW services in India. The legitimacy requirement of MSW Rules has put pressure to carry out the project development quickly. In this process, public sector sought it more appropriate to procure the whole components of MSW in an integrated manner and also intended that the private sector would bring creative and innovative approaches to the poignant MSW services. On the other hand, avoiding the public sector budget constraints and the capital investments are less motivating in comparison to the benefit to the public/public sector through PPP mode. Similarly, PPP is perceived to be not capable of reducing total project cost and also less effective for the motive of risk transfer. Moreover, findings suggest that inappropriate PPP procurement process can result in unfavourable results such as failed project, high transaction costs, and overexploitation by the private sector.

Secondly, this study showed how the risk intensity varies with the choice of technology, even though the parameters such as waste and scope of the project remain the same across the technological options. The findings indicate that financing risk, revenue risk, and waste collection/segregation risk are of crucial importance to address before procuring PPP MSW projects as this will help to decide the course and success of the project. The current study also indicated the need for bundling analysis in PPPs, which is also a fundamental premise influencing the risk allocation. These risks should be considered on a case-to-case basis before procuring any project through a structured methodology of factors governing bundling.

Thirdly, this study has highlighted the complexity inherent in bundling decision, arising out of the relatively scanty rationale by which stakeholders first developed. Not only are they different from the practice, but also many assumptions are proved otherwise. Poor sectoral developments, hindrances arguably caused to innovation, increase in transaction cost, and a decrease in the competition along with ex-post characteristics such as unfavourable transaction attributes made bundling a too early proposition to the bundled MSW projects.

This study suggests that the obligation to bundle is weak due to less realisation of bundling benefits advocated in the extant literature. A cognitive map has emerged from the study of six cases. Though empirical generalization cannot be attempted using multiple contrasting case studies, the findings suggest that this framework is generally

valid for every project. And, it is robust enough to predict the critical constructs and thus qualifies for use in the decision-making process.

Practical implications

This study has enabled a clear understanding of the behaviour of PPP in Indian MSW sector. Consideration of the attractive factors and devising strategies to overcome the negative factors will help the public sector to successfully adopt PPP in MSW sector. Besides, risks that were described can only be mitigated through appropriate policy, legislation, and support, as their purview of impact is beyond the project operations, and hence the risk allocation framework developed can be used by stakeholders of MSW sector as a guiding tool for appropriate risk allocation in future PPP projects. The developed framework for bundling decision would help the governments to create the right projects catalysing the bundling benefits and harness the full potential of private sector participation in the future PPP projects. The current study would be novel in advancing the theory of bundling in PPP projects. This would be of interest to academia, industrial practitioners, and policymakers notably the predictions on the use of alternative supply chain management options and firm-level organizational modes for achieving solutions for the municipal infrastructure. On the whole, the current study is a positive step towards integrating different perceptions and priority needs of MSW infrastructure stakeholders to the PPP process in order to ensure successful implementation of PPP MSW projects.

Originality/value

This work is novel providing sector-specific understanding about the nuances of this sector which is not offered in the extant literature. The findings from this study would facilitate policymakers in framing policies for procurement of MSW projects through PPP route. Studies on how to bundle/unbundle the projects having components of the value chain are in a nascent stage. The present study attempts to extend the body of knowledge on PPP to the complexity of bundling both the functions and components of the value chain in structuring the PPP project scope.

Limitation of the current study

The current findings are contextual in nature and, hence, further validation through a more significant number of case studies will enhance the reliability of these findings of the bundling framework. Data collection challenges, non-availability of data and limited access have prevented probe into many cases. Moreover, the

robustness of the present methodology is not too innovative. The limitations of the case study and survey methodology are applicable to this study. These limitations can be surmounted in future by choosing such appropriate methodologies that inherently overcome the prevailing limitations.

Future research directions

Future research can focus on field methods to verify the attractive and negative factors of PPP mode of procurement, particularly in MSW sector and consider including the effect of technology on the risk allocation preference. Besides, further research is needed to identify the conditions that can shape and dictate such that bundling is made only in a more reasonable setting. Lastly, studies also need to pay attention to the size of the project (either in terms of capacity or cost of the project) and verify the predictions on PPP suitability, risk management and bundling phenomenon.

Keywords: agency theory, attractive factors, auction theory, bundling theory bundling/unbundling decision, infrastructure delivery, municipal solid waste, negative factors, network infrastructure, procurement, public-private partnerships, conceptual framework. theory building, transaction cost economics theory.

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ABBREVIATIONS

ABBREVIATION	FULL FORM
CSF	Critical Success Factors
CVC	Central vigilance Commissions
D2D	Door to Door collection
EfW	Energy from Waste
EIA	Environmental Impact Assessment
EMD	Ernest Money Deposit
EOI	Expression Of Interest
EPC	Engineering Procurement and Construction
L1	Lowest bidder
L2	Second lowest bidder
MCC	Micro Composting Centre
MIG	Middle Income Group
MoUD	Ministry of Urban Development (presently **MOHUA**)
MSWM	Municipal Solid Waste Management
NGO	Non-Governmental Organisation
OCC	Onsite Composting Centre
PMC	Project Management Consultant
PSC	Public Sector Comparator
RDF	Refuse Derived Fuel
RFP	Request For Proposal
RFQ	Request For Qualification
SC	Service Contract
SLF	Sanitary Landfill
SPCB	State Pollution control Board
TPD	Tonnes (metric) per day
WPI	Wholesale price index

Metonymies

Since confidentiality agreements are signed with the case organisations and interviewees. All the names of cities, public and private organisations, names of special purpose vehicles are codified with metonymies. Such usages found in this thesis are as follows:

ULB	Urban local body of the concerned case study city
GAMET/Case G, PEARL/Case P, CORAL/Case C, EMERALD/Case E, SAPPHIRE/Case S, DIAMOND/Case D	Cities and cases of India on which case study research is conducted.
SPV1-C	First project company or special purpose vehicle of the PPP Concession in Case CORAL
SPV2-C	Second project company or special purpose vehicle of the PPP Concession in Case CORAL (post-termination of SPV1-C
GRANT Scheme	An innovative scheme designed and operated by the ULB-D
L1	Lowest bidder in any tendering
L2	Second lowest bidder in any tendering

Currency Standards and Exchange

£ Pound Sterling
₹ Indian Rupee

- 1 million = 10 lakh
- 1 billion = 1000 million = 100 crore
- 1 trillion = 1000 billion = 1 lakh crore
- 1 crore = 100 lakh or 10 million
- 1 lakh = 0.1 million

- 1 ₹ = 100 paisa
- 1 ₹ = £ 0.011904762 approx. (1 £ = 84 ₹ in July 31, 2019).
- 1 ₹ = US$ 0.015384615 approx. (1 US$ = 65 ₹).

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CHAPTER 1

INTRODUCTION

1.1 BACKGROUND

Indian Government, through the 74th Constitutional Amendment Act 1992, delegated the task of managing municipal solid waste (MSW) to urban local bodies (ULBs). Typically, this task of MSW management comprises the assets and services on four components of its value chain, namely collection, transportation, treatment, and disposal. Collection component denotes the gathering of waste generated by producers of waste, transportation component is concerned with the transportation of the generated waste, and treatment component denotes the adoption of any suitable and scientific measures to reduce the impact of this waste on the land, water, soil among others. Disposal component refers to the scientific burial of the residue waste after using appropriate waste treatment measures in a manner that is environmentally friendly. One of such methods which is widely accepted is by constructing a sanitary landfill facility. The role of ULB in MSW management (MSWM) is planning, designing, executing, and operating waste management schemes. Subsequently, the Central Government turned to take the role of facilitator in framing broad policies, programmes, and guidelines. Hence, while the Central Government rolled out policies, rules, and manuals, the ULBs emerged as the third tier of the Government.

After this administrative change, poor management of municipal solid waste caused plague in the year 1994. This plague has caused many deaths, and many people were affected in Surat. This situation also jolted the country and, as a consequence of this, Supreme Court of India formed an expert committee concerning the MSWM, in response to public interest litigation concerning this misfortune (Chatri and Aziz, 2012). This resulted in MSW Rules 2000. These rules are applicable to every municipal authority or an operator involved in the collection, segregation, storage, transportation, processing and disposal of municipal solid waste (MOEF, 2000, 2013). As per the Supreme Court order, all the ULBs are supposed to comply with the MSW Rules 2000 framed by the committee by December 2003. As a result, the ULBs are to report annually to the Urban Development Department, District Magistrate or Commissioner,

and Pollution Control Board to show that they are continuing their operations in compliance with the MSW Rules.

The municipal solid waste management in India has been egregious, and this problem is compounded as India is seeing consistent growth in urban population. As per 2014 statistics, 32% of 1.26 billion population live in cities (The World Bank, 2014). By 2030, it is estimated to reach 40%, leading to increased demand in urban infrastructure and services (Planning Commission, 2011). Annually, 115000 metric tonne (2005 estimate) of waste is generated in India and, out of this, 73% is from cities of class I[1] and above (DEA, 2009). In a comprehensive study to assess the situation of MSW implementation it has been revealed that, out of 59 cities, not one urban local body has conformed to MSW Rules 2000 (Kumar et al., 2009). The collection efficiency is in the order of 70-90% in major metro cities while in smaller cities, it is less than 30% (DEA, 2009). Estimates show that 60-70% of total expenditure is spent on street sweeping and collection while 20-30% is spent on transportation. Less than 5% on final disposal of waste. This highlights that scientific disposal of waste received hardly any consideration (MoUD, 2011a). The increase in population, changes in lifestyle, and shift to urban areas has led to an increase in the generation of solid waste.

Even after more than a decade, ULBs provide inadequate services in collection and transportation systems, technology selection, disposal methods, and sustainable financial management of MSWM (MoUD, 2014). The main reason for this could be attributed to the fact that ULBs are entangled with various challenges in managing solid waste. ULBs are not well equipped enough to handle the technical and planning issues (IL&FS, 2010). Their sources of revenue are tax, non-tax, and assigned revenues and are financially dependent on grants/funds or loans, leaving not enough funds to invest in the treatment of waste. This called to look for a better approach in handling projects, paving the way to PPP mode of procurement in the MSW sector.

It will not be incorrect to say that financial deficits of ULBs, insufficient capabilities, and lack of technical expertise have made PPP mode of procurement a preferred route for the MSW sector. PPPs started impregnating into MSW sector and projects needs to spur at a rapid pace in India. The position paper on MSW sector states that

[1] One lakh and above are 'Class I' cities

> *"...the Central Government should take up the role of a regulator by addressing financial sector and related regulatory issues. The State Governments should also respond by enacting Model Municipal Laws to enable PPP, setting up regulatory authorities, and creating a cadre of professionals at ULBs and state level."*

It also highlighted that the current limitation of PPPs as

> *"...there is lack of regulatory or policy enabling framework for PPPs barring few exceptions and lack of bankable and financially sustainable projects considering the opportunities and risks involved. There is also a need to rationalise tariff and user charges."*

However, the PPP mode of procurement caused extra challenges concerning the capacity building and abilities of municipal authorities in the procurement process of these kinds of projects.

The municipal solid waste management also has distinct characteristics of social infrastructure in comparison to other sectors of infrastructure. Social infrastructure is marked by at least three characteristics (Grimsey and Lewis, 2004; Jefferies et al., 2006). Firstly, they are smaller in scale in comparison to economic infrastructure, with gains being less tangible and difficult to value in financial or economic terms. Secondly, they are more complex due to the involvement in community; and thirdly financial demands are less with more complex operational demands. These characteristics become peculiar in the MSW sector when governments opt for PPP mode. In highways, the end-users have the opportunity to realise the benefits of saving in time, value for money and socially weaker sections are not negatively affected when tolls are levied directly. Whereas in MSWM sector, the economically weaker section would exhibit tax aversion or tipping fee aversion and, in addition to this, MSWM services are not excludable. Besides, the performance measurement of the MSW management sector is quite complicated because many parties are involved, and sophisticated metrics are required to measure compliance. Furthermore, there is very less realisation of value for the money by the producer of the waste, and this is unlike the reduction of travel time in transport infrastructure. Hence, the sectorial characteristics of MSW management demand unique consideration while opting PPP mode.

1.2 MOTIVATIONS FOR THE RESEARCH

PPP has been one of the preferred modes for delivery of infrastructure projects in India and stood as the largest PPP market in terms of private sector participation in infrastructure amongst the developing countries in the period 2008 to 2012 (Planning Commission, 2014a). However, in recent times, private investment in infrastructure development has been decreasing in India and other low middle-income countries. On the other hand, most of the developed countries are still able to attract private investments and have many projects in the pipeline in their PPP programs. The total private investment in developing countries has increased from US$ 754 billion in 2001 to US$ 1647.8 billion in 2010 (World Bank Group, 2016). India and Brazil combined have 1/4th of the global transport projects between 1990 to 2014 (World Bank Group, 2016). Amongst the top five economies (Argentina, Brazil, China, India and Mexico) across three sectors namely water, transport and energy, the total investment in PPP program has increased from 40% in early 1990's to 81% in 2009, and then has decreased to 63% (2014), and then to 54% in 2015. The decline in investment has taken place mostly in India and Brazil. In India, PPP infrastructure database indicates that private investment fell from US$ 53.3 billion in 2010 to US$ 4.1 billion in 2015. Investment in water and sewerage sector has also declined by 65%. A decreasing trend in global loans to project finance is observed in the waste management sector along with water and sewerage during 2009-2011 (Kennedy and Corfee-morlot 2012). *This decrease might be a pointer to reluctance by the private sector to invest in some sectors for various reasons.*

During the period 1991-2015, investment outlay in 121 low and middle-income countries totalled around US$ 1.5 trillion for about 5,000 infrastructure projects. Despite the vast investment outlay, these countries have experienced many challenges in the implementation of PPPs projects, including cancellations of these PPP projects. In fact, the cancellation rate (around 28%) was very high for public utility projects such as water and sewerage infrastructure. Furthermore, governments in developing countries, including Government of India has not been very successful in attracting private investment in social infrastructure specifically in public utilities such as waste management (Patil et al., 2016). Concerning municipal solid waste (MSW) services, the World Bank study indicated that an amount of US$ 5 billion annually would be required to expand and ensure adequate coverage of MSW management services to

urban India (Hanrahan et al., 2006). In addition to this, the cost of providing landfill was estimated at US$ 2 billion for the decade 2000-2010 (2006 price level). Estimates reveal that ₹ 39,186 billion investment is required in urban infrastructure between the period 2012-2031 (Ernst & Young, 2012). However, the lack of budgetary resources with local governments provides an opportunity for the private sector to play a prominent role in improving MSW services.

Cui et al. (2018) noted that India has made rapid progress in PPP studies in recent years and could also play a vital role in the field of PPP research. Nevertheless, much of the investment and focus of the previous studies have concentrated on transport sector (de Castro e Silva Neto et al., 2016; Eggers and Startup, 2006). Studies on PPPs in both global and Indian contexts have failed to concentrate focus on essential social infrastructure sectors such as MSW.

The decreasing investments and lack of interest in the private sector needs to be understood from the perspective of the MSW sector. This is important because if the bottlenecks of this sector are not cleared, and interest in the private sector is not developed, the few future projects that may be procured will be faulty. Measures that will increase the interest of the private sector on PPP mode can only facilitate these necessary investments. Otherwise, the private sector might continue to focus on other economic and attractive portfolios in their business. As extant literature argued, successful delivery of PPP infrastructure is dependent on the ability of the public sector to procure right projects in the right manner rather than expecting positive and automatic results (Koppenjan, 2015). The public sector needs to be more cautious in its approach to using PPPs. Besides these inadequacies, private sector use for the private provision of MSW services has been reported to have no savings on cost internationally. Bel and Warner (2008) reviewed 18 studies in MSW sector beginning in 1965 that have focused on more than 10 countries and found that there is no difference between public provision and private provision in the MSW sector. The authors suggest profound importance on various parameters concerning the importance of management, service characteristics, and the industrial organisation of the sector itself. They also argue that there is a need to form a theoretically based understanding of why there are no consistent efficiencies and cost savings across these countries and studies. This points out that opening this pandora's box is necessary.

India is having a low level of understanding and sophistication in applying the model to infrastructure development (Eggers and Startup, 2006). India needs to move up the 'maturity curve' with a fair understanding of the PPP market by using PPPs to drive service innovation, gain depth to expand to multiple projects and sectors, expand and support the shaping of the market place. India also needs to apply creative and more flexible approaches to the roles of the public and private sector, increase the focus on the total lifecycle of the project, and change the organisational approaches in government to support a more significant role of PPPs (Eggers and Startup, 2006). This requires an inquiry to extend the body of knowledge of PPPs to sectoral level. Hence, this study chooses to understand PPP mode in the context of MSW services and the first motivation for this study is as follows:

1.2.1 Motivation 1

PPPs are increasingly being used in Indian infrastructure, but its usage became indispensable in the MSW sector.

Public-Private Partnership (PPP) arrangements have been commended with the ability to overcome public sector capital deficit and bring private sector competence and skill to create and manage infrastructure assets (Akintoye and Mohan M. Kumaraswamy, 2016). Due to these benefits, many countries looked at PPPs as indispensable and therefore, PPP has emerged as the preferred route for infrastructure service provision (Klijn and Teisman, 2000). Such applications of PPP initiative have been advancing by focusing on specific dimensions in the research efforts. Particularly, the popularity of PPPs has changed the direction of research inquiry from '*how to operate PPP projects*' to '*how to popularise the utilisation of PPP*'(Cui et al., 2018). This suggests that research has turned from a positive narrative to a normative narrative. For instance, initial studies on PPPs attempted to understand the actual working of PPP projects while recent advances focus on extending to other infrastructure sectors such as urban land development projects to the procurement of social infrastructure projects.

Early adoption of PPPs is marked with the motive to attract the private investment given the decline in public expenditure for infrastructure service provision (Crosslin, 1991). This has motivated researchers to develop financial structures for PPP application and help in understanding the economic viability and the value for money of PPPs. In the later stages of research, it was observed that the joint partners

of PPPs have conflicting interests (Reijniers, 1994). This has been addressed by studying the organisation forms and paying specific attention to the procurement phase, thereby unlocking the application of organisational theories in studying PPP contracts and types (Zhang and Kumaraswamy, 2001). Attention to appropriateness and suitability to apply PPP and the conditions that configure a good PPP proposal has become a crucial aspect while making a sound decision in PPP recently. In this vein, Cui et al. (2018) have asserted that internal factors of the project such as its economic viability, value for money, and satisfaction of the stakeholders affect the suitability of PPP as the preferred route.

The advocacy of the general notion that PPPs improve the delivery of infrastructure service provision has been contested in some of the infrastructure sectors. Sectorial characteristics are asserted as one of the reasons (Flyvbjerg et al., 2004). For example, Eadie et al. (2013) have asserted that PPP/PFI appears to be appropriate for the development of both healthcare and transportation projects in the UK context. But, Henjewele et al. (2014) have emphasised that the performance of PPP projects in the transportation sector is superior to the healthcare sector due to fewer delays in the transportation sector in the UK. However, Rajan et al. (2014) have questioned the ability of PPP to eliminate time overrun and have concluded that PPPs have proven to be ineffective in the Indian transportation sector. Similar observations have also been made relating to the adoption of PPPs for implementation of public utility projects. For instance, John et al. (2015) have highlighted that there is no conclusive data to assert that the private sector per se improves the quality of service in PPP water supply projects. The could be attributed to the fact that water, sewerage, and energy require a very high amount of government support even in PPP mode, unlike road projects which are successful with user fee as the revenue source while water, sewerage, and energy does not have such option (World Bank Group, 2016). Furthermore, road projects are socially excludable, while public utilities such as waste management and sewerage projects are not socially excludable when provided by the private sector (Pu et al., 2019).

Green et al. (2005), in view of these reasons, have acceded the need to distinguish the ingrained contextual setting of the operations in these sectors. This assumes immense importance since the entry conditions and barriers are often different across the sectors. In fact, the entry conditions and barriers depend on the concentration

and fragmentation of the firms that are active in a particular sector (Green et al., 2005). Furthermore, the degree of regulations, competition, and market liberalisation are mostly specific to a particular sector (Markard, 2011; Pu et al., 2019). This highlights the need to acknowledge the strong influence of sector-specific regulations if one wants to study PPPs attractiveness in a particular sector (Markard, 2011). Besides, the observed interactions of techno-economic, organisational, and institutional characteristics are more discrete at sector level than at the country level (Markard, 2011). The network-based infrastructure, such as MSW and water supply projects, have a network of interconnected assets with different functionalities. Often the perception of these functions demarcates various sectors in terms of suitability and adaptability of delivery models such as PPPs. In such situations, local governments find the application of PPP for the provision of inter-related services as difficult and unfruitful (Janssen et al., 2016). Likewise, when opting the PPP model, the presence of sufficient qualified bidders needs to be accounted for by the procuring organisations. This is because the degrees of complexity vary across the project from different sectors (Pu et al., 2019). Thus, infrastructure sectors often differ on the degree of the required capital, the lifetime of the physical assets, the current role of public services, sector-specific regulations, degree of competition that is prevailing in that sector (Markard, 2011). These differences highlight the need for sector-specific studies.

In spite of this need, however, there is limited research focusing on PPPs in social infrastructure sectors such as water, and wastewater, and municipal waste management. Most of the studies have focused on highways and power. For instance, Cui et al. (2018) reviewed all the studies on PPP between the period 1990 to 2016 from all major indexing databases such as Web of Science, ASCE Library, Emerald, Elsevier-Science Direct, and Taylor & Francis. The findings showed that a significant number of PPP studies focused on the transportation sector, while the studies focusing on waste management were scanty. In fact, most of these studies focus on the waste generated from the construction site but not the municipal solid waste management as a sector. This highlights the trend that little attention has been paid to study the use of PPPs in the municipal waste management sector. Moreover, effective waste management has a strong correlation to achieve 12 out of the 17 sustainable development goals committed by the United Nations member states in 2015 (Rodić and Wilson, 2017).

Indian economic infrastructure such as transportation and power sectors have attained reasonable maturity in the PPP experience. Sector-level enablers such as model concession agreements and standard bidding documents are already in place for these sectors. In contrast, social infrastructure projects are still in the nascent stage (Laishram and Devkar, 2015). Infrastructure Today (2011), based on the survey of PPP adoption across sectors in India, has indicated that current progress on PPP adoption in most of the social infrastructure sectors is mostly confined to project level only. PPPs in such sectors are driven by fragmented project-level initiatives. Whether the evolution of PPPs is at the project level, country or at the program level, little attention is paid to study the application of PPPs at a sector level. This requires an inquiry to extend the body of knowledge of PPPs to sector level. Hence, this study chooses to apprehend PPP mode in the context of MSW service sector.

1.2.2 Motivation 2

Risk management in PPPs is an important research goal across countries and sector

Municipal Solid Waste (MSW) sector is one of the urban infrastructure sectors characterised with monopolistic and socially non-excludable nature in infrastructure service provision and usually motivated by political agenda. India is projected to generate 3.76 lakh tonnes per day of waste by 2025 (Hoornweg and Bhada-Tata, 2012). In 2015, the urban population was at 430 million and was increasing at 33% (Huang et al., 2018). With growing urbanisation and changes in lifestyle, the generated waste becomes a severe issue awaiting proper solution by the concerned authority, i.e. the urban local bodies (ULBs). Particularly, the absence of treatment facilities for MSW and its unscientific disposal has been the most threatening issue in the MSW service sector. As a result, MSW management services have increasingly been fulfilled by local governments through the creation of privately built MSW facilities through Public-Private Partnerships (PPPs) route.

Energy from Waste (EfW) can refer to the range of technologies that utilises the waste (non-diverted) to produce heat, electricity, or fuel (Thorneloe et al., 2007). China and India are among the top nations that are generating enormous amounts of waste and, therefore, are procuring much Energy from Waste (hereafter EfW) infrastructure. So far, India has more number of composting plants than incineration plants. In

contrast, China has more number of incineration plants than composting plants (Albores et al., 2016). From the circular economy principles, energy generation has been an added agenda to the programme and the trend is changing as composting technology is found to be limited in use to metro and megacities. Moreover, providing electricity has been Goal number 7 of the Millennium Development goals. In India, the number of MSW based EfW plants are expected to rise to 215 plants by 2031 and 556 power plants by 2050 that generate 2,780 MW power (Planning Commission, 2014b). This is because India has 1.49 GigaWatts of energy deficit during peak hours in the last fiscal year of 2018-19 (The Economic Times, 2019b). Though the governments have been promoting MSW projects on a massive scale, the failure rates of MSW projects procured through PPP route are increasing. For instance, the national master plan for energy from waste has projected that 4566 MW of energy can be produced from 265834 TPD of MSW by 2017 (MNRE, 2005). However, not much of this production is realised as presented by a task force review in 2014 (Planning Commission, 2014b). Currently, only 66.4 MW of energy is produced from 4516 tonnes of waste from five projects (MNRE, 2017). Hence, in EfW segment, India is considered as an experimental country while Europe, Canada and USA are seen as technologically matured (Huang et al., 2018; Metuzals, 2015). This is due to the presence of pertinent issues such as barriers and risks are effecting the project development.

Government of India, with an aim to promote energy from waste projects, have taken up many collaborative and capacity building exercises. Notable examples are preparation of (i) National master plan for EfW projects in 2005 supported by The United Nations Development Programme Global Environmental Finance (UNDP-GEF) (MNRE, 2005), (ii) tool kit to support the development of projects in MSW sector with a non-lending technical assistance co-financed by AusAID through the South Asia Region Infrastructure for Growth Initiative, Public-Private Infrastructure Advisory Facility (PPIAF) and the World Bank (Ministry of Finance, 2010b), (iii) Swedish collaboration in 2011 (Swedish Energy Agency, 2011), (iv) Taskforce by Planning commission in 2014 (Planning Commission, 2014b), among others. All these initiatives have failed to deliver successful projects. Even the most recently procured EfW projects have failed to perform and eventually ceased their operations showing the alarming rate of failures in India (Huang et al., 2018). One of the key reasons is that risk assessment has not been given considerable attention. In turn, private sector

incentive to invest decreases, large-scale development of projects is impeded, and sustainable waste management systems turn far from reality. Poor risk management is regarded as one of the reasons. In fact, amongst these projects, a significant proportion of the unsuccessful projects are with respect to projects adopting thermal treatment technologies such as RDF, incineration, and pyrolysis-gasification (Koshy, 2019). Very often, the failure of treatment projects has been the main reason for the resumption of open dumping of waste and the ULBs had to resume prohibited open dumping due to lack of a successful alternative.

A value chain of various segments characterises the MSW sector. Treatment is one of the segments wherein different technologies are available, ranging from low cost and less technologically complex such as composting to highly complex and expensive technologies such as energy from waste (EfW) technologies. The latest trend in MSW treatment has also been shifting gradually from landfills to waste treatment technologies (Farmer et al., 2015). The master plan, as well as the MoUD, sets out that India is considering two biological processes, namely biomethanation and landfill with gas recovery, and two thermal processes, namely gasification and pyrolysis. Biomethanation has been ranked as a top preference by the master plan (MNRE, 2005). Very often, the choice of technology is beyond being a choice. For instance, organic waste cannot be incinerated, while inorganic waste cannot be composted. Thus, the two kinds of waste treatment choices are inevitable to the waste management scheme. This calls for the understanding of risks for each class of technology. This is notably absent in the extant literature. In case of waste treatment, very often the need of the hour has been to understand every available option as opposed to choosing only one technology for a project in hand. This observation corroborates with the recommendation of the task force of planning commission that the suitability of technologies depends on the population of the cities.

The choice of technology adopted for the project, thereby, influences the risk profile of PPP MSW projects. In order to ensure successful implementation of PPP MSW project, an in-depth understanding of the risk profile of the project is required by taking into consideration the technological option as one of the important variables of the contractual structure of PPP MSW projects. This study, therefore, aims at understanding how the risk profile of PPP MSW project changes depending on the technological options adopted for the treatment of MSW.

1.2.3 Motivation 3

PPP procurement plays a key role in the successful delivery of value-for-money objective of MSW projects.

Robinson et al. (2010) noted that principles of 'governance' relates to the development process, the organisational structures, and decision-making aspects that are critical to the monitoring mechanisms available for 'governing' the development of a PPP/PFI project from one delivery stage to the next of the life cycle. The process of setting up these organisational structures along with the control and monitoring mechanisms is widely referred to as governance design (Asaduzzaman and Virtanen, 2016). This design is arguably most important due to the tension built up in PPP by virtue of public and business environments and has a strong bearing on viability (Hodge and Greve, 2010). Such a design of appropriate governance mechanism enables the protection of public interest regardless of the delegation of authority to parties dominated by business motivations (Klakegg and Volden, 2016). Governance is complex in PPP projects as it varies during the lifecycle starting from administrative governance during development, project or program governance during implementation and corporate governance during operations. The issues of governance carry right from the inception (ex-ante) until the end of the concession period (ex-post award governance). Also, PPPs are often exposed to ex-post governance issues related to internal, external, and public sector interfaces (Delhi et al., 2012). For each PPP project, exploring the inter and intra-relationship among the concerning parties – public sector bodies responsible for the project, the procuring authorities, the special purpose vehicle (SPV) set up for the execution and operation of the project, and between the SPV members - is essential (Vries and Yehoue, 2013). Explicitly, the focus is on the design of the procurement process to prequalify and select the bidder of the PPP concession. In principle, a public agency should focus on governance aspects such as establishing the institutional framework, the grounds of a decision to invest, procure, and finance the project with or without PPP mode, and also on maintaining integrity in the procurement process. Nevertheless, studies in this direction were scant as noted by Wilson et al. (2010) that the anticipated benefits from PPPs are the major focus whereas the crucial elements such as the structural relations within the PPP arrangement and the decision making has not been focused.

The Indian Government has undertaken various initiatives at both the state and municipal levels to promote the adopting of PPPs. Nevertheless, the adoption of these initiatives is significantly different across the states ranging from vibrant PPP programmes to creating hybrid institutional forms for project delivery instead of using PPPs (Mahalingam and Delhi, 2012). This showed that organisational fields that surround the organisations affect and shape the diffusion of the PPP regimes. Bel et al. (2010) argued that cost savings, cost characteristics of the service, the transaction costs involved, and the policy environment stimulating competition precedes the aspect of the choice of the delivery of the services in MSW sector. Joha and Janssen (2010) argued that public agencies are finding difficulty in making the right choice among various procurement arrangements and this requires to unravel intentions underlying their usage. Studies on infrastructure delivery models are mainly concerned with questions such as " …*what they are, how they are created, and how they change over time and across institutional fields* (Davies et al., 2019: 119)." Especially, as Bresnen (1991) noted, assessment of the potency of the different models of project delivery will require to understand and account the factors of influence on the practical operations. Procurement process would need particular attention from the selection of mode and various factors on which effective delivery is dependent. Weisheng et al. (2013) found that procurement system has evident dependability on the social, economic, technological, environmental, legal and political conditions in the realm of procurement innovation which aims at procurement methods that support the delivery of efficiency and value in public projects and services. Moreover, in such cases, lengthy concessions and the possible uncertainties during operations make contractual governance problematic (Strong and Chhun, 2014). Seppala et al. (2013), as a remedy to this situation, suggested considering the nature of the intended services, transaction costs, and the experience over the concession, in the selection of modes of sanitation service implementation. Because, in PPPs, governance issues are at the core and therefore needs articulation for better projects. Although PPPs are accorded as a right medium, inappropriateness of the current PPP models points to the need to devise appropriate PPP models that will facilitate effective operations based on the design, planning and implementation phases (Laishram and Devkar, 2015). Eriksson and Westerberg (2011) noted that knowledge of how different and new procurement procedures would work and affect the project performance is a key change agent and such research studies would increase the understanding and direct the client actions. Thus, sanitation projects

particularly of MSW sector will require accounting the long-term developments in the procurement process to achieve the objectives of governance (Seppala et al., 2013).

1.3 GENERAL RESEARCH QUESTION

The key research question that has been based on these motivations and that has driven the research inquiry of the current study is set as follows:

How MSW PPP projects are to be structured in India?

The research trajectory based on the motivations is pictorially represented in Figure.1.3.1. First, the inquiry intends to understand the approach of MSW service provision through PPP mode. Then, theorising the risk perceptions and management is intended. Later the intention is to develop a framework to guide the future MSW project procurement.

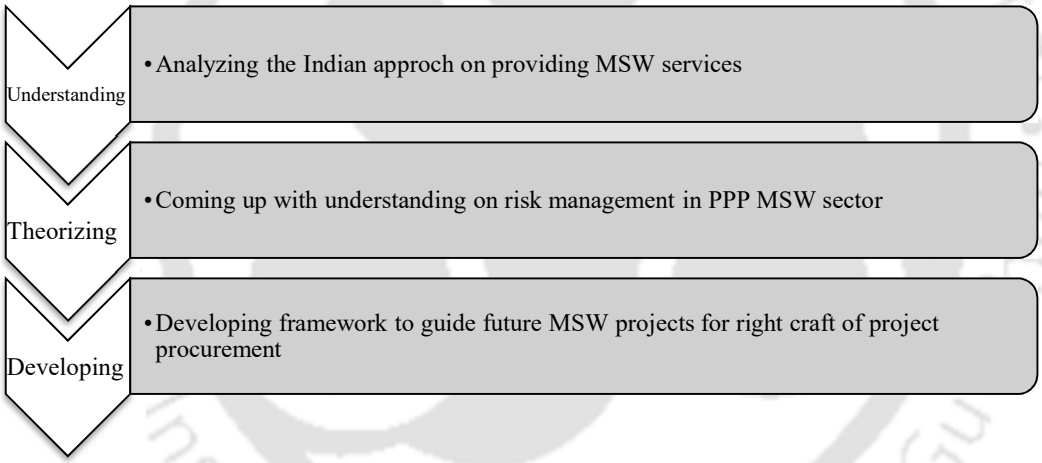


Figure.1.3.1 Trajectory of motivations for the study

The scope of the study and the research process adopted for the current study is shown in the Figure 1.3.2 and Figure 1.3.3, respectively.

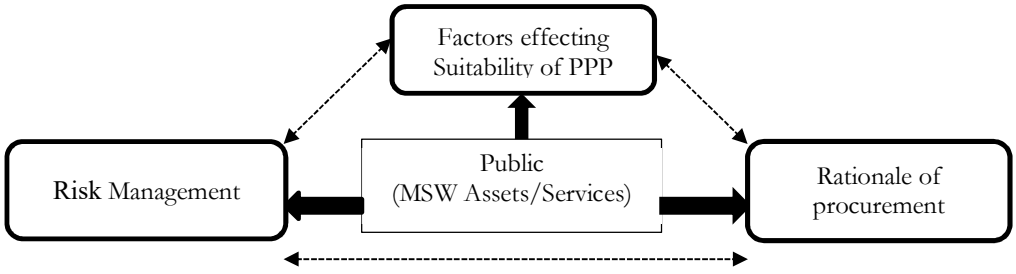


Figure 1.3.2 Scope and motivation of the study

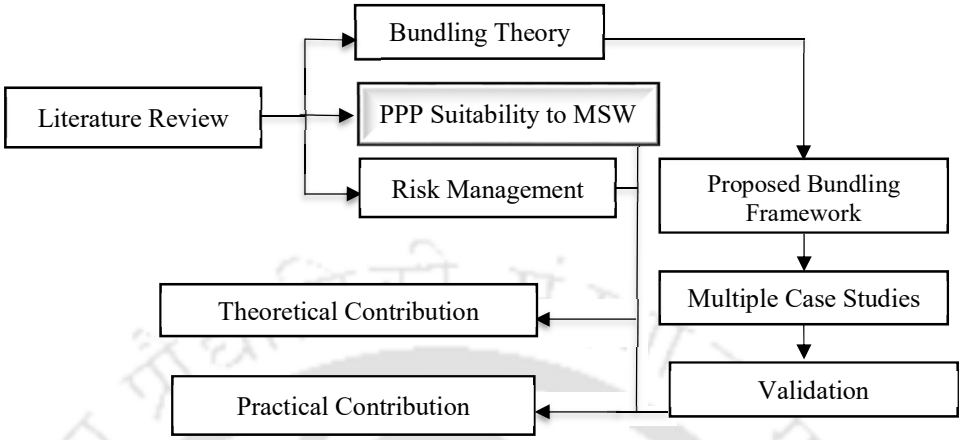


Figure 1.3.3 Research Process

1.4 SIGNIFICANCE OF RESEARCH

PPPs have gradually penetrated various sectors of infrastructure in both developing and developed countries. Former Indian Prime Minister Dr Manmohan Singh noted (The Economic Times, 2008):

> *"Projects and programmes are to be reviewed in the area of infrastructure development, including pure public-private partnerships, to ensure that their implementation is expedited and does not suffer."*

Success in one sector does not result in immediate success in other sectors. One of the objectives of the present study is to verify the historicity of PPP mode with the current case studies in MSW sector. This study tends to answer whether the objective of PPPs is appropriately addressed or compromised in Indian PPP sector. Given that energy from waste projects are the need of hour and also having very high failure rate, they require urgent attention. The questions that the current study is planning to examine are as follows: Are the projects' procurement in line with the objective with which the PPP emerged in the first place? What lessons can be drawn from the past projects in order to improve future project procurement? More specially, the technical manual of MSW has some lacunas regarding the choice of procurement through PPP mode.

For instance, MoUD (2014: 54) notes:

> *"...ULBs may decide to bundle certain services while contracting out solid waste management operations in order to build accountability and efficiency in the system."*

MoUD (2014: 88) also states:

> *"...while each of the operations have a distinct scope and can be handled under separate contracts, various models exist for efficient MSW management, which revolves around a combination of these operations."*

This highlights the fact that proper understanding of the implications of various choices among the available contract choices in the bundling spectrum will help in determining the right choice. The manual "*...strongly recommended to apply this toolkit for establishing a 'hand-tailored' PPP system* (MoUD, 2014: 89)." However, the manual does not offer an in-depth analysis of structuring the project based on the bundling theory.

As PPPs can play an essential role in driving infrastructure procurement and achievement of efficiency in service provisions, the focus of PPP research has also received much attention in the Indian context. Even though the MSW sector as such has been the interest of some researchers, their focus has not concentrated on bundling of the supply chain in PPP MSW projects. This indicates a paucity in this area of body knowledge of PPPs.

1.5 ORGANIZATION OF THESIS

This thesis is organised into ten chapters. The present chapter introduces the area of the study and discusses the three motivations driving the present study.

- **Chapter 1** is on the introduction of the research problem, its aims and objectives, which would be accomplished through this research. This chapter also discusses, in brief, the research methodology adopted for the current study.

  [PART I – Theoretical Foundations and Research choices]

- **Chapter 2** presents an overview of the existing practices and theoretical grounds in the usage of PPP projects. This chapter starts with the introduction on the infrastructure needs in various countries and articulates that PPPs are

used widely for infrastructure procurement in India. It then presents the generic procurement process of PPP projects and delves into the usage of different models of PPPs in the MSW sector. The difference between the various PPP models from the perspective of risk management is also discussed. The service provision of MSW supply chain as prevailing in India is sketched out with a specific focus on the aspects of bundling of the components of the MSW value chain. In doing this, this chapter highlights the three objectives of this research, thereby helping in the formulation of the research questions that have guided the current research inquiry.

- **Chapter 3** discusses the research methodologies adopted to address the research question set out in the study. The research process adopted for the study is discussed in detail. As the main objective of the current study focuses on theory building and theory testing perspective, the research methods and methodologies selected for the study to answer these three research questions are discussed in this chapter.
- **Chapter 4** presents the development of the theory relating to bundling in MSW value chain. This is done by first extracting suitable theories from economics and organisation theories and constructs are extracted by juxtaposing the characteristics of PPP with suitable theories. The theoretical propositions are, then, derived and augmented with the discussion on the applicability of these propositions to make a decision on bundling/unbundling the value chain.

[PART II – Empirical findings and discussion]

- **Chapter 5** discusses the results of empirical work relating to the factors affecting PPP adoption in MSW sector. This chapter reiterates the context of the objective and goes on to present the results and discussion. Various perceptions that promote or hinder the adoption of PPP in MSW is the focus of the discussion in this chapter.
- **Chapter 6** presents the empirical study to understand the risk management practices in Indian MSW PPP projects. This chapter presents the results obtained from structured interviews and discusses the findings with the intention to refine the risk management strategies for Indian MSW PPP projects.

- **Chapter 7** focuses on reviewing the bundling constructs to verify whether these constructs have any value in influencing the future decision related to bundling. The overview of six cases are presented, and the results of these case study are discussed in detail. It also presents the verification of empirical constructs on bundling theory. The analysis of the case study evidence is the focus of this chapter. Besides, the validation of the bundling framework through interviews with experts to assess its validity and generalizability is discussed.
- **Chapter 8** summarises the key conclusions from the study and the theoretical and practical contributions. The chapter concludes by discussing some key limitations of this study and suggests directions for future research. ■

CHAPTER 2

LITERATURE REVIEW

2.1 INTRODUCTION

This chapter reviews the literature on the need for infrastructure across countries and shows how PPP has emerged as a promising mode of infrastructure procurement with particular reference to India. It further appraises the procurement process of India to set the context of the present study. Further, the study discusses the usage of PPP in the MSW sector and argues the need for knowing the perception of PPP usage in MSW sector of India. Subsequently, it reviews the aspects of risk management pertinent to the treatment technologies in the MSWM services. Furthermore, a discussion is made on the aspects of service provision that is currently prevailing in the MSW sector supply chain. The attention is next drawn to the second-order aspects of PPP model, which is related to the prevalence of bundling and unbundling various components of the MSW supply chain. The chapter concludes with the summary and the remarks for the next course of action of the present study.

2.2 INFRASTRUCTURE DEFICIT AND PPPS

Infrastructure is realized as the contributing factor to the country's development. Studies confirmed the effect of infrastructure on the GDP and the countries overall economic growth (Kessides, 1993). The World Bank treats power, water supply, sewerage, communication, roads and bridges, ports, airports, railways, housing, urban services, oil/gas production and mining sectors as infrastructure (Planning Commission, 2008). The economic growth and potential of any country depend on the built environment and its quality in today's world (ADB, 2009; UNESCAP, 2006). Reliable infrastructure makes the capital more productive, whereas poor infrastructure cripples the growth of the country. In addition, India is aspiring to become a 5 trillion-US$ economy from the current 2 trillion US$ economy and provision of infrastructure is a key aspect to achieve it (The Economic Times, 2019a). Unfortunately, a huge infrastructure gap is observed in various countries, as shown in Table 2.2.1. Various estimates place global demand for infrastructure in developing and developed countries over the next decade at anywhere from US$ 10 - US$ 20

trillion (Scott et al., 2011). Hence, building infrastructure has been one challenge and maintaining and sustaining it to cater to the needs of the growing population has been another set of challenges for governments. In view of this, across the world, there has been a need to discover better ways to finance, govern, construct, and sustain infrastructure projects over the lifecycle (Scott et al., 2011).

Table 2.2.1 Infrastructure gap observed in various economies

Country/Region	Deficit
Canada	$60 billion (annual)
Germany	$90 billion (annual)
Australia	$19 billion (annual)
New Zealand	$4 billion (annual)
US	$1.6 trillion (5 years)
East Asia	$165 billion (annual)
India	***$250 billion (5 years)***

Source: Eggers and Startup (2006)

The revival of infrastructure through PPPs first occurred in the road transportation sector in India in the mid-1990s, even though the roots of PPPs could be traced back to 18th century globally (Chatterjee, 2014; Hodge and Greve, 2005). PPP model has been widely employed in the transportation sector as compared to all other sectors of infrastructure (Mahalingam, 2010; Meduri and Annamalai, 2012). Later, PPP mode has been tailored and applied to other sectors like ports, power, and urban infrastructure. Recently government is approaching to leverage PPPs in healthcare, education, and railways also (KPMG India, 2008; Mehta et al., 2010). While infrastructure occupies the major share in federal spending, similar high investment has been made by other private players. The total investment in infrastructure (which includes roads, railways, ports, airports, electricity, telecommunications, oil gas pipelines, and irrigation) is estimated to have increased from 5.7 % of GDP in the base year of the 11th Five-Year Plan to around 8.0 % in the last year of the Five-Year Plan. The pace of investment has been particularly buoyant in some sectors, notably telecommunications, oil and gas pipelines while falling short of targets in electricity, railways, roads and ports (Planning Commission, 2011). In the current 12th Five-Year Plan, the Government has planned to invest 1 trillion US$ out of which 50% is expected from the private sector to achieve a target growth rate of 9 - 9.5% when compared to 30% in 11th Five-Year Plan.

India is one of the leading PPP markets in the world. India is second to China in the number of PPP projects and second to Brazil in investments (Planning Commission, 2011). In India, investment in infrastructure is typically undertaken under two categories: central sector projects and state sector projects. In central sector projects[2], national highways have seen the highest overall project cost, followed by railways. In the state sector category, urban infrastructure has seen the highest overall project costs, followed by power. India stood as the largest PPP market in terms of private sector participation in infrastructure amongst the developing countries in the period 2008 to 2012. The PPP investment in Infrastructure over the past two decades is shown in Table 2.2.2.

Table 2.2.2 Investments In Infrastructure

Period	Infrastructure Investments (approx.) ₹	% of GDP	PPP Investments (%)
10th Plan (2002-07)	9,16,176 crore	5.15%	25%
11th Plan (2007-12)	24,24,000 crore	7.2%	37%
12th Plan (2012-17)#*	5,575,000 crore	8.2%	50%
Annual Plan 2014-15	1,81,000 crore	NA	NA
Annual Plan 2015-16	2,15,000 crore	NA	NA
Annual Plan 2016-17	2,21,000 crore	NA	NA
Annual Plan 2017-18	4,94,000 crore	NA	NA
Annual Plan 2018-19*	5,97,000 crore	NA	NA

* Estimated, # replaced with 'Annual Plan' under National Institution for Transforming India (NITI) Ayog; NA: Not available

India will require investments of over US$ 4.5 trillion by 2040 for the development of its infrastructure, according to the Economic Survey 2017-18 (IBEF, 2018). The Government of India is expected to invest highly in the infrastructure sector, mainly highways, renewable energy, and urban transport, prior to 2019. India needs ₹ 31 trillion (US$ 454.83 billion) to be spent on infrastructure development over the next five years (2017-2022), with 70 per cent of funds needed for power, roads and urban infrastructure components (IBEF, 2018). The Private Sector Participation (PSP) in the development and management of infrastructure and public services is recognised as the only way to meet the increasing infrastructure needs, especially for the developing countries.

[2] those that are sponsored by central government with a fixed portion contributed by state government

2.3 PPP PROCUREMENT IN INDIA

Broadly speaking, the PPP lifecycle has four phases (Bao et al., 2018; EPEC, 2012). These phases have been analysed from the perspective of construction law, management and economics (Winch, 2001). These different perspectives of analysis are needed because diverse phases of PPP life cycle have diverse challenges to deal with (Bao et al., 2018). Studying the governance challenges corresponding to the phases of PPP lifecycle is an accepted practice even in past governance studies (Hueskes et al., 2017; Zheng et al., 2008). The present study also has adopted this approach. Tombs (2002) argued that the core of governance includes information with which decision are made and also aid retrospective inspection of the goodness of such decisions. The relevant question in PPP governance then becomes - which mode of structuring the MSW supply chain can induce good governance and therefore lead to the project success. The advantage of this method is that the relationship between critical problems corresponding to PPP phases would serve as a valuable reference for PPP stakeholders to develop an effective management strategy. This is important in light of the transient nature of the PPP participants and discontinuities prevalent in between PPP phases (Bao et al., 2018).

As per DEA (2010a), PPP project lifecycle comprises of four phases: project identification, project development, project tendering and contract award, and project implementation and management. The key activities corresponding to these PPP phases in case of Indian PPP projects procurement are presented in Table 2.3.1.

Table 2.3.1 PPP Procurement Life Cycle

PPP Phase	Key Activities	Remarks
Project identification	Strategic planning	Assessment of current infrastructure situation; Infrastructure need identification
	Pre-feasibility study	Needs and optional analysis; Scoping social and environmental analysis; Financial Viability
Project development	Review of plans	Formation of Team; Review plan and procedure preparation
	Full feasibility study and PPP due diligence study	Market analysis; Environmental and Social feasibility (EIA and SIA); Technical feasibility; Financial and economic analysis; Risk studies; Value for money (VfM) analysis
	Draft of key documents	Expression of interest (EOI); Request for qualification (RFQ)
Project tendering and contract award	Procurement preparation	Formation of tender evaluation committee; Review of project information; Appointment of an independent monitor
	Prequalification of bidder	Identifying potential bidders through EOI; Qualifying the bidders for RFP through RFQ.
	Final bid documents	Request for proposal (RFP); Concession agreement (CA)
	Bidding	Distribution of RFP and preparation of bid; Evaluation of bids
	Contract finalization	The signing of CA; Auditing
Project implementation and management	Contract management and monitoring	Implementation and operation of the project; Performance monitoring and contract enforcement.

Source: (Ministry of Finance, 2010a)

The 'project identification phase' involves strategic planning and pre-feasibility studies. These studies aim to examine the viability of the PPP project, main project characteristics and assess whether PPP is the best procurement method. Governance principles suggest that procurement system should be selected such that the characteristics of procurement systems are aligned with the project's attributes (Ive and Chang, 2007). The selection and use of an unsuitable procurement approach could eventually lead to project failure. To formalize the procurement selection procedures, clients should establish a set of appropriate procurement selection parameters based on their distinctive characteristics and objectives, project requirements, and external environment (Luu et al., 2003). Furthermore, no clear direction on the scope of PPP with respect to bundling or unbundling is given in this stage.

The second phase called 'project development phase' envisages a detailed feasibility study, development, and initiate the procurement of the project on PPP mode,

if found to be attractive to PPP. In the development stage, scope definition is one of the critical aspects of this phase that have an important effect on the bundling decision of the components of the value chain. Common rationale for bundling is that as the scale and scope of activities in the project increases, the burden on the government to provide sovereign guarantee on loans to provide the same services also get reduced (Tiong, 1990). On the other hand, the private sector usually looks at the approach that maximises incentives for positive investment arising from economies of scope and property rights/bundling (Hart, 2003). Scale and scope of the project are typically looked into from the perspective of compromising effects of the strategy of the procurement (Grimm et al., 2006). Infrastructure projects are also expected to show economies of scale and possible economies of scope in preparation and implementation. Its formulation surfaces from defining the project development and continues till bidding if the authorities are knowledgeable on the interplay effects of the scope of the project (Estache and Iimi, 2009). Bundling and unbundling concepts are predetermined at the stage of project brief where the client or their transaction advisors rationalise the project programme, risk management, outputs specifications, and payment mechanisms.

Opportunity for innovations is very high in the development stage and has many benefits to the project in the subsequent phases. The public client expects innovation and effective management of whole-life costs. From the private sector perspective, innovations are not an end in themselves, but a means to achieve business aims. Procurement approach might also be regarded as an innovation in the use of performance incentives in relation to consultants as well as the prospective concessionaires (Loosemore, 2014). On the other hand, Roumboutsos and Macário (2013) found that the inability to capture the full range of performance-related issues such as innovation and societal benefits is amongst the factors for differences in PPP theory and practice. Complexity at the interface between the project delivery and the project operational functions can potentially diminish the innovation possibility (Barlow and Köberle-Gaiser, 2008). This is important because innovation may need to have direct evidence rather than inferring from other empirical proxies such as VFM achievement (Fischer et al., 2006). With such an emphasis on innovation in this stage, the remarks of Bennett and Iossa (2006a: 2159) are quite notable: "*PFI is more preferable [...when] the weaker the effect that innovations have on the benefit from the*

provision of the public service." Also, there is not enough empirical evidence on the PPP induced innovations (Akintoye and Mohan M. Kumaraswamy, 2016). This highlights the dilemma of innovation, its potential, and its influence in critical decision-making. Moreover, the public sector might keep control of future changes that would be significant, as innovation cannot be tested in a competitive market in the later phases. Thus, the key challenge for the public sector then is to ensure that there are appropriate levels in place to sustain innovation over the contract period of a PPP project (Roehrich and Caldwell, 2012). This is also required to prevent a skewed behaviour or interest on what aspects to focus on innovation as the public sector may find that private sector is not acting in the best interest of public/public sector.

PPPs predominately rely on specifications in terms of quality and/or quantity. This is due to the principal-agent conflict that arises in infrastructure procurement (Holmstrom and Milgrom, 1991). The ability to define the quality of construction and quality of service is cumulatively dictated by the specifications of the outputs prepared by the client, method statements prepared by the private sector contractor and approved by the client, monitoring management system, and payment mechanism (Javed et al., 2011). As the ability to define quality varies from one sector to another, quality specifiability should aim to be sufficiently tight to ensure compliance with what is required but not so explicit that it discourages innovative solutions that offer good value for money. From a technological point of view, the more dynamic and changing the technology prevailing in one sector is, the more necessary it is to assure internal decision-making mechanisms, which allow for efficient contract adaptation. This ensures that the value for money associated with the PPPs is maximized (World Bank, 2009). Additionally, in PPP governance, guidelines of commercial principles, legal instruments, and contracts are particularly relevant to reduce transaction costs from VFM perspective. They also create greater certainty for bidders (World Bank, 2009).

The 'project development phase' is followed by the 'project tendering and contract award phase' which involves procurement preparation, prequalification of bidders, final bid documents, bidding, and contract finalisations. The whole process is monitored by the procurement and evaluation team with the support of independent transaction advisory to facilitate interaction with bidders, contract award, and financial closure. This phase necessarily must follow good governance principles such as being transparent, accountable, non-discriminatory, competitive, and timely in the

procurement process. Stringent adherence to these principles will ensure the selection of the bidder with the ability to deliver the required service successfully (World Bank, 2009).

Transaction cost is an important aspect which plays a crucial role in the procurement of PPP project as PPPs have higher transaction costs when compared with the traditional procurement approach (De Schepper et al., 2015). Transaction cost can even affect the procurement decision as it is reflected in VFM of the project and can impede the specification, monitoring, or enforcement of an economic transaction (Soliño and Gago de Santos, 2010). The maturity of the market and level of competition in the sector are the other critical aspects that need to be considered while conducting procurement. Maturity is regarded as the subjective quality of accessibility to best projects management by weaving together actions, attitude and knowledge to increase project success (Henjewele et al., 2014). Maturity prevailing in the market is often viewed in tandem with competition observed in a project. According to the principle-based approach of governance theories, PPPs, characterised by market failure due to public-private risk-sharing, have to avoid the wholesale shifting of commercial and investment risks to actors who are divorced from the political economy of service provision to sustain a certain level of competition in the market (Muller, 2016; World Bank, 2009). Additionally, to ensure the successful establishment and implementation of a program of PPP projects, the government needs to foster the development of the private sector market by ensuring an adequate flow of projects with good and certain procedures for requesting and accepting proposals (World Bank, 2009). Such a practice will help in bringing competition in the market and ultimately make the market matured. Additionally, good governance principles also suggest that the primary goal of the PPP program is to improve the quality and efficiency of the project by attracting the best technology and expertise available in the market.

The final phase, namely 'project implementation and contract management' has components such as contract management, monitoring and sanctions rewards, and dispute resolution (EPEC, 2012). This phase involves the implementation of performance standards and its monitoring, dealing with changes, revenue sharing, disputes (if any) (Bao et al., 2018). Maximizing value for money and preserving the contract equilibrium and risk allocation are the two central considerations in the context of contract management (World Bank, 2009). Other issues that play a key role in the

contract management process is the resolution of disputes, contract amendments, and change in scope. These incidents would also increase the overall transaction cost of the project ex-post. Moreover, if the termination of the private party happens before the full concession period, switching private partner is often difficult and inefficient for the public sector and is involved with additional transaction costs. In this vein, Delhi and Mahalingam (2013) pointed out that project governance strategies, institutions and project characteristics are crucial determinant for the post-award success of PPPs. The sponsors are, therefore, under an obligation to monitor the performance of the project and make timely payments based on the pre-defined performance measures. Sponsor also would need to allocate sufficient resources to monitor the private partner performance and to enforce penalties if required. Management procedures would need to establish an efficient communication channel (e.g., clear reporting requirements so the public authority remains informed and can identify potential problems early on). In some PPP models, user charges are paid directly by users, and this ensures that users are alerted and have incentives to monitor whether the project indeed delivered value for money, automatically implying a higher level of accountability (World Bank, 2009).

2.4 MSW SECTOR PROFILE

The environment of municipal waste is problematic and is not a very attractive business for private providers (Spoann et al., 2019). It is also very complex due to dealing with the workforce and the adoption of untried technologies.

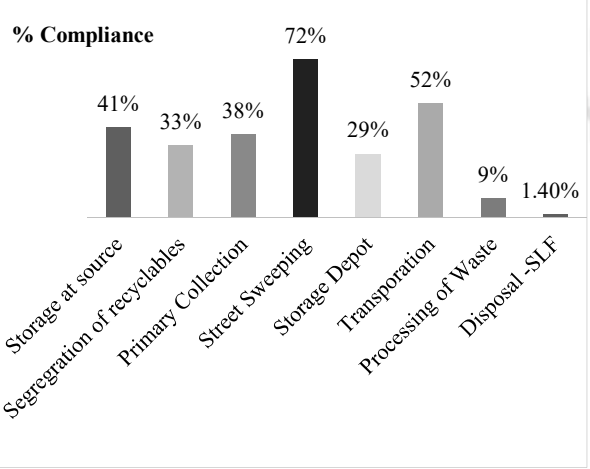


Figure 2.4.1 Compliance of MSW Rules 2000 as on 2004

In India the compliance is very poor. In 2004, the extent of disposal is 1.40% as shown in figure . Even in 2018, the extent of disposal is the same, considering the data from the whole country. This stands at 24.80%

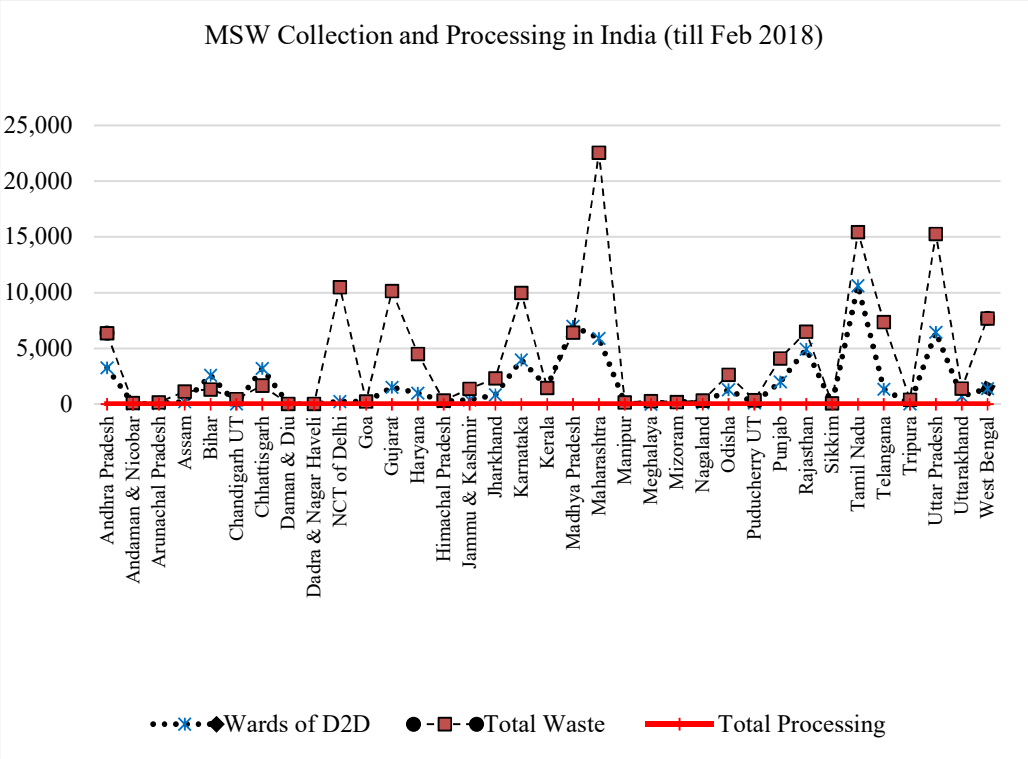


Figure 2.4.2 MSW Collection and Processing in India (till Feb 2018)

Source: (SBM, 2018)

Investment size

The average cost of the Indian highway projects is ₹ 1093.88 crore while the average cost (approximated with limited data) of the MSW sector is ₹ 121.55 crore. Thus in terms of project size, MSW sector is 9 times smaller than that of highway sector (Dolla and Laishram, 2019c). Table 2.4.1 shows the comparision of MSW sector with other sectors of infrastructure projects. MSW sector received grants only to an extent of 4.86% while transportation sector has received to an extent of 29.68%. Water supply received highest grant to an extent of 41.22%. Viewing at the big picture and the data, the average concession duration of the transportation projects and the MSW projects are almost same.

Table 2.4.1 Investment Size Comparision Across Sectors

Sector and Subsector	Number of Projects	Total Project Cost[@]	Sum of Grant Amount	Concession Duration (CD)[#]	Average D	% of Grant	Ranking of Grant
Energy	341	373381.12	190.54	123675	362.7	0.56	16
Social and Commercial Infrastructure	142	13808.12	84.57	44118	310.7	0.60	15
Transport	937	867894.24	27811.05	212124	226.4	29.68	4
Water and Sanitation	114	15684.93	1335.72	22329	195.9	11.72	8
Solid waste management	*65*	*7901.23*	*315.79*	*14344*	*220.7*	*4.86*	*11*
Grand Total	**1534**	**1270768.41**	**29421.88**	**402246**	**262.2**		

Source: (DEA, 2017); @ total cost in ₹ crore; # - in months;

Procurement

Concerning the prequalification, MSW sector has many variables such as experience in collection, transportation, treatment and disposal as technical qualification measured in terms of size of the projects. Whereas in the road sector, the technical qualification is the only variable considered which is measured in project cost in road sector (Dolla and Laishram, 2019c). This is because of sectorial characteristics rather than the difference in robustness of the assessment.

PPP database of India hosts the details of all the PPP projects across the sector and states (DEA, 2017). The total of 1534 PPP projects having a total cost of ₹ 1,349,125.67 crores (£ 160.6 billion) are reported so far in India. Our interest was limited to the 65 MSW PPP projects until 2017. The types of PPP modes of these projects and the distribution of those projects across various states is show in Figure.2.4.3 and Figure.2.4.4.

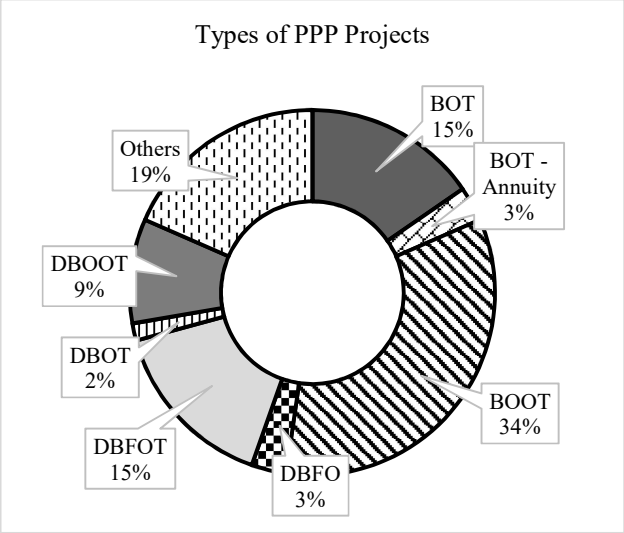


Figure.2.4.3 Types of PPP projects in MSW Sector, (DEA, 2017)

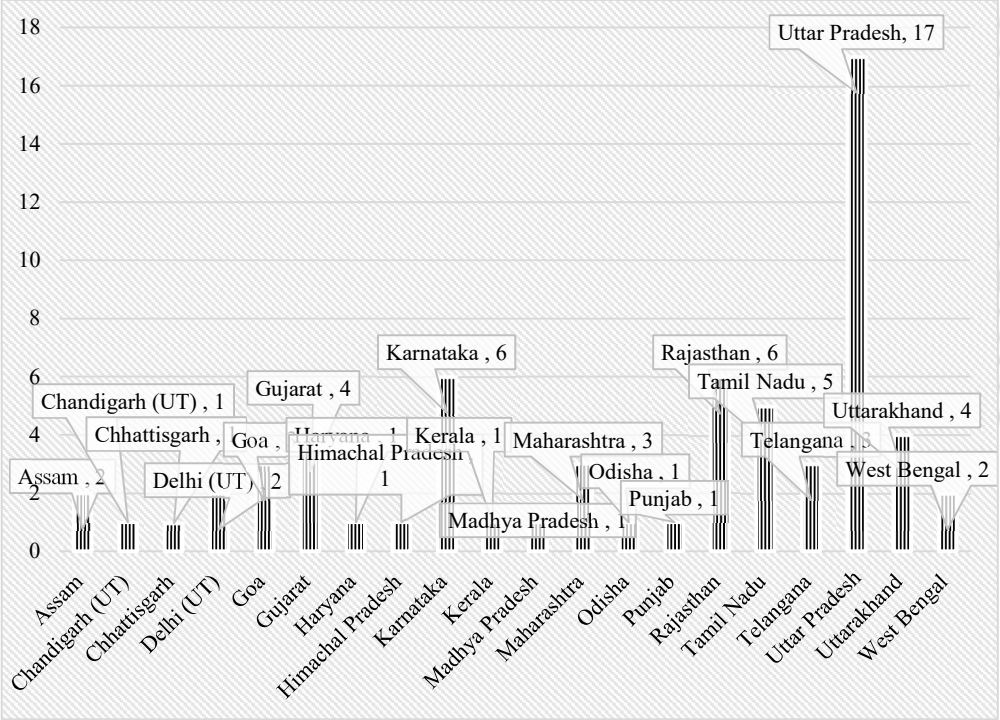


Figure.2.4.4 Distribution of PPP MSW projects across states, (DEA, 2017)

There is a buoyant increase of interest in the past five years. For instance, in the state of Andhra Pradesh alone 105 projects are in pipeline (at least crossed DPR stage) (SAC, 2016).

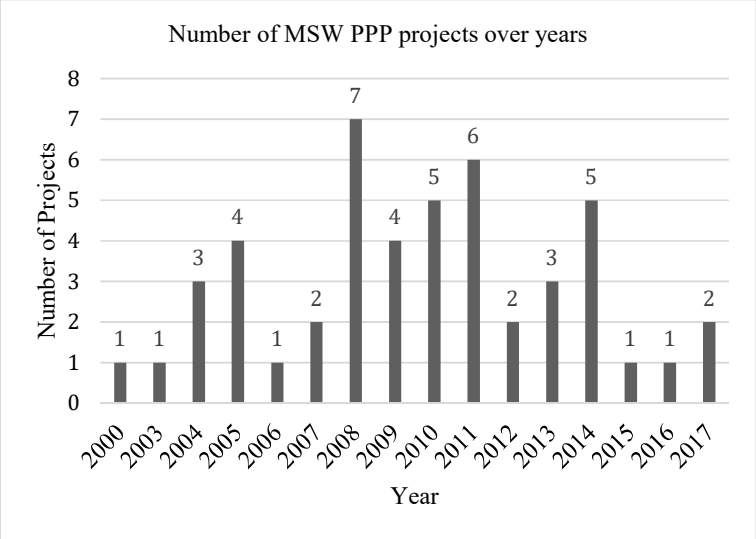


Figure.2.4.5 Number of PPP projects over years

In the state of Telangana, the detailed project reports for all the erstwhile 72 municipalities are ready and the detailed project reports for the remaining 68 municipalities are pending. These projects are envisaged under central government funds and 15th finance commission funds. These are just few numbers of one state in India. Similar condition with astonishing numbers is visible throughout India. The trend in the number of PPP projects, status of those projects are shown in Figure.2.4.5, Figure.2.4.6, and Figure.2.4.7.

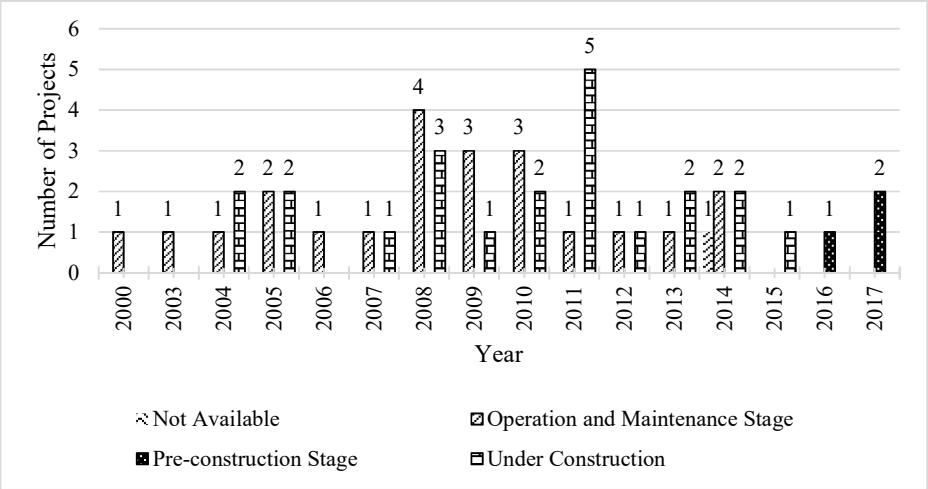


Figure.2.4.6 Number of PPP projects in various stage of procurement

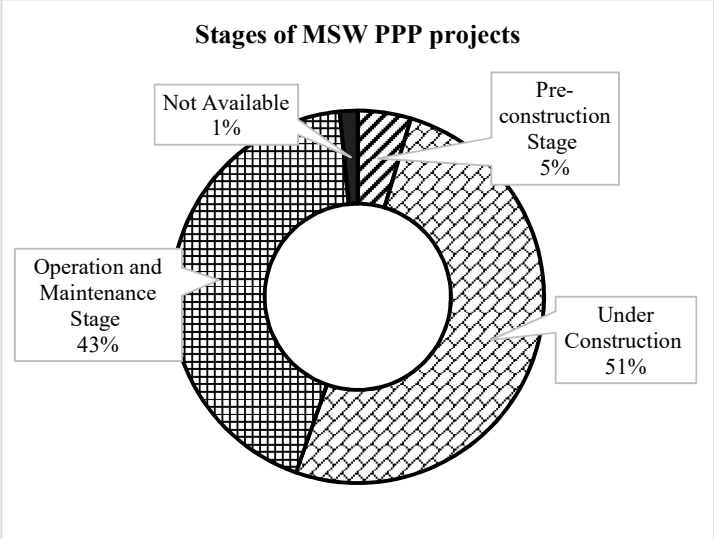


Figure.2.4.7 Stage of PPP projects

Revenue models

There are at least 4 revenue generation streams for MSW in general (MoUD, 2012). They are introduction of service charges to the users, sale of products and byproducts such as compost, RDF, eco-bricks, landfill gas, power from EfW projects, sale of recyclables, and revenue from carbon funds. Usually the structuring and financial modelling considers these parameters. Nevertheless, by and large, user charges tend to the major sources of revenues and other three areas are of little or no value in comparison to the required investments to provide necessary infrastructure.

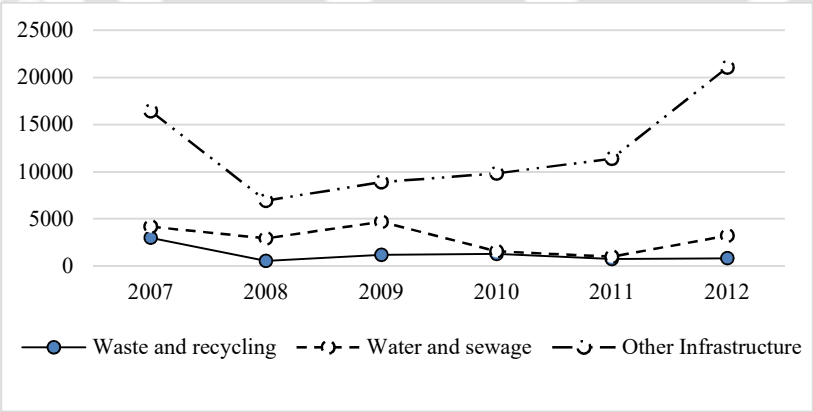


Figure 2.4.8 Private-Sector Project-Finance Commitments, 2000–2012

Source: (Yescombe, 2014), investment in US$ millions

On the other hand, there is significant reluctance of the private investors to invest in these projects (Dolla and Laishram, 2018). There is also stagnation in the amount committed to waste sector thourgh project finance across the globe as shown

in Figure 2.4.8. Project management researchers have considered distinct types of projects while studying the delivery models by viewing the distinctiveness on complex capital investments in infrastructure. They are major projects, large engineering projects, global projects, and megaprojects (Davies et al., 2019). Considering these figures, it may be worthwhile to classify MSW projects as major projects according to this prevailing typology.

Legislative framework

In India, waste management is governed by various sub-ordinate legislations and the Ministry of Environment, Forest and Climate Change, Government of India (MoEFCC) in conjunct with State Pollution Control Boards of different states (SPCB) administer the gamut of waste management regulations. Indian government, through 74th Constitutional Amendment Act 1992, delegated the task of managing municipal solid to ULBs. The role of ULB in MSW are planning, designing, executing, and operating waste management schemes. Subsequently, central government turned to take the role of facilitator in framing broad policies, programmes, and guidelines. Hence, government rolled out policies, rules, and manuals. The ULBs emerged as third tier of government. The typical structure of ULBs in India is presented in Figure 2.4.9. Twelfth Schedule of the constitution included the function of ULB in "*public health, sanitation, conservancy and solid waste management*". Thus the greater muncipal corporations ('Mahanagara Palika'), municipal corporations (Nagara Palika), and city counciles ('Nagar Parishad') are the final authorities accountable to and responsible for the MSW services in India.

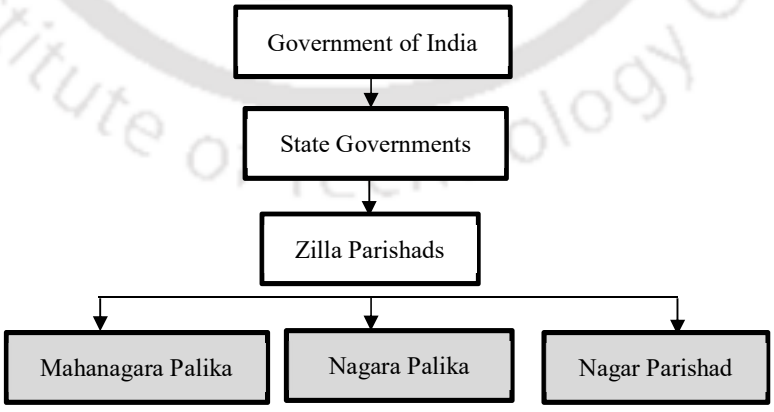


Figure 2.4.9 ULBs Structure in India

ULBs have gradually transferred the responsibility for management of solid waste to private with introduction of PPP models in different segments of the solid waste management value chain since the economic liberalization initiatives started in late 90s. Participation of private sector in initial stages were limited to collection and transportation of solid waste using model such as service contract and management contract. In the later stages with the maturity of the sector, integrated solid waste management options have been adopted by some of the cities through PPP route. Besides, the gradual involvement of private sector, the legal framework for MSW management has also gradually evolved with the enactment of MSW Rules in 2000, which was amended again in 2016 to meet the legitimacy requirements. PPP process in India has been guided by PPP toolkit under the aegis of Ministry of Finance, Government of India (DEA, 2010c). This nodal ministry issued guidance drives the PPP process of give infrastructure sectors including MSW. The overarching theme is to guide the PPP procurement starting with PPP background, the process of PPP, and tools and resources guidance. The procurement process of a project assumes PPP mode project until and unless some readiness check filter indicates otherwise. The list of acts and rules enacted by Indian Government in order to cater the needs of waste management and PPP mode are as presented in Table 2.4.2.

Table 2.4.2 Law and regulations related to PPP and MSW projects in India

Year	Law and regulations related to public private partnership waste projects in India
1992	***74th Constitutional Amendment*** *– Constitutional Amendment to decentralize the ULBs for better governance. Twelfth Schedule of the Constitution included the function of ULB in "Public health, sanitation, conservancy and solid waste management".*
1995	**J.S Bajaj committee.** The high powered committee on Urban Solid Waste Management
1998	**Barman Committee appointed by Supreme Court.** This is in response to Public interest litigation filed against the poor MSW conditions and the outbreak of Surat Plague.
2000	**The Municipal Solid Wastes (Management and Handling) Rules, 2000** apply to every municipal authority responsible for the collection, segregation, storage, transportation, processing, and disposal of municipal solid wastes.
2004	***PPP Cell, Ministry of Finance*** *is the State-level Agency for Executing PPP projects. This looks after matters and proposals relating to clearance by Public Private Partnership Appraisal Committee (PPPAC), Viability Gap Funding (VGF) except those in Road Sector, scheme for India Infrastructure Project Development Fund (IIPDF).*
2005	***Jawaharlal Nehru National Urban Renewal Mission (JnNURM_.***
2006	**National Environment Policy 2006**

Year	Law and regulations related to public private partnership waste projects in India
2006	***Guidelines for financial support to Public Private Partnership Projects in Infrastructure under the Viability Gap Funding Scheme of GOI***
2007	***Scheme and Guidelines for India Infrastructure Project Development Fund***
2008	**National Urban Sanitation policy (NUSP)**
2008	**Service level benchmarks (SLBs) in MSW Management.**
2010	***Online PPP Toolkit for five sectors including MSW Sector***
2011	***Public Procurement Bill (Draft)***
2011	***National Public Private Partnerships Policy (Draft) –.*** *The National PPP Policy seeks to facilitate this expansion in the use of PPP approach, where appropriate, in a consistent and effective manner, through setting out the broad principles, providing a framework for identifying, structuring, awarding and managing PPP projects and delineating the cross-sectorial institutional architecture and mechanisms for facilitating and implementing PPPs.*
2012	***Public Private Partnership (Preparation, Procurement and Management) Rules 2012 (Draft).***
2013	***MNES Subsidy for Waste to Energy Projects***
2014	***Scheme and Guidelines for Financial Support to Public Private Partnerships in Infrastructure***
2015	***Atal Mission for Rejuvenation and Urban Transformation (****AMRUT) – The scheme focus is on the urban renewal projects is to establish infrastructure that could ensure adequate robust sewage networks and water supply for urban transformation.*
2016	**MSW Management Manual Part I and II issued by CPHEEO, and MOUD**
2016	**Solid Waste Management Rules, 2016 -** The government released new rules in effect superseding all the earlier rules which focuses on holistic treatment of solid waste (not only just municipal waste) with in this framework

Source: Authors compilation. Italics indicate rules for MSW sector and others indicate rules for PPP procurement.

India's Institutional Framework is *PPP unit* and Regulatory Framework is *PPP guidelines* (UNESCAP, 2017). Table 2.4.3 presents the institutional framework of selected sectors of India. Roads can be taken as a representative of most widely used sector for PPP procurement, MSW sector can be viewed as moderately used, and Railways can be viewed as booming sector for PPP mode of procurement in the recent years.

Table 2.4.3 Institutional Framework comparison of Selected Sectors of India

Item/Sector	Roads	MSW Projects	Railways
State/ agency	National Highway Authority of India (NHAI)	ULBs	Rail Vikas Nigam Limited (RVNL)
Legal Framework	NHAI Act, 1988	74th Constitutional amendment, SWM Rules 2016,	Created under National Rail Vikas Yojana (NRVY)
Decision Making Responsibility	NHAI	Local/ILBs	RVNL

Project Development Responsibility	NHAI and Ministry of Road Transport and Highways (MoRTH)	ULBs/ Supported by Central Funding Agencies if any	Ministry of Railways (MoR), RVNL
State Support Funding	Central Road Fund and Aid from Donor Agencies	Not mandatory	MoR
Conflict Resolution within Government	MoRTH	--	MoR
Guidance Materials	Yes	Suggested	--
Standard Documents	Yes	Suggested	--
Model Contracts	Yes	Partial	--
Project Preparation Guidelines	Yes	Partial	
Established Regulatory Agency	MoRTH	--	--
Dispute Resolution	Contractual	Contractual	--

Source: Authors modified with adaptation from (The World Bank, 2006).

2.5 PPP USAGE -GLOBAL REVIEW

PPP initiative has spread from the experiences of developed nations such as the UK, Australia, and the USA to developing nations such as India, China, Brazil, and Ghana (Li et al., 2005; World Bank Group, 2016). The origin of PPPs dates to the private finance initiative in the UK. The cash strapped public sector opted for PFI/PPP mode to solve the constraints. Most of the PPP projects in the UK are privately funded (Hodge and Greve, 2010; Li et al., 2005). Particularly, the governments including developing countries are constrained on the public borrowing due to cap on the general government deficit and gross public sector debt (Akintoye and Mohan M. Kumaraswamy, 2016; Li et al., 2005). Besides this, the public sector infrastructure assets and services are far from the required standard. Globally, the waste sector of developing countries is criticised that there is a massive lack of infrastructure (Hoornweg and Bhada-Tata, 2012; Spoann et al., 2019).

PPP mode is regarded as quite suitable because of the constraints it potentially loosens. PPP provides a leeway to meet the growing demand and supply of infrastructure. Through the innovative project finance route, PPPs provide the capital investment and reduces the need for public money. Moreover, the debt component is recovered from the promising revenues earned from the project (DEA, 2015). This aspect has been an attractive factor for both the public sector and the private sector (Bain, 2009). Project financing is believed to bring in international expertise,

especially when international banks' funding is involved. With respect to the delivery of assets and services, PPPs are observed to provide benefits of integration in multiple forms (HMT, 2012). This is because responsibilities such as designing, financing, construction, and operation are considered to be better handled by the private sector. In addition, smaller and unviable projects which otherwise would never be implemented can be tendered as a single project in PPP mode. These are considered to be imparting the benefits of economies of scale and scope (Eaton et al., 2006; Hodge and Greve, 2010). Hence, PPPs are perceived to have enabled the governments to provide integrated solutions on the assets and service by cutting the blockages prevailing in the traditional delivery methods. As more and more projects are funded by project financing mode, governments were relaxed to fund the capital investment. The private sector makes the necessary investment and recovers along with return on investment through the user fee (Bain, 2009; Cheung et al., 2010).

Significant attractiveness to PPPs is also because of the reduction it provides on various aspects. The ruthless scrutiny of the private sector from commercial and profit-making perspective would facilitate the capping of final service costs to some expected levels as determined by the concession agreement in the PPP mode (DEA, 2015). Moreover, competitive bidding allows the public sector to contain the final cost of the total transaction. Thus, PPP usage assumes a check to cost overruns and the reduction of the total cost of the project due to its commercial emphasis combined with a freedom that allows to swiftly select innovative methods to deliver the assets and services (DEA, 2015; Eaton et al., 2006; Hodge and Greve, 2010). As a result, PPPs are noted as a solution to time overruns that plagued the traditional procurement. This is due to the incentive to start earning the revenues by finishing the construction early. For instance, in the Indian road sector, PPPs took 6 days to construct one lane-km while Engineering Procurement and Construction (EPC) took 16 days to construct the same one lane-km of road (Thillai Rajan and Deep, 2019).

PPPs are noted for the extra leverage it facilitates to the public services. In the procurement of PPP projects, it is accredited that the client can follow an approach of scoping the desired outcomes instead of detailed specifications of the assets required for the project (HMT, 2012). As a result, the ability of the private sector is quite challenged to create products and services that would meet the prerequisites of the project. So, PPPs contribute to the buildability of the project by using materials,

machinery and components by focusing on economies and efficiency to the meet the required quality levels (Ferguson, 1989). By doing so and with the grouping of asset responsibilities such as design, construction, operation and maintenance results in ease of maintaining the project (Eaton et al., 2006). Additionally, PPPs channelized the transfer of global technologies to local enterprises within the project vicinity through joint ventures and memorandum of understanding with local contractors with a win-win model (Li et al., 2005). In such a situation, public organisations can also prefer to liberate themselves by transferring the risk related to the provision of the facilities of the project. This included the aspects of assuming the responsibility to deliver on budget and on time. Public sector specifies the risk allocation beforehand and private sector bids and expects a profit for the risks that are transferred (Akintoye et al., 2016). Through appropriate risk allocation and the liberty PPP provides, the private sector can complete the project early. This would motivate the private sector to accelerate the whole process of project development by putting best and efficient resources and technical expertise of the private sector organisation. Hence, it is construed that PPP usage can reduce the administration costs of the public sector related to service provision (Cheung et al., 2010). This is because the government can take a less demanding role in supervising the project performance by deploying a project monitoring unit. Besides, PPPs share the cascading effect of local development near the facility. Many auxiliary services and productive opportunities are possible due to the project (Li et al., 2005). Moreover, the stimulus to PPPs in the MSW sector came when the services of the MSW sector are ordered by the Supreme Court of India and enacted by the central government (DEA, 2009). Prior to such requirements, this sector is least cared for.

Besides the benefits of PPP, it has also faced several criticisms and still suffer negativity on various aspects related to finance, institutional framework, transparency, benefits it potentially offers, and procurement process (Akintoye et al., 2016). Critics moot that project accountability is greatly reduced (Cheung et al., 2010; DEA, 2015; Li et al., 2005). The traditional project procurement is regarded as transparent due to the involvement of various government bodies of India such as the comptroller and auditor general, central vigilance commission (DEA, 2015). They have a streamlined process for information disclosure and reporting. On the other hand, most of the information of PPP apart from superficial details are excluded by citing confidentiality

and propriety of information reasons (DEA, 2015; Lee et al., 2018). Besides this limitation, the handover of the responsibility of infrastructure delivery is often coupled with the fear of losing jobs and the reduction of employment positions. For instance, airport development and modernisation projects in India faced still resistance from the Airports Authority of India (The Indian Express, 2015). These fears are informed by the private sector expectations such as throughput, efficacy, and cost-saving in the management of its human resources.

PPP projects typically have over-reliance on the incumbent private sector, as it will be difficult for a new entrant to continue the construction and / or operations in an incomplete but terminated project. This usually increases ex-post transaction costs to the public sector and provokes opportunistic behaviour in the private sector (Hodge and Greve, 2010). This situation particularly puts the public sector in a disadvantageous position. On the other hand, the requirements of projects procured in PPPs are inherently complex. This situation is perceived to cause an increase in the participation costs to the potential contractors. For instance, contractors have to undertake and invest in many supporting studies before making their bids to prevent unwanted loses in the later stages of the project (Mahalingam et al., 2011). Extant literature also points out that tendering costs are usually high in PPP procurement as compared with traditional procurement systems (Patil and Laishram, 2016). Often various private companies with diverse expertise must come together to submit the bid for a complex project, and this involves cost. This also includes the cost of equity that is invested in the business organisation, resulting in an increase in the bid price. As a result, many PPP projects confirmed the higher charges to the end-user, especially road projects (Thillai Rajan and Deep, 2019). Additionally, the procurement process of PPPs is found to be having more lead times than that of the traditional delivery methods. This includes consultations and setting terms and conditions. The pre-contract negotiations further add to the delays. Moreover, studies accede that PPPs have higher costs than the traditionally delivered projects (Cheung et al., 2010; Lee et al., 2018; Li et al., 2005; Patil and Laishram, 2016). Various reasons lead to this conclusion. Private sector adds high returns to the unknown risks, particularly at the early stages of maturity. Besides, the cost of private finance is higher than the interest rates of public sector borrowings (DEA, 2010b; Li et al., 2005). Since the projects are getting bigger and bigger in the PPP model, the concern of the increased project costs also increased in the PPP mode

(Flyvbjerg et al., 2004). Very often, the size of the project also affects the cost escalation of the project. These projects also suffer attacks that project promoters often misrepresent the cost-benefit analysis (Flyvbjerg et al., 2004).

PPPs also observed significant cancellation rates (Lee et al., 2018; World Bank Group, 2016). Since a considerable number of projects are aborted even before reaching the full concession period, PPP suitability is often questioned. The rest of the projects, more often than not, suffer from delays caused by political influences during the procurement and tendering process. This also causes further delays. Often, these political deliberations continue after the award of a project (DEA, 2015). Besides, PPPs objectives are often foiled as public agencies often lack the understanding of the PPP modalities. Considering the long term nature of PPP projects as compared with the other traditional delivery models, an added demand arises mainly to have an insight on how to specify the contract modalities and what assessment criteria should be followed to ensure the selection of a competent bidder (Hodge and Greve, 2010; Li et al., 2005; Mahalingam et al., 2011). The conflicting ideologies of various advisors such as financial advisers, legal advisors, and technical experts tend to result in ineffective objectives and evaluation criteria. The lack of skills is likewise true to private sector where construction contractors exhibit inadequate understanding of the finances, operations, and maintenance from long-term perspective. Moreover, due to stringent participation requirements and lack of necessary experience, PPP bidding is confined to relatively few players (Hodge and Greve, 2010; Lee et al., 2018; Li et al., 2005).

Based on this review, the attractive and negative factors that have been considered in this study are given in Table 2.5.1 and Table 2.5.2. To simplify, the attractive factors focus on the reasons that have compelled the public and private sector parties involved in infrastructure projects towards PPPs. Similarly, the negative factors are the ones causing adverse impacts as observed by the public and private sector parties involved in the PPP infrastructure projects.

Table 2.5.1 List of Attractive Factors for PPPs

	Attractive Factors	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
AF1	Solve the problem of public sector budget restraint	✓		❖	✓	✓	✓	✓		✓
AF2	Provide an integrated solution (for public infrastructure/services)	✓	✓		✓		❖	✓	✓	✓

	Attractive Factors	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
AF3	Reduce public money tied up in capital investment	✓			❖	✓	❖	✓		❖
AF4	Cap the final service costs	❖	✓		❖	✓		✓		✓
AF5	Facilitate creative and innovative approaches	✓	❖		✓	✓	❖	✓		✓
AF6	Reduce the total project cost				❖			✓		
AF7	Save time in delivering the project		✓	✓	❖	✓	✓	✓		✓
AF8	Transfer risk to the private partner	✓		✓	✓	✓	❖	✓		✓
AF9	Reduce public sector administration costs	❖			✓	✓		✓		
AF10	Promote local economic development	❖		✓	✓			❖		
AF11	Improve buildability	❖			✓	✓		✓		❖
AF12	Improve maintainability				✓			✓		❖
AF13	Technology transfer to local enterprise		✓		✓	✓		✓		✓
AF14	Non-recourse financing	✓			✓	✓	✓	❖		❖
AF15	Accelerate the project development	✓	✓		❖			✓		✓
AF16	Legitimacy requirements set by the government	❖		❖					✓	✓

Legend: ✓ – Indicates study/report has meant with analogous words; ❖– Indicates study/report has critiqued in a broad sense.
Reference: (1) (Hodge and Greve, 2010) (2) (Eaton et al., 2006) (3) (Akintoye et al., 2016) (4) (Li et al., 2005) (5) (HMT, 2012) (6) (Bain, 2009)(7) (Cheung et al., 2010) (8) (DEA, 2009) (9) (DEA, 2015);

Table 2.5.2 List of Negative Factors for PPPs

	Negative Factors	(A)	(B)	(C)	(D)	(E)	(F)	(G)	(H)	(I)
NF1	Reduce project accountability	✓			❖	✓		✓		
NF2	High risk relying on the private sector	❖			✓		❖	✓		
NF3	High rates of aborting projects before contract		✓		✓	❖		✓		❖
NF4	Lengthy delays because of political debate	✓			✓		❖	✓	❖	✓
NF5	Higher charge to the direct users	✓			✓		✓	✓	❖	
NF6	Less employment positions	✓			✓	✓		✓		
NF7	High participation costs	✓	✓		❖		❖	✓		✓
NF8	High project costs				❖			✓	❖	
NF9	More time spent in contract transaction	✓		✓	❖			✓	❖	✓

	Negative Factors	(A)	(B)	(C)	(D)	(E)	(F)	(G)	(H)	(I)
NF10	Lack of experience and appropriate skills	❖			✓		❖	✓		
NF11	Confusion over government objectives and evaluation criteria	❖			✓			✓	❖	✓
NF12	Excessive restrictions on participation	❖		❖	❖			✓		
NF13	Lengthy delays in negotiation	✓				❖		✓	❖	✓

Legend: ✓ – Indicates study/report has meant with analogous words; ❖– Indicates study/report has critiqued in a broad sense. # Reference: (A) (Hodge and Greve, 2010) (B) (Eaton et al., 2006) (C) (Lee et al., 2018) (D) (Li et al., 2005) (E) (HMT, 2012) (F) (Abdul-Aziz and Jahn Kassim, 2011)(G) (Cheung et al., 2010) (H) (Mahalingam et al., 2011) (I) (DEA, 2010b)

This led to the first research objective:

OBJECTIVE 1: To understand the perceptions on attractive and negative factors for Indian MSW projects in adopting PPP mode.

2.6 RISK MANAGEMENT IN MSW SECTOR

2.6.1 Importance of risk management studies

Risk management is the most popular research topic in PPPs in spite of numerous studies on this topic (Narbaev et al., 2020). This perpetual focus is caused by its nature, i.e. it is the fundamental mechanism grounding the PPP model and it plays a vital role in value for money achievement. Optimum risk allocation, i.e. identifying the party who is in the best position to manage the concerned risk is the prime motive of PPP risk management studies. PPPs are realized to have conflicting interest for which preparation phase was especially emphasized for attention (Grimsey and Lewis, 2002; Reijniers, 1994). PPPs predominantly rests on the contract theory where the principal (i.e. Government) appoints an agent to provide services on its behalf. These principal-agent relations are primarily resting on the contractual relations resting on two props namely the precise definition of the work and the attitude of the parties involved. This definition of work is often referred to the risk allocation framework that forms the fabric of the concession agreement in a PPP contract. PPP projects are typically funded using the project finance route, wherein significant portion of the funding is provided by lenders. Problems of vested interests are noted due to political influence (Handley, 1997) and conflict of interest between public and private sectors (principal-agent

problem) heighten the need for appropriate risk allocation. The lenders insist on the allocation of risk to the best party that can limit the risk exposure so that project company will have minimal residual risk (Srivastava, 2015). For proper management, it is necessary to undertake a thorough project risk assessment prior to construction (Serrano-Gomez and Munoz-Hernandez, 2019). Hence, appropriate risk management strategies are adopted in order to lower the probability of realization of the risk event and reducing the financial implication of the risk.

2.6.2 Stakeholders' viewpoint in risk management

Stakeholders' perceptions are important in the development process of a PPP project, and apprehension of such perceptions is needed, especially with respect to risks associated with the project (El-Gohary et al., 2006). Stakeholders relations are highly contingent on the way the risks are allocated, transferred, and managed in PPP projects (Burke and Demirag, 2015b). When it comes to municipal solid waste PPP projects, risk perception should be understood from all the three stakeholders like private developers, public officials, and also financial investors (IFC, 2014). Specifically, market-tested risk allocation is critical to ensure successful construction and operations of waste to energy PPP projects. There is a need for extensive risk analysis study in MSW sector as most of the studies have concentrated on risk analysis of economic infrastructure only (Ahmed and Ali, 2006). Furthermore, unique risks specific to MSW also come into play in PPP MSW projects such as waste collection and segregation risk that is also usually concerned with the composition of waste, and waste volume risk (often associated with or without minimum payment guarantee) (IFC, 2014). The implication of inappropriate risk allocation for public infrastructure is that it causes governments to pay a higher premium to the private sector while procuring the assets and services.

2.6.3 Studies on risk management in the MSW sector

Risk management has heightened interest in the research community as risks tend to vary with the sector of application, geographical location, and policy of the government. In MSW sector , Song et al. (2013) identified ten key risk factors using a case study with respect to PPP incineration projects of MSW sector in China. Adding to it, Xu et al. (2015) also, adopting content analysis, have identified risk factors based on incineration plants in China. The top five critical risk factors identified from their

study include insufficient waste supply, disposal of non-licensed waste, environmental risk, payment risk, and lack of supporting infrastructure. They argued that, in the case of incineration plant, site selection, waste classification, and recycling, waste transport, and waste incineration need in-depth attention during the procurement. Wu et al. (2018) studied PPP incineration projects in China. The risk assessment yielded 14 risk factors that can be grouped under construction and operation risk, macro-economic risks, legal and socio-political risks. Aiming to support the procurement of incineration PPP projects, Huang et al.(2018) presented the parameters that a potential investor should look on when considering incineration PPP projects. They have classified the risk under four categories, namely MSW-related, policy and financing, incineration technology, and other factors. Those risk factors include resistance from the local communities due to the pollution and potential health risks, operational efficiency, and technology that is selected. Moreover, they argued that these projects are affected by investment risk. Waste supply is also a critical risk that can affect these projects. Liu et al. (2018) argued that incineration projects of China have been affected by many risks that have originated due to longevity of the concession, participation by a wide range of stakeholders, and other factors that are typical of PPPs. With the help of multiple case studies and drawing from the experience of 35 PPP incineration projects, they have identified 18 risk factors among which six factors are rated as critical.

Fantozzi et al. (2014) studied the risks of PPP projects from the perspective of biological technology-related projects. The findings show that availability and prices of land, completion on time, the price of electricity, the quality of the environment, the operation and maintenance of the technology, health and safety of the public and their acceptance are among the risks that are posited to be influential. Zhang and Wang (2019) conducted a questionnaire survey and expert validation to identify 21 risk factors related to incineration PPP projects. The identified that completion risk, performance risk, design, construction and operation, waste supply risk, revenue risk, government decision making and the support that it has offered, environmental pollution and the corresponding public opposition are among the key risk factors that affect the incineration projects. Taking the cues from road infrastructure projects, Ministry of Finance (2010) has identified that PPP risks in MSW sector and has classified the risks under pre-operative task risks such as land acquisition, supporting utilities, financing, planning, permits; construction phase risks as those related with the design,

construction; operations risks and allied influencing factors such as volume of waste, payment, revenue, environment, health safety. Besides, handover risk and other risks such as change in law and force majeure also affect EfW projects along with the risks that are caused by the sponsors and the concessionaires. Wang and Zhang (2018) stated that risks can be classified into systematic risks such as the legal, economic, social and political and the specific risk that emerge from the project itself. They identified that revenue risk, interest rate, credit risk, cost overrun, operation performance, environmental pollution and technical risk are the seven critical issues in the incineration PPPs. Massoud and El-Fadel (2002) conducted a case study to analyse the issues stemming from the private provision of public service in the context of Lebanon. The authors found that health risks are serious in private infrastructure. Moreover, privately built facilities are prone to risk raising from the support required, financing, planning, clearances, operations, and maintenance (Massoud et al., 2003; Spoann et al., 2019). Besides, the ability to collect segregated waste also has a serious bearing in the PPP projects in the MSW sector. The concessionaire also often at default while providing these services.

Often private developers also fail to deliver the promises and leave the project under jeopardy. This risk caused due to concessionaire is often, if not always, connected with the sponsor, i.e. the policies and approaches of the government (Spoann et al., 2019). Direct political risk is considered to affect the project if the government introduces changes in the law, or any hindrance to the performance of the private sector's obligations as per the agreement (Ferdan et al., 2015; Nema, 2009; Wang and Zhang, 2018). Moreover, the ability to recoup the investments and have a set market for the end-products of the EfW projects has a crucial relationship with the success of PPP projects. Waste supply risk is concerned with the supply of sufficient about of waste collection and delivery (Ferdan et al., 2015; Nema, 2009). In some cases, instead of specifying the waste to be supplied, the ULB may assign a locality to provide the services. So far, in power, sector international political risk has played a crucial role and governments have learned lessons from the failures, mainly when the international players are involved. The contemporary energy from waste (EfW) projects are also increasingly facing this political risk (Moran et al., 2008). MSW projects are characterized by the need for intensive maintenance of assets and facilities and success of the project also depends on the proper operation of the services. Thus, operation and

maintenance risk is identified to be one of the critical risks in case of PPP MSW projects. Market risk is referred to the outputs of the project, and subsequent sale of those outputs like compost, RDF, power, gas, and bricks and is identified to affect the MSW PPP projects (Massoud et al., 2003; Mittal et al., 2018; Nema, 2009).

Based on the literature review, 22 risk factors were identified as shown in Table 2.6.1. These 22 risk factors are the subject of analysis for this study. All the studies on risk management in MSW sector largely reported are in Chinese context dealing with incineration EfW projects and little research is carried out with other available technologies and that too in Indian context. Since the conditions between India and China are quite different, much of the extant literature would fail to deliver successful projects, if applied directly. In case of MSW sector, the previous studies have focused mostly on PPP MSW projects using technologies such as incineration only. Whereas in developing countries like India, most of the PPP MSW projects have adopted only the proven and cost-effective technologies such as composting, biomethanation, RDF to power, while there are a limited number of projects adopting advanced technologies such as incineration, pyrolysis-gasification along with the sanitary landfill (MoUD, 2011c). As a result, a comprehensive study with respect to Indian context needs to be undertaken as such a study towards the development of appropriate risk allocation framework is crucial even in Indian PPP market, considering the nuances of technologies in PPP project procurement. Thus, the addition of technology as a variable in developing the risk management framework seems to be warranted. The objective of the current study is to identify significant risk factors in PPP EfW projects and establish the risk allocation preference among stakeholders.

Table 2.6.1 Risk factors for Energy from Waste PPP projects

Risk Code	Risk Factor	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
R01	Land acquisition risk		✓	✓	✓	✓		✓	✓						✓	
R02	Supporting utilities risk	*				✓		✓	✓		✓		*		✓	
R03	Financing risk	*		✓	✓	✓		✓			✓	✓	✓	✓	✓	✓
R04	Planning risk	*			✓	✓	✓				✓	✓			✓	*
R05	Permits and Clearance risk			✓		✓		✓	✓		✓	✓			✓	

Risk Code	Risk Factor	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
R06	Design risk		*			✓			✓						✓	
R07	Technology risk	*		✓	✓		✓		✓	*	✓		✓	✓	✓	*
R08	Completion risk			✓	✓			✓	✓	*	✓				✓	
R09	Operations and maintenance risk	✓			✓	✓			✓	*	✓	✓			✓	
R10	Environment, health and safety risk	✓	✓	✓	✓	✓	✓	✓	✓	*	✓		✓		✓	*
R11	Waste Volume risk	*	✓	*		✓			✓		✓		✓	*	✓	*
R12	Revenue risk	✓	✓	✓		✓	✓		✓	✓	✓			*		
R13	Market risk			✓				✓			✓		✓	✓		*
R14	Waste collection and segregation risk		✓		*		✓		✓			✓	*	*	✓	*
R15	Handover risk / Terminal value risk			*		✓					✓					
R16	Force Majeure			✓		✓		✓	✓							
R17	Concessionaire risk		✓		*	✓			*	*	✓	✓	✓	*		
R18	Sponsor risk		✓	✓		✓			*	*		✓	✓	*	✓	
R19	Indirect Political Risk	*		*			✓	✓	*	*		✓				*
R20	Direct Political Risk	*		✓	✓	✓	✓	✓		*			*		*	*
R21	Insufficient households	✓	✓						*	*	*		*	✓	*	
R22	Competition (Exclusive right)		✓		✓									*	*	

Legend:

✓ – Indicates authors have used the same specifically; *– Indicates authors have used the same in a broad sense; References: 1-Wu et al. (2018), 2-Huang et al. (2018), 3- Liu et al. (2018), 4-Fantozzi et al. (2014), 5-Ministry of Finance (2010), 6-Song et al. (2013), 7-Xu et al. (2015), 8-Zhang and Wang (2019), 9-Wang and Zhang (2018), 10-Massoud and El-Fadel (2002), 11-Spoann et al. (2019), 12-Nema (2009), 13-Mittal et al. (2018), 14-Wu et al. (2017), 15-Ferdan et al. (2015).

The second research objective, thus, derived from the above-mentioned reasoning on the role of risk management in PPP MSW sector is as follows:

OBJECTIVE 2: To understand the perception various stakeholders on the risk profile of various technologies in MSW PPP projects and risk allocation

2.7 SERVICE PROVISION IN MSW SUPPLY CHAIN AND BUNDLING

Adoption of PPP mode in MSW services has increased progressively in India with time. The reasons for this could be attributed to many factors. Firstly, the shortage of urban local body's (ULB) workforce has led to deploying private agencies to clear the community bins (refuse containers) and transfer the collected waste to the dumpsite.

Later, door-to-door collection services were initiated. To optimise the cost, ULBs have sought secondary transportation with the help of transfer stations. Moreover, treatment of waste has been gradually undertaken to fulfil the statutory mandate. In this regard, projects were utterly dependent on the private agencies because such facilities were non-existent previously as ULBs do not have the competency. In view of this, the Central Government has taken initiatives to improve the MSW conditions of India through flagship programmes. For instance, Swachh Bharat Mission (SBM) of India, launched in the year 2014, aims to achieve 100% scientific solid waste management in all 4041 statutory towns of India. In addition to this, many ULBs have also started delegating the whole supply chain of rendering MSW services to a single private partner. However, most of the ULBs in India lack the capacity to develop social infrastructure projects on PPP mode. In order to achieve the intended benefits, ULBs should have adequate capacity to incorporate the principles of institutional design while undertaking environmental programmes such as waste management through PPPs (Forsyth, 2005). In fact, conditions observed in India relating to MSW sector relating to the existing mechanism of waste management and their inadequacy, inadequate competencies of ULBs and lack of finances, the usage of private sector participation to improve the services are commonly observed in most of the developing countries (Rodić and Wilson, 2017).

The inefficient public services are notably revamped through public-private partnerships (PPPs) with their commercial principles and procedures in the operation of utilities (Seppala et al., 2013). Since PPPs have turned out to be the essential mode of infrastructure delivery, an effective and implementable procurement is argued to be important (Zhang, 2005b). Extensive usage of PPPs is due to value for the public money achieved when obligation for design (D), construction (C), finance (F), operation (O), and maintenance (M) of an asset is entrusted to the private sector as a single project through bundling. After prolonged usage of PPPs across countries and sector, bundling the functions relating to creation and operation of infrastructure asset became an indivisible characteristic of PPP route of infrastructure delivery (Garg and Garg, 2017) and is eventually considered as a hallmark (Dewatripont and Legros, 2005). While procuring PPP projects, multiple benefits were perceived due to bundling. As the scale and scope of activities increases because of bundling DCFOM (Design, construction, finance, operation, and maintenance) functions of the assets of

infrastructure, the burden to provide a sovereign guarantee on loans is reduced (Tiong, 1990) and governments became more comfortable to push today's debt to tomorrows payments, as private finance is not accounted in countries sovereign debt. Such a move has also become attractive as project finance is protected against direct political influence. Viewing DCFOM functions from life cycle perspective gave the private sector more opportunity for cost savings over the whole life-cycle, which could result from innovation, risk pricing and trade-offs between higher initial costs and lower operating costs (Grimsey and Lewis, 2009). As Bennett and Iossa (2006) stated, PPPs are in itself motivated to take advantage of possible synergies in the different phases of a project in the bundled mode. Bundling is also perceived as a motivation for early project completion addressing the time overruns in traditional procurement due to the incentive to the private sector for earning early returns (Buckberg et al., 2015). Ultimately, achieving value for money has been the most compelling reason for such bundled PPPs due to the lifecycle integration prospect in bundling fostering innovative thinking in private consortium (Fischer et al., 2006).

Nevertheless, some case studies have commented critically on the positive implications of function bundling. Bundling of the functions resulted in higher cost of PPP road projects (Blanc-Brude et al., 2009), inhibited the opportunity for operational efficiency and chances of private investment recoupment in hospital projects (Roehrich and Caldwell, 2012), and compromise of the life cycle benefit is observed within the consortium of PPP light rail project (Carpintero and Petersen, 2015). Van den Hurk and Verhoest (2015) findings show that bundling PPP does not always live up to the expectations. Hence, it would be beneficial to scrutinize other cases of bundled PPPs. Such scrutiny should evaluate the situation in which the bundling decision can be a desirable tool, probably more important, and in which context it is not, by considering political, technical, and multi-actor perspectives. Van den Hurk and Verhoest (2015) also pointed out that bundling and unbundling is a governance problem and governments should consider the complexities that are likely to emerge in this situation.

In addition to this limitation, the rationale of bundling in PPP model needs further scrutiny when the infrastructure project comprises of several assets with different functionality forming the components of the value chain. Network infrastructure has shown indications for such a need, and this decision may be relevant in other infrastructure projects also. Network utilities are public utilities that require a

fixed network to deliver their services (Newbery, 2000). Electricity, natural gas, water and wastewater, solid waste, communications, public transport, power are recognized as utilities and network services. The decision on bundling in such sectors not only needs to take the merits and demerits of bundling the functions into consideration but also the synergies that could be expected in bundling the various components of the value chain (Michaels, 2004). For municipal solid waste management and sewerage projects, provision of services requires the creation and operation of separate assets for collection and transportation, treatment, and disposal. Similarly, the provision of water supply/power also requires separate assets for the treatment/generation, transmission, and distribution. Empirical evidence in the past studies have shown that some network infrastructure has undergone a transformation of being bundled to unbundled mode in their service provision. For instance, power sector reforms directed the separation of generation from the transmission to create a competition in both the components in countries such as Argentina, Australia, Colombia, New Zealand, and the United Kingdom. A similar shift is observed in gas and telecommunications sector also (Kessides, 2012). Unbundling in water supply and wastewater management infrastructure has been observed in the state of Victoria, Australia (Wellman and Spiller, 2012). Also, in case of sectors with several assets for various components of the value chain (especially power sector), the practice has been directed towards unbundling these components and make it responsive to PPP mode of procurement.

However, the extant literature on PPP and governance such as OECD (2012), Grimsey and Lewis (2009), and Garvin (2009) does not differentiate between bundling of assets - representing the components of the value required for providing the infrastructure service, with the bundling of functions - relating to a single asset for providing the infrastructure service. For decision-making in such cases, the traditional PPP option analysis for structuring project scope and size relating to the bundling of functions corresponding to a single component of the value chain will need to be extended even to include which components should be included in the project scope. Studies in this direction are scant and the present study, thus, attempts to extend the body of knowledge on PPP to the complexity of bundling both the functions and components of the value chain in structuring the PPP project scope.

In India, ULBs of various cities have started opting for different variants of PPPs to provide MSW services either for a particular component or in an integrated

manner. Table 2.7.1 shows the various variants of PPP used for MSW services provision either in bundled or unbundled mode by few of the notable cities in India. The manner in which the services and components are bundled in these cities can be presented in a generic fashion using Figure 2.7.1. For instance, the cities which have opted for PPP mode for the treatment component bundle the design, construction, operation and maintenance (DCOM) services relating to this component. The cities which have opted for integrated solid waste management option not only bundle the services within this single component but also bundle all the components while delegating the responsibilities to private sector. In such a situation, deciding on whether the government should adopt a PPP for a specific component or multiple components in the MSW services will require evaluation of the diverse scenarios and conditions relating to several economic and social factors to ensure efficient and effective performance by the private sector.

Table 2.7.1 Services on PPP and Notable PPP Projects in India

Sl. No.	Services on PPP	Contractual arrangements	Example PPP Projects in India
1	Door-to-Door Collection	Service/ Management contract, Engineering Procurement and Construction (EPC) and Operation and maintenance (O&M) contract for short term	Bangalore, Ahmadabad, Nagpur, Jaipur, North Dumdum, Gandhinagar, Delhi, Mumbai
2	Secondary Collection and Transportation	Build-Operate-Transfer (BOT) and its variants, EPC and O&M contract, Management contract	Surat, Ahmadabad, Mumbai, Delhi, Chennai, Nagpur,
3	Treatment & Disposal	Design Build Operate Transfer (DBOT)/BOT (long term), EPC with 5-7 years O&M contract, EPC with O&M contract on renewal basis	Delhi, Bangalore, Coimbatore, Kolkata, Chennai, Ahmadabad, Surat, Ahmedabad, Indore, Guwahati (contemplating), Guntur, Vishakhapatnam, Jabalpur, Varanasi
4	Transfer Station	DBOT/BOT (long term), EPC with 5-7 years O&M contract,	Surat, Ahmedabad,
5	MSWM (complete value chain)	DBOT/BOT (long term)	Guwahati[#], Hyderabad, Ranchi[#], Allahabad[#], Raipur, Asansol,

Source: Authors representation based on (DEA, 2019; PWC, 2017); # indicates terminated projects.

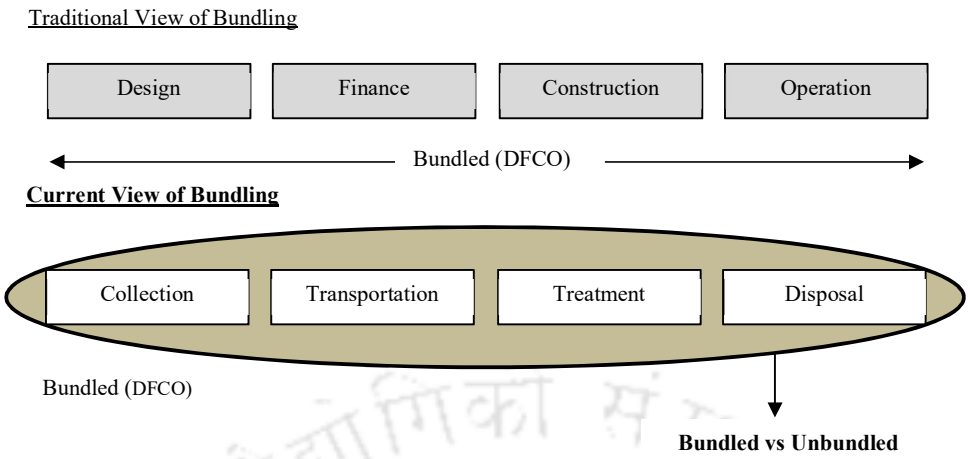


Figure 2.7.1 Bundling and bundling problem in MSW sector

Various public entities and transaction advisory in MSW sector have been considering both bundling the components of value chain into an integrated PPP project and unbundling the components of the value chain with bundling/unbundling of functions, without knowing the implications and effects of such decisions. Thus, filling this gap in the body of knowledge is the current requirement in India. The basic premise in this third objective is that a procurement system should sceptically examine the craft of components when delegating them to the private sector (Weisheng et al., 2013). By using comprehensive literature review as the methodological backbone, this study purposes to develop a testable holistic framework that examines various motivational constructs in PPP that drive better performance in PPPs. In this manner, the current inquiry will contribute towards a holistic perspective on the procurement governance and provides discussion on the effect of those PPP motivational constructs called bundling factors on the through-life performance of the project. To this end, a comprehensive literature review of factors affecting the bundling decision and fundamental motivations of PPP usage is needed to build the predictions of the framework on the project performance concerning the bundled or unbundled procurement. The third research objective is based on this review and the objective is as follows:

OBJECTIVE 3: To develop a bundling analysis framework to support the procurement of MSW PPP projects of India

2.8 SPECIFIC RESEARCH QUESTIONS

The three research objectives discussed in this chapter are translated into three specific research questions, which are presented below:

1. How suitable is PPP for procuring assets and services in Indian MSW sector?
2. What are the risk factors pertinent and relevant to various 'energy from waste' technologies in this sector and how such risk factors should be allocated?
3. What framework will facilitate the procurement of projects in MSW sector when the sector is characterised by various components of value chain representing different assets and facilities for delivery of MSW services?

2.9 SUMMARY

This chapter has explored the concepts related to the present study and helped in identifying the research gaps and the need for the study. Given the prominent role of PPPs for infrastructure development, it has been observed that MSW sector also started using PPP mode rigorously. However, studies that focussed on the MSW sector are few both in the international context and in the Indian context. Thus, there is a need to understand the perception of PPP preference with the experience gained so far by the Indian MSW practitioners. The chapter further found that poor risk management might have been the cause of failure in the treatment component of the MSW supply chain. This failure is more noticeable as various energy from waste technologies are used. This calls for study on the risk management since such a study in Indian context is missing. Lastly, literature on the supply chain management of infrastructure projects are reviewed. This highlighted that the rationale of bundling of components of supply chain is not understood comprehensively in the context of network infrastructure - particularly MSW sector. The key conclusion from this review is that there is a need to develop a bundling framework to cater to the needs of decision making in MSW sector supply chain.

Next chapter presents the research design and methodologies employed to address the identified research question and the objectives stemming from it. Explicit attention is given to the data collection, data analysis and organized into various chronological phases in carrying out the present study. Also, distinct focus is paid on

the available research methodologies and on the rationale for choosing methodologies in the present research inquiry. ■

CHAPTER 3

RESEARCH METHODOLOGY

3.1 INTRODUCTION

This chapter explains the research methodology adopted to achieve the research objectives and answer the research questions that have been raised. The next section reiterates the research objective and the specific research questions while the fifth section compares and delineates the various research methods that are available to assess the suitability for each research question. To explicate the process of the undertaken research, model showing the three stages of research design has been used to guide the flow of work. In the discussion of each stage, the fundamentals of the research design have been presented in the ontological and epistemological standpoints of the research method. Furthermore, the design of instruments for data collection, sampling, and collection of data, analysis techniques are highlighted. The concept of research methodology and method is explained, theory-building and theory testing, research strategies suitability and appropariteness are presented in Annexure 1 at the end of the thesis.

3.2 CURRENT PROBLEM STATEMENT

The general research question of this thesis is ***How MSW PPP projects are being structured in India****?* This main research question has been translated to three research questions and three objectives that are proposed to be achieved in this inquiry. The first objective aims to understand the perceptions of PPP usage in MSW sector at a broader level. The second objective extends the general question that, when PPP mode is considered as the suitable form, how risks should be managed particularly in the treatment component that uses energy from waste technologies. The third research question extends the focus to formulate a framework to support the procurement of such projects by taking cues from first and second objectives. The three research questions are recapitulated as follows:

1. *How effective is the procurement of MSW services by the ULBs through PPP route using the conventional procurement approach? How suitable is PPP for procurement of assets and services in Indian MSW sector?*

2. *What are the risk factors pertinent and relevant in this sector and how such risk factors should be allocated?*
3. *What framework will facilitate the procurement of projects in MSW sector when the sector is characterised by various components of value chain representing different assets and facilities for delivery of MSW services?*

3.3 RESEARCH METHODOLOGY

The research methodology adopted for answering the three research questions is schematically represented in the Figure 3.3.1. The study has adopted a three stage research inquiry to answer the three questions and these stages are elaborated in the subsequent sections. The appropriateness of the research techniques used in second stage to gain insights on each of the research questions is also discussed in these sections.

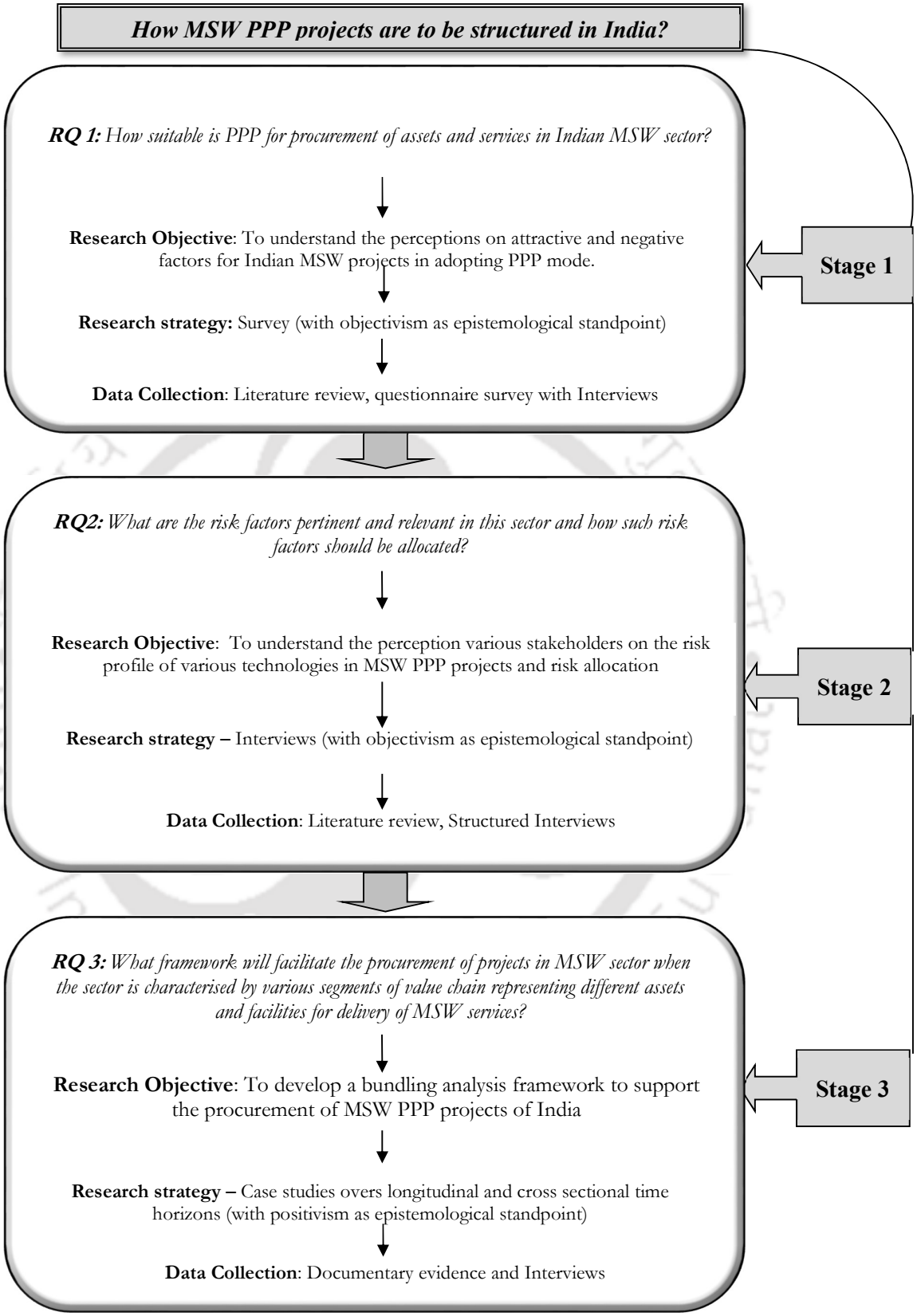


Figure 3.3.1 Research Process Adopted for The Current Study

3.3.1 Stage 1

The stage 1 has focussed on addressing the research question - ***"How suitable is PPP for procurement of assets and services in Indian MSW sector?"*** The current study is exploratory in nature and used mixed methodology. Mixed method means using more than one research approach. Mixed methods have been used relatively less in construction management research. Mixed methods are noted to complement the merging of different aspects of inquiry where one method compensates for deficiencies of one genre with the strengths of another. This study employed a questionnaire to collect quantitative data. This data was augmented through interviews by collecting rich quanlitative data by seeking elaboration on the attractive and negative factors of PPP usage. This would modify or strengthen the analytic findings when the results of each genre of method support, corroborate or contradict each other (Abowitz and Toole, 2010; Johnson et al., 2007). In doing this, the limitation of ecological validity of survey is countered with interviews. Moreover, for the underlying phenomenon, i.e. the factor affecting the PPP preference, usage of mixed methods ensures of survey results are interpreted by the respondent by taking interpretivism as epistemological standpoint instead of positivism. This potentially translates the nomothetic findings to idiographic findings. The thick description can potentially reveal the solutions for the most critical factors in the Indian context.

Questionnaire design

The questionnaire comprises three sections. The first section of the questionnaire contained general information about the target respondents. This includes qualification, general experience and MSW PPP experience, and organisation. The second section consisted of phrases related to the attractive factors for using PPPs in MSW sector. Similarly, third section focused on the negative factors affecting the MSW PPP projects. Five-point Likert scale was used from 1 (strongly disagree) to 5 (strongly agree) to capture the perception of the identified attractive and negative factors for PPP in the Indian context. Based on their experience, every respondent is requested to select a perceived agreement rating of the phrases. By this process, the inquiry aimed to validate/extend the findings of generic PPPs in developed countries to India - a developing country and more specifically to the MSW sector.

Sampling and data collection

The questionnaire was administered between October 2018 and January 2019. The target respondents were representatives from the public sector, private sector, transaction advisory, financial institution, and academic institution who are typically the key stakeholders of PPPs. Snowball sampling has been adopted to reach the stakeholders. Additional support is derived from data sources such as the empanelled list of consultants issued by Government of India for the MSW sector. Pilot testing of the questionnaire instrument was carried out with two experts (one from industry and one from academia). Based on the inputs, the terminology of scale and working of variables was finalised. Accordingly the questionnaire is modified. For example, AF16 was modified to 'comply with the MSW Rules set by the Indian government.' This suggestion concurred with the emphasis by position paper on MSW by Department of Economic Affairs (DEA) that PPP is inevitably necessary due to poor compliance to the MSW rules. It states that "…*Given the lack of in-house capability of municipal authorities and paucity of resources, it is desirable to outsource certain services and resort to PPP/NGO(non-governmental organisation) participation in providing SWM services* (DEA, 2009: 2)."

Around 120 survey forms were sent in paper and digital formats. 76 respondents attempted the survey. Of these, 24 respondents could not complete the survey or responses have missing values. Hence, the analysis has been carried out with the 52 valid responses. This is on par with response of many previous studies such as Kometa et al. (1994) with 52 responses from the UK construction industry, while Li et al. (2005) had 61 responses for the UK, Cheung et al. (2010) with 34 responses for Hong Kong and 11 responses for Australia in the studies related to PPP. Therefore, the final response rate is 43.33%. The demographic details of the survey respondents are shown in Table 3.3.1. This shows that the knowledge and experience of the respondents' correlates with the age of Indian MSW sector and the number of projects executed by each ULB so far. Out of these 52 respondents, interviews with two representatives from public, two from private, two from transaction advisory, and one from financial institution were carried to understand their perceptions and rationale. The selection of these interviewees is to have representativeness with the stakeholder groups. Respondents with rich experience and that are willingness to participate gave the qualitative interviews about the perceptions. The average experience of the seven

interviewees was 14.9 years. Each interview lasted between 45 to 90 minutes. The interviews were guided by a structured interview template aimed to capture the reasons for their responses in the questionnaire survey. Interview transcripts were coded and analysed using Nvivo 10.

Table 3.3.1 Survey Respondent Profiles

Characteristic	Category (%)
Qualification	Undergraduate degree (7.6%) Postgraduate degree (65.3%) Postgraduate diploma (3.8%) Doctorate (13.4%)
Working Experience	Five or less years (5.7%) 6-10 years (7.6%) 11-15 years (19.2%) 16-20 years (9.6%) 21-25 years (13.4%) More than 25 year (36.5%)s
Experience in MSW PPPs	Five or less projects (59%) 6-10 projects (25%) 11-15 projects (1.9%) 16-20 projects (1.9%) More than 20 projects (1.9%)
Stakeholder Group	Financial Institutions (7.6%) Research Institutions (7.6%) Private Sector (32.6%) Public Sector (26.9%) Transaction Advisors (25%)

3.3.2 **Stage 2**

The stage 2 addresses the second research question - ***What are the risk factors pertinent and relevant in this sector and how such risk factors should be allocated (RQ2)?*** Risks are often regarded as subjectively biased and socially mediated (Zinn, 2008). The results of this conception are that objective risks are subjectively perceived and calculated. Subsequently, the subjective experiences of real risks are socially mediated. Hence, psychometric paradigms are popularly used in risk studies (Zinn, 2008). This is widely observed even in infrastructure PPPs across sectors and countries. In this vein, the current study used structured interviews that captured both quantitative and qualitative measures by using an interview protocol. The perceptions are quantified using the 5-point Likert scale, which is the most popular scale of psychometric questionnaires. Thus, triangulation methodology with both quantitative and qualitative

data has been used in current research as theory development with respect to MSW PPP projects particularly in India as this is in a very nascent stage (Fellows and Liu, 2015). Moreover, this kind of 'data combination' is an additive process that supports the discovery of patterns and gives due diligence to the diversity and complexity of the data (Vogl, 2019). This approach is seldom seen in management research, where Alireza et al. (2014) is one such study.

Interview protocol

Structured interviews were performed with 34 representatives. This comprises of 16 interviews from public sector, seven from private sector, and 11 representing transaction advisors. Structured interviews provide two advantages: it supports the deductive approach, and it helps to focus on particular issues rather than working with the discursive interview responses in unstructured interviews when aiming to form themes and make sense of the whole interview data (Bazeley, 2002). The qualitative answers are hand written during the process of interviewee. Additionally, a five-point Likert Scale comprising of linguistic terms with corresponding numerical value – 'Very Low-1', 'Low-2', 'Moderate-3', 'High-4', and 'Very High-5' - had also been used to solicit risk rating from the experts along with their verbal explanation giving quantitative data for the study. The template used for the interviews has an introductory note about research, followed by the research questions pretending to the study in two sections. The first section focused on the effect of the chosen four technologies on the risk profile of PPP projects and second section focused on the party that is best able to handle that risk. The risk allocation preference on the party which is in the best position to manage the risk was also solicited from the respondents as subsequent data set.

Sampling and data collection

Selection of the respondents has been made based on the concept of specific and prequalified panellists participation as they are most appropriate and knowledgeable about the intended research questions (Fellows and Liu, 2015). The selection criteria employed to select the respondents were public agencies with rich experience in the EfW projects who are involved from inception to the operations, private agencies and transaction advisory who have handled all the technologies in the EfW category. Given the experience of EfW in India and the selection criteria demanded by this study, 34 interviews helped to reach saturation in the theoretical level

of interview notwithstanding that quantitative data can potentially vary. Since the numbers of interviews are greater than 32, central limit theorem suggests that sampling distribution can be approximated to normal distribution. Therefore, it is possible to quantify the responses and apply statistical methods as a complementary technique to the same qualitative data. Moreover, the qualitative data is coded and analysed using Nvivo (Version 10), a computer-assisted qualitative data analysis software.

Table 3.3.2 Profile of Interviewees

Characteristic	**Category (%)**
Qualification	Undergraduate degree (20.5 %) Postgraduate degree (44.1 %) Postgraduate diploma (26.4 %) Doctorate (8.8 %)
Experience in MSW PPPs	Five or less projects (61.7 %) 6-10 projects (20.5 %)/ 11-15 projects (11.7 %) More than 15 projects (2.9 %)
Stakeholder Group	Private Sector (20.5 %) Public Sector (47.0 %) Transaction Advisors (32.3 %)

The categories of interviewees are consultants (selected from the empanelled list of consultants prepared by Government of India for MSW projects), and public and private sector representatives who are actually involved in different MSW PPP projects. From these categories, the respondents were selected using snowball sampling. Suggestions from the initially chosen experts led to further identification of other key players belonging to category of public sector, private sector, and consultants (Fellows and Liu, 2015). This approach of referral allows the researcher to reach populations that are difficult to sample when using other sampling methods and this is commonly observed with the projects related to local governments where there is an absence of centralised database required for such kind of research. Snowball sampling potentially maximises the number of qualified panellists (Fellows and Liu, 2015; Zheng et al., 2019). The profile of respondents who had participated in the study included executive engineers of public sector, managing directors, consultants, project specialists, project managers in PPP MSW of India (Table 3.3.2). Their academic background ranged from finance, management, environmental studies, economics, civil engineering and legal studies.

3.3.3 Stage 3

The third stage of the research inquiry focuses on gaining insights to address the third research question - ***What framework will facilitate the procurement of projects in MSW sector when the sector is characterised by various components of value chain representing different assets and facilities for delivery of MSW services (RQ3)***? To address this, case study research strategy has been found to be most appropriate for testing theory.

"The essence of a case study is to illuminate a decision or set of decisions: why they were taken, how they are implemented, and with what result" (Yin, 2009: 17). Hence, case study can be inductive in nature i.e. generation of theory where the epistemological position is interpretivism while ontological position is constructionism. When the intention of the case study is to test a theory, the epistemological position is positivism and ontological position is objectivism (Knight and Ruddock, 2008). The four major applications of case study are: to explain, to describe, illustrate, and enlighten (Yin, 2009). 'Case' being studied is a concrete entity, event, occurrence, action but not an abstract topic such as a concept, argument, hypothesis, or theory (Yin, 2009). Dulaimi et al. (2010) have noted that when the exposure to the market to PPP type is less and when there is limited or restricted research on the topic, case study is the best research strategy. In this context, though survey was employed for first two objectives, third objective necessarily demands the usage of case study methodology for the above mentioned reasons. This study aims to develop and validate bundling framework to aid the decision making of bundling of various components of PPP infrastructure projects especially those having multiple assets and service within the scope of the infrastructure delivery of the sector. For this purpose, case study research method is used to test the bundling framework that is developed from extant literature.

The steps suggested by Mills et al. (2010) for theory testing using case study is presented below.

1. Formulate the theoretical statement that will be tested
2. Select an appropriate sample
3. Specify the hypothesis for that sample
4. Measure the relevant variables
5. Test the Hypothesis

6. Formulate the test result
7. Formulate the implications of the test result for the theory

Martin and Turner (1986) suggested that researchers could use the existing body of knowledge to develop a theory that could possibly be tested with case evidence. This research is grounded on this approach by employing qualitative methods of utilizing the extant literature (Eisenhardt, 1989b). This study first built the theory from econometric studies on bundling and tested it with case studies pertaining to MSW PPP projects. The unit of analysis for this study is a PPP MSW project.

This study has adopted case study research approach to answer the research question **"*How the bundling decision is made in case of PPP MSW projects?*"** This research approach is positioned in an abductive manner suggested by Dubois and Gadde (2002). This is based on forming a logical inference that starts with an observation, then seeks to find the simplest and most likely explanation. Abductive study differs with the inductive or deductive logic in the process of formulating a theory. It starts with studying facts or results and explain those facts. This forms a theory. This iterative linking of data with the existing theories or propositions is unique and is believed to make meaningful contributions (Rahmani and Leifels, 2018). This method has also been employed in comparable problem setting by Roehrich and Caldwell (2012) where the authors collected the required transformation of PPP organizations by grounding the analysis on government reports and interviews. Similarly, this study's research design has the research question and propositions highlighting the theoretical background on bundling. In this process, the study draws from the literature of auction theory, agency theory, and transaction cost economics theory, to provide the framework for analysing bundling phenomenon of PPP infrastructure projects.

Case study protocol

The study attempted to unravel the phenomenon over period of time in longitudinal manner. The main strength of longitudinal research is the capability to study change and development over time (Saunders et al., 2009). This approach enables to study how the project unfolds over time rather than merely seeking to illustrate cross-sectional variation (Huber and Van De Ven, 1995). At the same time, the study nevertheless reflects the theoretical propositions posed by the case study (Yin, 2014: 53). Retrospective studies aim at recognizing themes indicative of the dynamic

developments while the longitudinal studies offer a close-up view of the themes as they evolve over time (Leonard-Barton, 1990). This helped to identify explanations of bundling phenomena that have evolved over time and which have received little prior investigation (Yin, 2003)(Yin, 2003).

Yin (2009) reports that individuals, small groups, organization, and partnerships are more concrete unit of analysis whereas communities, relationships, decisions, and projects are less concrete unit of analysis. This study proposed to consider MSWM sector as unit of analysis. Similar consideration was taken by Parker and Hartley (2003). More specifically, ULBs are considered as the unit of analysis because the ULBs are the organizations which have the vested power and interest to the deliver the service to the public.

Selection of cases

Yin (2009) suggests that in doing a multiple case study, selection of cases that best fit the **literal** or **theoretical** replication design as analogous to multiple experiments. Replication can be in findings, exact conditions of the original case/experiment, to see whether findings can be duplicated in the other experiment when original findings are unimportant. Therefore, Yin (2009) suggests that each case much be carefully selected so that it either 1. ***Predicts similar results (a literal replication), or 2. Predicts contrasting results but for anticipatable reasons (a theoretical replication).*** Replication procedures require rich theoretical framework. Literature review has provided the theoretical framework which is translated into case study protocol. The framework needs to state the conditions under which a particular phenomenon is likely to be found (a literal replication) as well as condition when it is not likely to be found (a theoretical replication). So, the theoretical proposition is that the developed theoretical constructs are relevant to the decision of bundling because of the causation observed in the failure of past projects.

Elman et al. (2016) noted that 'medium-n' samples can be mostly unstable in methodology as compared to small-n case studies that have efficiency as an advantage. The 'medium-n' samples also lack representative that can be claimed from 'large-n' samples. Noting on the dilemma, how should a case or cases be selected for analysis? There are no minimum number case studies to be carried. The selection of cases has been based on Yin (2009) recommendation to set an operational criteria for selecting

the potential 'candidates.' Yin also adds that the screening could consist of querying people knowledgeable about the project. This study attempts to carry six cases of MSW projects with replication logic. The 'candidates' are projects in this study, and the collection of limited documentation has become 'mini case' for every project. Moreover, the rationale of selecting projects/ULBs for case study information is set out to be:

1. Three projects procured in bundled mode and three projects either procured or planned in integrated mode.
2. Similarity in bundling of activities in the supply chain of MSW for the project under scrutiny. This is to ensure best fit for replication in research design (Yin, 2009).
3. Willingness of knowledgeable persons of the ULBs to participate.
4. Access to documentation and information.

The selected cases are shown in the Table 3.3.3. GAMET, PEARL, and CORAL (hereafter, bundled concessions) are the cities where private sector is employed to provide the services for all the components of the MSW supply chain namely collection, transportation, treatment, and scientific disposal. These cases satisfied literal replication. This meant that similar results can be expected if the theory holds good. On the other hand, EMERALD, DIAMOND, SAPPHIRE (hereafter, unbundled concessions) follow similar literal replication as MSW services are procured either by the combination of ULB and private sector to provide services or more than one private player to provide the services to the MSW supply chain in addition to the ULB services. The bundled concessions and the unbundled concessions are expected to satisfy a theoretical replication. This meant that contrasting results can be expected if the theory holds well in these cases.

Table 3.3.3 Classification of Cases

←--- Literal replication---→	**Bundled Concessions (C,Tp, Tr, D)**	**Unbundled Concessions (one or more of C; Tp; Tt; D)**
	ISWM GAMET	RSWM at EMERALD
	ISWM PEARL	ISWM DIAMOND
	ISWM CORAL	RSWM SAPPHIRE
	← ---------- **Theoretical replication**---------- →	

Legend:

(C, Tp, Tt, D) – Collection, Transportation, Treatment, Disposal; RSWM-regional solid waste management; ISWM-integrated solid waste management;

Data Collection

The evidence from multiple case studies is often considered more compelling and the overall study is therefore regarded as being more robust. For instance, pattern matching of all the similar cases and diversity in all the contrasting cases would enhance the generalizability of the theoretical propositions by eliminating the possibility of being idiosyncratic. This also enhances the internal validity of the methodology. This study adopted the recommendation of Yin (2009) to use multiple sources of evidence in converging the data points leading to triangulation of mixed method research for each case study. Yin (2009) also suggested six variety of evidence for doing case study such as documentation, archival records, interviews, direct observations, participant observations, and physical artefacts. Taking cues from Yin's suggestions, the present study has drawn from archives, interviews with stakeholders, project documents (concession agreements, RFQ, RFP, feasibility reports), policy documents of governments, and site visits to four case projects to directly observe the collection, transportation, treatment, and disposal activities. A total of 39 interviews were carried concerning the six cases studies. 21 interviewees represented public sector, seven represented private sector, four represented non-governmental organisations, and seven represented transaction advisory. Among the interviewees, private sector and transaction advisory personnel are often key informants in the top management level and even have participated in more than one of the cases chosen for this inquiry. The current study adopted an inductive logic approach as suggested by Creswell (2009). All the cases were analysed and case reports were prepared to ensure the validity and reliability of the findings. Metrics were drawn from literature for analysing the factor of the framework within the unit of analysis.

Data Analysis

The current method of analysis is heavily drawn from Miles and Huberman (1994), Miles et al. (2014), and Yin (2009). Amongst the suggestion by these authors, the strategy of examining rival hypothesis and the technique of pattern matching seems fitting for our current objective. Hence, the analysis of the data is focused on drawing evidence which negate the super rival hypothesis, thereby achieving confidence on the hypothesis, believed to close fit the date and explain the failure mechanism. The

interview data were transcribed, open and axial coded, summarized and displayed in an iterative process assisted by the computer-based software tool NVivo 10. The theory of interest would help to specify how certain conditions change over time, and the desired time intervals would presumably reflect the anticipated stages at which the changes should reveal themselves.

The logic of linking data with the propositions is to look at the positive/negative evidence, which prove/disprove the propositions of the identified constructs. The criterion of interpreting the finding is to validate the framework (i.e. bundling framework).

Validity and Reliability

The four criteria – construct validity, internal validity, external validity, and reliability – for ensuring the quality in case study research (Yin, 2009) were maintained in this study. The principles were derived from Yin (2009), Mahalingam (2010), and Taylor et al. (2011). The external validity concerns the generalizability of the study's findings. This was ensured by the use of multiple case studies in the research design. Moreover, usage of macroeconomic and organisational theories ensured external validity. Attention has been given in research design stage. Construct validity relates to the establishment of operational measures for the concepts being studied. Corroboration of data from multiple sources through triangulation ensures construct validity in with-in case study method. Precaution has been given in the data collection stage. Internal validity is concerned with the rigor with which the study was conducted. It also seeks to establish a causal relationship, whereby certain conditions are believed to lead to other conditions as distinguished from spurious relationships. Analytical techniques such as pattern matching and explanation building, addressing alternative explanations have been used to ensure the internal validity. Caution has been given in data analysis stage. Reliability concerns with the operation of a study such as the data collection procedures can be repeated, with same results. To ensure reliability, case study database has been developed in which a case writeup of around 5000 words was made for each case. Additionally, case study protocol has been used to ensure reliability. For this, attention has been given in data collection stage.

3.4 SUMMARY

This chapter discusses the research methodology adopted for the present study. The three research questions set out for inquiry demands different methods and corresponding methodologies. For the first research question, questionnaire survey is found suitable. For the second research question, structured interviews are found appropriate. Lastly, case study methodology with theory developing and theory testing is found appropriate for the third research question. The choice of respondents in this process needs to be confined to experts who are knowledgeable about projects in MSW and in PPP mode of procurement. Next chapter focusses on the theory development for addressing the third objective. ■

CHAPTER 4

BUNDLING CONCEPTUAL FRAMEWORK

4.1 INTRODUCTION[3]

The literature review has pointed out that the rationale of component bundling has not been studied enough and such a decision can have detrimental results. Indian MSW procurement clearly identifies with this phenomenon and thus demands further investigation. This chapter now develops a bundling framework by configuring three theories namely transaction cost economics, agency theory and auction theory to support the procurement decisions concerning the components arising from the project. Next section sketches the exposition of theoretical underpinnings that forms the basis for analysing the bundling problem. This is done by arguing its suitability and appropriateness. It then shows the development of bundling framework in light of the theoretical lens. The later section discusses the theoretical propositions unveiled from the extant literature arranged in the order of stages of PPP development.

4.2 THEORETICAL UNDERPINNINGS

The current study on opting to bundle or unbundle the components of value chain relates to making a decision by the organisation (i.e. ULB) on the mechanisms through which MSW PPPs should be structured. For this purpose, organisational economics literature is reviewed to find out the suitable theories to theorise the problem and develop the framework. Organizational economics studies the nature, roles, and performance of organizations (Gibbons and Roberts, 2013). In this process, it applies the economic logic and methods to understand the nature, design and performance of organizations. The study of the governance of economic organization has become a diverse field of research over the past four decades. The development of organizational thinking started when Coase (1937) inquired the vertical boundaries of the firm. He argued that economizing on the costs of market transactions would cause some activities to be removed from the market and brought inside the firm under hierarchic

[3] This chapter is published as Dolla, T. and Laishram, B. (2019), "Bundling in Public-Private Partnership Projects – A Conceptual Framework", *International Journal of Productivity and Performance Management*, In Press, available at:https://doi.org/10.1108/IJPPM-02-2019-0086.

control. Cyert and March (1963) also did some seminal work in this area besides Coase but on the behavioural theory of the firm. They challenged the profit maximisation and perfect knowledge assumptions of the theory of the firm. By doing this, the predicted the behaviour of the firm on parameters such as price, output, and resources allocation decisions but taking firm as the unit of analysis. Later, the role of capabilities such as information, knowledge and skills became the research interest to determine the effectiveness of intra and inter-firm activities. Organizational theorists later confirmed that imperfect contracting in organizational settings could sow conflict, collusion, and strategic behaviour with severe economic consequences when the organization fails either at the project or the whole entity level. The approaches employed in the analysis of vertical integration are as diverse as the study of organisations itself. However, transaction cost economics (TCE), agency theory, and contract theory emerged as the major force and are directly relevant to the current research (Gibbons and Roberts, 2013). The comparison of these major theories of organisation economics is shown in Table 4.2.1. Among these three approaches, TCE powerfully encompasses the broader efforts in the organisation economics studies that include agency theory and the design of the mechanism, property rights theory, the resource-based view (RBV) of the firm and the competency theories (Gibbons and Roberts, 2013; Joskow, 2008).

Table 4.2.1 Comparison of major theories of Organisational Economics

	TCE	**Agency Theory**	**Auction Theory[@]**
Key Idea	Complex contracting and non-market organizations	Principal-agent relationships and the efficient organization of information	Pricing and allocating key financial instruments Industry-specific bidding characteristics in Auctions
Basis of Organisation	Allocation of economic activity	Efficiency	Efficiency and cost-effectiveness
Expected outcome	Governance of economic organization	Efficient organization form	Best value (low cost)
Problem Domains	Vertical boundaries of the firm	Relationships in which the principal and agent can have differing goals (e.g. vertical integration)	Optimality of product bundling, bilateral and multilateral contracting and auctions
Independent variables	Optimal contract (with lowest transaction costs)	Relational outcome	Efficient mechanism/ procurement design

	TCE	Agency Theory	Auction Theory[@]
Dependent variables	Transaction costs, asset specificity, Uncertainty, Complexity, Frequency,	information asymmetries (during operations),	Bidders entry and nature (market), information asymmetries (during operations), number of bidders (competition).
Assumptions	Contracts are incomplete	Principals and agents are rational economic-maximising individuals	Incomplete contracts Holdup problem and opportunism.
Unit of Analysis	Transaction	Contract/Relation	Procurement
Causes of problem	Bounded rationality induced opportunism	Self-interest induced Agency costs, Moral Hazard, Adverse selection	Private evaluation of price by firms, Quality shading and Shirking due to inability to foresee and contract

Source: Adapted by authors from Williamson (1985), Eisenhardt (1989a), Hart (2003), Bolton and Dewatripont (2005), Gibbons and Roberts (2013)
[@] relates to procurement auction (which is typical first price sealed bid auctions) as this branch of contract theory is argued to be relevant in infrastructure projects (Bolton and Dewatripont, 2005; Drew and Skitmore, 2006).

Traditionally, governments deliver public services such as infrastructure through public sector organisations. In some cases, as in the usage of private sector participation, public sector organisations engage private entities to deliver public goods and services. The advent of procurement models such as PPPs has changed the role of public sector organisations. Since it is the individual factors and the organisational conditions under which the private sector services are sought and must be analysed, the organizational theory that is traditionally focused on private organizations/companies has been extended to understand the organizational decisions, policymaking and the efficiency of public sector organizations (Christensen et al., 2007). 'Make or buy' decisions by public health care agencies in the provision of health care goods and services is a hallmark example of the application of organizational economics by public healthcare organisations (Preker et al., 2000). This make-or-buy decision typically needs to consider the overall production activity, i.e. the service provision as a unit of analysis (Teo and Bridge, 2017). Hence discretion is expected from the public sector organizations (ULBs in this case) to identify and configure the procurement of assets and services from the private sector under the make or buy framework. Particularly, the ULBs need to focus on what to buy and from whom as ULBs no more providing

some services (e.g. treatment facilities, recycling facilities) on their own in sectors such as MSW.

4.3 PERSPECTIVES OF BUNDLING

Vertical integration is an arrangement in which a company owns the whole supply chain of a product. The vertical integration is also referred to as make or buy decision (Williamson, 1985). In the development of the governance framework, neoclassical theories depend on the market imperfections that associate with the power of the market, uncertainty, and economies of scale to explain vertical integration. However, the later advent transaction cost economics (TCE) perspective of vertical integration focused on the role of incomplete contracts and relations specific investments through asset specificity (Joskow, 2008). Bundling in PPP projects is identically a derivative of vertical integration from the economics literature. Bundling in the context of public infrastructure projects is a much larger decision of the government particularly driven by social welfare, whereas vertical integration is a purely economic decision of a firm (Hart, 2003).

TCE provides a tool for the analysis of governance and organisational choice where governance is the overarching concept (Williamson, 2002). TCE has been a useful tool to study the governance structure, degree of outsourcing, assess the success of outsourcing and the analyse the inter-organisational coordination and collaboration. Governments need to prevent making an ex-ante decision of an inferior option. TCE theory is a rich and logical framework being applied more widely for bundling/vertical integration problems and is an integration of all major theories of vertical integration (Williamson, 2002).

Agency theory explains the relationship between principles and agents in a transaction with a focus on the individual agent. It facilitates the systematic assessment of vertical integration problem, especially when used in complementarily with TCE (Eisenhardt, 1989a). Agency theory emerged as a framework for analysing transaction or relation between two parties that are engaged in service or delivery of goods and some economists have viewed agency theory as the theory of the firm. Though it is similar to the transaction cost perspective (Williamson, 1985), it brings additional unique and independent variables to the formulation (Walker and Weber, 1984) and

thus has explained problem situations such as 'make or buy' decision even when TCE failed to provide an explanation (Eisenhardt, 1989a; Lajili and Mahoney, 2006).

Contract theory examines how economic actors can write contracts, chiefly when there is asymmetric information. In the later development of this theory, studies added the influence of incentives to this process of writing contracts particularly in cases involving relationship-specific investments. This is popularly known as the theory of incomplete contracting. A notable application of this theory is the vertical integration problem of PPPs (Hart, 2003). Thus, optimal allocations can be implemented by combinations of simple mechanisms such as auctions and authority relationships. In incomplete contracts, governments auctions off the contract to provide public services (Hart, 2003). Hart's model showed that vertical integration has benefits with attached costs. In summary, these three theories, namely auction theory, TCE theory, agency theory, and auction theory can help in recognising and explicating the boundaries between the government entity and one or more private entities in the context of infrastructure service provision.

Several studies have demonstrated the applicability of these theories in problems similar to the fundamentals of vertical integration. Preker et al. (2000) adopted TCE theory along with agency theory to suggest the public-private mix in service delivery of health care. Lajili and Mahoney (2006) used agency theory and TCE theory to predict the vertical financial integration decisions of internet information technology and e-business derivatives of a frim. They argue that agency and transaction cost economics theories can be used to explicate and predict the vertical integration decision through microanalytic empirical research. González Díaz et al. (2000) used TCE theory to study the vertical integration problem to understand the incidence of subcontracting in Spanish construction firms. Brahm and Tarziján (2014) employed TCE to construction projects demanding speciality trade for some activities and investigated the make or buy decision of the building contractors. Teo and Bridge (2017) used theories of transaction cost and agency theory, among others, to determine whether a project or part(s) of a project can be efficiently assigned to a PPP. Their suggestion was to exclude the project activities that would increase the bid price and hold up to the government agency and form a bundle of rest of the activities to form greater value for money (VFM) PPP project. Though appropriate, it may sound, Teo and Bridge (2017) framework assumed that left out activities from the bundle needs to

be procured using traditional procurement. This situation is least applicable to Indian MSW sector as PPPs are inevitable but how many concessions are required to achieve an efficient and value for money PPP project should be the focus of analysis. Besides, Indian MSW sector seems to be affected by thin markets for its activities to be procured in PPP mode. Lastly, Estache and Iimi (2011) used auction theory to understand the effect of competition and market conditions surrounding the bidders to analyze whether governments will benefit by bundling of treatment Component along with the distribution works in water supply and sewerage projects of developing countries.

4.4 CHARACTERISTICS OF PPPS

PPP delegations are plagued with agency costs, transaction costs and contractual incompleteness. The aspects lead to the problems of adverse selection and moral hazard as articulated by economic theory (Iossa and Martimort, 2012). Hence, the strategic intents are essential in selecting from various procurement configurations. PPPs are distinctively *Project-based firms* which are the subtype of network firms typically having the nodes of complex multi-actor systems at an organisation and individual levels. This focuses on singular product, often unique and customised for long periods, confronted with complex and contested environments and provided with contributions of specialised entities. These project-based organisations would differ from the typical firm's view of the solitary actor and emerge as a focal unit in the field of actors (Scott et al., 2011).

In the context of bundling, the governance decision refers to a situation where public sector contracts all the components of the supply chain to single private contractor, i.e. pure bundling, mixed bundling refers to delegating to more than one private contractors, and unbundling assigns each component through independent, who are having a specific objective and goals, to complete the service provision. All these structures would differ on how the relationship between public and private organisation is managed, and moreover, the number of contracting parties also influence governance forms (Provan and Kenis, 2007). Bundling analysis in MSW sector to craft an efficient PPP project can suit the application of TCE because contracting problems can be investigated to economize the transaction (Williamson, 1985). Government contracts are typically awarded by procurement auctions. Auctions are the means that counter the possible market power conferred by a PPP to a private operator. Auction theory focuses

on the efficiency of procurement auction design and potentially explains the industry-specific bidding characteristics such as the construction industry (Dyer and Kagel, 1996). Competitive procurement of construction services is classified as an auction, making auction theory a suitable theoretical lens for analysing procurement situations (Crowley and Hancher, 1995). Therefore, auction theory identifies with bundling decision where the government should use procurement auction to handle the optimal bundle of components of the value chain to achieve the services at the lowest cost to the government. Theory derived from auction literature helps the regulatory authorities to design an efficient procurement (Menezes and Monteiro, 2008). Hence, bundling decision would qualify for the usage of governance and organisational theories as the lens for inquiry and analysis.

4.5 DEVELOPMENT OF BUNDLING CONCEPTUAL FRAMEWORK

The constructs that influence the transactional characteristics of bundling decision in case of PPP MSW projects have been derived from review of literature on PPP through theoretic lenses of transaction cost economics theory, agency theory, and auction theory (Table 4.5.1). Though the emergence of a particular construct is presented under one theory, many researchers (Eisenhardt, 1989a; Hart, 1995; Williamson, 1985) identify some overlaps among the assumptions and variables of these theories. In this study, the integration of theories is sought on account of seemingly disparate theoretical perspective but leading to a more complete understanding of the same phenomenon i.e. bundling problem. The bundling conceptual framework has been derived from these constructs and the development of this framework is organised according to the three stages of the PPP procurement process namely development, procurement, and contract management.

Table 4.5.1 Identified Constructs for Bundling Decision

Theoretical base	Construct	References	Stage of PPP
TCE *Component characteristics that lower (increase) net transaction costs with an external private sector participant should increase (decrease) the*	Economies of Scope	Kwoka (2002), Greco (2015) Williamson (1985), Estache and Iimi (2011), Hart (2003) Klein (2008).	Project Development Stage
	Transaction attributes namely asset specificity, transaction costs, uncertainty.	Lajili et al. (2007), Dewatripont and Legros (2005), Iossa and Martimort (2012), Perry (1989).	Procurement Stage

Theoretical base	Construct	References	Stage of PPP
likelihood that ULBs would choose (reject) to bundle those components into the project.			
Agency Theory *This theory suggests that components characteristics that lower potential principal-agent conflicts between the ULB and the private contractor should increase the likelihood that ULB would choose to bundle into the project.*	Innovation possibility	Dmitrieva and Guseva (2017), Hoppe and Schmitz (2010), Roehrich and Caldwell (2012), Lind and Borg (2010), Grimsey and Lewis (2009), Hart (2003), Bennett and Iossa (2006b).	Project Development Stage
	Quality Specifiability	Grimsey and Lewis (2009), Hart (2003), Eisenhardt (1989a).	Project Development Stage
	Subcontracting	Grimm (Grimm, 2007), González Díaz et al.(2000), Quiggin (2004), Estache and Iimi (2011).	Contract Management Stage
	Information asymmetries	Iossa and Martimort (2012), Dewatripont and Legros (2005).	Contract Management Stage
Auction theory *This theory suggests that the availability of a sufficient number of competitors for the market and in the market determines the bundling of components of the value chain for efficient outcomes in procurement auctions.*	Level of competition	Estache and Iimi (2008), Grimsey and Lewis (2009), Ahmed et al. (2016), Chakraborty (2006), Riordan (2008).	Procurement Stage
	Maturity of markets	Perry (1989), Roehrich and Caldwell (2012), Brewer et al. (2013), Iossa and Martimort (2012), Riordan (2008) Estache and Iimi (2008).	Procurement Stage

4.5.1 Project Development Stage

In PPP projects, the scope of the project is determined in the project development stage, driven by the intention to reduce costs by promoting innovation from the private sector (Parker and Hartley, 2003). PPP contracts are unavoidably incomplete. In this context two things become crucial. First, the ability to specify the terms and conditions or in other words the quality of the asset or service, and whether the intended assets and services have any economies of scope or can they be safely detangled to achieve better efficiency. Second, the possibility of getting innovative solutions and knowing the conditions which prevent such innovations, if a simple

contract is adopted. The governments typically carry these actions during the project development stage. In the past, incomplete information among the scope and asset specificity resulted in opportunistic behaviour in PPP partners (Parker and Hartley, 2003).

Studies have advocated the usage of TCE while studying the dynamics of PPP contracting due to incomplete contracting nature (Ping Ho et al., 2015). The most popular explanation of TCE on vertical integration has been that when economies of scope between successive stages could be achieved due to technological and organizational interrelationships, then these activates should be provided under joint ownership. This life cycle perspective should be viewed relative to transaction costs to explain the possible patterns in bundling phenomenon (Williamson, 1985). The agency problem is more relevant in situations in which contracting problems are severe such as the setting out an effective contract and its specifications with an agency and where there is an expectation of innovation from the agent (Eisenhardt, 1989a).

4.5.2 Procurement Stage

PPPs are supported due to advantage the market competition brings into the bureaucratic organizational forms through a contract, thereby increasing the efficiency due to incentives and profit maximization, and efficient resource allocation (Grimsey and Mervyn K. Lewis, 2005). To achieve value for money and innovation, the maturity of the markets available to provide the assets and services become crucial. Procurement auctions such as PPPs depend on the level of competition and the maturity of markets to make a compelling design (Klemperer, 2004). Potential bidders respond to the scope of the project based on their portfolio of business. So, the level of competition (i.e. the number of bidders available to bid for the project) has a significant bearing on the transaction cost to the public entity while using PPP.

According to agency theory, contract specifications linked with monitoring capabilities would align with the party incentives in case market forces motivate the agents to deliver efficiently. This phenomenon is further dependent on the number of sellers available in the market. Moreover, in procurement auctions, governments are not aware of an efficient contractor with whom they could directly negotiate. Hence, they depend on the lowest-cost firm in the market. In such situations, procurement auctions would reveal the sellers' true value of the product or service. Also, if there are

a limited number of sellers for a particular type of product or service, the seller has the advantage to decide the price of the product, preventing the revelation of the true value due to lack of sellers producing a similar type of product. This represents a monopoly, thereby symbolising an immature market. In such a situation, the contracting agencies may have difficulty in finding an alternative service provider if the project suffers termination. Thus, the prevailing market structure has an important role to play in case of PPP market. The lack of alternative service providers is typically reflected in the poor availability of private agencies/bidders, which is unlike the condition of a competitive market. Hence, general awareness of the market is essential and, in such situations, auction theory guides the procurement auction to search the best contractor.

The decision for bundling/unbundling depends to a great extent on the comparative transaction cost analysis of procuring the projects in either of the modes. Transactions are characterised by namely asset specificity, uncertainty and frequency, which have an impact on the total transaction cost either directly or indirectly (Chang, 2013). However, Williamson ignores this frequency dimension in some of his later developments wherein this variable also turns out to be least relevant for the construction industry (Winch, 2001). As a result, bundling/unbundling decision making from the perspective of transaction economics can be limited to transaction costs, asset specificity, and uncertainty. Thus, the government needs to look into the attributes of a transaction before entering into the concession during the procurement stage.

4.5.3 Contract Management Stage

PPP concessionaire is the agent which forms a project-based firm intending to maximize the profits while the government is the principal who delegates its responsibility to provide public services or assets. These rational actors, however, come into either long term or short agreement through incomplete contracting. Moreover, there is a goal conflict in which the government aims to save the public spending and wants to contract for services which when procured through private sector are cost-effective through positive externalities.

During the contract management, the government's interests can only be safeguarded to the extent specified in the contractual provisions. The possibility of information asymmetries compels the parties to hide information, subsequently leading

to hidden action that will ultimately jeopardise the interests of the public sector. The consideration of possible information asymmetries even before entering into a contract becomes a critical aspect to be considered while making bundling decision. Moreover, when the government delegates the project to a consortium, individual strengths and weakness of the participants are essential for the sake of collaboration (Zhang, 2005a). The possibility of subcontracting specific components of the value chain by the PPP consortium could further have a substantial impact on the bundling decision.

Agency theory considers the contract as a unit of analysis and fits the assumptions about agents, organisations, and information into the articulation of behaviour based contracts and outcome-based contracts (Eisenhardt, 1989a). Agency cost, i.e., the extra cost borne by the principal because of the negative effect of the agent's self-interest is because agency problems raised from asymmetric information would incur endogenous contracting costs to the public agency (Dewatripont and Legros, 2005; Iossa and Martimort, 2012).

4.6 DISCUSSION OF THE FRAMEWORK

The theoretical framework that has resulted from the critical examination comprises of eight aspects relating to a PPP transaction. The derived theoretical propositions are shown in Table 4.6.1. These constructs are discussed in the following sub-sections.

Table 4.6.1 Theoretical Constructs Related to Bundling Decision

Sl. No.	Construct	Theoretical Proposition on Bundling/Unbundling
1	Economies of scope	Greater functional unity of the scope of the components increases the likelihood of bundling
2	Innovation	
	Life cycle innovation	Presence of performance measure for innovation and optimizations will have a positive influence on the bundling decision of the components of the value chain in case of PPP project. If such measures are not possible in contract documents, unbundling is the preferred option.
	Externality of innovation	Bundling is the preferred option if innovation is associated with positive externalities. For innovation with negative externality, stipulations or contractual provisions are required to compel the private sector to innovate.

Sl. No.	Construct	Theoretical Proposition on Bundling/Unbundling
3	Quality Specifiability	Bundling is the preferred approach if the quality of service can be specified and incorporated in the contract.
4	Transaction economies	
	Asset specificity	• Bundling is the preferred route in case of high asset specificity. • Highly idiosyncratic asset specificity, especially human asset specificity, favours bundling as the preferred governance mode. • Transaction investments which are highly specific and of low frequency, contracting out to a contractor through competitive bidding and retaining the role of monitoring of contracted work by the public entity is the preferred strategy.
	Transaction costs	• Ex-ante and ex-post transaction costs usually increase on bundling the components of the value chain. • Bundling decision should take into consideration the public entity's internal capability and competencies besides transaction cost. In case, the public entity has the capability, procurement in either bundled or unbundled mode should be based on comparative transaction cost of procuring in either mode.
	Uncertainty	• Bundling decision is contingent on the possibilities of containing the level of uncertainty with the aim of economizing the transaction cost. • Bundling is a favourable option when technology is flexible to meet unforeseen challenges and demand uncertainty is low.
5	Competition	Bundling could be a preferred strategy only when the level of competition is not compromised due to the bundling of components.
6	Maturity of markets	More mature the market, greater the likelihood that the public sector will bundle the components of the value chain.
7	Tendering out to subsidiaries	The possibility of tendering to subsidiaries increases the likelihood to opt for unbundling. Bundling would prevent the parties from specializing in single components.
8	Information asymmetries	Bundling is not the preferred approach when uncertainty is pervasive, and there is a possibility of asymmetric information in any of the components of the supply chain.

4.6.1 Economies of Scope amongst the Components

Economies of scope are about the combination of components that are complementary/synergetic and exhibit appreciable positive externalities upon which the efficiency gains can be generated. So, the economy of scope is said to be achieved when the cost of jointly producing two products is less than the costs of manufacturing two products separately (Kwoka, 2002). This is due to the presence of cost complementarity wherein the marginal cost of producing good (say in component 1) declines as more of the good (say in component 2) is produced. If bundling, therefore, leads to economies of scope, then the cost of the bundled service would get reduced. Li et al. (2015) also asserted that bundling of the components is expected to bring economies of scope if the private sector operating in that market have the expertise and competency to provide services for all the components of the value chain, then the public authority should consider bundling those components into a single PPP contract. This is due to competence management which in a broad sense consists of different processes and approaches for several functions in the organization and this conjoins strategy, product/service development, and innovation (Medina and Medina, 2017). On the other hand, if the private sector operating in that market have the expertise to provide service relating to just one of the components of the value chain, then it would be preferable to unbundle the components. If there are no such technologies that demand a physically joining between the plants, bundling is viewed as unnecessary by the industrial organization theorists. So, a call nonetheless to vertically integrate is attributed to efforts to create or explore market power (Joskow, 2008). One measure which can act as a proxy measure of these economies of scope is entry cost. Entry cost is referred to as the lowest bid value quoted by the bidders in the bidding process (Estache and Iimi, 2011). This entry cost reflects the revenue and the investment required to be made by the private sector (Estache and Iimi, 2011). In the case of construction contracts, Chakraborty (2006) has found that when the entry cost is low bundling has been adopted as the preferred strategy. Moreover, in case bundling leads to an increase in entry cost, governments tend to unbundle the components to lower the entry cost of the bidders.

If government adopt a bundled approach in a market situation where only a few bidders submit the bids for the integrated project, it could result in the selection of a private party who had the requisite expertise for undertaking one component and lack

the competency to undertake the other components of the value chain. In this case, the bundled approach would not lead to economy of scope because there is no cost advantage for the firm as the needed expertise, knowledge, skill and equipment to operate is not substitutable between those two components. If the private firms operating in a market are highly diverse in their expertise, the normal practise followed is to form a consortium, if the public authority adopts a bundled approach. In such a situation, Greco (2015) is of the view that promoting bundling of components would lead to imperfect bundling and can be treated as equivalent to agency problems within the consortium's members. As a result, private firms may face the challenge of information asymmetry and would affect the cost of service provision. It is also argued by Martimort and Pouyet (2008) that when the bidding consortium is affected by such agency problems, then unbundling would be the preferred strategy. In such a case, unbundling would facilitate small and specialised firms to participate in competitive bidding (Grimm et al., 2006). Thus, this construct would hypothesize that higher the functional unity of the scope of the components (intended to be bundled) perceived by the decision-maker, greater the likelihood of bundling those components into a single PPP project.

4.6.2 Innovation Possibility Through Life Cycle

Innovation is one of the principal drivers favouring bundling of services to be implemented by the private sector while delegating the responsibility for design, finance, construction and operation of an infrastructure asset in case of PPP projects. Innovation is considered as an essential concept in PPPs as it is argued that it leads to cost savings and, ultimately, value for money. In case of PPP projects, the traditional notion is that bundling of services would compel the private sector to consider construction and operation related aspects in the design phase, thereby forcing them to bring in innovation to maximise their return on investment. In the context of PPP infrastructure projects, Dmitrieva and Guseva (2017) classified innovation into four kinds: product innovation, process innovation, marketing innovation, and organisational innovation. The opportunities for bringing in product innovation is typically observed in greenfield projects while process innovation potential is generally seen in brownfield projects (Dmitrieva and Guseva, 2017). Product innovation usually deals with bringing in new technologies. Procuring authorities can take advantage of the latest advances and can bring in state-of-the-art technologies through competitive

bidding in greenfield projects. But brownfield projects may need to revamp the existing technology-based product and hence process innovations can be more easily carried in comparison to product innovation. This is due to the sunk costs. On the other hand, Hoppe and Schmitz (2010) categorised innovation into quality innovation and cost innovation and stated that bundled PPP are believed to provide strong incentive to bring in cost-reducing innovation in PPP projects, but that innovation leading to cost reduction might increase or decrease the quality of service also. The public sector imposes bundling with the motive to bring in innovation leading to cost savings (Grimsey and Lewis, 2009). From the private sector perspective, the consortium is more likely to consider the overall implication of the innovation on cost when activities are bundled (Dewatripont and Legros, 2005). But in practice, private sector opts for the innovative technical solution if it is sound and cost-effective (Zhang, 2005a), apparently placing little importance on innovation for the success of PPPs. The cost-effective technical solution for PPP projects has overshadowed the importance of innovative technical solution in their study of critical success factors of PPP projects (Zhang, 2005a). Additionally, if the coordination mechanisms by the private sector decrease in the iterative aspects, lifecycle performance decreases proportionately in the actual operations (Antillon et al., 2018). Therefore, bundling/unbundling decision from the perspective of innovation needs to be made, taking into consideration the availability of performance measure and the externalities of innovation.

Performance Measures for Innovation

In PPP projects, governments tend to transfer most of the responsibilities to the private sector and expect the private sector to innovate (Roehrich and Caldwell, 2012). However, Lind and Borg (2010), taking the example of road sector, argued that no radical innovation has been introduced by PPP concessionaire in the road sector and posit that to harness the potential of private sector's knowledgebase granting authority would need to include stipulations. In case of the sector such as waste management with high uncertainty about treatment technologies but with massive opportunity for innovation, contract documents should include provisions to promote innovation (Eggers and Startup, 2006). Furthermore, Roehrich and Caldwell (2012) also argued that integrated solutions could only be the option to deliver a better result in case of those sectors where there is a low expectation about the introduction of innovative solutions by the private sector. The traditional notion, though, is that integrated delivery

methods such as bundled PPPs would incentivise the private sector to innovate even without intervention and imposition of stipulations from government, Lind and Borg (2010) contended that such obligations from granting authority act as a motivating factor for innovation by the private sector. Stipulations in the form of tender instructions from the public sector to serve as driver for lifecycle optimisation, realistic and plausible performance benefits over the entire bundled phases should be able to be quantified to ensure that innovation is achievable (Grimsey and Lewis, 2009). Thus, the hypothesis is that the presence of performance measures for innovation and optimisations will have a positive influence on the bundling decision of the components of the value chain, in the case of the PPP project.

Externality of Innovation

Innovation in project design or implementation is associated with externalities, and private sector willingness to bring innovation will depend on the nature of the externalities. The externality of innovation could be either negative or positive. Innovation in construction or design that increases the social benefit from the project may be associated with either reduced cost at the operation stage, which is known as the positive externality, or increased cost at the operation stage, which is considered to be a negative externality of the innovation (Bennett and Iossa, 2006a). Positive externality of innovation serves as a strong incentive for the private sector to bring innovation in asset creation only. Hart (2003), therefore, commented that productive kind of innovative investments is the one which makes the operation of the private sector easier and cheaper. If innovation leads to negative externality, then the private sector would not be interested in innovating as the motivation of private sector for cost savings is to maximise its return on investment and not the maximisation of social welfare objective (UN-Habitat, 2011). Under such circumstances, the public sector needs to set stipulations and impose tender instructions or contractual provisions to compel the private sector to innovate so that welfare function is maximised with the introduction of innovation with negative externality. For instance, the UK HM Treasury has mandated adoption of building information modelling (BIM) by 2016, as it has been well documented that innovation in the form of adoption of BIM in public projects leads to saving in procurement cost (around 20%). However, the private sector is reluctant to use BIM as it is costly to adopt it (Smith, 2014). If the innovation is associated with positive externality, then bundling will be the preferred option as this will also

somewhat weaken the hold-up problem, reduce the agency costs, and enhance the welfare function and social value of the project.

4.6.3 Quality Specifiability in the Contracts

Quality in the context of infrastructure projects can be looked at from the perspective of quality of product or service. Ability to define the quality of service is another determinant that will influence the bundling decision (Grimsey and Lewis, 2009). This determinant relates to the feasibility/capability of granting authority to define the quality of service in the contract documents. Hart (2003) argued that bundling should be preferred if the quality of service can be well specified in the initial contract (this is when suitable performance measures are there for rewarding and penalizing the service provider) and quality of the building cannot be specified. This is because underinvestment in 'productive investment' is more hazardous than over-investment in 'unproductive investment' under PPP. Hart (2003) also argued that the private sector could make an unproductive investment that shades the quality. Iossa and Martimort (2012) further extend this by considering that when uncertainty is prevalent and both public and private parties cannot predict what comes during operation, incentives of bundling will motivate the private sector to bundle, as they could adopt a better design that reduces the operational costs. Furthermore, bundling concept hinges on the notion that a firm increases the quality of construction if it could reduce the operational costs. The reason for advocating bundling is grounded on the assumption that it is difficult to transfer the knowledge of construction quality from one firm to another firm and intra-firm transfer of knowledge is easier than inter-firm (in unbundled case). Moreover, service specifications (of performance) are much more complex and require more resources than specifying quality specifications (of assets). Bundling decision on grouping the activities should be governed by the likelihood of achieving quality improvement (Grimsey and Lewis, 2009). When the quality of service is specifiable and incorporated in contracts, then bundling is the preferred strategy while unbundling is the preferred strategy if specifying the quality of service is not viable, and quality of construction could only be well specified.

4.6.4 Transaction Attributes of Components

Three key aspects of TCE such as asset specificity, transaction costs, and uncertainty are discussed in this section in the context of making bundling decision in MSW sector.

Asset Specificity

The reason for engaging in opportunistic behaviour by the private party could be attributed to one of the key aspects of transaction, i.e. asset specificity. Asset specificity can be defined as the degree to which assets cannot be redeployed, except at a significant loss (Williamson, 1996). Asset specificity can arise in four different contexts, namely: site-specificity, technological asset specificity, human asset specificity, and dedicated assets. Asset specificity is an important factor taken into consideration while making the decision to "make or buy" by the firms. In the case of high asset specificity, hierarchy is the preferred governance structure while market governance is a suitable option in case of low asset specificity. Vertical integration of the supply chain is therefore suggested to be the preferred governance structure in case of high asset specificity for economizing the transaction cost. In the context of contracting, the concept of asset specificity has been looked into from the perspective of idiosyncrasy (Williamson, 1979). Idiosyncrasy has been used to characterize the asset specificity in the context of contracting (Reve and Levitt, 1984). Idiosyncratic goods and services refer to the ones where investments of transaction-specific human and capital are made, and, contingent upon successful execution, benefits are realized. The four types of asset specificity lead to an idiosyncratic relationship between the transacting parties which become locked into a continuing relationship (Reve and Levitt, 1984). Furthermore, different governance structures such as classical contracting, neoclassical contracting, relational contracting, and internal organization have been suggested for commercial contracting. The classical contracting structure has similar characteristics with market governance, and this has been suggested to be the preferred mode for non-specific transactions. When the asset specificity is highly idiosyncratic, the preferred governance mode is an internal organization (or vertical integration) wherein a single ownership spans both sides of the transaction.

Infrastructure projects are characterized by huge capital investment involving a wide range of specialized expertise and equipment. These investments have been made

to either gain economies of scale or meet demanding technical specifications and these investments have limited alternative usefulness outside the project. When the transaction investments are highly specific, and transaction frequency is low, then neoclassical contracting is the preferred governance mode. The trilateral governance structure of client-consultant-contractor exemplifies neoclassical contracting. In the context of traditional procurement of a construction project, the public entity enters into a construction contract with the contractor and engages an engineering consultant through a professional service contract. A similar mechanism is also being followed for the operation and maintenance of the project. These contracts are normally awarded based on competitive bidding, thereby exhibiting appearances of being a pure market transaction governed mainly by the supply and demand forces. When the obligations for design and construction of the projects is contracted to a contractor, the public entity (or client) has more interest in the monitoring of the contracted work, and this introduces the elements of hierarchy in a pure market relationship. Finally, relational contracting is the dominant governance mode if the transaction is recurrent and highly specific or semi-specific.

Infrastructure projects can be considered to have different degrees of specificity. Infrastructure projects are highly site-specific, and technologies normally used are highly complex and non-standardized, particularly in case of big projects. Regarding human asset specificity, it is not economical for a public agency to develop specialized skills and expertise for the implementation and management of a single project. However, if the public agency develops other similar types of projects, then the skillsets could be put to alternative economic uses, thereby economizing on transaction costs. In case unbundling of services or components of the value chain enables public agencies to put to use their expertise, then the degree of human asset specificity would be low. Public agencies can, therefore, procure the relevant services/components taking into consideration their technical expertise to supervise or monitor construction or maintenance work effectively. On the other hand, human asset specificity will be very high if bundling of components or services makes public agency to acquire specialized expertise and skills which will not be used for other alternate uses (i.e. development of similar types of projects). At the same time, huge relationship-specific investment needs to be made by private parties as it entails a larger need for legal, technical and financial advice. Bundling will help to achieve economies of scale if specialized human

and physical assets could be made adaptable to variation in quantity or price. In MSW, components of value chain do not perform identical jobs or goods. So, as the asset specificity is more for heterogeneous outputs, the tendency to unbundle will increase (González Díaz et al., 2000). Therefore, the decision to unbundle or bundle the components or services should be made, taking into consideration the human asset specificity of the public agency.

Transaction Costs

Transaction costs play an important role in deciding on bundling/unbundling as the decision largely depends on the comparative transaction cost analysis of procuring the projects in either of the modes. Increase in costs would render the choice of PPPs ineffective and a wrong governance choice for infrastructure delivery (Ping Ho et al., 2015). Transaction costs refer to the cost of using the price mechanism or the cost of carrying out a transaction by means of an exchange on the open market (Coase, 1937). Transaction costs, in the context of infrastructure projects, can be considered as the costs incurred to plan, adapt, and monitor the delivery of service/asset of an infrastructure project (Soliño and Gago de Santos, 2010). The measurement of transaction costs is carried by classifying into (i) ex-ante or front-end transaction costs, and (ii) ex-post or back-end transaction costs. Higher ex-ante transaction costs also have the adverse effect of limiting the competition to large-sized private players, thereby limiting the benefits of "competition for the market." In the context of PPP projects, contracts are inevitably incomplete in various aspects, resulting in information asymmetries, knowledge gaps, and missing provisions. Imperfect information enables parties to a contract to operate opportunistically exploiting any information asymmetry and may lead one of the contracting parties to behave opportunistically when the contract is renegotiated, thereby increasing the ex-post transaction costs. Higher transaction costs, therefore, will outweigh the potential savings in the whole lifecycle cost of procuring the projects in bundled mode.

Minimizing the transaction costs has been the key objective in making the decision to select a particular governance structure according to transaction cost economics. Procurement analysis for opting either bundled or unbundled approach should, therefore, aim at minimising the transaction cost. Parker and Hartley (2003) suggested that procurement analysis transaction cost analysis relies on the resource-based perspective of the stakeholders' internal capability and competencies. In the case

of low internal capabilities and high transaction costs or vice versa, the preferred procurement decision would be to enter into some partnership to procure the service. In case, the public entity has the capability, bundling decision should depend on the outcome of transaction costs comparative analysis of procuring the project in either bundled or unbundled mode (Roehrich and Caldwell, 2012). There is some evidence recorded in the extant literature that, in some contexts, private participation has indeed increased the costs of collection and transportation while improving the services. On the other hand, other studies indicated that PPPs have improved the service level but, at the same time, increased the costs when compared with public provision of the service (Rogge and De Jaeger, 2012). Thus, the transaction costs of bundling the components of the value chain into a single contract vis-à-vis procuring the components in the form of separate contracts hold the key to bundling analysis. Ex-ante transaction costs for bundled projects seem to be more expensive than the unbundled approach due to long and complex contract negotiations and involvement of various experts (Soliño and Gago de Santos, 2010). For instance, collection and transportation projects typically follow input specifications and do not require high speciality firms. This ease of setting specification results in lesser lead time in the procurement. On the other hand, treatment project typically using thermal or chemical processes have longer lead times in the procurements and have rigorous studies, right from the ratification of the proposed technology, approvals from wide range of government ministries, business model including the cost of the power sold to the power grid, import of technology and construction/erection. These have a protracted nature of negotiations.

Uncertainty

Uncertainty is another dimension that has been suggested for characterising transactions. Infrastructure projects usually are highly complex, and this complexity has a strong co-relationship with uncertainty, posing major problems of bounded rationality. The bounded rationality resides in the fact that all complex contracts are unavoidably incomplete. Extending the discussion on the selection of an appropriate governance structure for economising the transaction costs, Williamson (1979) has suggested two possibilities for transaction-specific investments under a high degree of uncertainty. The options are: (i) sacrifice the design features in favour of more standardised good or service, or (ii) preserve the design but surround the transaction with an elaborated governance apparatus, thereby facilitating more effective adaptive,

sequential decision-making. These possibilities have been formulated to reduce the uncertainty of the transaction environment to economise the transaction costs.

Initial discussion on uncertainty in a construction project by Winch (1989) from transaction cost perspective has focused on four types of uncertainty: task uncertainty, natural uncertainty, organisational uncertainty, and contracting uncertainty. In the context of infrastructure projects funded with private capital, the types of uncertainty given more importance are the one that has a profound effect on the project financial viability. The key uncertainties that are worth mentioning include technological uncertainty and demand uncertainty. Extending the bundling/unbundling problem in the context of the level of uncertainty faced by the project, the decision to bundle should be made to economise the transaction cost. Uncertainty about when the technology will become obsolete will compel the firm not to choose a highly firm-specific technology and, hence, this reduces the likelihood of deciding to bundle the components/services (Lajili et al., 2007). Furthermore, Dewatripont and Legros (2005) pointed out that when there is uncertainty about the performance of the technology proposed to be used in the building and operation of the project, it is most likely that ex-post realisations of the cost would also differ from the targeted cost. The firm, when faced with such uncertainty, may not want to exercise its option to commit to bundling. The maturity and flexibility of the technology to handle future scenarios is also an essential determinant for making bundling decision. Bundling is a dominant strategy when technology has the flexibility to adapt to unforeseen circumstances. Similarly, Iossa and Martimort (2012) indicated that when the uncertainty in demand is low, bundling is a dominant strategy. In the case of high demand, the authors suggested unbundling to be the preferred approach. The source for demand uncertainty could be attributed to the lack of reliable data on the volume of users for the new project proposed to be funded using private capital (Buckberg et al., 2015). This problem gets aggravated furthermore in case of innovative projects, which lack historical demand data. It has also been observed that private parties, at times, priced the demand risk more aggressively only to bag the contract turning a blind eye to contract management hazards (Burke and Demirag, 2015a). Therefore, the hypothesis is that the higher the uncertainty of technology and demand, the more likely that the public sector should unbundle the components of the value chain of the infrastructure service.

4.6.5 Level of Competition for the Components

One of the essential requisites of a successful PPPs is competitive bidding and characteristics that govern the market. Competition has the potential to clear the inefficiencies prevalent in a monopolistic sector and induce competition for the market (Trebilcock and Rosenstock, 2015). Level of competition amongst bidders has an influential effect on the cost of the infrastructure projects. For instance, Estache and Iimi (2008) quoted that high level of competition could reduce the cost of infrastructure development to the extent of about 8.2% in the case of developing countries. Participation by more number of bidders would contain the transaction cost, prevent collusion and corruption, and bring value for money into the project (Atmo and Duffield, 2014; Estache and Iimi, 2011). Hu et al. (2014) asserted that providing enough competitive landscape will also promote efficient construction and operation. Limited participation by bidders, therefore, has the ill effect of increasing the cost of public procurement. Furthermore, the competition also has the potential to ensure the achievement of value for money through building up of private sector competencies (Ameyaw et al., 2015). Competition also drives institutional change and incentives organizations to invest in knowledge to survive in the market (North, 1993). For infrastructure procurement, extant literature has shown that five to eight bidders at least participating in the technical and financial bidding is a threshold for good competition (Dolla and Laishram, 2019b; Teo and Bridge, 2017).

Grimsey and Lewis (2009) expressed that the level of competition in the market appears to be declining in the case of procurement using a bundled approach vis-à-vis the competition observed when procured through unbundled route. Bundling of the components limits the participation to a limited number of bidders and invoke the negative results of imperfect competition. Mainly, patented technologies, which are the case often with MSW treatment projects, can restrict the number of available bidders if pure bundling is opted and, thus reduces the competition drastically due to limited availability of such contracts (Teo and Bridge, 2017). This reduction of the competition in case of pure bundling seems to be induced by a monopoly in PPPs (Massoud and El-Fadel, 2002). Additionally, since domestic developers cannot handle every component/project, the ability of a particular international developer in handling the components of the value chain also become more crucial.

The level of competition is said to constrain the behaviour of private operations, especially in the dynamic perspective of winning future contracts to be awarded (Chong et al., 2006). This seems to explain the situation of MSW sector where it is transformed from concessionaire paying a royalty (example of Surat energy from waste plant in 2004) to the government in exchange of waste received to concessionaire received a tipping fee for the waste received (Hyderabad in 2009) (DEA, 2019). Bundling induced thin markets have gradually impacted the operators in the subsequent competitive auctions. Unbundling into legally and functionally distinct companies will allow a clear understanding of technical and financial performance, besides allowing greater competition in the market (UNIDO, 2015). The choice between bundling and unbundling should be towards the one that encourages bidders to bid less aggressively to win the project and, at the same time, provokes the bidders to avoid winners curse (Ahmed et al., 2016). Therefore, when the sector is in a nascent stage with few numbers of private players (less than five), the level of competitiveness in the market could be increased if projects are procured in unbundled mode. The same market, when it is matured with the presence of many private parties (greater than eight), the option of bundling the components could be explored since a competitive landscape has been established.

4.6.6 Maturity of Markets for the Components

The benefits from PPPs, although positive also under incomplete contracting, will increase as the delegation gets more matured (Iossa and Martimort, 2012). The capability of a private partner is repeatedly pointed as a vital factor for the success of PPP projects. On the other hand, the experience of the agency initiating the project is also of crucial importance. The private firms typically use their experience to predict the events that may be realised in the operation stage. And, when this experience becomes much more apparent and evident to the government, i.e., when it is observable and verifiable, then the government will consider the sector as a whole has matured. The private parties, typically, would not accept responsibility for the events that are beyond its control or not included in the risk allocation framework. Furthermore, the ability of the private sector to control the costs to achieve budgeted delivery is again highly dependent on the firm's implementation capacity, which is evident from its historical experience (Estache and Iimi, 2011). There is a highly significant relationship between concessionaire maturity level and cost-reduction results. Brewer

et al. (2013) concluded that the extent of innovation in the design and construction phases of the project are restrained by the capability of the organisation, relational and contextual issues. If an organisation's maturity is too low, the introduction of best practices such as an innovative cost- reduction methods may fail (Schiele, 2007). In this regard, the government bodies ought to stimulate in the direction of greater participation of the private sector. The typical market structure can be seen as perfect competition (very large number of firms producing a homogenous product), oligopoly (when a small number of firms have at least 40% of market share, and monopoly (ruled by only one firm). Imperfect competition arises in cases such as oligopoly and monopoly. Thus, ensuring the presence of enough competition and facilitating perfect competition should be the main motive behind making the decision for either bundling or unbundling the components of infrastructure service value chain.

The type and extent of innovation being introduced in a market are also strongly related with the maturity of the market, with an expectation of more innovation in a more matured market (Perry, 1989; Roehrich and Caldwell, 2012). However, market power arguments can be brought to bear on organizational innovation of bundling decision in two ways. One is that possessors of market power prefer certain organizational arrangements. This preference by firms can be due to factors such as increased project value that can allow more debt borrowing and/or earn higher profits. The second is that firms use bundled organizational structure strategically as an impediment to rivals and allowing themselves to become uniquely qualified parties for bundled projects (Williamson, 1985).

In case, the private sector has exhibited maturity in efficiently handling DCOM obligation an individual components obligations, then bundling would lead to innovation when the private sector is given the DCOM obligations of more than one component as a contract (Iossa and Martimort, 2012). However, if the market is not matured and bundling is adopted as the strategy, then it will prevent the market from maturing. In such a case, the preference should be given to unbundling policy so that the market players can build on their competencies. Thus, the hypothesis is that the more mature the market is, the greater the likelihood that the public sector will bundle the components of the value chain. In the MSW sector, Massoud et al. (2003) observed that having one firm to manage every aspect of the multiple operating components could promote monopoly. To counter this, authors suggested to have a highly developed

market to control the monopoly of the private sector and by this competition should be encouraged through widening ownership and decreasing barriers.

4.6.7 Possibility of Tendering out to Subsidiaries

Extant PPP literature asserts that even in forming a strong private sector consortium, individual strengths and weakness of the participants are important for the sake of collaboration (Almarri, 2019). The possibility of subcontracting certain components of the value chain by the PPP consortium could further have an important impact on the bundling decision. Prevalence of subcontracting has been viewed as an unfavourable move to the rationale of bundling (Estache and Iimi, 2011). This resistance is because bundled procurement discriminates against companies that are strong in a single component of the value chain (Grimm, 2007). The winner of the bundled project can earn high profits from the project operation by subcontracting the construction to its subsidiaries and in the process eliminates competition from parties which specialise in a single component of the value chain. González Díaz et al. (2000) found that factors that would favour subcontracting include output dissimilarity, geographical dispersion, shortage of capacity, intangible assets (given subcontracting activities are implementation tasks). For a typical construction project, technical tasks are the ones which are carried by design management team having a design, supervisory and problem-solving capabilities that enable them to make competitive bids for all kinds of contracts. Implementation tasks are the activities that require cost control, operative capabilities and knowledge of local labour markets (González Díaz et al., 2000). Another argument is that PPP projects, which are led by the financier, the financial institution devotes substantial resources in putting together a consortium to make a bid. This consortium unbundles the components as soon as the bid is successful. In such circumstances, Quiggin (2004) commented that the government would do better by contracting directly with the private parties that ultimately bear the risk rather than contracting through the financial intermediary. Subcontracting in Indian PPP projects is not completely barred. For instance, in Chennai port PPP project and Hyderabad metro rail, the subcontracting can be done with prior approval by granting authorities. In Indian MSW sector due to absence of model concession agreements, the practice of subcontracting is purely at the discretion of the concession granting agency. Particularly, the possibility of involving the community and informal sectors to delegate the responsibility of collection is advocated in the MSW sector. Thus, greater the

likelihood of subcontracting the components of the value chain in the past unbundled projects, higher the possibility of considering unbundling of components in the future projects also.

4.6.8 Information Asymmetries Between the Parties of Contract

The possibility of the existence of asymmetric information is posited as one of the determinants in making bundling decision (Iossa and Martimort, 2012). Dewatripont and Legros (2005) stated that the sources of information asymmetries are productivity shocks and information about operational risk. Bundling is usually adopted as the dominant strategy when both the parties to the contract are equally aware of the productivity shocks. However, in case of a complex environment and if bundling strategy has been adopted for the project, then, in case of realisation of productivity shocks during operation stage, the information about the productivity shocks will become private information. In this new scenario, the ex-post verifiability for public sector becomes difficult, and the private sector could bargain for unrealistic compensatory measures. The problem of asymmetric information could also arise in case of the existence of the high possibility of operational risk in the operation stage. Hence, in those cases where uncertainty is pervasive, and there is a possibility of the situation leading to asymmetric information about productivity shocks, unbundling would be the preferred strategy over bundling. This understanding of uncertainty is vital as extant literature on PPPs has mostly ignored the effects of contract renegotiations and terminations (de Castro e Silva Neto et al., 2016).

4.7 SUMMARY

PPP infrastructure projects are hallmarked with the bundling of various phases of a project and bundling of various Component/service in the facility. Extant literature has provided ample guidance to bundle various phases whereas the influence of Component bundling on PPP infrastructure project has not been studied. This study has initiated the research trajectory by identifying and discussing various determinants in the form of a conceptual framework which would dictate the bundling decision in projects involving private sector participation. The study has grounded the theoretical insights on the established and prominent theories of economics, organization, and procurement namely transaction cost economics theory, agency theory, and auction

theory. The chapter theorizes the following crucial aspects for empirical testing– innovation, maturity of markets, quality specifiability, economies of scope, the possibility of tendering to subsidiaries, competition, information asymmetries, and transaction attributes such as assets specificity, uncertainty and transaction costs - as the ones which might influence the bundling/unbundling decision. This chapter extends theoretical understanding of governance issues in PPP projects by providing a conceptual framework for the practitioners and academicians to explain and predict the use of alternative supply chain management options and firm-level organizational modes for achieving an economic cost-minimizing coordination solution for the municipal infrastructure of India.

CHAPTER 7 presents the testing of the constructs in the six test cases using case study methodology. This testing will make use of the empirical evidence concerning the constructs of the bundling framework. This would establish the validity and reliability of the theory presented in this chapter. The next chapter (CHAPTER 5) will focus on the perception of PPP experience in Indian MSW sector that aims to address the research question 1 (RQ1).

CHAPTER 5

FACTORS AFFECTING PPP ADOPTION IN MSW SECTOR

5.1 INTRODUCTION[4]

This chapter presents the empirical results of the exploratory study that was carried out to understand the perception of stakeholders on the preference of PPP in MSW sector. This perception is captured using attractive factors and the negative factors identified through the literature review as presented in the previous chapters. Next section presents the data analysis of the survey data using methods such as relative importance index, Mann-Whitney U test, and factor analysis. Subsequently, discussion of the attractive and negative factors is presented. This discussion aims to get an understanding of PPP usage in Indian MSW project with reference to the contextual, institutional and legitimacy requirements of the country. The closing section distils key inferences from the results and discussion.

5.2 DATA ANALYSIS

The collected data is subjected to tests of the reliability of the survey instrument, hypothesis testing to assess differences in the preference between stakeholder groups, and exploratory factor analysis. Besides, the ranking of the attractive and negative factor affecting PPP preference was also carried out from the survey data. The formulae for calculating the relative importance index is given as $\text{RII} = \frac{\sum w}{AN}$, where w is the weighting given to each factor by the respondents ranging from 1 being least important and 5 being most, N is the total number of responses, A is the highest weight which is 5 in this study (Kometa et al., 1994).

Firstly, the internal consistency of the factors was tested using reliability analysis. Cronbach's alpha captures the reliability of Likert based survey instrument (Fellows and Liu, 2015). The results show that the factors are reliable measures for assessing the attractive and negative factors of using PPPs (Cronbach's alpha =0.820). The validity of the questionnaire instrument is ensured through pre-testing with experts

[4] This chapter is published as Dolla, T. and Laishram, B. (2019), "Factors affecting public-private partnership preference in Indian municipal waste sector", *International Journal of Construction Management*, pp. 1–18. 10.1080/15623599.2019.1703085

in the questionnaire design stage. Next, the nonparametric Mann-Whitney U test was employed to study the association of ordinal (rank order) data in a hypothesis testing situation with two independent sample groups based on their differences in ranks using SPSS 20.0 (Kraska-Miller, 2013). According to the Mann-Whitney test, the two groups are statistically different if the p-value is equal to or smaller than a predetermined level of significance (α=0.01). On the other hand, there is no significant difference between the two groups if p is larger than this level of significance (α=0.01). The respondents were primarily classified into two groups namely 'public parties' and 'private parties.' Transaction advisory including academic institutions renders competency enhancing services to the weakly equipped procuring authorities right from the feasibility studies to the monitoring the contract management including preparation of bills to private sector (Devkar et al., 2013). Hence, these two respondent categories were included in the 'public parties.' On the other hand, financial institutes respond to the loan proposals of the private sector and hence may act on the interests of the profit and the project's debt-service coverage ratio. Hence, financial institutions are considered in the group of the 'private parties.' Such a classification is observed in past studies as well (Li et al., 2005). Mann-Whitney test results are greater than *p*-value (0.01) at 99% confidence interval showing that there is no statistically significant difference in the perception of attractive and negative factors in using PPP among the sample groups and therefore null hypothesis is retained (Table 5.2.1). However, the lack of consensus was observed amongst the groups with respect to the importance of 'Excessive restrictions on participation' (NF12). This strengthens the fact that motivations and possible risk aversions are different among the stakeholders who strive for the success of the same project. This also implies that a multidimensional view is essential in framing the projects in this sector.

Table 5.2.1 Statistical Analysis of the Factors

	Public Parties (n=31)		Private Parties (n=21)		Overall					
Code	**RII**	**Rank**	**RII**	**Rank**	**Mean**	**RII**	**Rank**	***Chi-S***	***a sig***	**S/NS?**
AF1	0.70	13	0.70	15	3.52	0.70	13	0.546	***0.946***	***S***
AF2	0.75	9	0.87	4	4.00	0.80	6	7.539	***0.022***	***S***
AF3	0.77	6	0.73	13	3.79	0.76	9	3.626	***0.524***	***S***
AF4	0.71	11	0.74	11	3.62	0.72	12	9.052	***0.570***	***S***
AF5	0.85	1	0.90	1	4.33	0.87	1	3.422	***0.457***	***S***
AF6	0.62	16	0.68	16	3.21	0.64	16	3.395	***0.381***	***S***
AF7	0.77	6	0.85	5	4.02	0.80	5	6.693	***0.186***	***S***
AF8	0.63	15	0.74	11	3.38	0.68	15	2.336	***0.077***	***S***
AF9	0.71	11	0.75	10	3.63	0.73	11	4.108	***0.678***	***S***
AF10	0.77	8	0.88	2	4.06	0.81	4	6.117	***0.044***	***S***
AF11	0.80	2	0.85	5	4.10	0.82	3	5.664	***0.219***	***S***
AF12	0.79	4	0.88	2	4.12	0.82	2	13.702	***0.010***	***S***
AF13	0.74	10	0.76	9	3.73	0.75	10	4.710	***0.543***	***S***
AF14	0.70	14	0.71	14	3.52	0.70	13	5.420	***0.840***	***S***
AF15	0.79	4	0.82	7	4.00	0.80	6	1.402	***0.593***	***S***
AF16	0.79	3	0.78	8	3.94	0.79	8	1.109	***0.734***	***S***
NF1	0.50	13	0.56	13	2.63	0.53	13	4.932	***0.445***	***S***
NF2	0.61	8	0.65	11	3.13	0.63	9	0.218	***0.585***	***S***
NF3	0.70	3	0.77	4	3.63	0.73	4	5.204	***0.231***	***S***
NF4	0.75	1	0.86	1	3.96	0.79	1	5.409	***0.029***	***S***
NF5	0.58	10	0.61	12	2.96	0.59	11	0.106	***0.720***	***S***
NF6	0.54	12	0.67	10	2.94	0.59	12	7.530	***0.027***	***S***
NF7	0.56	11	0.68	9	3.04	0.61	10	6.778	***0.045***	***S***
NF8	0.63	7	0.70	8	3.29	0.66	8	3.383	***0.220***	***S***
NF9	0.73	2	0.74	5	3.67	0.73	2	0.884	***0.694***	***S***
NF10	0.68	4	0.74	5	3.54	0.71	5	1.218	***0.409***	***S***
NF11	0.68	5	0.82	2	3.67	0.73	2	4.162	***0.029***	***S***
NF12	0.59	9	0.78	3	3.35	0.67	7	9.351	***0.004***	***NS***
NF13	0.65	6	0.74	5	3.44	0.69	6	3.861	***0.196***	***S***

S - Significant at 99% confidence interval at *p*-value =0.01.; NS – Not significant and hence the null hypothesis that distribution of the factor is same across the groups of respondents is rejected;

5.3 FACTOR ANALYSIS

Factor analysis is a multivariate statistical approach adopted with an intention to reduce the number of variables into a smaller set of variables. Since the application of attractive and negative factors of PPP in the MSW sector is new, this study assumed no prior theory. Hence, it is intended to generate the main dimensions to generate a theory for this sector using exploratory factor analysis protocol. Prior to the extraction of factors, the suitability of the respondent data for factor analysis is carried using

Kaiser-Meyer-Olkin Measure of sampling adequacy and Bartlett's Test of Sphericity. Since the sample to the number of variables ratio is less, extant literature suggests that KMO index should be greater than 0.5 and Bartlett's Test of Sphericity should be significant ($p<0.05$) to be suitable for factor analysis (Hair et al., 2018). The data of the present study have passed the tests as shown in Table 5.3.1.

Table 5.3.1 KMO and Bartlett's Test for Attractive and Negative Factors

		Attractive Factors	Negative Factors
Kaiser-Meyer-Olkin Measure of sampling adequacy		.773	0.646
Bartlett's Test of Sphericity	**Approx. Chi-Square**	432.643	228.845
	df	102	78
	Sig.	.000	.000

The analysis adopted principal component analysis (PCA) by using Scree test and Kaiser's criteria of eigenvalue greater than 1 for extraction of factors (Hair et al., 2018). Figure 5.3.1 and Figure 5.3.2 show the Scree plot of attractive and negative factors with the eigenvalue associated with each underlying grouped factor. The orthogonal varimax rotation method is followed for easier interpretation of results (Sullivan et al., 2003). For attractive factors, four underlying grouped factors were extracted and accounted for 67.73% of the variance in responses. Typically, SPSS discard the individual factors whose eigenvalues are less than 1.0. In this study, no factor has been discarded. All loadings of the factors in the present study were greater than 0.5. For negative factors, likewise, four underlying grouped factors were extracted and accounted for 64.32% of the variance in responses. Factor analysis technique may group all the factors without any exclusion and explain the threshold variance as observed in some previous studies (Chan et al., 2010; see Tam et al., 2006).

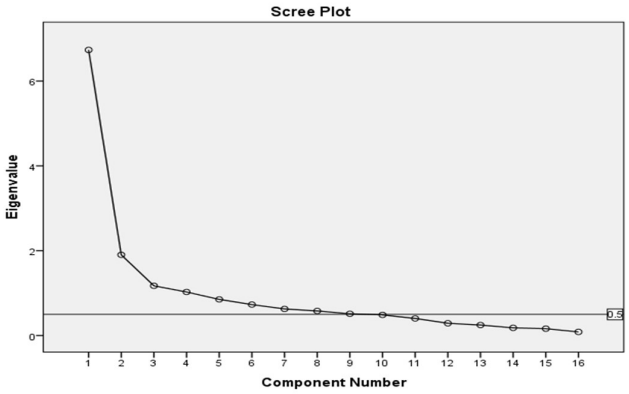


Figure 5.3.1 Scree Plot of Attractive Factors

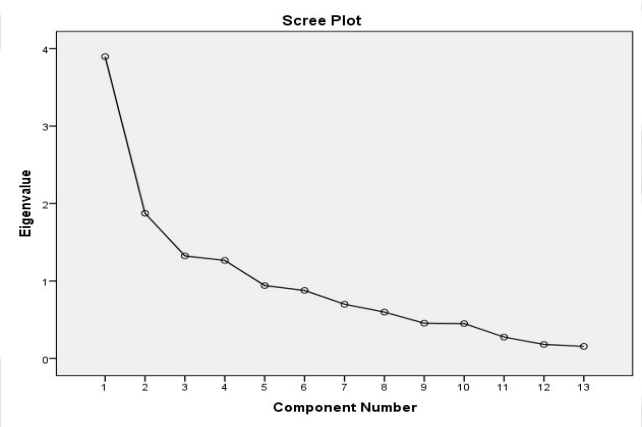


Figure 5.3.2 Scree Plot of Negative Factors

Factor loading varies between 0 and 1. Higher values represent a greater contribution of the factor to the component and it is a measure of the degree of contribution (Hair et al., 2018). Moreover, a positive factor loading represents a positively correlation of individual factors to the usage of PPP and vice versa. The cumulative variance explained by the principal components extracted is greater than the threshold of 60% for robust factor analysis (Hair et al., 2018; Sullivan et al., 2003). The results are shown in Table 5.3.2 and Table 5.3.3. It should be noted that the labelling of factors is subjective and theoretical to reflect the conceptual intent (Sullivan et al., 2003).

Table 5.3.2 Factor Grouping Results of Attractive Factors for PPP in MSW Sector

Item	Factor loading	Eigenvalue	Percent of variance explained
Component 1: Necessity and Urgency of the services		**6.733**	**42.083**
Accelerate project development (AF15)	.772		
Improve maintainability (AF12)	.757		
Provide an integrated solution (for public infrastructure/services) (AF2)	.722		
Save time in delivering the project (AF7)	.628		
Facilitate creative and innovative approaches (AF5)	.601		
Comply with the MSW Rules set by the government (AF16)	.580		
Component 2: Greater benefit to public		**1.904**	**11.899**
Benefit to local economic development (AF10)	.776		
Cap the final service costs (AF4)	.671		
Reduce public sector administration costs (AF9)	.660		
Improve buildability (AF11)	.658		
Technology transfer to local enterprise (AF13)	.619		
Component 3: Avoid financial stress on public sector		**1.173**	**7.332**
Solve the problem of public sector budget restraint (AF1)	.851		
Reduce public money tied up in capital investment (AF3)	.785		
Non-recourse or limited recourse to public funding (AF14)	.539		
Component 4: Achieve value for money and reduce transaction costs		**1.027**	**6.419**
Transfer risk to the private partner (AF8)	.749		
Reduce the total project cost (AF6)	-.477		

67.733 is the cumulative variance explained by the principal components extracted.

Table 5.3.3 Factor Grouping Results of Negative Factors for PPP in MSW Sector

Item	Factor loading	Eigenvalue	Percent of variance explained
Component 1: Incompetent procurement		**3.897**	**29.978**
Excessive restrictions on participation (NF12)	.895		
Lengthy delays in negotiation (NF13)	.855		
Confusion over government objectives and evaluation criteria (NF11)	.793		
Lack of experience and appropriate skills (NF10)	.471		

Item	Factor loading	Eigenvalue	Percent of variance explained
Component 2: High Transaction costs		**1.875**	**14.426**
High participation costs (NF7)	.832		
High project costs (NF8)	.813		
More time spent in contract transaction (NF9)	.629		
Component 3: Ineffective projects		**1.324**	**10.187**
Lengthy delays because of political debate (NF4)	.829		
High rates of aborting projects before contract (NF3)	.743		
High risk relying on the private sector (NF2)	.609		
Component 4: Over exploitation by private sector		**1.266**	**9.739**
Reduce project accountability (NF1)	.730		
Less employment positions (NF6)	.707		
Higher charge to the direct users (NF5)	.644		

64.329% is the cumulative variance explained by the principal components extracted.

5.4 FINDINGS

This section explains the extracted attractive factors and negative components. The factor loadings are shown in column 2 of Table 5.3.2, and Table 5.3.3. They indicate which factor belongs to which component. The results of factor analysis are interpreted based on the interviews with representatives from public and private sector organisations. The section also highlights the relevance and the criticality of the extracted components in Indian context as corroborated with interview findings.

5.4.1 Attractive Factors

Component 1: Necessity and Urgency of the services

The first component accounted for 42.083% of the variance among the attractive factors. This component is associated with the context under which PPP is primarily sought in MSW sector. MSW services were found in a pathetic condition in India, and hardly any assets and services were provided by the public sector (DEA, 2009). Among these, the factor 'accelerate project development' (AF 15) has been ranked important. The public sector, which is in desperate need of establishing the much-needed MSW infrastructure wants to provide the services quickly. One of the transaction advisors noted, "…*to some extent, this is an attractive factor*." Nevertheless, interviewees' cast

doubt on the results as noted by one of the public sector respondents "…*we want a project quickly, but that is what is exactly not happening in reality*." 'Improving maintainability' (AF12) was ranked similarly as public sector opined that the private sector could improve the maintainability of the built asset. One transaction advisor of the public agency noted: *"...we very much want a reduced burden on operation and maintenance in the project.*" This expectation of the public sector is more grounded on the life cycle integration perspective on assets and services which the private sector is expected to consider during the design stage. On the other hand, 'Provide an integrated solution (for public infrastructure/services)' (AF2) has been ranked 6th. Integrated solutions are typically sought when the focus is on the expansion of the scope of the project. In the MSW sector, the main concern is related to delegation of services such as collection, transportation, treatment, and disposal to a single private concessionaire. The responses necessarily establish the fact that integrated solutions are beneficial only on a case-to-case basis. Involvement of the private sector through PPP route has been advocated with the objective to overcome the limitations of traditional procurement. PPPs are considered to save time in delivering the project (AF7), and this has been reflected accordingly by 5th rank. Conversely, though PPPs are supposed to accelerate the delivery time of projects, many Indian MSW PPP projects seem to be affected by delays in execution. This is reflected by delay in implementation of some notable PPP MSW projects in cities like Guwahati (5 years' delay and subsequent termination), Hyderabad (4.5 years' delay), and Pallavapuram (4 years' delay and on the verge of termination). PPPs have been promoted initially with the expectation of creative and innovative solutions from the private sector. The factor 'Facilitate creative and innovative approaches' (AF5) has been top-ranked. In fact, the procuring authorities prefer to transfer the obligations of collection, treatment, and disposal to the private sector using output specifications of the services. However, interviewees were uncertain on the realisation of innovations in the past projects. This suggests that bidders are yet to show their ability to develop unique and creative approaches in these projects. Finally, the factor 'Comply with the MSW Rules set by the government (AF16)' is due to mandate that was steered by the Supreme Court to Government of India in framing and implementing the rules. Due to this imposition in this social infrastructure, the government has sought PPP as a means of procuring the assets and services.

Component 2: Greater benefit to the public

The second component explained 11.899% of the variance. This component is related to intended benefits to the public sector organisation because of the provided services. Infrastructure development is commonly advocated with the objective to promote the local economy. This perception could be verified from the 4th ranking of the factor 'promote local economic development' (AF10). However, the interviews revealed quite an idiosyncratic opinion on the role of PPPs in local development as this sector is quite affected by "not in my backyard" syndrome where the public would not prefer to establish any kind of facility near their dwelling units. Unlike the road sector projects, which will enhance the property value in the nearby vicinity and promote business opportunities, MSW projects actually reduce the property values and suppress the local economic development. One transaction advisor noted,

> *"…this has been not clear… as of now I have not seen any project in this angle, particularly in MSW sector."*

Though MSW projects potentially improve local health and sanitation conditions, the failure to quantify diseases prevented and quality of health improved seem to have a different connotation in this social infrastructure, i.e. MSW sector.

In similar lines, "capping the final service cost (AF4) has not been perceived as an important attractive factor for adopting PPPs. In fact, interviewees' have expressed doubt about the ability of the private sector to cap the final service costs. On the other hand, ULBs lack competency to provide a reasonable estimate and this problem is further aggravated by cost escalation problems even before the commercial operation date, thereby affecting their ability to cap the final service costs. Similarly, it has also been observed that reducing public sector administration cost (AF9) has been ranked 11th amongst attractive factors. The public sector expects to transfer administration cost to the private sector and is one of the reasons for engaging the private sector.

Improving buildability (AF11) has been ranked as important attractive factors, as evident from its 3rd rank. The stakeholders opined that PPPs could actually improve the capacity to build assets and services. However, this is more of a theoretical aspiration rather than a practical observation. In this vein, one interviewee responded as

> *"...we the public sector don't know how to build or establish the technologies for treatment that are needed. So obviously we expect that the private sector will do at least something better than the current status of nothing. This requires a lot of knowledge and updates about what is happening around the world, and the private sector has that [capability]"*

Similar to the concept of risk to the private sector, competency enhancement through technology transfer to local enterprise (AF13) has been an important agenda of PPP programs in India. Unlike the perception in other developed countries such as Hong Kong, Australia, and the UK that it is least important (Cheung et al., 2010), this factor is ranked below attractive factor in the Indian MSW context (ranked 10th). However, the experts opined that this is actually necessary and deserves a better response. In this vein, one responded as

> *"...this is yet to happen ...though lot of technologies are already tried in various projects. Such transfer will happen only when the local contractor is able to establish the next projects and operate them successfully with the transferred technology, which is currently not the case."*

Component 3: Avoid financial stress on public sector

The third component accounted for 7.332% of the variance. This component is related to the ability of PPPs in solving the cash strapped public sector. However, solving the public sector budgetary constraint (AF1) has been observed to be not an important attractive factor. In this sector, the projects are typically structured in a manner where public sector pays to the private sector for every tonne of waste collected, transported, treated, and disposed of in the sanitary landfill as defined in the scope of the concession. For MSW projects, one respondent said

> *"...Public sector budget constraint comes at two stages. One is the capital investment, and the other is the tipping fee. For tipping fee, the private sector is of no use because, ultimately, they (public sector) have to pay from their budget only. The private sector can come only for capital investment... either way, the private sector cannot solve the public sector budget restraint.*

Thus, the lack of funding cannot be construed as a reason for PPPs. Similarly, reducing the public money tied up in capital investment (AF3) was not ranked highly

(ranked 9th). Unlike the Indian MSW context, in Hong Kong and the UK context, PPP projects were procured with an intention to reduce the public money for capital investment (Cheung et al., 2010). However, the perception of the public and private sector is different on the attractiveness of PPP to reduce the public money in capital investment in Indian and the UK context. Apart from this, the private sector expects guarantees and upfront grants from the public sector. One respondent noted, "*…bankers will not fund when there is no commitment or guarantee from the government for payment."* This is reflected in the situation where viability gap funding and upfront capital grant up to the extent of 50% is prevailing in most of the PPP MSW projects. This has become a minimum expectation by the private sector. Erstwhile Jawaharlal Nehru National Urban Renewal Mission (JNNURM) provided a viability gap funding of 50% where centre contributed 35%, and the stage added another 15% in the project cost. The private sector is expected to bring the rest 50% through debt and equity instruments. The recent Atal Mission for Rejuvenation and Urban Transformation (AMURT) and Smart Cities Mission also extended the upfront grant support to the MSW PPP projects. Hence, Indian MSW PPP projects are not necessarily attracted for the sake of reducing capital investment, and this situation may also be valid for other operational intensive public utility projects such as water supply, sewerage treatment projects. Furthermore, the private parties seem to be opportunistic as their main aim is of maximising the temporary public funding opportunity. The long-term sustainability of projects in effect becomes questionable due to the dependency on public funding.

PPP projects are characterised with non-recourse or limited recourse project financing. However, the provision of non-recourse financing has not been ranked important amongst the attractive factors (AF14 is ranked 13th). MSW PPP projects in India encounter challenges in attracting debt financing for these projects, as there is a heightened expectation of viability gap funding for projects that are not financially lucrative. This may partly be due to the sectorial nature where the revenues from the projects, most of the times, tend to be acutely short to meet the debt servicing requirement. This grave concern is expressed by one the interviewees

> *"…this is not an attractive factor. When the financiers look at it, they don't find it attractive. I have been trying to get the project financial closure in 3 projects…Financiers are saying lots of lots of things and painful*

discussion. They say that if the project fails, it is the technology that got failed. That plant is of no use to me because the plant has failed because of the technology and the physical characteristics of the waste. In other sectors, say road projects, user charges are there, and that becomes an attractive feature in PPP. Now the banker has to see and look at the government only. But when direct user charges are allowed, the bankers would immediately take over and start funding themselves when it is generating revenues..."

Another transaction advisor noted that

"... This is not an attractive factor. The projects are structured on a tipping fee basis, and the tipping fee has to come from operation and maintenance sources. The full project is to be paid with the public funding only...The contracts are written ...say if the project fails due to default by the private sector, still the financial institutions are safe. Many contracts are written like that."

Component 4: Achieve value for money and reduce transaction costs

The fourth component accounted for 6.419% of the variance relating to the objective of value for money and the transaction costs in procuring the assets and services. Appropriate risk allocation has been one of the critical factors for successful implementation of PPP projects and in the value for money achieved (Bing et al., 2005). Adopting PPPs for transferring risks to the private sector (AF8) has been ranked 15th. This shows that Indian MSW stakeholders strongly perceived that transfer of risk is not an important attractive factor for MSW PPP projects. Several reasons can be attributed to such a response. This will require a proper understanding of the sector, various prevailing risks, and risk allocation practices. One transaction advisor noted

"...MSW is one such sector where both the parties are at risk ...all the regulatory risks belong to public sector... they don't realize and when they try to pass it on to the private sector the project fails. So, in my opinion, it is absolutely in between - it is the business risk and the technology risk carried by the private sector. Rest all belong to the public sector. The private sector has been found less effective for the household collection activities on account of 'privatization' fear and the user charge.

One private sector noted that

> *"…for collection, the public sector has a very well-established mechanism. They know the mind-set of people and know how to handle things. That is why we say…public sector is the best person to handle the collection and transportation risk or in other words the responsibility."*

This meant that among the supply chain of MSW services, the ability of the private sector to handle each segment is critical as opposed to the notion of delegating the whole MSW services. These responsibilities are often translated as a risk in the MSW segment (MoUD, 2011b).

Public agencies did not opt PPPs for reducing the project cost (AF6) in MSW projects, as it has been ranked as the least important attractive factor. The negative sign of this factor in the factor analysis further validates this perception as it is negatively correlated. This implies that governments need to understand clearly how cost reduction can happen particularly if PPP is used. This requires a robust value for money analysis which is missing in the Indian context in general (Grimsey and Mervyn K Lewis, 2005). In this vein, one of the respondents stated

> *"…cost reduction due to PPP to ULB is debatable as the government have to mostly provide for collection and transport services and the plant operation charges. In some cases, when the waste is less than mentioned in the contract, the government have to pay the additional cost."*

5.4.2 Negative Factors

Component 1: Incompetent procurement

The first component accounted for 29.97% of the variance among the negative factors. This component is related to the expertise of the public sector in procuring the projects. The factor 'Excessive restrictions on participation' (NF12) has not been viewed as a significant negative factor by the stakeholders, ranked 7th. In fact, one of the interviewees noted, "*we do not have enough participation, forget about excessive restriction on participation.*" However, sometimes ULBs have a tendency to set very high qualification limits as evident in the High Court of Cuttack verdict to reduce the qualification limits and retender the projects (Patnaik, 2017). Additionally, governments also had to rethink what to include in the qualification requirements. The

struggle is often to allow more participants or not. Finally, the experience of the public sector to complete the procurement of PPP projects successfully can also affect the attractiveness of such schemes to private sector. Lengthy delay in negotiations (NF13) has been ranked 6th amongst the negative factors. This lower ranking in Indian MSW context may be because negotiation with the bidders is restricted in the Indian procurement process.

Streamlining the procurement process can attract private investors to PPP projects. In the MSW context, "Confusion over government objectives and evaluation criteria" (NF11) has been ranked an essential negative factor, ranked 2nd. MSW sector projects are often contested among the various stakeholders about the cost of the solution with the quality of services that are possible, about the tendering process and methodology of selection, the mechanism to attract strong and capable promoters, and clarity on the requirements of the project. As a result, this sector has been a neglected sector for so many decades with a massive deficit in infrastructure provision. With respect to the needed changes, one transaction advisor noted that *"...evolving a cross subsidy model on a need-based basis is very much essential in this sector*". One expert noted

> *"...clarity in the procurement process will also make the project bankable, as without which no PPP project will work as the project investments are high initially and recovers over a period of time."*

Lack of experience and appropriate skill (NF10) is ranked 5th by the respondents, whereas it is ranked 1st in Australian context. The traditional notion that the private sector is competent enough is refuted by the public sector representatives also. The major challenge that has been pointed out is the lack of know-how of the technology and its operations, and many local contractors import the technologies without ascertaining the suitability of it for their projects. An example of it is the MSW project in Pune where Mailhem Private Limited established a biomethanation plant, which was abandoned since 2017 (after a year of establishment), causing massive loss of the investment. Similar incident happened in Vijayawada in 2004. When the ULB sought to rejuvenate the existing plant, no bidders showed up in the bidding stage. Similarly, lack of competencies with the public sector for successfully implementing PPP projects in India has been highlighted by Devkar et al. (2013). One respondent stated that

"When the projects started... there was not enough experience and processes to improve our skill... So we didn't know what is PPP…it was imposed on us… we did not have any idea about this PPP."

One transaction advisor cites the reasons as *"... the sources of the risk include improper RFP document conditions, inadequate mechanism to attract strong and capable promoter (technical and financial strength)*". One public sector representative noted *"... [Public sector] need to build capabilities to estimate project cost correctly and evaluate technologies for appropriateness.*" This factor is applicable to the public sector, the private sector and more importantly to the transaction advisory. Another interviewee noted

"...methodology and selection process needs to be appropriately structured with laid down procedures and appropriate evaluation systems ... for example all shortlisted consultants should have adequate sectorial experience and expertise."

This confusion affects the value for money (VFM) of the project due to the uncertainty in the project context and the insisted changes in the aspects such as costs, timelines and the public sector requirements (Henjewele et al., 2011).

Component 2: High Transaction costs

The second component accounted for 14.42% of the variance. This component relates to the factors causing an increase in the costs of the transaction. Among these, 'Higher participation cost' (NF7) has been ranked 10th. This might represent a callous approach adopted by Indian stakeholders on the participation/tendering costs such as the cost of assembling and setting up a consortium, and the cost of capital. The public sector has an opinion that, as there is no alternative option available with them, such costs were not given priority in making PPP decisions.

'Higher project cost' (NF8) has been ranked 8th in the MSW context. This highlights the perception that PPPs are not strictly perceived as the cause of the increase in project cost. Instead, irrespective of public sector or private sector being the provider of the service, the cost would still be on the public sector. One respondent presented his justification as

"...actually public sector is not really able to quantify the total costs of public provision and private provision. They (public sector) were only

spending minuscule amount, and they were not doing anything before private sector pitched in."

MSW services in India did not have much successful precedent of public provision, though there exist stories of treatment and disposal facilities being established and operated by the public sector. As a result of this, public sector have not been able to build enough expertise for provision of such segments by the public sector while procuring the projects.

On the other hand, "More time spent in contract transaction" (NF9) has been ranked 2nd. Contractual transactions in case of PPP are time consuming and complicated, requiring many studies to establish social, economic, financial, and legal feasibility and to finalize the concession agreement.

Component 3: Ineffective projects

The third component accounted for 10.18% of the variance and portrayed the reasons why the projects are becoming ineffective and failing. Among these, 'Lengthy delays due to political' (NF4) has been ranked the most significant negative factor for PPP in Indian MSW sector. MSW sector is socially sensitive and essential social infrastructure. One transaction advisor noted

"... One of my projects was an exceptionally well-designed project, and no other project has all the necessary clearances before the procurement stage. We had done all the necessary studies, but at the end of the day, the project was cancelled because of political debate between the ruling and opposition party."

Not only that, one of the significant impediments is stressed as "…*location of the project is of big concern since villagers are objecting to setting up of the project and this leads to inordinate delays and rise in project cost*." The respondents opined that a lot of political interference in this sector is undermining the seriousness and proper execution of these projects. One expert noted

"...as large piece of land is required, developer and builder lobby with support of politicians bring all obstruction to derail the project. State and Central Authority become a spectator rather than helping to resolve the deadlock."

Lack of successful experiences in the form of the factor "High rates of aborting projects before contract" (NF3) has been ranked among the top five negative factors. It has been ranked 4th in the Indian MSW context. The main reasons attributed to this phenomenon were delays in land acquisition (MSW project in Tirupati), political debate (MSW project in Mumbai – Taloja), and the inability of the private sector to reach financial closure by the private sector due to rejection of loan application (Pallavapuram in 2008 bidding).

In a PPP structure, public sector plays the role of a facilitator while a significant portion of the responsibilities and the risks are transferred to private sector. As a result, "High risk relying on the private sector" (NF2) has been ranked as an insignificant negative factor (ranked 9th). Public sector, in fact, is currently showing more reliance on the private sector without owning any responsibility. However, it is argued that the response of private sector may not always be what the public sector wants and thus private sector tends to be risk-averse if the risk is beyond their scope (Li et al., 2005). Concurrently, the public sector has apparently not been active once the services are delegated to private sector. The public sector still fails to realize that projects need to be enforced strictly by the public sector itself with the help of coordination agencies. One public sector representative noted *"...the risk may seem to be on a private player, but when a concession agreement is prepared, there is a liability on government as well*." One transaction advisor noted, "*…this situation arises when the public sector fails to continue monitoring. This is indeed a negative factor that is observed in the field….*"

A suggestion made by one of the respondents is as follows:

> *"...we (public sector and the coordination agencies) should try to be more transparent first and thereafter more specific to what is the current scenario and what we look forward ahead, in short, medium, and long-term horizon. I honestly say that no private company or individual can enforce the law the way a government body can."*

Hence, deciding whether private firms should operate the whole supply chain of collection, transportation, treatment and disposal or any part of this utility system, will be a cascading implication. This will inform governments to institute a robust PPP environment and refrain from using PPPs when the private sector is incompetent to enforce the respective parts of services (Dabarera et al., 2019).

Component 4: Overexploitation by the private sector

The fourth component accounted for 9.73% of the variance. This component depicts the ill-effects of using the private sector in the MSW sector. Reduction of project accountability (NF1) has not been rated as significant among the negative factors as implied from its 13th rank. In the Indian system, it was revealed not until 2013 that PPP concession companies are under the purview of the Right to Information (RTI) Act 2005 and as per this act a great deal of information can be accessed by the general public. Nevertheless, the accountability that is severely impaired in the MSW sector is the monitoring of its day-to-day activities, practical performance standards and honesty in the payments. Interview evidence suggests that the survey respondents might have attempted to pacify the reality that is existing in practice. Though all parties projected so, there is substantial concern expressed by the transaction advisory that represented the public body in various PPP projects stated:

> *"...we are missing one crucial point which all the PPP pursuit does. Once it is given to the private sector, they just blind their eyes. It should not happen. I am not against PPP but don't leave the project. It remains yours. It is always your asset, and then it is the private sector. So, when he loses, he loses only the finance. When you lose the project, you lose the project, and you lose the social welfare, you lose the environment, you lose the project development. You lose everything that is intended from the PPP project. But for the private sector, he suffers only the financial loss.*

Another expert noted

> *"...in the last four to five years, the rules have become so stringent that the private sector is struggling.... not to be accountable. He just can't go and do anything he wants. He has to remain within the law. This is a recent transition, before 2013 I think the things were not that much."*

This indicates a promising situation and a strong suggestion that the public sector should not provide leeway by deserting the accountability either in the contract framing stage or in the contract monitoring stage. In this line, another expert said that

> *"...the government does not have people to look after the projects. That is why projects are going in PPP mode...but even in PPP, ULB (urban local body) is the responsible agency. They should not forget that. In terms of*

accountability as far as the partner is concerned, I have no doubts that PPP business partner had got no accountability, the effort only starts with civic authority."

Debriefing this situation, one respondent noted

"…large part of the failure is due to the local authority wanting to pass the responsibility onto the private party without assisting in setting into motion proper principles of operation, maintenance, reporting and delineating responsibility of the two parties.

Another expert suggested "…*Stringent actions against ULBs for not complying with MSW Rules, delay in implementation, non-performance and non-compliances.*"

Less employment positions (NF6) due to adoption of PPP do not seem to be relevant in the MSW sector in comparison to other infrastructure sectors. One respondent noted, "*...PPP gives employment opportunities, but job security, working condition and remuneration are pathetic."* Labour strikes (for example in the case of Hyderabad MSW project of India) motivated by the fear of job loss do occur when the collection and transportation responsibilities are transferred to the private sector when opting for PPP project. Since this sector is labour intensive, a systematic change needs to be carried on the aspects of job security, minimum wages, and incorporation of rag pickers into the collection streams to eliminate these possible PPP ill effects instead of sudden privatisation of jobs.

The higher cost associated with PPP due to usage of private capital is perceived as one of the demerits of PPPs. However, the factors related to the cost are not among the important negative factors. For example, 'Higher charge to the direct users (NF5)' has been ranked 11th in the India context. One transaction advisor has noted

"...majorly, there are no user charges in this sector earlier. Only some cities are charging a user fee. This is also because there is no such practice before in India. I think there is one city in the south which has adopted direct public user fee. And people are challenging the user fee as water and sanitation charges are already included in the taxes. So, this has been delinked and collected separately in some locations."

All the stakeholders agreed that a higher charge to the direct users could not be construed as a direct implication of PPP usage. This is because the public sector did

not provide complete assets and services prior to the usage of PPP mode. Hence, this prevented the cost comparison of user charges with traditional procurement methods.

5.5 INFERENCES

The adoption of PPP in the Indian context, especially in the MSW sector has been marked with the desire to reduce capital investment from the private sector. Nevertheless, MSW projects tend to have component of upfront government guarantees, unlike other sectors where grant is not expected in financially viable business case. Governments continued to provide capital support under various programs expecting that private sector will charge lesser tipping fee for the initial subsidy (DEA, 2009). Eventually, this might compromise the level playing field for other modes of infrastructure procurement (HMT, 2012). Indian PPP MSW projects seem to be conceived with a desire to facilitate creative and innovative approaches. PPP is also majorly propelled to improve the buildability and maintainability of the assets/services of the MSW by integration of functions such as design with operation. This is also envisaged with the objective to ensure quick delivery of the much-needed infrastructure in MSW sector. For this sake, public sector tends to transfer risk to private sector, but this reduces project accountability and unduly rely on the private sector. This is mainly caused by less involvement and monitoring by the public sector because of false notion that private sector will self-regulate and self-monitor even without the involvement of public sector. Moreover, the high asset specificity of MSW treatment assets might have affected its project finance commitments.

On the other hand, PPP infrastructure development in MSW is strongly affected by negative factors such as prolonged delays caused by political debate, lack of expertise and relevant skills with both public sector and private sector, perplexed objectives and evaluation criteria, prevailing situation where limited projects have essentially reached the operations phase, and longer time for contract transactions. Political debates, in particular, are more relevant in this sector (Li et al., 2016). Government need to take proactive measures to reduce the tensions in the governance. Moreover, biases in the processes such as the tendering and the land allotted for treatment facilities are prevalent. Though benefit to local economic development is unlike the other infrastructure sectors such as roads, ill-effects due to health and sanitation loss are quite detrimental to otherwise productive health of the citizens

(DEA, 2009). Governments and urban local bodies need to devise strategies to overcome these negative barriers to allow successful projects in the future (Li et al., 2016).

Though the dire need for infrastructure suggests PPPs, it is advisable to governments to consider carefully the market opportunities that would bring the best value for money and the quality of services. This is particularly relevant due to the condition of inadequate competencies of public and private sector parties in procuring, operating, and monitoring the deliverables. Instead, public authorities need to proactively involve in MSW services and use PPPs appropriately with caution (Akintoye et al., 2016). More particular, there is a need to enable a robust monitoring mechanism to reveal the benefit of PPPs for the aid of future projects. This adds to the claim that PPP is no panacea for the successful delivery of assets and services, but the public sector must also devote resources to develop successful projects. The findings of this study have shown such a framework for development. There seems to be a gap in the understanding of project financial packages for the MSW sector. Mainly, limited recourse nature to public funding is not promising, and subsidies and upfront grants are more expected. This is because private investors are never interested in the high-risk infrastructure asset class (HMT, 2012). So, the already cash strapped public entities cannot bear the extra monetary burden of procuring projects in project finance mode (HMT, 2012). This must redirect the scale and the scope of services for which PPPs is most appropriate. This includes preserving long-term flexibility over service planning and coordination (Akintoye and M Kumaraswamy, 2016). Subsequently, the complexity of the projects and thereby the delays in transaction and negotiations can be reduced, evaluation by governments can be most specific and focused. These measures will further enhance the attractiveness of PPPs. The usage of mixed-method showed that there are differences in theory (as perceived in the survey) and practice (as elicited in the interviews). For instance, though survey findings did not reveal, interview evidence qualifies the long-standing criticism that PPPs lack empirical support on its innovation potential. CIB Task Group 72 Research Roadmap on PPPs (Akintoye and M. M. Kumaraswamy, 2016) state that "*[there is] ...lack of empirical evidence on how PPPs generated/ drove innovations (despite that being an important expected benefit)*." Moreover, studies confirm that project accountability is highly compromised in MSW sector (CAGI, 2008; Spoann et al., 2019) and this was not

noticed from the survey findings but revealed in the interviews. Finally, the current findings might be comparable to findings of similar studies conducted in other developing countries on account similarities on status of MSW management and synonymous legitimacy requirement in managing the waste (Hoornweg and Bhada-Tata, 2012; Spoann et al., 2019). The findings are shown in Figure 5.5.1

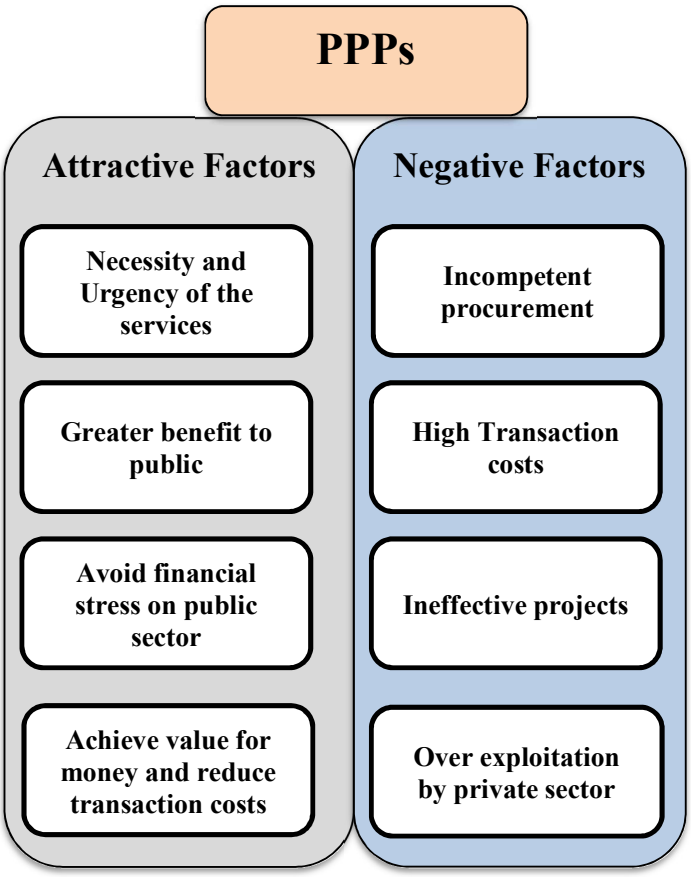


Figure 5.5.1 PPP Attractive and Negative Factors

5.6 SUMMARY

As a part of answering the first research question, this chapter intended to understand the factors that are presently motivating the adoption of PPP mode in MSW sector. This is done by extracting opinions from experts through questionnaire survey. While the question is not whether PPP should be used in Indian MSW sector, it is rather delving on the strategies and mechanism to make PPPs more attractive and successful. This is because MSW sector needs private expertise and participation to revamp the MSW services. The findings also support these assertions. The attractive factor for

PPP adoption has been the necessity and urgency of the services. There are undoubted benefits to the public through PPPs in MSW sector. It is also considered as an immediate thought if the ULBs do not have funds and related services, which is often the case. In principle, practitioners have perceived that PPPs can achieve value for money and opine that they have reduced transaction costs in the service provision. However, incompetent procurement has been affecting the performance of MSW projects when procured through PPP mode. On the contrary to the theoretical expectation, MSW PPP projects seem to be affected by high transaction costs. These reasons might have been caused by ineffective projects and the prevailing notion that the private sector is overexploiting the MSW sector with low-quality results. ■

CHAPTER 6

RISK MANAGEMENT OF EFW PPP PROJECTS

6.1 INTRODUCTION

This chapter deals with the analysis of the risk factors relevant to waste treatment projects employing four energy from waste technologies. In India, the technology adoption for treatment and disposal is diverse, but extant literature states that technology also determines the risk profile of the project. Hence, this study adopted the technologies currently in practice such as biomethanation, refuse-derived fuel to power, incineration, and pyrolysis-gasification. Next section presents the results of tests such as Cronbach's alpha for reliability, relative importance index for ranking, Kruskal-Wallis one-way analysis for variation of risk among the groups of stakeholder, and the preference of risk allocation. The fifth section presents the findings of the questionnaire survey carried out to understand the risk management practices relevant to Indian MSW PPP projects. The variation of risks across the technologies is also highlighted. The last section presents a discussion of the main findings and the inferences for future MSW PPP projects of India.

6.2 RELIABILITY AND RELATIVE IMPORTANCE INDEX (RII)

The scale used for soliciting the rankings from the respondents was first tested using Cronbach's alpha values. Cronbach's alpha values for the scales for each treatment options are 0.780 for 'biomethanation', 0.881 for 'RDF to power', 0.825 for 'incineration', and 0.854 for 'pyrolysis-gasification'. The high values of Cronbach's alpha values highlight that the instrument is highly reliable since the index values have exceeded 0.7 as suggested by Nunnally (1975). The calculations were performed using SPSS (Version 20). After establishing reliability, the ranking of the risk factors was determined using relative importance index (RII) which is one of the most widely used metrics for ranking the risk factors in construction management research due to its simplicity (Kumaraswamy and Morris, 2002). Figure 6.2.1 shows the variation of risks' criticality measured through the relative importance index vis-à-vis the four EfW treatment technologies used in MSW PPP projects.

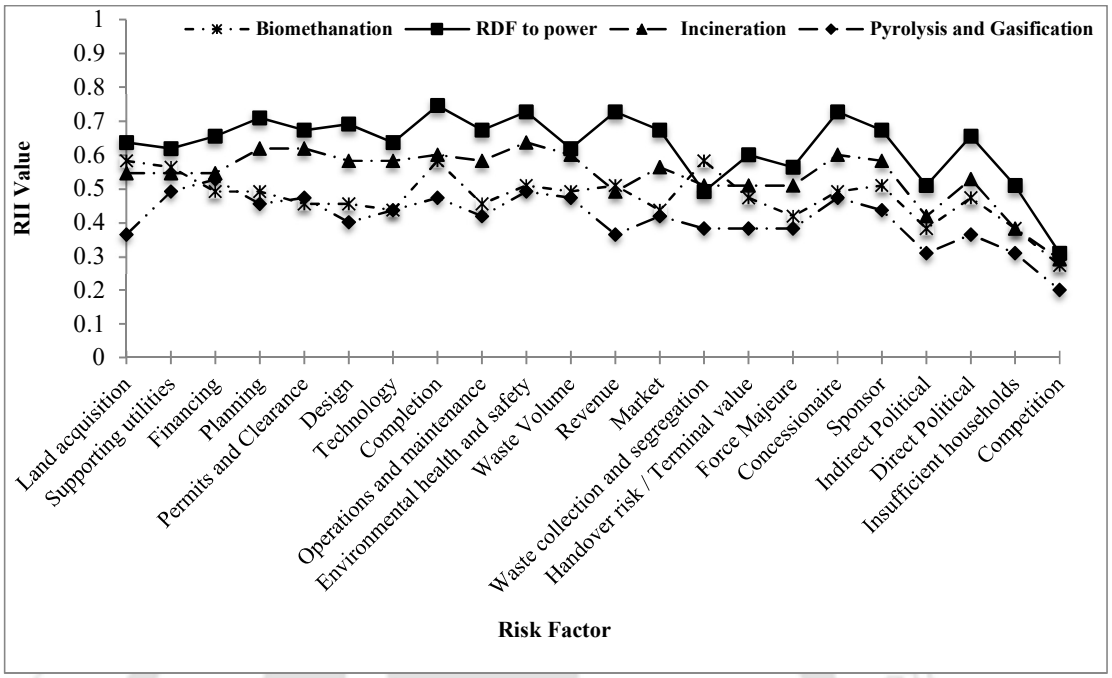


Figure 6.2.1 Criticality of Risk measured by RII over the EfW technologies

6.3 KRUSKAL-WALLIS ONE-WAY ANALYSIS OF VARIANCE

Kruskal-Wallis one-way analysis of variance was carried out to ascertain whether the rankings of the risk factors vary amongst the different categories of respondents (namely respondents representing the public sector, private sector, and transaction advisor). Through this analysis, the hypothesis "*whether the distribution of the risk factor is the same across the different categories of grouping*?" has been tested. The finding shows that the null hypothesis could be retained at a 0.05 significance level, indicating that there is no significant difference between the perceived criticality of each risk factor among the three groups of the PPP stakeholders. The summary of results for the 22 risk factors with asymptotic significance level is presented in TABLE 6.3.1.

Table 6.3.1 Reliability and K-W Test Results

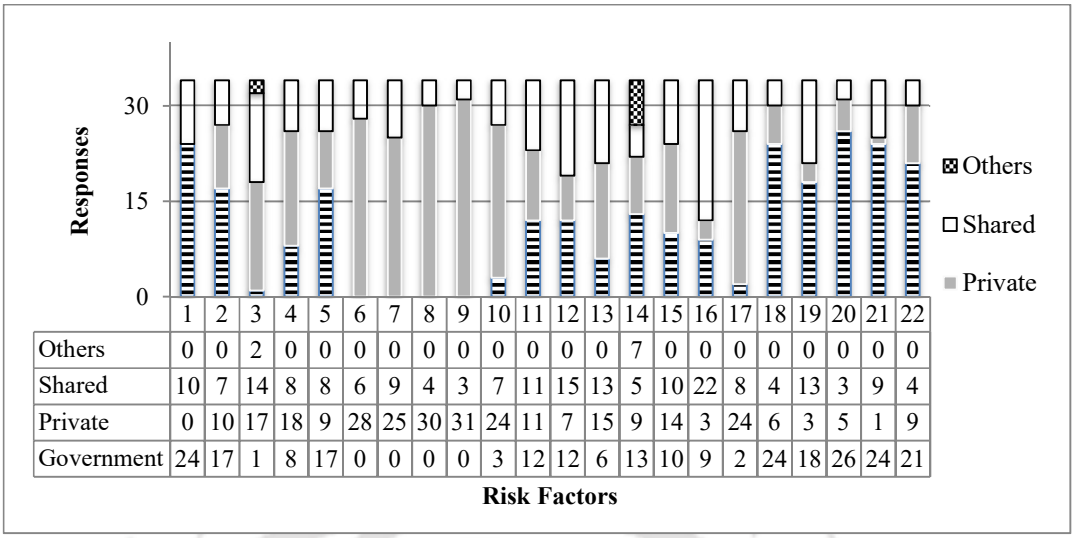
Risk Code	Bio		RDF		Inc		P&G	
	α	Asym Sig	α	Asym Sig	α	Asym Sig	α	Asym Sig
R01	0.760	0.229	0.890	0.108	0.872	0.362	0.903	0.391
R02	0.764	0.286	0.877	0.665	0.840	0.542	0.876	0.394
R03	0.748	0.692	0.865	0.332	0.805	0.877	0.289	0.440
R04	0.755	0.734	0.873	0.623	0.804	0.736	0.840	0.576
R05	0.769	0.898	0.878	0.416	0.834	0.497	0.849	0.179

Risk Code	Bio		RDF		Inc		P&G	
	α	Asym Sig	α	Asym Sig	α	Asym Sig	α	Asym Sig
R06	0.772	0.774	0.873	0.244	0.795	0.875	0.864	0.642
R07	0.774	0.774	0.863	0.334	0.795	0.875	0.839	0.882
R08	0.796	0.227	0.884	0.696	0.839	0.741	0.861	0.335
R09	0.757	0.422	0.865	0.327	0.795	0.875	0.842	0.397
R10	0.773	0.245	0.878	0.617	0.839	0.721	0.861	0.516
R11	0.760	0.867	0.878	0.698	0.831	0.255	0.849	0.179
R12	0.768	0.772	0.872	0.485	0.84	0.814	0.867	0.395
R13	0.794	0.695	0.886	0.416	0.384	0.439	0.847	0.233
R14	0.787	0.202	0.882	0.851	0.788	0.744	0.822	0.653
R15	0.790	0.753	0.886	0.837	0.798	0.733	0.822	0.653
R16	0.775	0.767	0.868	0.438	0.798	0.733	0.835	0.642
R17	0.765	0.521	0.878	0.528	0.811	0.255	0.842	0.233
R18	0.769	0.918	0.876	0.241	0.832	0.265	0.845	0.244
R19	0.782	0.422	0.883	0.780	0.790	0.657	0.831	0.653
R20	0.791	0.202	0.870	0.213	0.805	0.741	0.836	0.516
R21	0.758	0.641	0.877	0.708	0.799	0.895	0.835	0.882
R22	0.750	0.348	0.876	0.795	0.807	0.744	0.855	0.516

Legend: Cronbach's alpha (α) represent the scale reliability, and asymptotic significance is from the Kruskal-Wallis test for group differences.

6.4 RISK ALLOCATION PREFERENCE

The respondents were asked to give the preference of risk allocation for EfW projects of India. These preferences for the allocation of these risks amongst the various categories of stakeholders were then analysed in a manner employed by Hwang et al. (2013) such that contestations and agreements are clearly depicted. The findings from the risk allocation preference amongst the respondents are shown in Figure 6.4.1.



	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
Others	0	0	2	0	0	0	0	0	0	0	0	0	0	7	0	0	0	0	0	0	0	0
Shared	10	7	14	8	8	6	9	4	3	7	11	15	13	5	10	22	8	4	13	3	9	4
Private	0	10	17	18	9	28	25	30	31	24	11	7	15	9	14	3	24	6	3	5	1	9
Government	24	17	1	8	17	0	0	0	0	3	12	12	6	13	10	9	2	24	18	26	24	21

Figure 6.4.1 Risk allocation preference in EfW PPP projects

6.5 FINDINGS AND ANALYSIS

This section presents the key findings and the analysis of the critical risks and of the contestations in the risk allocation.

6.5.1 Critical Risks of EfW Projects

The risk profile of EfW technologies highlights the fact that around 50% of the risks are rated as highly critical. The results show that RDF to power technology is perceived as the technology with the highest risk level while pyrolysis-gasification is perceived as less risky in comparison. Practitioners perceived that biomethanation technology is most affected by risks related to land acquisition, timely completion, waste collection and segregation, supporting utilities, and environment, health and safety. RDF to power technology is perceived to be significantly affected by completion risk, environment, health and safety, revenue risk, concessionaire risk, and planning risk. Incineration technology is affected by environment, health and safety risk, planning risk, permits and clearance risk, completion risk, and waste volume risk. Pyrolysis-gasification is affected by financing risk, supporting utilities risk, environment, health and safety risk, permits and clearance risk, and completion risk.

A careful observation of the data shows that environment, health and safety risk and completion risk stood among the top five risks related to all the EfW technologies. Other risks that are perceived with seriousness are supporting utilities risk, permits and clearances risk, and planning risk. Land acquisition risk (R01) is often triggered when

the urban local bodies (ULBs) are unable to provide the land for construction and operation of treatment facilities. Findings indicate that biomethanation technology is more affected than other technologies. This could be because of the localised problems that attract 'not in my backyard' phenomenon due to the poor air quality near the digesters. The completion risk (R08) and the environment, health and safety risk (R10) have been rated as very critical by many of the respondents for RDF, incineration, and pyrolysis-gasification technologies. In comparison, pyrolysis-gasification is regarded as an environmentally friendly technology when compared with incineration. It has also higher energy recovery efficiency. The typical by-products from MSW project are leachate, odour, and toxic gases such as dioxins and furans. The probability of pollution from these products is extremely high, mainly if the technology/design is ill-suited or the private operator do not perform the operation and maintenance properly. These situations tend to causes immense public oppositions, particularly in MSW projects but not much in other infrastructure sectors. Likewise, supporting utilities risk (R02) is another project-level risk that has to be shared between the public and private sectors as this risk gets accentuated in case of inability of the public sector to provide the necessary support and the site accessibility. This risk is found to be often dependent on other risks such as the need for segregated waste for its successful operations. Comparatively, RDF based power and incineration technologies are not as much affected, as they are capable of handling unsegregated waste. However, the calorific value needs to satisfy the requirements of the technology.

Planning risks (R04) is one of the critical risk factors, which could affect the success of the whole project, particularly in RDF to power and incineration-based projects. Additionally, these projects require meticulous planning, as most of the technologies used in the projects are proprietary in nature, which needs to be imported. The reasons for the realization of this risk could be attributed to poor studies when an incompetent consultant is appointed for the studies, and when unrealistic expectations and timelines set by the ULBs. Permits and clearance risk (R05) in MSW projects tend to be diverse in nature as compared to other sectors and is particularly significant for thermal technologies such as RDF to power, incineration, and pyrolysis-gasification. This is often considered as meso-level risk (Ke, Wang and Chan, 2010) and often faces conflicts at the interface of the teams or internal to the teams. This risk is mostly

allocated to the public sector with exceptions where the private sector is responsible for getting approvals with the support of the government.

Amongst the technologies being utilized in India till date, there is a lot of diversity in the success and maturity of the technologies such as RDF and incineration and thus making design risk (R06) significant. Technology risk (R07) is, therefore, one of the pivotal risks in MSW management similar to sectors such as power (Rebeiz, 2012) while it is not so critical in other sectors such as transportation. One of the reasons for the realization of this risk in the MSW sector is faulty waste characterization studies in pre-feasibility and development phases. This could even lead to the choice of inappropriate technology. Few technologies involve the utilization of mixed waste, whereas some technologies need specific requirement relating to the characteristic of the waste. Respondents indicate that mixed waste technologies are more prone to failure than a technology(s), which is dependent on having a segregated supply chain (R14). There is a strong consensus among the interviewees that equipment used in the projects is not designed in the first place to handle the waste characteristics of India.

While the private sector is always positive about their proposed technology, evidence indicates that the maturity of technology is still low, indicating high risk in India. This prevents designing large scale and complex projects. Instead, interviewees indicated that projects, which maintained segregated supply chain for provision of waste to projects in the form of a separate package, seem to be more productive. On the other hand, it has been observed that indigenous technologies have been more successful when applied on a smaller scale with many cases of successful completion of the construction and operation. With respect to the discussion on technology selection, another expert opined that

> *"...After they (private sector) got the project, they will realize segregation of waste is not happening, and waste characteristic is different. So, the private developer, when they promote the technology, they should do a proper study of the town in terms of characteristics as well as the segregation level, then only they should promote. At the same time, ULBs should also carry out to know whether this is suitable for this town or not."*

One of the key informants have said,

> *"...risk will be higher while moving to pyrolysis-gasification as compared to the traditional composting. We are aware of composting, and to some extent biomethanation and RDF technology, but for incineration, pyrolysis-gasification we do not have the know-how of the technology for mixed waste which is prevailing in India."*

Waste collection and segregation risk (R14) has a close association with technology risk and has a significant impact on the success of the project. But little attention is paid to in the extant literature. The allocation of this risk is highly complex in case of projects where there exist a possibility of using NGOs for collection. NGOs are typically involved in addressing societal pressure but do not satisfactorily perform as they are non-profit driven. And, this is an issue that has been asserted by at least 20% of the interviewees.

Financing risk (R03), one of the foremost risks in case of EfW projects. This risk is generally borne by the private party in case of a typical PPP project by adopting appropriate hedging instruments and a highly leveraged capital structure in case of projects with a low-risk profile. However, since projects in MSW sector are highly operational oriented and require substantial operational investment along with capital expenditure, the risk of the private sector and to equity investor is still high in this sector compared with other infrastructure sectors (Rebeiz, 2012). In these lines, one of the respondents opined –

> *"...financing risk and revenue risk are important for a project to be financially sustainable. In India, the MSW sector is still in an evolving stage, hence government grant support for funding MSW project is important, which reduces the financial risk of the private operator."*

In addition to this, the reason for the perception of high financing risk is that such projects used commercially unproven technologies. The risk perception is very high risk in those cases. Low competency levels of the private sector to handle and operate the latest technologies at its optimal level adds to the prevailing high-risk perception in these kinds of projects.

The risks such as waste volume risk (R11), revenue risk (R12), and market risk (R13) are amongst the risks that directly affect the financial viability of a PPP MSW

project. In fact, waste volume risk (R11) has been considered to be one of the reasons leading to the failure of projects conceived in the early stages of this sector when the sector was yet to mature. However, with experience from previous projects, the projects are currently structured with a guarantee that private sector will provide the promised quantum of waste at the tipping point or will ensure that collection will result in an assured minimum quantity of waste. The projects are also structured to accept the dynamic collection within a range, which is acceptable to both public sector and private sector. 'Insufficient households' risk (R21) is a variant of waste volume risk, particularly if the contract specifies the area of service instead of tonnage of waste. Realization of 'insufficient households' risk will alter and magnify the revenue risk of the concessionaire. Revenue risk (R12) is relevant in PPPs where the private sector is allocated the responsibility of collecting the tipping fee from households, and revenue from the sale of its products like compost, power, and bricks similar to traffic risk in toll road projects. In case, the public entity pays the monthly payment of tipping fee to the private sector, the revenue risk to the private sector is well mitigated. Amongst the treatment technologies, incineration and RDF are found to be affected by revenue risk, as both these technologies have high operational costs and often need auxiliary fuel if the input characteristic differs from design specifications. High sunk costs due to poor planning have also caused this situation.

6.5.2 Contestation of Risk allocation

The preferred allocation for all the risks is undisputed excluding financing risk, revenue risk, and waste collection and segregation risk. These three contested risks are very critical for PPP MSW projects as they affect the financial viability and selection of technological options for the project. The disagreement between the stakeholders on the preferred allocation of these risks, therefore, highlights the influence of contextual issues on who should bear these risks as elaborated in the subsequent discussion. The current findings concur with the established notion that risks are often contested (Zinn, 2008). The significant portion of the risks is not allocated to any individual stakeholder. Risks like delays in land acquisition and supporting utilities risk are clearly allocated to the government as the reason for delays in land acquisition could be attributed to them only. The various factors affecting the allocation of waste collection and segregation risk are – presence and strength of local unions involved in the existing collection systems, the efficiency of existing collection systems, and lack of or poor

enforcement levels of ULBs in implementing policies on source segregation. In this regard, one of the respondents said

> *"...our city exhibited a network of waste collection system, which is very difficult to break by government. As of now, the government is not in a position to delegate the risk of waste collection to private sector. The risk of waste collection is a major risk in all the MSW projects in our jurisdiction."*

6.6 DISCUSSION

Based on the perspective of stakeholders, the findings section focussed on the intensity of risks and their variation with the EfW technologies used in India. It also highlighted the critical risks in each technology which needs special consideration. The discussion now focusses on the risks and their mitigation, risk allocation preferences, and the policy implications that emerge from the findings of the current study.

6.6.1 Intensity of risks

Though the after-effects of the unmitigated risk are more in the private sector, the initial triggers of the risk factors are more within reach of the public sector. This supports the researchers' views of sharing the risk instead of bearing the risk by any single party (T I Lam, 1999). The findings also indicate that the risk-sharing profile is different from the extant literature. Ke et al. (2010) and Ameyaw and Chan (2016) indicated that no single risk is borne by the private sector alone. But, in Indian conditions, couple of risks are borne by the private sector alone, indicating a risk aversion behaviour in the public sector on the risk allocated to the private sector even though the ULB has a role to play. This causes conflict in sharing the responsibilities instead of forging a strong partnership for executing the project. ULBs have to exhibit more responsibility in executing the PPP projects and should work with the private sector as a team instead of adopting an obligation averse attitude in the bling fold of private procurement.

Feasibility studies with risk analysis are major parts of the pre-project phase (Ferdan et al., 2015). The financial model is very critical in the procurement of PPP projects. Singh and Kalidindi (2009) have provided evidence supporting the financing risk perception. They highlighted that lenders often take this aspect into consideration

while making decisions to extend debt to a project. Often credit rating agencies such as Standard and Poor's often take operating risk into account, but such phenomenon is not observed in Indian MSW projects (Rebeiz, 2012). This remits the need to assess whether the cost of a project is increasing because of using PPP mode of procurement as there exists no specific public sector comparator mechanism in India. In this scenario, exploring alternative funding mechanism such as municipal bonds can reduce the financing risk in this sector and lower the costs of public procurement. In order to mitigate this revenue risk to a certain extent, MSW fee could be combined with property tax charging either at the rate of per capita waste generation multiplied by persons living or a certain percentage multiplied by property tax (Dolla and Laishram, 2018).

To mitigate market risk, the private sector is expected to have MOUs with a relevant organization that would be the buyer of their products. These requirements are ignored, but recent projects are taking such MOUs to secure their revenue streams. As PPPs tend to have long-term contracts, any change in the demand of products or changes caused by external factors like consumption patterns will result in lowering of the demand for such products and this risk could be mitigated if the buyer is a public sector organization. This risk could be better managed by mandating letter of intents from probable buyers in the bidding stage. In order to handle delays in land acquisition, making a site selection checklist with respect to various norms could lend support for preventing undue delays in land acquisition. Besides, there is a need to understand the acquisition powers for land.

6.6.2 Preference for allocation

Often the advice and criticism are divided between various stakeholder groups regarding the preference for risk allocation. For instance, funding agencies typically focus on the technical, financial aspects of EfW projects. Critical issues identified under this class is the uncertainty of quality and heat value of the waste along with the costs recovery understanding, and this concurs with previous findings (Huang et al., 2018). The public administration side of the advice and criticism concerns the ineffective operations and lack of information disclosure related to the emission standards. The risk management strategy should be to treat the contested risk factors on a project-by-project basis rather than adopting a general rule of thumb. Amongst the contested risk, financing risk is the risk where a consensus could not be reached on who should bear

this risk as risk allocation through the lock-in of finance binds the financers as well as the private sector to the project. It is argued that better risk management techniques are to be incorporated when the private financing mode exists in the project. This implies that when the extent of private sector funding decreases, the risk-taking behaviour of the private sector also decreases (Grimsey and Mervyn K. Lewis, 2005). More dependence on the collection of user charges brings more uncertainty to project revenues. In cases where the public is not willing to pay, alternative revenue generation models should be encouraged. In case the uncertainty of financing still exists, the government may give a part of assured tipping fee in the form of an annuity without compromising the private sector innovation capability to generate revenues. Like financing risk, waste collection and segregation risk is also highly contextual and is dependent on socio-political factors. These critically contested risks are the ones that define the scope of the project and, in turn, are the distinctions across the PPP models. The current strategy of transferring more risks to the private sector should be relooked with caution, particularly in the MSW sector (Ke, Wang, Chan, et al., 2010). It is better to decentralize the supply chain to eliminate private sector participation in waste collection and segregation. Moreover, centralised solutions are found to be more prone to risks than decentralised waste management projects. The risk magnitude also increases in case the project is a large-scale integrated project (Estache and Iimi, 2011). This indicates a definite need for bundling analysis before procuring the project, i.e. ascertaining the appropriate scope of the project. In other words, deciding the appropriate scope of the project among the segments of the supply chain by contemplating on the best value instead of assuming that private sector has to do from household collection to disposal of waste through single contract (Akintoye and Beck, 2009). The conflict between the long-term concessions required for PPP projects and the differences in the various technologies and the concession period that they demand would add up to the current dilemma of the bundling decision. This study offers critical insights that play an essential role in improving the bankability of the projects and ensures predictability of the risk/reward profile of different types of technologies and PPP contractual structure. This also enhances the confidence of investors as the terms and conditions of the bidding documents are well known in advance.

6.6.3 Policy Implications

The top risk factors can be very well related to the many essential policy suggestions made in the extant literature. Indian EfW PPP projects particularly suffer from lack of adequate openness, transparency, and sufficient stakeholder engagement (Yeboah-Assiamah et al., 2017). Though success in EfW projects is often needed in the current situations, ULBs should not endanger the reduction and recycling initiatives. In order to address the financial implications of the direct and indirect political risks, a careful social impact assessment should be carried out by the public body before adopting the PPP mode. Appropriate contractual provisions to compensate the concessionaire and lenders with a pre-defined return should also be included in the concession agreement. Nevertheless, this particular risk in the form of breach of contract remains the most critical concern for investors in public utility projects in developing economies (World Bank Group, 2016).

The acceptance of people groups surrounding the project have a strong influence on the operations and effectiveness of the EfW projects (Achillas et al., 2011). Protests against MSW treatment and disposal facilities i.e. 'not in my back yard, have been reported in many countries/regions because of potential hazards and release of harmful gases (Li et al., 2016). Likewise, public opposition is predominant in MSW projects of India. Hence, besides the adoption of appropriate technology and design, the focus should also be on proper execution of the environmental management plan as a part of the risk mitigation strategy. ULBs are concerned with technical assessments but care much less on the opportunities for the interested stakeholders from the public. Winning trust and seeking transparency has a powerful implication in attaining good projects which are currently lacking the country. For instance, Thessaloniki in northern Greece revealed rather a supportive community approach on the usage of MSW thermal treatment due to various dissemination strategies by the government (Achillas et al., 2011). In contrast, Jabalpur is one of the recent project, which is in operations and regarding widely for replication. However, there are no reported studies on the emission compliance of Jabalpur MSW project, nor there is available data for the sake of assessment. The online monitoring system of emission is found to be mere on paper rather than being in practice. This is a risk which is peculiar and more prevalent in MSW projects, where environmental governance relates to public participation. Public protest against the EfW projects if they apprehend that government is acting in self-

interest or if they perceive that neighbourhood is not really connected to the rest of the stakeholder groups (Achillas et al., 2011). Governments can bridge this gap by taking measures such as social reassurance (e.g. regulatory control to perceive unsafe situations), persuasion (e.g. showing robustness in environmental standards and site selection), arousal (e.g. apt actions to emergency), and adequate technical expertise (e.g. selection of proficient operator and regulator) (Achillas et al., 2011). Additionally, Li et al. (2016) suggested that ULB should adopt one of the approaches such as hierarchical problem solving, tension reduction, collaborative governance, and meta-governance approach depending on the intensity and type of public resistance. These dissemination methods need to be compared with the organisational power strategies used by private agencies for economic infrastructure. Since governments often face opposition from the citizens, the study of governmentality i.e. 'strategies of organisational governance' (Clegg, 2019) becomes crucial. For instance, to induce practices to fulfil the objectives or government's policies, particularly in waste management EfW projects. Governmentality effects the image of project and the vicinity and hence these strategies related to governmentality are different between various kinds of infrastructure projects. For instance, Indian metro project is seen as socially committed, safe, clean, prestigious and iconic for the city (Clegg, 2019). Local community participation can be strengthened by using the local community to participate in structured and informed discussions in what is called risk communication programme (Snary, 2002). It also requires encouraging vision of promoting EFW, considering its benefits of renewable energy and the conservation of land (Ren et al., 2016). These measures move the project closer to public participation instead of the traditional outlook of information and consultation. The local oppositions are becoming stronger and stronger and raise serious questions. Consequently, India's ability to provide the necessary infrastructure to achieve the target waste treatment and energy generation becomes questionable. Currently this domain is under researched.

The failure of emission standards also will defame the image of this sector's necessity and the public agenda's and policies. Though ULBs are primarily responsible for public acceptability of the project (Fantozzi et al., 2014), unfortunately, the risk related to this public acceptance is poorly handled by the Indian public agencies. The case of Bengaluru Waste to energy is a classic example. There is a strong notion expressed by many experts (except the private parties) that governments are turning a

blind eye to the emissions of the projects. For instance, after repeated pressure from a non-governmental organisation, Central Pollution Control Board (CPCB) inspection has found that dioxins and furans in the vicinity of the Okhla Incineration project in Delhi are several times higher than the permissible limits of the country's norms (Kushwaha et al., 2018). The modification of the technology to suit the project is detrimental to environmental health and safety risk. Very often, the authorities are not aware of the effects of these modifications on the environmental standards of the project. This is one of the key problems not reported in the extant literature but identified in this study. Hence, when these modifications are made, thorough scrutiny is required not only during the initial testing but more rigorously after the issue of readiness certificate.

The ULBs should make sure that the segregation supply chain is accurately maintained. In case, the collection is carried by public or outsourced as a separate contract to NGOs or other allied agencies, ULBs need to carry out proper monitoring of the collection (Rajamanikam et al., 2014). In order to mitigate waste collection and segregation risk, the planning process should concentrate of undertaking activities for increasing the awareness and educating the public to overcome the "not in my back yard" (NIMBY) mind-set, pertinent in developing countries, and change the mentalities of the general public in India (Kruljac, 2012). One of the strategies for overcoming this risk is through the involvement of NGOs. However, though NGOs are found to be effective in increasing the awareness and stimulating source separation, boosting door-to-door collection, utilizing wastes as raw materials and generated more job opportunities, little attention has been paid for including these measures in the procurement stage (Rajamanikam et al., 2014).

Emerging markets are particularly affected by the concessionaire risk due to shortage of matured and competent private players (Rebeiz, 2012). Amongst the technologies, the adverse effect of concessionaire risk was found to be most prominent in the case of RDF technology, and this explains why RDF projects in India failed the most. This could be attributed to inadequate technology know-how with the private sector which is expected to build and operate the facilities in PPP mode. To address this, the Indian Government may need to take a two-pronged approach as a response to this prevailing scenario. One is to boost the confidence of private sector by running a greater number of smaller size pilot projects; and, two, by making more stringent

performance bonds and security deposits to prevent causal players from entering projects and also to compensate the failure and performance issues to the public. In order to address the financial implications of these two risks, careful social impact assessment should be carried out by the public body before adopting the PPP mode. Appropriate contractual provisions to compensate the concessionaire and lenders with a pre-defined return should also be included in the concession agreement. Nevertheless, this particular risk in the form of breach of contract remains the most important concern for investors in public utility projects in developing economies (World Bank Group, 2016). As reflected in the findings, economic risks have much greater influence than the risk caused due to delays (Serrano-Gomez and Munoz-Hernandez, 2019). In importance, risks related to delays follow economic risk.

India is not the lone sufferer of the poor treatment and management of waste. Many developing countries such as Bangladesh, the Philippines, China, African countries, among others, have similar experiences. On the other hand, EfW projects in the developed countries are not significant shareholders in the treatment. For instance, the majority of Canadian waste is landfilled: incineration, or in many cases Energy-from-Waste (EfW) accounts for less than 5% of total Municipal Solid Waste (MSW) management (Metuzals, 2015). A similar situation is presently seen in other developed nations such as Denmark, Sweden and the Netherlands where the share of technologies such as incineration in considerably going down. Moreover, in Sweden, EfW is uncontroversial and has public acceptance as green technology. Hence, more research is needed even other geographical contexts where EfW projects still demand a significant share and thus need to advance the knowledge of risk and their effective mitigation in the future to successfully handle MSW sector. MSW treatment projects are often regarded as a means to low carbon pathways. Particularly, governing agencies are looking for carbon-neutral and carbon-negative technologies that can efficiently handle the waste generated from the urban dwellings (Rennie, 2011).

The importance and contribution of the current study are manifold. Firstly, clear and robust concession agreements form an essential element in the success of PPPs. In India, model concession agreements for PPP projects relating to different infrastructure sectors such as roads, ports, and airports have been drafted in India suggesting its maturity and understanding of the sectorial nature for executing successful projects (Ramakrishnan and Raghuram, 2012). Nevertheless, model concession agreements

have not yet been drafted for MSW sector in spite of the fact that various cities have initiated the development of MSW projects through PPP route. As a result, this might yield erroneous outputs and unsuitable selection of a PPP model. Despite this necessity in the understanding of risk in the MSW sector, there is a paucity of studies in this direction. Moreover, studies on other sectors of infrastructure can be of little benefit as PPP policies, approaches and strategies are unique to the sector of application (Eggers and Startup, 2006). The risk allocation preferences and theories on causes of failure identified from this study can be used by stakeholders of the MSW sector as a guiding tool for framing appropriate risk allocation framework in future PPP EfW projects. Study in this direction will also strengthen the knowledge base and will play an important role in streamlining and standardization of concession agreement for PPP MSW projects for successful projects. Second, Indian PPP projects are often criticised that they lack a structured methodology and therefore the application of public sector comparator (PSC) for calculating value for money in PPP procurement (Grimsey and Mervyn K. Lewis, 2005). Globally also, few studies have focused on value for money in bioenergy projects risk management and value for money (Fantozzi et al., 2014). PSC calculation is based on risk allocation. In other words, as PSC mainly deals with risks in every stage of its assessment namely by constructing risk matrix, identification, estimation of probabilities, valuation of costs of the risks, and allocation of risks (Fantozzi et al., 2014), current study enhances the PSC development for MSW PPP projects of India. In-effect, these contributions will serve the broader goals of sustainable development in the domain of waste management particularly to developing countries who have similar problem settings both in waste management discipline and usage of PPPs for their infrastructure goals.

6.7 SUMMARY

Risk management is considered to be an essential element in the structuring of PPP projects. In this chapter, an attempt is made to understand risk management in the MSW sector. This is done by giving focus to the influence of technology in the risk profile of a PPP project. In Indian conditions, four energy from waste' technologý options are prevalent, and hence they are analysed. The results show that risk profile varies with technology. Table 6.7.1 shows a summary of the key findings.

Table 6.7.1 Summary of Key Risk Factors of EfW Projects

Tech/Rank	Bio	RDF	Inc	P&G
Rank 1	Land acquisition risk	Completion risk	Environment, health and safety risk	Financing risk
Rank 2	Completion risk	Environment, health and safety risk	Planning risk	Supporting utilities risk
Rank 3	Waste collection and segregation risk	Revenue risk	Permits and Clearance risk	Environment, health and safety risk
Rank 4	Planning risk	Concessionaire risk	Completion risk	R05
Rank 5	Environment, health and safety risk	Planning risk	Waste Volume risk	Completion risk

This suggests that an appropriate skill set is required for each choice of technology. Moreover, private bidder selection and procurement process need to account this finding while aspiring for PPP procurement. As far as risk allocation is concerned, there is a difference of opinion on some risk factors. These contested risk factors actually are so pivotal that it would change the course of the structure of PPP project and might have significant implications on the way projects are developed by the public sector and executed by the private sector. ■

CHAPTER 7

EMPIRICAL ANALYSIS OF BUNDLING FRAMEWORK

7.1 INTRODUCTION

The objective of this chapter is to empirically validate the developed bundling framework. For this purpose, the evidence gathered on six case studies are analysed using the primary and secondary data sources Next section presents a quick review of the bundling framework followed by a brief overview of a longitudinal description of the six case studies. The fourth section presents the results of each case arranged according to the developed framework. The fifth section presents the key inferences from each case. Based on these findings, within-case and cross-case analysis are presented in the last section of the chapter.

7.2 BUNDLING FRAMEWORK

The theoretical framework comprising of eight constructs to a PPP transaction emerged from the earlier literature review. The eight constructs of bundling framework are innovation, quality specifiability, maturity of markets, economies of scope, tendering out to subsidiaries, information asymmetries, competition, and transaction attributes namely asset specificity, uncertainty and transaction costs. These determinants would help ascertain the decision of opting a bundled PPP project or multiple PPP projects when empirically validated (See Section 4.6). These eight constructs are schematically shown in Figure 7.2.1.

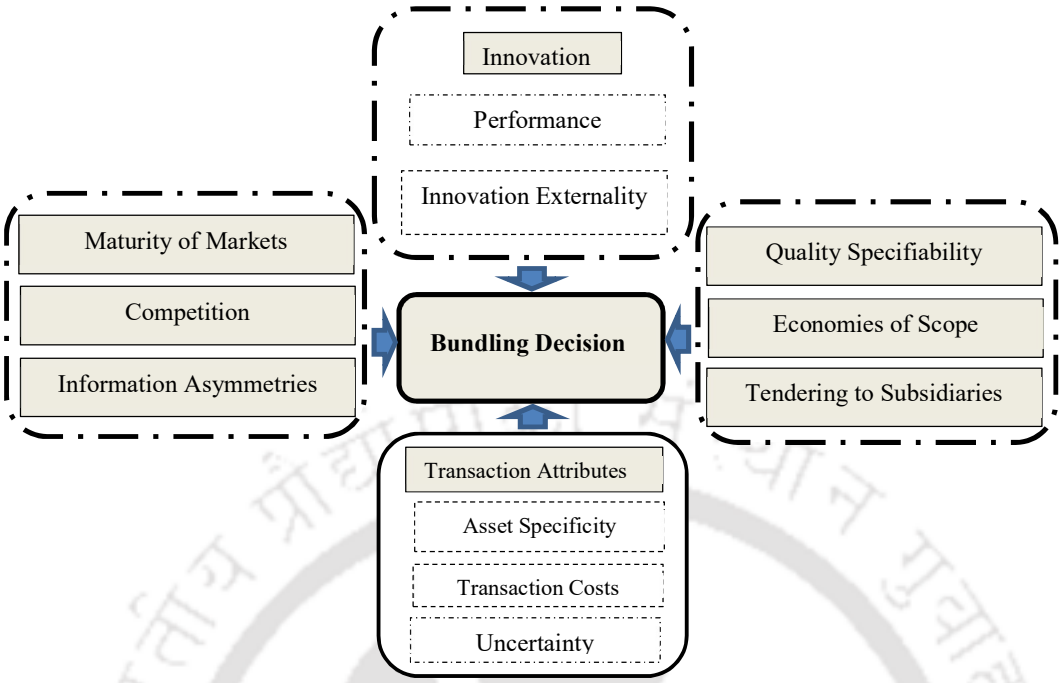


Figure 7.2.1 Framework of Bundling Factors

7.3 CASE STUDY RESULTS

This section shows the results and analysis of the evidence collected through the case study interviews and other project-related documents. Table 7.3.1 and Table 7.3.2 highlight the within-case and cross-case analysis of the evidence across the bundled concessions and unbundled concessions. It can be observed from these tables that constructs such as the performance measures related to innovation, quality specifiability, maturity of markets, possibility of tendering to subsidiaries, competition, and asset specificity are found to have a strong influence to support the unbundling strategy. Also, the externality of innovation, economies of scope, information asymmetries, transaction costs, and uncertainty have found weak evidence to support the unbundling strategy.

Table 7.3.1 Analysis of Unbundled cases

	Construct	EMERALD	DIAMOND	SAPPHIRE
1	Innovation			
	Performance measures related to life cycle innovation	@@	++@@	+@
	Externality of innovation	+@	++@	+@
2	Quality specifiability	+@	++@@	++@@
3	Maturity of markets	@@	+@	++@@
4	Economies of scope	+@@	+@	+@

	Construct	EMERALD	DIAMOND	SAPPHIRE
5	Possibility of tendering out to subsidiaries	+	++@@	++@@
6	Information asymmetries	+@	+@	+@@
7	Competition	++@@	++@@	++@@
8	Transaction attributes			
	Asset specificity	+@@	++@@	+@
	Transaction costs	+	+@	+@
	Uncertainty	+@	++@@	+@

Legend: The evidence is to **accept** the hypothesis that **unbundling** was the most suited form.
+ + indicates that there is strong evidence on this construct
+ denotes weak evidence.
@ symbolizes that the phenomenon was also established by weak documentary evidence
@@ strong documentary evidence
& indicates that it is "desirable" that
= indicates dormant nature of the theoretical concept with respect to bundling decision
IS- inconclusive evidence (documentary and interview) on this construct

Table 7.3.2 Analysis of Bundled cases

	Construct	PEARL	GAMET	CORAL
1	Innovation			
	Performance measures related to life cycle innovation	++@@	+@	+@@
	Externality of innovation	IS	++@	@
2	Quality Specifiability	+@@	+@	@@
3	Maturity of markets	++@@	++@@	@
4	Economies of scope	+@	+@	@
5	Possibility of tendering out to subsidiaries	+ @@	++@	+@
6	Information asymmetries	+@@	++@	@
7	Competition	+@@	++@@	@@
8	Transaction attributes			
	Asset specificity	+@	++@@	@@
	Transaction costs	++@	+@	@@
	Uncertainty	IS	+ @@	@

Legend: The evidence is to **reject** the hypothesis that **bundling** was the most suited form.
+ + indicates that there is strong interview evidence on this construct
+ denotes weak interview evidence.
@ symbolizes that the phenomenon was also established by weak documentary evidence
@@ strong documentary evidence
& indicates that it is "desirable" that
= indicates dormant nature of the theoretical concept with respect to bundling decision
IS- inconclusive evidence (documentary and interview) on this construct

The interpretation of the findings from the within-case and cross-case analysis is presented subsequently to show the logical relationship between the empirical evidence and the predicted patterns from the hypothesis of the bundling framework.

7.3.1 Case GAMET (G)

Innovation

It has been observed from the concession agreement that the contractual stipulations have been limited to basic compliance with the prevailing statutory requirements for the provision of MSW services as per MSW Rules 2000 only.

Bundling the components did not compel the private sector to adopt innovative solutions as they even failed to adopt a few of the possible innovation relating to transportation and collection operations. The failure to adopt innovative solutions beyond compliance with the basic requirements could be attributed to the lack of enforceable performance measures as contended by Lind and Borg (2010) that such stipulations from granting authority act as a motivating factor for innovation by the private sector. Another reason for the lack of introduction of life cycle innovation by the private sector could be attributed to the lack of maturity of the market. As the project was the first MSW project taken up on integrated mode, the number of private players with the competency to handle all the components of the value chain in an integrated manner was limited to just one bidder. The evidence from secondary literature highlights the fact that the type and extent of innovation being introduced in a market is strongly related with the maturity of the market, with the expectation of greater innovation in a more matured market (Perry, 1989; Roehrich and Caldwell, 2012).

For cases with negative externality, the public sector needs to set stipulations and impose tender instructions or contractual provisions in order to compel the private sector to innovate so that welfare function is maximized. Evidence from this case also supported these findings as ULB-G had imposed relevant provisions in contract documents to impose and implement process and product innovations (with negative externality) relating to collection and transportation components of the unbundled project. For instance, after unbundling, the private sector had brought in innovation in the collection process with the introduction of waste assimilator, which is an innovative approach for decomposing the household garbage. Waste assimilator is, in fact, designed to produce organic manure and bio-pesticide from the biodegradable solid waste produced by each household. It is argued that this will help in reducing the cost of MSW operation due to the proximity of the treatment process to its generation. In addition to this, the ULB-G had also envisaged installation of organic waste converter drying section at some of the transfer stations. Bundling of the components had failed to generate interest for the private sector to adopt such innovation with positive externality.

Quality specifiability

The case study evidence highlighted that the concession agreement specified neither the quality of the output from the plant nor the quality of service to be rendered by the concessionaire even when the value chain components were bundled. Evidence from the audit report even corroborated these findings when the report highlighted the lack of any enforceable performance standards or benchmarks in the contractual agreements. The audit report even stated that appropriate clauses were not even included for penalties in case of failure by the concessionaire to adhere to the time limits, a shortfall in achieving targets of collection, transportation, and processing of waste. The performance certificate issued by the ULB-G divisional engineers revealed that the monthly coverage of the households by the developer towards primary collection was limited to around 61% only. Absence of appropriate specifications for the quality of service could be attributed to the lack of maturity of the private players, as one of the private sector respondents had stated that *"...we're struggling to meet standards and you are asking about innovation. First, let us meet the standards and then we can surpass the standards and go for innovation.*" However, after unbundling the components, technical specifications resembling the quality of the asset relating to the treatment process have been specified by the ULB-G. For instance, for biomethanation plant, information on the specifications of the plant, specification of segregated organic municipal wastes, biogas generation, electricity generation using a gas engine, and manure generation were expected from the private entities. Moreover, the ULB-G has established performance measures and incentives at the corresponding components, particularly collection. In order to enhance efficiency in collection activities, NGOs were presented with an incentive scheme of 20% increase in their revenue if the amount of waste collected from household and commercial establishments is more than 70%.

Economies of scope

The project did not show any evidence of economies of scope on bundling the components of the value chain. The cost of the bundled project was equivalent to the costs of the individual projects relating to the components of the value chain. The cost of providing collection and treatment services in bundled mode was higher than the cost of the corresponding services in unbundled mode. After transferring the duties and responsibilities of the collection of MSW under PPP to the developer, ULB-G failed to

reduce its expenditure towards primary and secondary collection in comparison to the period before the commencement of the project. For instance, the expenditure for 2006-07 was ₹ 3.16 crore (£ 0.37 million) with average monthly expenditure of ₹ 0.26 crore (£ 0.03 million), ₹ 4.12 crore (£ 0.49 million) with average monthly expenditure of ₹ 0.34 crore (£ 40,476) in 2007-08, and total expenditure in 2008-09 (7 months 11 days) was ₹ 2.44 crore (£ 0.29 million) with average monthly expenditure of ₹ 0.30 crore (£ 35,714). After the procurement of bundled PPP project, total expenditure in 2008-09 (for 4 months 20 days) was ₹ 1.18 crore (£ 0.14 million) and monthly average expenditure was ₹ 0.24 crore (£ 28,571), in 2009-10 it was ₹ 6.64 crore (£ 0.79 million) with average monthly expenditure of ₹ 0.55 crore (£ 65,476 million). This indicates that the cost of collection and transportation was lower prior to the commencement of PPP project than the total tipping fee paid to the developer for the collection and transportation. This also points to the occurrence of diseconomies of scope in the bundled project. Adopting a bundled approach in a market setting where only one bidder had opted to submit the bid for the integrated project resulted in the selection of a private party who had the requisite expertise for undertaking one component and lacked the competency to undertake the other components of the value chain. In such a situation, Greco (2015) is of the view that promoting bundling of components will lead to imperfect bundling and can be treated as equivalent to agency problems within the consortium's members. As a result, private firms may face the problem of information asymmetry and will affect the cost of service provision. In such a case, unbundling will facilitate small and specialised firms to participate in competitive bidding.

Tendering out to subsidiaries

The project company i.e. SPV-GAMET had explored the possibility of involving the community and informal sectors to carry out the responsibility of collection on account of bundling the components. A society named GAMET Waste Management Society was formulated with informal sector involvement to carry out collection activities. However, this initiative had also been perceived poorly by the users. One of the respondents' remarks that "… *public may not view the private sector as doing something out of their concern unless there is something profitable to them. Even if they do so, it is difficult to win their confidence*". It could be observed from the

case study evidence that bundling of the collection and treatment components did not yield economies of scope.

After unbundling the components, the ULB-G had focused on letting only the entities with the expertise to directly bid for the various components of the value chain. All the tendering documents post bundling for collection, construction of biomethanation plant and organic converter drying section had stringent clauses preventing subcontracting. For example, as per the clause, "*the bidder has no right to give, bargain, sell, assign or sublet or otherwise dispose of the contract or any part thereof, as well as to give or to let a third party take benefit or advantage of the present contract or any part thereof.*" The clause preventing subcontracting restrained the right of the bidders from engaging in any activities for subletting the work. In cases, where there is a possibility of subcontracting by the private entities, Quiggin (2004) commented that the government would do better by contracting directly with the private parties that ultimately bear the risk. Thus, greater the likelihood of subcontracting the components of the value chain in the past unbundled projects, the authority should consider unbundling of components in future projects.

Competition

The case study evidence indicated that a high level of competition was observed when the scope of the project was earlier confined to the collection, transportation, and treatment using composting. Nine bidders were shortlisted for bidding wherein the request for qualification was issued to them (as shown in Table A2.0.2 of appendix). However, on expanding the scope of work with the bundling of the new component of waste to energy plant, the competitive landscape was reduced to participation by one bidder only. Due to the bundling of waste to energy component, the financial cost of the project increased requiring more financial exposure for the private entity. The share of the private entity (project developer) increased from ₹ 15.33 crore (£ 1.82 million) to ₹ 65.81 crore (£ 7.83 million). Besides, the increase in financial exposure, the lack of maturity of the market to handle highly technical complex projects was another key factor limiting competition, as waste to energy plants are more complex than composting plants.

The private entities had the expertise for collection and transportation, and treatment using conventional technologies such as composting. The level of

competition was, therefore, high when the components were unbundled. While tendering for collection and transportation of MSW for 31 wards, it had been observed that multiple numbers of NGOs had participated in bidding for 23 wards. The bidding for the remaining wards, which did not receive more than one bid, had also experienced more competition when it was re-tendered. Considering the lack of maturity of the market and the absence of private parties with high financial capacity, the ULB-G had even reduced the amount of performance guarantee so as to improve competition. For instance, the bid security deposit for biomethanation plant was reduced to ₹ 5, 00,000 (£ 5,952) while the guarantee amount for service contract relating to collection and transportation was reduced to ₹ 10,000 (£ 119) from ₹ 1, 00,000 (£ 1,190). On the other hand, the guarantee amount for the bundled project was earlier set at ₹ 5 crore (£ 0.59 million). The trend observed in this project appears to be in line with the observation made by Grimsey and Lewis (2009), when they expressed that level of competition in the market appears to be declining in case of procurement using bundled approach vis-à-vis, the competition observed when procured through unbundled route.

Information asymmetries

The evidence from unbundling of the project components have highlighted that unbundling strategy has prevented the effect of information asymmetry between the ULB-G and the private entities. Collection of MSW was one of the components of the value chain that had experienced productivity shocks due to information asymmetry. This asymmetry between the public and private stakeholders is due to the variation in the quantity of waste. As per the concession agreement, the concessionaire was under the obligation to undertake door-to-door waste collection from 100,000 households, wherein the total number of households in the city was 250,000. However, there was no clear demarcation on whom to include within the limit of 100,000 households from the total households in the city and this uncertainty had an impact on the waste available for treatment. The concessionaire, then, delegated this obligation to NGOs, thereby evading its responsibilities under the concession agreement citing lack of adequate information about the scope of collection within the city limit. On the other hand, on unbundling the components, the scope for the service relating to the collection was well defined with a separate service contract for each ward, thereby increasing the precision about the estimates of waste and the area of operation. Furthermore, the NGOs assigned for collection had immense knowledge about the city and this helped in reducing the

information asymmetry between the parties. Information asymmetry due to technical uncertainty regarding the waste to energy component was another area of concern when the project was procured in bundled mode. In the unbundled mode, biomethanation/biogas plant was the technology selected for treatment of waste. In order to reduce technical uncertainty, bidding process had limited selection to only those bidders who either had their own design for biomethanation plant which have already been technically certified by the central /state governments or adopt process technically proven by some of the nodal agencies in India such as Bhaba Atomic Research Centre (BARC) or The Energy Resources Institute (TERI). These measures had been adopted to ensure a reduction in information asymmetry and uncertainty.

Transaction attributes

The case study evidence highlighted that the transaction cost for the bundled project was comparatively higher than the unbundled project, though there is no absolute estimate of the transaction cost. Opportunistic behaviour by the concessionaire, delay in the procurement process of the bundled project, and termination of the project were some of the instances highlighting additional expenses for completing the transactions. Examples of opportunistic behaviour by the developer include failure by the developer to bring in their share of financing in advance as stipulated in the concession agreement, monopolistic behaviour of the developer in handling the collection activities, and evading the responsibilities obligated to the concessionaire relating to waste to energy plant. A total amount of ₹ 8.16 crore (£ 0.97 million) was paid to the developer for primary collection and a tipping fee of ₹ 130 (£ 1.54) per TPD for treatment. Ministry of Urban Development, Government of India had raised objection on the justification of charging ₹ 130 (£ 1.54) per TPD for waste treatment. The reason for engaging in opportunistic behaviour by the private party could be attributed to one of the key aspects of transaction cost, i.e. asset specificity. ULB-G had the experience of handling the procurement of collection and transportation only. They had to depend on external agencies not only for the procurement of the bundled project but only for monitoring the project implementation. They are neither equipped to monitor nor aware of the complex financial and technological aspects of the project induced by bundling. An important observation from the case regarding the cost. ULB-G had to bear for the lack of monitoring capability was the bill of ₹ 45 crore (£ 5.35 million) submitted by the developer in 2011, wherein neither the project

engineer nor the ULB-G could verify and quantify the bill for ₹ 25.59 crore (£ 3.04 million).

It could be observed from the case study that the ULB-G did not have required internal capabilities for executing this project on bundled mode. The preferred approach should be to enter into some kind of partnership. However, the public-private partnership entered into by the ULB-G and the private sector was not equitable, resulting in project failure. ULB-G had the experience of executing the collection and transportation activities. The necessary competencies have been acquired by contracting various services for which the ULB-CBs is responsible. Conventional formats such as lump-sum contract, design-build, item rate contract, and percentage contract have been used. Besides, unbundling of the components was exercised with the practice of further dividing the wards into smaller divisions. Unbundling of the components along with the breaking up of wards enabled the public agency to put to use their expertise across the various sub-divisions, thereby resulting in a lower degree of human asset specificity. The duration of the procurement of the various components had reduced drastically on unbundling the project. ULB-G was able to incorporate innovative clauses in the contractual arrangements to exercise control, impose a penalty and stringent regulations for replacement of the contractor in the event of failure to accomplish the work, without affecting the operations in other wards or other operations. Very aggressive implementation schedule had also been set by the ULB-G for the various components and wards, thereby creating a market governance structure. For example, for waste collection and transportation, the prescribed time for completion was 6 months in the bundled contract, whereas after unbundling, the prescribed time was set to be within seven days after ULB-G notified the successful bidder through a Letter of Award (LoA). The project duration for completion of treatment facilities was set as 1 year from the date of issue of LOI (Letter of Intent), but after unbundling, the various treatment processes, including the establishment of transfer stations was fixed as three months.

The technologies used in the current case for collection and transportation were already technically proven. The composting technology for the treatment of the waste has also been technically proven but there exists uncertainty regarding the demand of the compost. As per DPR-I, MoUD raised concern about the economic viability due to the high cost of production and lack of marketability of the product. Demand

uncertainty about the compost product was due to lack of promotion of usage by the governments and ULBs, lack of awareness of compost at that time, and lack of proper laboratory facilities for assessing its quality. These failed in building confidence amongst the farmers for using compost instead of chemical fertilizers. With respect to waste to energy plant, it faced tremendous technological uncertainty as the technical feasibility of the technology depends on the availability of segregated waste, thereby imposing stringent requirements on input feed. However, the practice of segregating the waste at source is a practice not widely prevalent in India. Furthermore, as a similar type of plant had not been established in India at that time, ULB also could not build capacity for monitoring and supervision of the design and construction of this plant. As energy from waste is a new technology, there is uncertainty about the flexibility of the plant to cope up with changing scenario and about the performance of the project. Bundling the 'energy from waste' component with the other components of the value chain, therefore, failed to bring economy from a transaction cost perspective.

7.3.2 Case PEARL (P)

The ULB-P met the expenditure towards the management of solid waste through grants received from GoI and State Government besides their own resources. Even it was stated in the Government order (no 859 dated 20/12/2008) that "*in case, if any proportionate share of government of India and state government of the eligible project under JnNURM is not materialized, ULB-P shall bear the cost and the rest of project cost shall be borne by concessionaire*". Under 13th Finance Commission recommendations, GOI released the ULB's share of funds. In 2012-13, the budget allocation was ₹ 544 crore (£ 64.76 million) whereas the actual spending was only ₹ 365 crore (£ 43.45 million). From the period 2012 to 2017, there was an increasing trend in receipts and expenditure. Moreover, the receipts were always greater than the expenditure (except in 2017). For instance, the expenditure on MSW during 2017 financial year revealed that capital expenditure incurs a far less than the budget allocation while revenue expenditure is also less than budget allocation. This is because of attributed staff union problems and land disputes to short utilisation of funds towards the implementation of solid waste management. The capital expenditure on MSW was far less than the budgeted allocation during the period 2012- 2017, except that revenue expenditure during 2015 and 2016 has crossed the budget allocation. Public authorities have reasoned that staff union problems and land disputes are the main reasons for less

spending of the budget. It can be established that there is under-utilisation of the budgeted funds towards implementation MSW activities. Thus, the typical notion that ULBs have very weak financial capacity cannot be established in this case. From this case, it can be construed that lack of funds was not the reason for opting private financing nor for bundling of components.

Innovation

Evidence were inconclusive to establish the occurrence or non-occurrence of innovations in terms of products, processes, cost, marketing or organizational innovations. Majority of the responsibilities were not undertaken by concessionaire due to the factors outside the purview of the private sector. For instance, due to protest by the existing workers, land disputes, and non-finalization of drawings, the private sector did not carry out the development for five new transfer stations, upgrading three old transfer stations, collection and transportation activities, the establishment of two new processing and disposal units. As per the concession agreement, the task of primary and secondary collection of segregated MSW was to be handed over to concessionaire in 2009. But only a few areas in the two out of 24 circles were handed over to concessionaire in 2014. In remaining areas, the door-to-door collection was carried out by ULB-P with the out-sourced staff. ULB-P could not address the union problems with labourers who were collecting MSW from households. Additionally, the management of existing three transfer stations was taken back from concessionaire by ULB-P in 2012, succumbing to union problems. The required land was not provided by ULB-P even as of March 2017, thereby preventing the start of work by the concessionaire. Hence, the possibility of innovation by concessionaire was not observable nor verifiable.

The responsibilities of collection and transportation fell back to ULB-P. Subsequently, ULB-P has adopted good practices related to information, education, and communication (IEC) activities. They introduced 'Swachh Community Resource Persons' (Swachh Dhooths) for creation of awareness on segregation at source by way of one to one interaction at the household level. They also initiated a programme called 'Parichayam' (know your worker) to know their sanitation worker by the general citizens, duly displaying the name and contact number in their respective jurisdiction to resolve grievances. ULB-P distributed around 4.365 million bins to domestic units in 2015-16. As per the monthly report of December 2017, the segregated waste

constituted around 27 *per cent* (near about 1000 tonnes) of the total MSW collected by them. This suggests the need for proactive community involvement but not just the distribution of bins. One public sector official noted, "…*the segregation would require an attitudinal change and a behavioural change in the citizens*." Realising this, ULB-P had conducted massive campaigns to educate people about the importance of segregation, while distributing waste bins. The ULB-P had even involved schools to spread awareness about this, apart from introducing a door-to-door collection of garbage using 2,000 Swachh Auto Tippers (SATs). The public authority claimed that this move has improved waste management in the city. Imposing fine on eateries, enhancing vigilance near lakes to check illegal slaughtering and suspending SAT drivers who do not turn up for work, were some measures that have helped in improving the sanitation situation. Hence, this construct seems to have an influence on the decision of bundling, though to a lesser extent. In addition, ULB's ability to carry out ICE activities has also been weakly established. Integrated solutions are best when the expectation of innovation is not phenomenal (Roehrich and Caldwell, 2012). But the MSW sector is argued to raise up to this kind of innovation level, given the need in the field (Eggers and Startup, 2006). Thus, it may indicate that it is an unwise move to integrate the MSW sector.

Performance measures

As per the concession agreement, the operation and maintenance requirement is stated as "*…the concessionaire shall ensure that the project is operated and maintained to the standards and specifications as set out in the construction requirements and also meet the other requirements, if any, set out in the agreement*." In addition, performance measures in this project were oriented in terms of the percentage achievement on 15 criteria identified in the concession. Coverage of MSW management services through door-to-door collection of waste, number of bins attended daily, maintenance of the bins by the concessionaire, vehicles for MSW management on the road under good condition for primary collection, vehicles for MSW management on the road under good condition for secondary collection, vehicles for MSW management on the road under good condition for transportation, hygienic transportation of MSW, collection efficiency, extent of segregation of waste, functioning of transfer station, functioning of integrated facility, extent of recovery of waste collected, extent of scientific disposal of waste in landfill sites, efficiency in redressal of customer complaints, and daily

collection of waste were the performance specifications mentioned in the contract. The desirable target on these criteria was 100% with a tolerance limit of 5-10%. Each of these 15 criteria was weighted between 4% to 20% deductions of the total tipping fee. However, physical verification of the project reports implied that these performance measures were far from motivating the private sector for innovation in the current state of implementation. The payment mechanism and the assessment of this performance measure by the independent engineer indicates the poor possibility of innovation with these kinds of performance measures. Additionally, in every annual report that concessionaire had submitted, it certified that no innovative idea is implemented to tackle a problem related to solid waste. Hence, there is no evidence to indicate that performance measures to promote innovation actually existed in this project framing.

Innovation externality

Innovative measures in this project as per the concession agreement deals with the treatment of various kinds of wastes such as (glass, rubber, plastic) with specialized technologies. Concerning the treatment and sanitary landfill construction, the concession agreement (CA) specified that

> *"...without prejudice to the generality of the foregoing, concessionaire shall have the right to develop the project facilities using such technology that it considers suitable and commercially viable for the purposes of implementing the project, in accordance with terms of this agreement and applicable law".*

It also states that "...*Concessionaire shall adopt suitable technology or municipal solid technologies to make use of wastes so as to minimise the burden on landfill."* For collection component, CA states that "*Concessionaire shall ensure that all vehicles used for transportation of waste shall be fitted with automatic position identification systems using appropriate technology*". Also, for leachate treatment CA states that

> *"The concessionaire shall provide a leachate treatment plant of appropriate capacity with suitable technology to ensure treatment of leachate to Inland Surface Water Standards as per IS: 2490: Part I 1981 Tolerance Limits for Industrial Effluents and standards set out by SPPCB."*

IEC Activities and GPS usage in collection vehicles is a concession agreement mandate. Adoption of innovations on route optimizations and measures that would increase service levels and transparency in project governance could not be observed in this project due to default by the public sector. Moreover, the private sector also exhibited opportunistic behaviour when the public sector failed to transfer the collection rights to the private sector. The private sector has been observed to fail in meeting the treatment standards. Failure by the private sector to maintain the non-functional equipment has also prevented timely treatment of waste, resulting in the production of by-products such as leachate. It would not be incorrect to say that this is triggered due to the negative externality as meeting standards require additional capital and operational investment on assets and materials. These developments expected from the private sector have not yet been realised in reality and the expected benefits from the private sector could not be realised resulting in a delay in the execution for the essential services.

Quality specifiability

Quality specifiability in these projects is looked from the perspective of input specifications and output specifications. Concession agreement prescribed very less about the output specifications. For treatment technology, it was specified in concession agreement that "*it is acknowledged that it is the intention of concessionaire to use the technology associated with the concept of an integrated waste processing plant, a process diagram of which is provided in schedule 7 and that concessionaire shall have the right to modify, adapt, upgrade or change the Technology, from time to time, based on actual operations of the plant and requirements of the project*."

Contract clauses in MSW are found to be highly subjective. For instance, terms such as 'suitable', 'appropriate' for technologies, 'acceptable level' for operations '…maintained clean and hygienic' for transfer stations and 'good condition' for vehicles, 'hygienic conditions' for project sites are some of the terms used in MSW contract with respect to service levels of assets and operations. This may be because the quality specifications are tedious and difficult to specify and quantify. But, this brings less amount of objectivity in decision-making. Hence, differences in interpretation of contract clauses by the concessionaire, independent engineer, and public agency were observed in this project, leading to disputes. Moreover, such subjective contractual provision brings difficulty in *ex-post* verification by the public

sector as this is required for making payments for the work performed. ULB-P adopted a more prescriptive form of specifying the quality of building both in concession agreement with the private sector and later during the procurement of assets for collection activities by ULB-P.

In 2017, for collection and transportation activities led by the ULB-P, ULB envisaged adopting tri-cycle rickshaws which have compartments for collection of wet and dry waste separately from households (Notice No: 001/6BIN - TRCL/AC(H&S)/ULB-P/2017 dated 23.12.2017). Procurement of these collection vehicles followed highly prescriptive specifications concerning body, chassis, cart, and wheels made of steel satisfying IS: 2061:99 with 12-month defect liability period. The period of supply was within 15 days from the receipt of the work order. These were the same requirements mentioned in the concession agreement of the bundled project. The evidence indicates the difficulty in framing the quality of service but shows the ease in specifying the quality of building or supply of assets in both the bundled and unbundled strategies. So, this construct favour unbundling the MSW supply chain while adopting PPP mode.

Maturity of markets

Invitation of expression of interests (EOI) for this project attracted responses from 22 bidders. Out of the 22 bidders, only six firms have directly participated or expressed concerns via letters in the pre-bid conference. Only five of those six firms were shortlisted in the EOI stage, thereby suggesting that the rest of 17 bidders were unsure about being shortlisted and they did not participate due to their poor experience. This may also suggest poor development of markets where bidders were not confident to participate in the proposal stage. This view is supported by the results of the qualification of the bidders. The reasons for disqualification of the 16 firms in the RFP phase were: lack of technical competency as prescribed by RFQ documents (13 firms), and non-responsiveness and missing documents (3 firms). Those 13 firms neither have the requisite experience of handling 0.3 million tonnes per annum of MSW in the last two years nor catered to have a minimum of 1 million population. Moreover, three firms out of these 13 firms were rejected because they have experience in collection and transportation only but lack experience in treatment and disposal. Similarly, among these 13 firms, one firm has vast experience but only in composting while another firm has experience in treatment only. Thus, it will not be incorrect to infer that the poor

maturity of markets is reflected in poor turn out in the pre-bid conference and in the shortage of enough bidders with the requisite experience to handle this bundled project. Hence, case study evidence strengthens the theoretical understanding that there is less likelihood of innovative solutions from private sectors in a market which is not matured. And, in such cases unbundling is a more preferred approach.

Economies of scope

Economies of scope are assessed by considering the expertise of the winning bidders and bid structure of L1 and L2 bidder as a proxy for cost advantage. The collective expertise of the L1 bidder is less than that of L2 bidder. Since final selection was based on the financial terms, the contract was awarded to L1 bidder who is having relatively less expertise than L2 bidder but quoted 16% less tipping fee. L2 bidder was a consortium of 3 companies (L2a, L2b, and L2c) with diverse expertise. One of the consortium members of L2 bidder (company L2a) has an experience of 19 years. It designs, develops, operates and maintains integrated waste treatments, storage and disposal facilities in major states across India. L2b had an experience of 15 years in providing logistics which is a subsidiary with specialised expertise in storage, collection, segregation and transportation of MSW. For instance, it handled MSW services in West Zone of Delhi and was first of its kind in Delhi and in the country. They also adopted the first and largest fleet of CNG Buses in the Delhi & national capital region to drastically reduce the level of pollution in Delhi and play a key role in achieving the objective of "Green Delhi". Another uniqueness is the complaints redressal system for the complaints regarding the collection and transportation of waste in the west zone called a "command and control system" is established. For facilitating the awareness amongst the masses and to seek their participation, "information, education, communication" campaign cell has been introduced by the L2b. Also, L2b has developed global positioning system based tracking system in association with TMT Fleet Management Solution to locate the position of refuse removal trucks and other vehicles to increase their efficiency and productivity. L2c had an exclusive experience of more than 15 years in waste processing with nearly 4 million-ton annual processing capacity. This company has established 24 plants, out of which 16 are in operation and 8 plants are under implementation.

As L2 bidder was a consortium of bidders, the joint venture had increased the bid price due to the necessity to reach the benchmark IRR (13%) for investment

projects. On the other hand, there was no comparable evidence to directly validate the cost advantage due to bundling in this project due to lack of a real comparable unbundled alternative. But, the bid structure of the L1 (40% to the collection, 20% to transportation, and 40% to treatment) and subsequent payment mechanism to concessionaire suggested that cost complementarity may not exist in case of bundling as inferred from the bid structure of L1 and L2. It is can be hypothesized that unbundling might lower such individual benchmark IRRs and facilitate the best expert service providers such as those in L2 to actually win the bid. Hence, this construct has provided necessary evidence that bundling has prevented the possibility of achieving economies of scope in this case.

Tendering to subsidiaries

Concessionaire carried out collection and transportation for a very brief period of time. During this time, the collection and transportation activities were carried out by the workers, who were previously employed by the public sector. Secondly, the winning bidder had subcontracted the composting process. Compost has been an important component of treatment by the concessionaire. During 2016-17, out of 16, 33,231 MT of MSW, composting produced 1,10,090 MT of compost and 2,16,507 MT of residual waste. In the tendering process of PEARL, it could be observed that L20, who has been eliminated in the tendering process due to lack of experience of handling 2 Lakh MT of MSW in the last 2 years, has again been deployed by the winning bidder L1 for producing and marketing the compost, through a memorandum of understanding. Thirdly, the plastic treatment facility of 15 TPD has been established by the concessionaire in partnership with a speciality plastic-to-energy company of India. These three instances highlight that bundling could encourage tendering to subsidiaries as opposed to procuring services directly from the actual service providers in an unbundling strategy. Hence, this supports that unbundling must have been the most suitable form when observed from subsidiary tendering perspective.

Competition

22 firms have submitted their expression of interest for ISWM project at PEARL (as shown in Table A2.0.2 of appendix). Out of these 22 firms, 6 firms were issued the request for proposals. Amongst these 6 firms, only 2 firms were technically qualified in the bidding process for which the financial bids were requested.

Furthermore, 6 bidders who were qualified are screened based on the technical competition and the rest were not invited to the financial bidding as they scored less than 60 marks in the technical criteria evaluation. Rest of the 16 firms did not meet either the financial worth of net worth of ₹ 175 crore (£ 20.83 million) or experience in collection, transportation, treatment and disposal which was given 70% weightage in the technical criteria. Only 30% weightage was given to the proposed methodology and approach for the project. The bidding scenario for this project indicates that lack of competitive players for the scale and scope that is envisaged in this bundled project. Normally, typical infrastructure projects expect the participation of 5-8 bidders in the financial stage as well assuming that all these bidders are technically sound. However, only 2 financial bids were submitted during tendering, indicating that this can be regarded as low competition. Though competitive dialogue may enhance the value for money and reduce the time of procurement (Reeves et al., 2017), Central Vigilance Commission's guidelines recommend post tender negotiations only with L1 and avoid negotiations with other L2 or L3 bidders. As a result, renegotiation, in this case, is carried with L1 bidder only. Low level of competition and dialogue with only the L1 bidder was found to be detrimental in this PPP procurement. Hence, high financial requirements in the shortlisting stage caused by the bundling strategy has prevented the required competition.

Information asymmetries

The bundled project has seen many instances of information asymmetries that have affected the smooth implementation of the project. The source of information asymmetries could be attributed to uncertainty concerning the necessary information and withholding the necessary information on the quantum of waste reaching the dumpsite. For instance, the public sector did not give any concrete assurance nor indicated the risks of possible land disputes and resistance to collection segment by engaging previously employed workers. The private sector did not anticipate these situations. These resulted in a significant amount of delays as observed in various missing timelines. Also, some facilities are not constructed. For this reason, the total investment made till date in this project is only ₹ 139.22 crore (£ 16.57 million) as compared with ₹ 727.2 crore (£ 86.57 million) (budgeted cost as on commercial operation date). The share of ULB-P was ₹ 250 crore (£ 29.76 million) and only ₹ 52.86 crore (£ 6.29 million) of it has been invested so far. The private sector also could

invest only ₹ 86.36 crore (£ 10.28 million) instead of ₹ 477.18 crore (£ 56.80 million) so far. In 2014, the concessionaire has requested the ULB-P to hand over maintenance of two transfer stations as it has been developed at a cost of ₹ 15 crore (£ 1.78 million). Concessionaire reportedly asked the civic body to either hand over the stations or refund the money it spent on it. The concessionaire approached the court in August 2014 complaining that there was a delay in handing over the collection and transportation of garbage from various places to the dump yard for which it gets a tipping fee from the ULB-P. As per the agreement, the collection and transportation of garbage should be initiated by the developer within 180 days from the date of agreement and treatment cum scientific disposal of waste within 2 years. Waste treatment works began at the landfill site in February 2012. The ULB-P has been paying about ₹ 560 (£ 6.6) per metric ton (equal to 40% of total ₹ 1431 or £ 17.03) tipping fee for the disposal. However, collection and transportation could not be handed over to the developer due to stiff resistance from workers' unions and concern over outsourcing of jobs by employees. ULB-P had initially planned to hand over MSW services of East Zone and West Zone to the private sector, but the unions have opposed the move. Hence, the transfer stations that are developed in the later stages are being maintained by the ULB-P.

Some of the clauses of the concession agreement has also resulted in information asymmetry. The collection stage witnessed uncertainty of diesel price and this usually dictates the cost of collection activities. During the tendering stage, private agencies requested for a provision for escalation of the tipping fee based on the fuel charge, separately linking it to a base price of the prevailing diesel price on the date of the award. They also requested to incorporate the revision of the diesel price from time to time. Private firms opined that diesel price is volatile and is linked to the fluctuating international crude oil prices, which bidder has absolutely no control. On this note, the private sector said, "*instead of fixed escalation, the tipping fee should be linked with wholesale price index (WPI) which is published by the government from time to time*". Nevertheless, ULB-P partially regarded this proposition of the bidders and asked to bid their prices according to the clause that collection related tipping fee will be revised every year by considering 60% of the wholesale price index (WPI). Adopting such a cost escalation mechanism will cause productivity shocks and increased the risk in operations. As per the concession agreement, the charges for MSW services were to

be collected by the private sector from the individual households. The private firms during bidding opined that it will not be successful in this task as the private operator would not be able to penalise any citizen in case of default and perceived this to be a source of information asymmetry. The firm also stated that ULB-P would have better control over the same through an effective system. They further indicated that service charge collection component would affect the bid price. Accordingly, the inability of the concessionaire will ultimately affect the various stages of implementation of the project. Finally, the responsibilities for collection of waste and the user charges fell back to the ULB-P, apparently making the implementation of the project in an unbundled manner.

Private sector neither employed suitable mechanisms to ensure sharing of information on the quantum of waste reaching the site nor public sector insisted on the same. CAGI audit found that "*there was no mechanism to assess the quantity of waste generated/collected in the corporation. Existing intermediary storage facilities (transfer stations) were not equipped with weighbridges both at entry and exit points (concession agreement mandates such provision). The quantum of MSW collected in ULB-P was not accurately known*". Since the collection and transportation responsibility was not delegated to the private sector as per the agreement, patterns of information asymmetry and opportunistic behaviours that are relevant to those components are not directly verifiable. Nevertheless, private sector opined that it suffered serious loss because of the investment made in machinery for undertaking collection activities, which were not put to use. On the other hand, serious lapses were observed in the payment mechanism that favoured the private sector. On a whole, necessary evidence indicates that uncertainty induced information asymmetry distorted the behaviour of bundled concession to an apparent unbundled concession but had poor level of services.

Asset specificity

Complexity, lack of adjustment features built into the contract to allow prices and quantities to adapt over time, employment of courts to enforce contractual commitments either by the public sector or private sector or both are some of the situations that indicated the poor human asset specificity for managing a bundled project. Weak human asset specificity has led to excess payments and this situation is the converse of typical underinvestment problem.

The human asset specificity of the public sector during the procurement of this project was different for different components of the supply chain. For collection, the asset specificity was low but underdeveloped for ULB. This is because ULB-P operations were not up to the mark and were of poor standards, violating the norms of MSW Rules. For instance, though as per the rules waste should be carried in completely enclosed containers and there should be no leakage of leachate during transportation, the practice has not adhered to the rules. Moreover, it can be observed that the competency enhancement and achievement of results have taken much time for ULB-P to see the results in collection and transportation. This requires structural changes in the organization, policy, and public practices and these are often considered as a slow process (Oxtoby et al., 2002). Nevertheless, in recent times when the public sector is directly involved with operation and monitoring and is in a position to implement and stimulate the changes, many capacity development initiatives were implemented. In 2017, for procurement of tri-cycle rickshaws (in 2017) to conduct segregated door to door collection, ULB-P has initiated a smart and quicker method of procurement through empanelment of suppliers or manufacturers. The plan was to phase out the single containers to compartmental carriers throughout the 6 zones of the city with a total required 500 (approx.) tri-cycles. Though ULB has practised the collection and transportation earlier, this organisational change could be attributed to the legitimacy brought by the imposition of MSW Rules 2016.

ULB, though, seemed to have the necessary capability to carry out the treatment and disposal responsibilities but, in practice, they have exhibited a case of weak human asset specificity. This has been inferred from the lapses observed in payment and in monitoring aspects of the project. ULB had to heavily depend on the consultant's technical expertise to supervise and monitor the entire bundled transaction. ULB was not equipped to meet such high human asset specificity. For instance, the provisional readiness certificate was issued to the concessionaire in 2013. However, the mandatory listed items were not completed by the concessionaire as of July 2017. There were no records to show the deficiencies pointed out by independent engineer in the execution of project works by the concessionaire. ULB-P had also failed to identify and demand to rectify these lapses in the project. In another instance, periodical (fortnightly) submission of progress reports to ULB-P was not ensured by an independent engineer. A test-check of progress reports showed that all the fortnightly reports for the period

between April 2015 and March 2016 were submitted by the independent engineer in April 2016. ULB-P also expressed their dissatisfaction over the duties to be discharged by an independent engineer. Additionally, the independent engineer did not ensure strict compliance to the environmental parameters in and around the dumping yard by the concessionaire. This was evidenced from zero points in three consecutive monthly reports (January – March 2017) under 'Compliance to Environmental Provisions'. Similarly, gas emissions in the landfill were 100% against the stipulated cap of 25% in the concession agreement. In January 2017, ULB-P imposed a penalty of ₹ 20 lakh (£ 23,810) on independent engineer for not complying with the contractual conditions, thereby indicating poor monitoring by independent engineer over the activities of the concessionaire. Furthermore, delegating the responsibilities for selection and termination of the independent engineer to concessionaire also highlights the lack of competency with ULB, thereby indicating weak human asset specificity. The public sector also acknowledged that the bundled project is very complex because integrating various scope of works results in increasing the complexity in technical, economic and legal dimensions.

The disparity in the required human asset specificity for undertaking the various components of supply chain and the lack of organizational field development i.e. inappropriate understanding on how organisations need to involve and develop the collection, has affected the project. Instances of poor organization field development concerning problems such as protest and resistance from public or unions are not new to the MSW sector. Such situations required collaborative governance approaches such as consulting the actors, seeking consensus and initiating negotiation (Li et al., 2016). All these activities are best carried out by the public sector. Hence, there exist necessary evidence to assert that the prevalence of poor asset specificity of the public sector made bundling an unsuitable tool to procure services. This situation points out that competency development within the public sector is all the more required to facilitate bundling of services as opposed to suddenly imposing the need to develop specialised skills to attain the minimum level of human asset specificity.

Transaction costs

Bundling has caused an increase in *ex-ante* transaction costs from multiple dimensions. The complexity of the bundled project has made it necessary to appoint a transaction advisory with the required expertise and this has resulted in more fee. Also,

from the perspective of bidders, the costs for participation in the tendering has been reflected in the form of higher security deposits and earnest money deposits. This may have reduced the interest of bidders. During the pre-bid conference, bidders raised concerned to reduce the EMD but this request was disregarded by ULB-P as the earnest money deposit (EMD) was set at 1% of the project cost as per DPR. A similar request was made when project development fee to the transaction advisory was set at ₹ 4.5 crore (£ 0.53 million) where the public authority has reduced it to ₹ 3 crore (£ 0.35 million) instead of the requested ₹ 4.5 crore. The reason for reducing it to ₹ 3 crore was because the project was a non-revenue earning model. ULB-P believed that extra cost in the form of project development fee would be charged back to ULB-P in the form of higher tipping fee. Moreover, the performance security originally proposed it to be ₹ 27 crore (£ 3.21 million) which has been worked out to be 3% of the total project cost. The bidders have requested for reduction of performance security to ₹9 crore (£ 1.07 million). Since the primary collection was proposed to be implemented in phases, it was proposed to revise the performance security to ₹ 18 crore (£ 2.14 million).

While the approved project cost of ISWM was ₹ 434 crore (£ 51.66 million), the project cost has been revised to ₹ 727.2 crore (£ 86.57 million) while issuing commercial operation date (COD) on 18 Feb 2012. The revised Detailed Project Report (DPR) was submitted by the developer based on the analysis of 2010-11 rates in 2012, citing escalation in the rates as earlier estimates were based on the rates prevailing in 2008-09. For instance, the developer proposed remodelling of the existing three transfer stations and upgrading of the road and revised the cost to ₹ 84.26 crore (£ 10.03 million) from the earlier estimate of ₹ 37.40 crore (£ 4.45 million). Similarly, capping and reclamation of four sites was earlier proposed at ₹ 51.22 crore (£ 6.09 million) which was later revised to ₹ 106 crore (£ 12.61 million) and the cost of ISWM complex development at the landfill site escalated from ₹ 200 crore (£ 23.86 million) to ₹ 214 crore (£ 25.47 million). Though there were no change in the scope of the work, project and methodology followed and components approved by the government, the project developer revised the project cost to ₹ 727 crore (£ 86.57 million), far beyond the official cap of ₹ 500 crore (£ 59.52 million). Then, the project cost was brought down to ₹ 508 crore (£ 60.47 million) by removing certain components such as energy from waste plan that would have costed ₹ 180 crore (£ 21.42 million) and sanitary landfill and common facilities for a zone, which would have resulted in an additional

expenditure of another ₹ 38.36 crore (£ 4.56 million). The project had observed a revision in project cost to an extent of 206% from the date of signing concession to the issue of commercial operation date.

This project has been observed to incur more policing and enforcement costs. The number of disputes that have been raised, the cost of court litigations and settlement of disputes are some of the reasons for the increase in *ex-post* transaction costs. Due to lack of competency of the public sector to monitor both directly and through independent engineer the performance of the project, excess payments had to be made and this had increased the overall transaction cost to the public sector. In line with this, the audit team had observed that the tipping fee bills of ₹ 8.66 crore (£ 1.03 million) were paid in excess to the concessionaire for services between February 2012 to December 2016.

Uncertainty

This project could produce compost and market it by entering it into an MOU with another company, so as to reduce the uncertainty with respect to output. On 26 May 2017, the concessionaire proposed the expansion of the project by constructing the waste to energy power plant from 19.8 MW (current capacity) to 48 MW by processing about 5500 TPD of MSW. However, the environmental clearance wing has reduced the capacity to 19.8 MW. In light of this, ULB-P again proposes to extend the project to 2 units of 600 TPD MSW combustors with 24 MW capacity each. Nevertheless, the EfW plant is under the process of implementation and technological uncertainty cannot be verified as on writing on this case study.

7.3.3 Case CORAL (C)

Innovation

This project failed to have two levels of innovation typically possible in MSW project: (i) the ability to reduce the waste reaching the landfill, and (ii) promotion of decentralized waste treatment and reduce the cost of collection and transportation. The work of providing MSW services to CORAL was awarded to an agency and agreement was executed in June 2011 with the concessionaire for completion of treatment and disposal facilities in one year from the date of award of the agreement (commercial operation date). The concessionaire's performance was found to be very poor as opposed to the expectation of being innovative and achieving the service level

benchmarks. The project failed to generate innovation even after structuring the entire supply chain as a bundled project.

Performance measures

Concession agreement of SPV1-C specified penalties for three service-level violations. The penalties are as follows: (i) if MSW was not collected for more than 24 hours from any ward, ₹ 1, 00,000 (£ 1190) per ward for every day of default would be charged, (ii) if there is overflowing of waste in any secondary storage container for more than 12 hours, ₹ 5000 (£ 60) penalty for every hour per bin would be charged, and (iii) if street sweeping waste was not collected for more than 24 hours, penalty to be charged will be ₹ 5000 (£ 60) for every hour. In concession agreement for SPV2-C, 14 indicators related to the extent of service coverage were specified for compliance with collection activity. The penalty clauses in the CA indicate service levels and they fail to qualify to be indicators that may promote life cycle innovation.

Innovation externality

As per the concession agreement of SPV1-C, enough flexibility has been given to produce RDF in addition to compost, however, extra cost is to be borne by the concessionaire. RDF is considered as an innovative co-production from waste. Since it involves an extra cost, concessionaire did not take any actions to produce RDF. In addition to this, the concessionaire was also allowed to maximize mechanized operations by increasing the mechanical sweeping and reducing the number of wheelbarrows and manpower for sweeping at their own cost. However, concessionaire of SPV1-C opted for 2 automated desilting machines to save their operational costs and this innovation can be considered as a positive externality. With respect to SPV2-C, it was observed that implementation of GPS and vehicle tracking system were the only innovative measures implemented by the concessionaire (SPV2-C) and these measures can also be considered to be of negative externality as the public sector had to pay. Hence, the projects did not see improvements in the quality of services, suggesting that the negative externality has prevented concessionaire from such investments.

Quality specifiability

The specifications followed in this project were different for each of the components of the supply chain. For instance, input specifications were specified for the procurement of collection and transportation for SPV1-C. For primary collection,

RFP of SPV1-C states that "*...it is proposed to deploy containerized tricycles each having 6 containers of 35 litres […]… 1.5 cum capacity mini tippers […], …adequate provision of manpower shall be done to provide door-to-door collection service 365 days in a year".* Accordingly, procurement of 396 number of 1.1 cum steel bins and 4,70,740 bins for adopting a 2 bin collection system for household's collection has been done using an item rate contract. Similarly, ULB imposed in the concession agreement for construction of 4 transfer stations where the bidder cannot increase or reduce the number of transfer stations. Treatment involves the generation of bricks and compost. The sanitary landfill construction should be as per the design standards of MSW Rules 2000 Schedule (III)/ 2016 Schedule I. For treatment, the procurement process of SPV1-C encouraged the adoption of various treatment technologies, though composting of organic waste and brick-making of inorganic waste was implicitly given more preference. Other technologies such as plastics processing, paper recycling, among others have been given equal weightage in the concessionaire selection. Nevertheless, the successful bidder promised 'appropriate treatment' in the CA. Hence, treatment facilities tend to have more service specifications i.e. the treatment technologies should adhere to the emission standards and operating conditions as specified in the MSW rules 2000/2016. There was no incentive mechanism to achieve the targeted collection efficiency as it is the obligation of the private firm for the tipping fee and grant he received.

Maturity of markets

Bundling the segments and offering it as an integrated project failed to generate interest amongst the private parties during the bidding process. Due to lack of participation of competent private players, the private player who was selected for SPV1-C failed to discharge the services effectively and the contract had to be terminated prematurely. Subsequently, rebidding was undertaken in 2014 but the bidding process still failed to generate enough interest amongst the private parties and only one bidder submitted the bid. As a result, the bidding process had to be cancelled due to lack of participation of the sufficient number of bidders who have the capacity to operate the integrated project. The ULB again attempted to revamp the project and awarded the contract to the new concessionaire (SPV2-C). The concessionaire for SPV2-C also failed to discharge the duties and a termination notice was issued in 2017 and the contract was finally terminated in March 2019. After termination, ULB-C had

taken over the door-to-door waste collection services. This indicates that the market is not matured to handle the PPP MSW projects in bundled mode. Additionally, concerning the defunct EfW project procurement in 2015, ULB accepted that the basic idea of generating electricity from waste was 'flawed' and had not succeeded anywhere in India. The ULB representatives also asserted that EfW component makes the project complex and makes it prone to failure. The reason for the failure of EfW could be attributed to the need for 100% source segregated waste for the operation. Furthermore, EfW failed to generate enough revenue and make it profitable on account of the high cost of electricity needed to burn mixed waste, thereby making the project unattractive to operators.

Economies of scope

The scope of the project has been demanding various competencies from the private sector and also required different assets for its operations. However, the bundling of the components did not show any evidence of the economies of scope on account of bundling. For the bundled project, the concessionaire had quoted a tipping fee of ₹ 585 per tonne (£ 6.96 per tonne) and capital grant of ₹ 39.99 crore (£ 4.76 million). Out of this grant, ₹ 25 crore (£ 2.97 million) was towards the cost of collection and transportation vehicles, ₹ 7.9 crore (£ 0.94 million) towards site development, and ₹ 7.0 crore (£ 0.83 million) towards the scientific landfill development (SLF). This suggest the possibility of extending a separate EPC contract for SLF construction with the capital grant. In spite of the provision of the capital grant, it was observed that the agency faced financial issues during operation stage and the concessionaire had to reduce its staff, which directly affected the quality of service delivery. Workers also resigned as they were not being paid on time. This underscores that bundling fails to bring economies of scope as the project still failed to provide the deliverables as per the terms and conditions of the concession agreement. Nevertheless, after the termination of the contract, the door-to-door collection has reached over 60% of the households as a result of contract staff recruitment between 2013 to Dec 2015 when the project was procured in unbundled mode. Moreover, the ULB has come up with a strategy of decentralised and compact waste management plant within each developmental plot- where most biodegradable waste is treated at source and converted to bio-fuel. In this minimum waste strategy, only 30% of the waste was intended to be sent out to site for disposal.

Tendering to subsidiaries

With respect to the procurement undertaken in 2011, the successful concessionaire did not execute the brick manufacturing unit and composting unit. Hence, the subcontracting of the components did not take place for treatment and disposal. On the other hand, for the 2016 procurement, the project had an EfW component. The concessionaire consortium had a technology provider who would be handling the EfW component. However, as the project got terminated, it is difficult to establish that EfW component would be contracted out separately. Nevertheless, the concessionaire would definitely require joint ventures/subcontracting to support the technology as it was not available in India at that time.

Competition

Concerning CPV1-C, eight (8) private parties were shortlisted during Request for Qualification stage out of the 11 bidders who showed interest in the project (as shown in Table A2.0.2 of appendix). ULB had observed that private parties do not have enough experience to handle all the segments of the value chain. As a result, ULB had revised the technical competency levels by doing away the requirement of experience in door to door collection, secondary collection and transportation by issuing a corrigendum to RFQ in Oct 2010, 5 days before the RFQ closure. Subsequently, 5 out of the 8 bidders submitted the technical and financial proposals in the RFP stage. Though L1 was selected as the winning bidder but scrutiny of its proposal revealed that the bidder (L1) did not meet the requisites technical and financial qualification criteria in aspects of door-to-door collection and transportation. In similar lines, as per the CAGI audit report, it had been highlighted that there should not have been any marks allotted to the L1 bidder on these two parameters. Considering the fact that the contract was awarded to L1 in spite of not meeting the requirements comprehensively, it was evident that the tender was finalized in favour of a party which did not meet the stipulated criteria instead of possibly unbundling the supply chain and delegating to experienced players. Moreover, ULB seemed to exhibit a nature of assigning every responsibility to the concessionaire probably to evade its responsibility in the service provision. For instance, as per the bidding document for the bid carried out in 2011, the scope of work to segregate the biomedical waste and transport it to the location was included within the scope of work by the ULB-C. However, in the pre-bid meeting, the prospective bidders had requested to exclude the scope but ULB-C did

not change the scope. The ULB-C has made the concessionaire collect the user charges and handover to the ULB-C. Apparently this has reduced the competition in the project as bidder expressed that they will not be able to handle that responsibility competently. The project specified that turnover from bundled projects only would be considered in the RFQ/RFP stages in ascertaining the technical and financial capability of the projects. This is another reason why there is no participation by specialist competent private players. In the bidding carried out in 2014, ULB-C invited tenders to revamp the MSW project. Only one bidder participated in the tendering process. The firm that had submitted a bid for the projects was also found to not adequate technical competence to carry the work based on the technical evaluation perspective.

Information asymmetries

The information regarding the availability of land for the construction of treatment facilities was an important issue for information asymmetry between the stakeholders. The ULB had not made the land available to the private concessionaire. However, as per the procurement procedure of the state, the bidding process should be initiated only after the acquisition of land required for the purpose. This was not followed by the ULB. The ULB stated only the availability of land instead of confirming the ownership of the land for the landfill site. The tendering process was initiated even before taking the possession of the proposed land and once the private concession has been awarded, a different site for the landfill was provided to the concessionaire.

The private sector (SPV2-C) also perceived an increased level of information asymmetry in the form of hidden action on the ULB's intention to terminate the contract. This is because ULB issued termination notice in October 2017 and then it was withdrawn. As a result of this, the private sector was still apprehensive about the possibility of termination in the future and withheld further investment and construction activities. The performance of the concessionaire also deteriorated after the issue of the termination notice as it had been observed that the private sector had performed satisfactorily on only eight performance indicators out of the 14 parameters specified in the contract. The concessionaire also had difficulty in arranging funding for the EfW project due to high-risk profile of the project and the project was found to be not financially viable due to high capital requirement for running the power plant.

The private parties for both the concessions had also hidden information from the public sector leading to the creation of information asymmetry between the stakeholders. Relating to this, audit scrutiny revealed that the private parties did not maintain records of the collection receipts and daily collection registers in support of user charges with the public sector. Similarly, despite the lapses in the scheduled completion, neither the vehicles/equipment proposed to be utilized as per the revised development plan for collection and transportation had been procured nor the civil works for the treatment and disposal facility were completed by the concessionaire (2011). The concessionaire had even diverted the capital grant given for the creation of collection and transportation infrastructure. In fact, prior to the termination of the project, the concessionaire was simply collecting the waste from the designated wards and dumping it in the landfill site without any systematic processing of waste disposal, while full tipping fee was being paid by the ULB-C.

Asset specificity

Bundling of the project had necessitated the ULB to build capacity for managing the entire supply chain even after employing the transaction advisory, indicating the case of high human asset specificity. ULB will need specialised expertise and skills for implementing and monitoring a bundled PPP project. However, the lack of adequate capacity with the concerned ULB had resulted in additional transaction costs and incurred unnecessary expenditure. The case of lack of competency with the ULB had been highlighted by the issue of payment of tipping fee to contractor. With regard to this, an amount of ₹ 23.95 crore (£ 2.85 million) was paid to the concessionaire as tipping fee between April 2011 to Sep 2013. But the payments were made without linking it to the progress made in establishing the complete collection and transportation system by the firm. In fact, the tipping fee statement should be verified and approved by the PMC-cum TA/PE before it was sent to ULB for payment. Also, no payment was to be made to the concessionaire if any quantity was not verified by PMC. However, between July 2012 to Dec 2012, an amount of ₹ 4.19 crore (£ 0.49 million) was paid to the concessionaire without verification of the quantities by PMC. In another instance, an amount of ₹ 3.82 crore (£ 0.45 million) was paid to the concessionaire without verifications by the project engineer (PE) about the quantities transported by the private party. PE failed to invoke a fine of ₹ 13.38 lakh (£ 15,929) even during the event of failure by the concessionaire to provide the services of collection and

transportation as per the CA. Moreover, the ULB had assigned the task to a private party on which the private party did not have the capability to execute those tasks. For example, ULB had allocated the task of collection to the private sector. Huge shortfalls in user charge collection could be observed and, in fact, the collection percentage was 16.05% in the first year of operation and 39.74% in the second year of operation. This incidence provides the necessary evidence that this construct negatively informs the bundling suitability.

Transaction costs

Transaction cost both *ex-ante* and *ex-post* of the project had increased in both the cases when the project was procured in 2011 and 2016. The complexity of bundling the components had resulted in an increase of *ex-ante* transaction costs on account of the need for rigorous studies. Additionally, huge delays in conducting these studies also had an important role in increasing transaction costs.

In the early stages of implementation of MSW projects through PPP in India, the ULB and domestic consultants did not have the capacity to carry out detailed feasibility studies. In view of this, these works were assigned to foreign players. Due to lack of competent players for carrying out such studies, the consultants also exhibited opportunistic behaviour and even failed to address the deficiencies identified based on the technical evaluation of the DRP report by the approving authority. In a similar manner, the concessionaire, selected in the bidding process carried out in 2011, had also exhibited several instances of opportunistic behaviour. For instance, as per the concession agreement, 50% of the tipping fee must be paid as per the work performed. However, the concessionaire made requests with the ULB, on the pretext of increase in wages and cost of fuel, that if full payment was not made they would not be able to fulfil all the conditions of the agreement and meet the statutory requirements. Furthermore, they declared that they would have to suspend the operation as they could not withstand the financial obligations. Subsequently, ULB was forced to pay the full tipping fee and even release the previously withheld payments from April 2013. ULB was forced to adopt this decision due to political and social pressure for providing uninterrupted services to the community. All these events increased the transaction costs and these acted against the objective of value for money.

Additionally, as per the agreement with PMC, PMC was required to render the for a period of 24 months and, in case of non-completion of the project, the PMC was required to still render services for ₹ 1.25 crore (£ 0.14 million) without any extra payment. However, PMC did not render the services beyond 24 months and ULB had to appoint another PMC for the job, thereby increasing the transaction cost of the project.

The concessionaire of SPV1-C had to provide the mandated services to the households and other commercial establishments. But, during the period between June 2011 and June 2014 when no action was taken against the service provider during the period of services (between June 2011 and June 2014) by the ULB. Further, ₹ 2.63 crore (£ 0.31 million) was paid to the concessionaire under MSWM in CORAL to construct a processing plant for disposal of waste into brick making, composting, among others at cost of ₹ 20.22 crore (£ 2.40 million). However, the contract was terminated (in January 2014) and the processing plant was not constructed as per the approved DPR in September 2009. However, the payment of ₹ 2.63 crore (£ 0.31 million) made to the concessionaire was not recovered which proved a loss to ULB-C. On a whole, the audit of the PPP project revealed that ₹ 41.96 crore (£ 4.99 million) investment has been a loss due to poor performance collection while the treatment and disposal assets were not established. Apart from this transaction costs, the costs for PMC, consultancy and financing expenses are calculated to be ₹ 9.59 crore (£ 1.14 million) in the 2011 project. This also points to high transaction costs due to the increased complexity through bundling.

In SPV2-C, the additional *ex-ante* transaction costs are, as SPV1-C (2016 project) has noted, imported technology from M/s Hitachi Zosen involves in-depth preparatory studies. Hence, pre-operative expenses tend to increase. Nevertheless, the termination of the project resulted in wastage of the consultancy fees that were paid in the form of grant and tipping fee. Thus, when the transactions failed, the ULB suffered huge financial loss as *ex-ante* and *ex-post* transaction costs.

Uncertainty

The concession of 2011 did not involve any EFW component but was restricted to collection cum transportation services and developing compost plant, brick making plant, and sanitary landfill facility. In this case, technological uncertainty was low.

Hence, the 2011 procurement did not face any technological or demand uncertainty. However, in the 2016 procurement, EFW component was added to the scope of the project increasing the complexity of the project. The successful bidder of 2016 has executed one EFW project elsewhere in India. Nevertheless, the project was terminated because the private firm could not reach a state of showing competency in the collection and activities because of which they were unable to establish the EFW component as well, though it is within their competency to construct and operate an EFW project. This is because bundling has increased both the operational and financial risks in the project. Hence, the uncertainty increased due to the bundling of the components.

7.3.4 Case EMERALD (E)

The EMERALD project has been structured by studying the risks that have been realised from the experiences of the development of MSW projects across the country. This approach was adopted with the objective to mitigate the risks comprehensively so that the project would become successful in the long-term. The status of the MSW supply chain around the time of procurement of this project is presented in Table 7.3.3. This table suggests that the incoming PPP operator was expected to provide the assets and services for the sanitary landfill wherever open dumping was practised. The observation of the prevailing trend indicates that the performance of service provision with respect to some of the components of the supply chain of MSW has improved drastically. For example, collection efficiency was observed to set reasonably high (>90%) but the ULBs encountered a problem in segregation and the extent of segregation is very poor (<10%). The ULBs were more comfortable in payment of charges/tipping fee for the processing and treatment, and operation of the landfill. However, they were not willing to financially contribute to the creation, operation, and maintenance of the facility. The ULBs opined that since there is an established mechanism of collection, they sought only a waste treatment and scientific disposal facilities and preferred unbundling as the strategy of for mitigating the risks associated with such projects.

Table 7.3.3 Status of MSW services for EMERALD procurement

Project ULB	Waste Generated	Collection efficiency of MSW (%)	Extent of segregation (%)	Extent of MSW recovered (%)	HH Coverage (%)	Disposal
ULB1	550	98.8	8.8	5.5	99.27	Open Dumping

Project ULB	Waste Generated	Collection efficiency of MSW (%)	Extent of segregation (%)	Extent of MSW recovered (%)	HH Coverage (%)	Disposal
ULB2	280	90	5.7	10.7	77.46	Open Dumping
ULB3	400	91.64	NA	NA	61.52	Open Dumping
ULB4	280	96.59	<1	NA	27.75	Open Dumping
ULB5	50	96.09	11.7	12.24	94.65	Open Dumping
ULB6	35	75	<1	6.5	86.25	Open Dumping

Performance measures

The environmental norms prescribed for operating and emission standards for thermal processes were based on the Environmental Protection Agency Standards. These standards are accepted by CPCB and are more stringent than those in the MSW Rules 2000/2016. Since the technology choice was given to the private sector, bidders were able to develop the technical proposal and propose technology in accordance with the characteristics of the incoming waste. However, the collection and transportation segments do not have any influence on the measures of innovation and optimisation, which are achievable only in a bundled procurement.

For the establishment of the transfer station, treatment facility, and sanitary landfilling, the performance of the concessionaire has been guarded against financial loss. The ULBs believed that financial loss to the concessionaire have been a major cause for poor operations in MSW sector. Hence, the tipping fee was structured to have a fixed share and variable share. The winning bidder quoted a fixed tipping fee of ₹ 477 (£ 5.67) per tonne in the year 2014, which was then increased to ₹ 504 (£ 6) in the 4th year of operation, with ₹ 342 (£ 4.07) towards the variable component. The fixed tipping fee was applicable for a fixed quantity of 1800 TPD irrespective of quantum of waste received in order to cover the capital investment of the investor, with no provision for escalation of the tipping fee. The fixed tipping fee has been set to cover the capital investment of the investor. While the variable tipping fee has been linked to the quantity received at the processing facility and this has been linked with the wholesale price index (WPI). This tipping fee structure was believed to lower the scope of manipulation in specifying the quantity of waste claimed by the operator to process in the treatment facility since such a situation was prevailing in the MSW sector.

Regarding the nature of performance payments, the adopted mechanisms tend to have characteristics of item rate contracts. For instance, the tipping fee was payable on the weight of waste received at the processing facility. This was to avoid paying for the weight of moisture, which is nearly 12% at the transfer station resulting in the cost savings of nearly 12% in the pay. Hence, the measures observed to have been adopted in this project were of such a nature that prevent malpractices and ensure satisfactory performance of the operator, instead of expecting innovations with obscure conditions.

As the project did not achieve commercial operation further analysis on whether unbundling has promoted any new innovations could not be carried out. Moreover, since the project did not adopt any life cycle innovation measures, unbundling strategy appears to be most appropriate for the project development activity.

Innovation Externality

The ULBs perceived the provision of successful treatment facilities in itself as a sufficient innovation in the status quo. For instance, the participating ULBs had expressed that they were unaware of the latest trends in the processing and treatment of MSW. Therefore, it would be a challenging task for the ULBs to come up with the design of such facilities as well as maintaining the facilities. The ULBs assumed that setting up of processing plans and sanitary landfills for disposing of MSW in each ULB is uneconomical when compared to the low volume of waste generated by most of the ULBs. The regional facility was introduced based on the consideration of economies of scale i.e. to reduce the high capital costs and operating expenses on the participating ULBs.

Since the components were unbundled, the focus on the innovation was to bring suitable technology to meet treat incoming mixed-waste. However, the ULBs perceived no additional innovation could be adopted that can reduce the cost of the project. The technology choice in the RFP specified that the bidder needs to separate the bio-degradable and recyclable content through material recovery facility, process the biodegradable and combustible content separately through suitable processing technologies. In addition to this, the bidder should also process the recyclables. On a whole, the condition was to ensure that no more than 25% of the MSW received should be disposed of in the landfill site. In this manner, the procuring authority ensured that the possible innovative options were extracted during the procurement and that those

innovative options would not bring negative externality as this would be reflected in higher bid prices.

Quality specifiability

The primary collection and transportation systems were carried out by the ULBs through their existing manpower and machinery. And, the ULBs were performing moderately satisfactorily relating to the collection and household coverage (Table 7.3.3). The procurement of machinery was carried out using an input-specification based supply contracts and this was considered to be the most appropriate for meeting the service needs and at the same time reducing the cost related to procurement.

The project had adopted a carefully crafted set of questions for technical evaluation and the bidders were expected to correctly answer all the questions. This was to avoid any disparity and false representation from bidders and obtain a sound technical evaluation of their proposal. These measures were adopted in the RFP stage itself and this was believed to be the key motivator for innovation i.e. selecting an appropriate technology. For instance, RFP states that

> *"though the bidder satisfies certain technical capacity requirements from eligible projects, and meets the financial capacity requirements, it does not meet the individual proposed technology experiences as per clause 5.1.1.(a).(i), the bidder is not qualified."*

Concerning the operation during treatment and disposal, the project had provisions of stringent punishable actions in the contract for violations by the developer. Unbundling had enabled to separate the input specification components in the supply chain such as the collection and transportation from the output specification based supply chain components such as the treatment facility. Moreover, the technical capacity was set exclusively for processing the waste. For instance, the bidders should have successfully processed at least 125000 tonnes of MSW in the last 3 financial years, which is equivalent to 114 TPD in the last three years. The technical proposals were considered based on the aspects related to transfer stations, processing facility, scientific landfilling, and potential environmental compliances. These compliances were specified for all the scope of work. The risk of waste segregation was mitigated in the input specifications to the bidders while the variation in incoming waste was

completely controlled by the public sector through a waste supply agreement with all the participating ULBs.

Maturity of markets

Concerning the collection of waste, the reason for the current collection efficiency was that operations were supervised and implemented by ULBs with the support of non-governmental organisations. For instance, the ULBs of EMERALD had carried the programmes of decentralisations for the past two decades. For instance, advanced locality management (ALM) programme was a decentralized collection and treatment programmed aimed at the ward level at around 2004. Slum Adoption Scheme and Parisar Vikas Programme were some other schemes that were active before outsourcing the waste collection systems through service contracts. Later, this methodology was replaced with privatizing the collection and transportation to unbundled PPP contractors in the same jurisdictions.

This PPP project had focused on the material recovery facility and usage of incineration for 75% of waste. 25% of organic waste was proposed to be treated through composting. The residual inert to be disposed of in the landfill site was restricted to not more than 25%. The participating ULBs were more concerned about the economies of scale and had neglected the maturity of the market to handle waste at such a scale. Since the collection and transportation were handled by the respective ULBs, the immediate point of concern was the ability of the private sector to treat the waste effectively and meet the requirement i.e. to dispose of less than 25% of the incoming waste. Though many companies had participated in the bidding process, the selected bidder had been blacklisted by some civic bodies in India due to poor performance. The procurement committee was also doubtful about the credentials and capability of the winning bidder and they expressed their concern about the socio-political consequences that would arise in case of the failure of the project.

In order to verify whether the market is mature enough to bundle, the evidence is gathered regarding the performance of L1 bidder in the past projects pertaining to collection and transportation. The same winning bidder i.e. L1 of SPV-E is given a contract of collection and transportation by a civic body of India. This L1 bidder SPV-E had not performed efficiently and many incidents of mismanagement and malfunctioning were found by that civic body. Nevertheless, concerning the treatment

and disposal of EMERALD project, the ULBs had no choice due to competency limitations but had to employ the private agency for the services. As one expert notes, the PPP mode has served their objective of bridging the "*lack of expertise and exposure to global technologies*." This also favours unbundling

Hence, the evidence shows that there is a thin market of bidders that have suitable in the treatment experiences in the Indian MSW sector. The failure of past integrated projects was due to increased complexity. This situation can be attributed to the L1 of SPV-E also as bundling has prevented it to show a proven track record. Furthermore, as the theory of bundling argued, allowing the individual components to mature is needed. This allowance is facilitated in unbundled projects. This also strengthens the argument to allow markets to prove its competencies of the technology and the operations.

Economies of scope

The ULBs assumed that unbundling of the supply chain helps to improve financial performance due to diseconomies of scope in the bundling strategy. Accordingly, the unbundling of the project had reduced the capital investment of the private sector. For instance, the total cost of the project was ₹ 1000 crore (£ 119.04 million) and out of which major portion of the funding was proposed to be funded through debt financing, i.e. ₹ 700 crore (£ 83.33 million). The unbundling exercise had made the project bankable due to a reduction in debt finance. However, since the project did not enter into operations, there is no conclusive evidence to verify the diseconomies of scope due to unbundling.

Tendering to subsidiaries

Rigorous and objective technical evaluation was followed by the procuring authority for the second round of qualification. As part of this, measures were included to know whether the technology expert is involved as a partner in the project or just lending its brand name to win the bid. Regarding this measure, the transaction advisor noted, "…*we have done it first time similar to what is now suggested under draft PPP rules."* Regarding the treatment and disposal of MSW, the project had observed proposals for the adoption of both indigenous and imported technologies. Technologies that had been proposed to be imported were submitted by a joint venture. Joint ventures are usually viewed as to bring benefits to the local economy for the possibility of

bringing technological capacity building of the local companies if any (Tetteh and Chan, 2019). In this case, the private parties did not attempt to engage subsidiary companies and had limited partnership to joint venture only. Hence, the preliminary evidence support the hypothesis that unbundling made subsidiary tendering a needless proposition.

Competition

A total of 37 entities had responded to the call for EOI (as shown in Table A2.0.2 of appendix). Of these, 22 players, about 60% of the bidders, had existing operations in India. While 5 bidders had only international operations and responded individually without entering into a joint venture with local companies. 12 participants had the experience of handling up to 750 TPD of daily waste. Amongst these, 5 bidders were Indian joint venture companies. 10 bidders had both Indian and international operations and, out of these, 2 bidders had less than 750 TPD experience. 14 bidders, who had responded to EOI, were small players and they were considered to be not suitable for EMERALD project and were discarded. 23 respondents to the call for EOI were medium to large respondents and they were found to be suitable at the EOI stage. Amongst these, most of them were single entities and they had experience in composting, RDF to power, and incineration technologies. Only a few bidders had the experience of treating MSW using technologies such as pyrolysis and biomethanation. From the responses to EOI, it also showed that most of the companies did not have any significant experience in the transfer stations, transportation, processing and disposal stage of the current projects. Only four bidders had experience in setting up and operating transfer stations, transportation, processing, and disposal up to a capacity of 500 TPD. It has also been observed that international players have a better track record in operating the processing facilities than the domestic players.

Four consortiums with joint ventures comprising of 12 entities responded to call for proposal in the RfQ cum RfP stage. The experts opined that treatment and disposal of MSW are relatively new practices for MSW in India and there is no precursor of good management practices. As a result, the extent of competition observed from the participation of five to eight bidders could be seen in the present project. However, with respect to collection and transportation, NGOs and small private agencies can provide these services at a much lower cost and enough amount of competition could be observed for these components.

Information asymmetries

Lack of reasonable estimates of waste to be collected and uncertainty about the technology to be adopted to perform the operations were few of the sources of information asymmetries observed in this procurement. The waste collection and supply of minimum waste were taken care of through the waste supply agreement of all the participating agencies. The user fees were collected by their respective ULBs and the risk of direct user fee collection by the concessionaire was evaded. ULBs also noted that, in case there is a shortage of supply, they will be still able to make up the shortage with the waste from the old deposits and transfer the same to avoid the penalty, indicating a better control of ULBs in handling the possible opportunistic behaviour, had it been bundled. One respondent noted that "…*in MSW there are instances of players defaulting in ensuring sustained operations and hence checks of surety have been built into the qualification criteria".* This was made possible in the treatment and disposal components that were facilitated by the unbundling.

The assumption of mixed waste, upfront environmental clearance, and upfront land acquisition had prevented the effect of information asymmetry. This is said to be the first project for which all the clearances including pollution control board were obtained prior to the bidding. These aspects are considered very crucial in these kinds of projects. The effect of information asymmetries was reduced because of the unbundling strategy in this project.

Asset specificity

The six participating ULBs did not have any prior experience in handling a long term concession PPP project in the MSW sector. Hence, it has been observed in this project that many initiatives and reforms were adopted to support the project and reduce instances of information asymmetries. The development authority has amended the act to support regional facilities and also developed PPP toolkit to guide the process. In order to buttress the development, the agency has involved separate technical, financial, and even legal consultants. Furthermore, the process of procurement was carried out in stages and the scope was refined at every stage and with every additional inputs from all stakeholder groups. The project development was also closely monitored by the procurement committee in addition to the bid process monitoring responsibility typically observed in MSW PPP projects.

Many alternatives to conventional procedures have been adopted in this project. For instance, the procurement committee focused mostly on the treatment of waste and hence the emphasis was on the adoption of suitable technology which will give best VFM. In the pre-process preparation, a one-day workshop was organized with the participating ULBs for explaining the project and other project documents including waste supply agreement. The inputs received from the ULBs who had participated in this workshop were then incorporated in the revision. In this project, EOI focussed on understanding the capabilities of market players in MSW projects. Moreover, the RFQ cum RFP stage had even separated the project experience in PPP and technology supplier experience in EPC contracts and evaluated in terms of the proposed technology, scientific landfill experience, development experience and capability of various technologies. These measures ensured that the markets and the ULBs are brought on par in the understanding of the project. Specifically, these measures are advocated when the sector is about to mature. This has also reduced the delay in the procurement process and delivery schedules. All the monitoring mechanisms require high expertise and the work-specific knowledge, understanding of the technical specifications, and ability to handle the technological uncertainty in the operation. In this case, the ULBs and the independent monitoring agency have a good understanding of these parameters, thereby indicating a very high level of human asset specificity. Notwithstanding all these initiatives, the approach of the procurement authority matches the theoretical prediction that since the ULBs have not developed the necessary human asset specificity to handle the complete value chain, unbundling has been the appropriate choice to procure the MSW services.

Transaction costs

The ULBs have estimated that scientific treatment landfill of 200 TPD would require ₹ 2.05 (£ 0.0244) per tonne in site development, ₹ 25.43 (£ 0.302) per tonne towards equipment usage, and ₹ 135 (£ 1.60) per tonne in construction of the landfill. Accordingly, the committee of ULBs had pooled the necessary infrastructure in a regional facility for providing the treatment and disposal facilities with the six surrounding ULBs. Experts opined that this mechanism prevents the difficulties in land allocation procedures at all the ULBs, lack of expertise and exposure to global technologies for treatment, and the capital cost to develop scientific waste facility by achieving economies of scale. These estimates are simplified because of the separation

of collection and primary transportation of the waste from the scope of treatment and disposal project that is procured on PPP mode. The winning bid of EMERALD for treating the waste was ₹ 525 (£ 6.25) per tonne tipping fee for a contract. This tipping fee was based on the actual quantity of waste delivered prior to removal of any moisture at the transfer station.

In spite of unbundling, the participating ULBs had faced financial hurdles in operating the system and complying with the standards of MSWM. In order to reduce the burden further, all six ULBs requested to get 50% subsidy on the tipping fee from the nodal development authority of the state. This subsidy was at a level of ₹ 504 (£ 6) per metric tonne (fixed and variable) which comes out to be ₹ 33 crore (£ 3.92 million) per year. Thus, this evidence points to the fact that unbundling has facilitated to economise the costs of the transaction to the public sector and has also prevented the contexts that would raise the costs of the transaction.

Uncertainty

The ULB had adopted appropriate measures to reduce uncertainty in the operation of the MSW supply chain. For instance, the minimum supply of waste agreements had been entered into with the participating ULBs to restrict the uncertainty in collection and transportation of waste. And, as a measure to reduce information asymmetry, ULBs had insisted on the incorporation of very strict compliance measures in the contract documents of the treatment project. For instance, with the objective to ensure timely completion, the concessionaire has to pay damages to the authority calculated at the rate of 0.1% of the amount of performance security for delay of each day, until COD is achieved. Moreover, damages to be paid for each day of delay until the breach is cured had been calculated based on the amount higher of either (a) 0.5% of daily tipping fee, or (b) 0.1% (zero point one per cent) of the cost of such repair or rectification as estimated by the independent engineer.

ULB received proposals to treat mixed waste and this had reduced the uncertainty of the technology performance to some extent while framing the project. However, the uncertainty of technology was still significant in the unbundled treatment project. For instance, even after the award of the project, there was a huge debate on the likelihood of the success of the project as the bidders do not have a completely successful track record of the treatment operation. These evidence highlight the fact

that ULBs decision to unbundle and separate out the components with uncertainty is to economise the transaction.

7.3.5 Case SAPPHIRE (S)

Performance measures for innovation

The public sector had steered the collection and transportation components with an objective of treating the waste in a decentralized manner. No product-related innovation had been observed to be made in these segments, however, the process of establishing onsite composting units and micro composting units had helped to reduce the costs suggesting a process related innovation for waste management.

On the contrary, the concession agreement of SPV-S showed that the concession agreement did not have any tangible and upfront performance standards for the treatment and did not show the capability to promote innovation. For instance, regarding the operation and maintenance manual and plans, Schedule II of CA stated that "*prior to making application for the readiness certificate for the project the concessionaire shall finalize in consultation with the project engineer: the O&M manual (including the formats for the reports to be submitted during the active operations period and the post-closure period).*" The requisite laboratory and testing facility for waste quality, leachate, and other environmental monitoring needs to follow the latest MSW Rules. Similarly, the produced compost and RDF should comply with MSW Rules and MNES rules respectively. Similarly, for disposal of waste, ULB had adopted the approach for asset specification where the sampling and testing, weighment, monsoon cover liner, daily cell cover, landfill closure, vegetative cover, leachate collection and removal system, provision for landfill gas recovery/venting systems, and environmental monitoring system are specified as per the MSW Rules 2000. This highlights that the private sector was expected to comply with the existing rules and regulations without giving them any initiatives for bringing innovation.

The concession agreement had provided the liberty to the private sector to claim carbon credits and implement landfill gas capture systems. But the choice of technology should be in such a way that the only inert should be disposed of in the landfill and, hence, landfill gas capture system will be needless. Moreover, performance measures related to treatment and disposal have no bearing on the collection and transportation of waste since the treatment facility was procured with

mixed waste as the input. Hence, the lack of performance measure to promote life cycle integration makes bundling a needless proposition based on this construct and supports the ULBs' decision to unbundle the MSW supply chain.

Externality of Innovation

ULB had considered a few innovative options such as IT enabling collection and transportation system for bringing efficiency. However, the cost associated with the adoption of such a system made this proposition to have negative externality i.e. will not reduce the operational costs. Instead of adoption such a system, ULB had resorted to operational and managerial innovation with the objective to reduce operational cost. With this intention, ULB had adopted decentralised waste reduction and management system. Likewise, expecting process and operational related innovation in the treatment process will lead to have the implication of negative externality. In this line, the concessionaire of SPV-S stated that the capital cost for various projects under execution is about 20-30% higher side due to its varying scope including combination of closing the existing dumpsite, constructing weighing bridges, secondary transportation, building transfer stations, development of scientific landfill (SLF) sites, and closure of SLF post concession period. The SPV-S had requested the SERC to consider the norms individually for plant and machinery, civil and construction cost, cost of scientific landfill sites, evacuation infrastructure, soft costs, among others and fix a capital cost of ₹ 18 crore (£ 2.14 million) per megawatt. This fact affirms that the scope of treatment and disposal segments are of a negative externality.

These evidence further support that the product and process innovation in the typical MSW supply chain are of the negative externality. On the other hand, the private sector lacks the capability to adopt options such as decentralised waste management which can reduce the cost of operations.

Quality specifiability

ULB had defined the input specifications for the assets to be built for collection and transportation of the supply chain. On the other hand, for treatment and disposal, the ULB did not mention the specifications of the assets but spelt out the requirements only. Consequently, the private sector procured 14 numbers of bulk container carrying vehicles, closed windrow composting platform with shredders among others, scientific

landfill, and waste to RDF conversion plant. However, the concession agreement states that "*all items of building works shall conform to Central Public Works Department (CPWD) specifications for Class 1 building works and standards given in the National Building Code (NBC)*." On the other hand, regarding the treatment facility, as per the concession agreement the amount of rejects from the facility should not exceed 15% of the total incoming waste and this should comprise of only inert. Suitable penalties were proposed to be levied if the amount of rejects exceeded 15% of the total incoming waste. It could be understood that the ability to contain the rejects to 15% has no bearing on the collection and transportation activities and suggests that there are a different kind of quality specifications in the unbundled project. Moreover, the concessionaire failed to make important kind of 'productive investment' particularly on the leachate treatment plant and the reverse osmosis plant. Leachate treatment plant is an important facility to prevent contamination of the groundwater and is one of the non-tolerable issues in MSW activities.

These evidence show that collection, transportation, treatment, and disposal have different specification requirements and the quality of the whole supply chain cannot be specified by either the asset specifications or service requirements alone. Therefore, in such a context, unbundling is a suitable strategy for these operations as verified in this case.

Maturity of markets

ULB had been providing the collection and transportation services and wanted a private player through PPP for treatment of waste. For the selection of the private player, ULB had designed the procurement process to select the private party with maximum experience through competitive bidding. However, the bidding did not attract much attention amongst the private players and, hence, the number of bidders that had participated in both the technical and financial stages of procurement were found to be less than five. The winning bidder had proposed a non-incineration based energy recovery system from waste. The winning bidder was a joint venture with a multinational company that specializes in technology producing high-quality refuse-derived fuel (RDF). However, this company could not deliver the technology and had requested an amendment to concession agreement to allow mass-burn incineration. Subsequently, the winning bidder signed an MOU with another German-based multinational company for setting up the power plant but, in this case also, the winning

bidder failed to deliver the assets and services. This winning bidder had been awarded the contract for the implementation of MSW projects in another seven locations in India but, out of these seven projects, only one project is operational. A key observation that can be drawn from this project is that the firm is yet to prove its ability to implement EfW project efficiently, particularly in controlling the technological and financial risks.

Evidence of poor competency on the part of the private party could be observed in the implementation of the project subsequent to procurement. The private party could not initiate the plant on account of the uncertainty in the cost of the unit to be sold to the public sector grid, thereby suggesting that the private sector failed to predict and quantify this revenue risk. This indirectly suggested a lack of maturity in handling such kind of projects. Furthermore, the delay in the construction of EfW project for more 4 years has indicated the inability of the private sector to correctly handle the treatment projects in this sector and shows the lack of maturity of the market to handle energy from waste projects.

Economies of scope

Economies of scope are concerned with the reduction in cost due to the functional unity of the components. Two aspects reported Concerning the collection and transportation, the lead ULB had used 228 sanitary workers to cater their 69252 households and a total population of 2.77 Lakhs as of 2018. The fleet of vehicles and these operations have a deficit of 253 workers. The ULB has outsourced these jobs to private parties including NGOs to provide the collection and transportation activities and the ULB provided all the required equipment. Owning to the poor performance of the private operator and the insistence of decentralisation by state pollution control board, three of the member ULBs have begun sending high calorific non-recyclable waste directly to cement factories. This strategy has been proved to cause a reduction in the costs to the ULBs. Therefore it indicates that it is not cheaper to get the same products and services than to handle them separately and thus would not have economies of scope as predicted by theory (Besanko et al., 2013).

As per the agreement, the concessionaire has to receive ₹ 541 (£ 6.44) per tonne after the completion of phase 1 and 2. While collection and transportation components are able to contain the costs of operations, treatment and disposal components are affected due to poor competency of the private operator. Consequently, the

concessionaire has pointed that the plant is running in huge financial loss wherein operation cost as on 2018 is ₹ 714 (£ 8.5) per tonne against the tipping fee revenue of ₹ 327 (£ 3.89) per tonne. This is besides, the private sector has revenues from the sale of RDF and compost. This poor performance can be attributed to the lack of maturity and understanding of the risk relevant to project structuring, revenue modelling, risk intensity and occurrence. The ULBs opined that they have breached the contract as the private sector failed to deliver the promised treatment services. They also indicated that various components of the supply chain do not have economies of scope. This is because the components have their own operational expenditure and there is a lack of innovation to economise the transaction. Data also verify that a lack of sharing or joint utilisation of inputs of each component can lead to diseconomies of scope (Besanko et al., 2013). The evidence shows that this unbundled project did not have any possibility of economies of scope had it been bundled in the first place.

Tendering to subsidiaries

The bidder who was awarded the contract in the procurement carried out in 2012 was a consortium of three distinct companies. These private firms had executed an MoU for sharing the technology and know-how of MSW management, processing, and power generation. Amongst these members, L1a took the lead for the construction and operation of civil and material transfer facility, while L1b was a provider of technology for producing refuse-derived fuel (RDF) to power using incineration based technology. The share ratio of the joint venture is 80:10:10 making the lead consortium having the vested interest. Though it has MOU, the intention behind the JV is to make the technology provider responsible for their component. However, there was no subletting of works in the treatment and disposal component since unbundling made subletting of components a needless proposition.

Competition

ULB had attempted to delegate and select the private operation/services for this project in the year 2009 and 2012 (as shown in Table A2.0.2 of appendix). In the bidding carried out in 2009, eight bidders had initially expressed their willingness to participate in the bidding. Out of these eight bidders, only five bidders were able to qualify the RFQ stage. Subsequently, out of the five bidders, technical and financial proposals were submitted by two bidders only. The bidder who had been awarded a

contract for the project also could not execute the project as it could not achieve financial closure and requested for termination. In the next bidding carried out in 2012, three bidders had shown their interest, and those bidders were invited to participate in the bidding. The main reason for inviting all of them was to promote competition. The results show that treatment component has low bidder participation as it is particularly new in terms of the technology and there exist few success stores for successfully operating such projects.

Information asymmetries

Four instances of information asymmetries could be observed in the project on account of unbundling the segments of the value chain. Firstly, during the period 2005-06 to 2008-09, the private sector operator could not achieve the objective of segregating the waste into biodegradable and non-biodegradable waste but had received excess payments. This situation can be attributed to the non-verifiability of quality specifications in this MSW sector. Particularly, the poor performance of private operator had become a source of asymmetric information to the public sector

Secondly, after the procurement of SPV2-S, some of the participating ULBs were reorganised and hence had moved out of the project. This would have affected the projected operational capacity. However, after merging of two of the project ULBs with the corporation of a neighbouring city, three more new ULBsv were added into the project as a solution for delivering the minimum waste to the project.

Thirdly, the implementation of the treatment component encountered uncertainty in fixing the unit price of the project. Responding to the approach adopted by the public sector, the private sector said

> *"...EfW is not erected in this project. We agree, then why ULB started to deliver the waste before completing EfW here? Why the municipality is still supplying waste to us? This is their fault. They should have said EfW is not completed and therefore we will terminate the contract. Now, after three years, their problem is solved and they are saying this should be terminated."*

However, as per the concession agreement, the ULB was not bound to assure any unit price to the concessionaire, either directly or indirectly. The concession agreement stated that

> *"the Concessionaire shall be free to sell or otherwise dispose of the recyclables, compost or organic manure, energy (power) and/ or other material recovered after Processing the Municipal Solid Waste, at the Project Facilities at such price and to such Persons and using such marketing and selling arrangements and strategies as it may deem appropriate subject to meeting the O&M Requirements."*

This instance shows the opportunistic behaviour of the public sector and information asymmetry on both parties.

Fourthly, the concessionaire noted that the reduction of the price of pet coke has affected the possibility of cement industries purchasing the RDF. Inspection Committee in 2018/19 observed various lapses on the performance of the private sector. Most of the lapses were connected with the lack of power generation plant from the RDF. Subsequently, the operator showed an apparent failure to make quality investments. For instance, it was observed that secondary shredder and the hot air generator is kept inoperative for more than 2 years. This has affected the quality of RDF. As a result, only 7.69% of the total RDF could be sold and the rest was stored in a landfill. Storing of RDF in the landfill was against the concession norms and this eventually resulted in a fire accident in the RDF storage site. Yet, the ULB did not suffer any financial or operational loss in the provision of basic collection and transportation activities due to the unbundling strategy. Notwithstanding, the decentralising the treatment facilities was both a countermeasure to the poor performance of the ULB and also a response to the SPCB and High court interventions.

These evidence suggest that the instance of information asymmetry did not affect the overall operation, particularly on collection and transportation components. This suggests that unbundling strategy has helped the ULB in tackling many situations of information asymmetry and prevented the holdup of ULB in the hands of concessionaire for the provision of the MSW services.

Asset specificity

Prior to the procurement of SPV-S, one of the ULBs had employed private sector to handle the operations of collection and transportation. In this system, segregation of waste was neither carried out by the households nor by the private entities and the entire mixed waste was dumped in the municipal dumping site. It was

also noted that, though the contractor did not carry out the work relating to segregation of waste, the municipality had to pay the full contract amount of ₹ 1.31 crore (£ 0.15 million) for the period 2005-06 to 2008-09 to the contractor. Due to this reason, the ULBs had resolved to carry the collection and transportation themselves considering the difficulty in monitoring the service quality of the private sector delivery.

ULBs continued to provide the collection and transportation activities with their available resources. They depended on the SPV-S for the treatment and disposal of waste only. The unbundled procurement has provided enough leverage for the public sector to optimally use their low human asset specificity to acquire, supervise and monitor the entire transaction within the available budget. The ULBs even effectively handled the traditional composting technology at the ward level, thereby putting to optimal use of their human asset specificity. In 2019, the lead ULB had procured assets and services related to onsite composting centres and micro composting centres. The time of procurement was rapid because the ULB has adopted input specifications and item rate contracting methods which are used routinely by the ULB. It took only 6 months to make the plants completely operational to treat the whole of organic waste emerging from the wards. Similar moves were observed in 2019 in other ULBs which they are supposed to send the waste to the PPP project. Subsequently, the ULBs through a memorandum of understanding with a leading fertilizer company in India has started distributing manure to farmers in four nearby districts of that state.

These evidence suggests the suitability of unbundling option in case of low human asset specificity. More importantly, the ex-post verifiability of the operations becomes difficult if the human asset specificity is not to the level required for procuring the project in bundled mode, even after employing independent monitoring agencies, thus providing the necessary evidence to the theoretical proposition.

Transaction costs

The project had experienced a huge delay in the construction of the energy from waste plant. Out of ₹ 99 crore (£ 11.78 million), an amount of ₹ 54.75 crore (£ 6.51 million) was to be invested in Phase I for the establishment of two transfer stations, procuring 14 numbers of bulk container carrying vehicles, closed windrow composting platform with shredders among others, scientific landfill, and waste to RDF conversion plant. In phase II, RDF to power plant at a cost of ₹ 37.41 crore (£ 4.45 million) was

to be constructed. This RDF to power plant, which is part of phase II, was not operational as on writing of this case. The delay is mainly due to non-finalization of per-unit cost of electricity. Subsequently, the ULB had promoted the onsite composting centres (OCC) and micro composting centres (MCC) along with purchasing vehicles for collection activities, and organic shredding machines at a cost of ₹ 5.86 crores for a total capacity of 48 TPD of organic waste. ULB opined that this unit of cost of treatment of organic is much less than the equivalent cost paid to the private sector as a tipping fee. Moreover, according to the lead ULB, the OCC and MCC model has been operating well where the additional revenues of producing and selling the compost. This additional revenues were an incentive to the sanitary workers and had caused more interest to work towards the success of this model. The trial tests were conducted and free manure was provided for the local residents and a reputed fertilizer company has been involved for branding and selling the produced compost. The base price per tonne was fixed at ₹ 2500 (£ 29.76) and was sold to farmers with a margin of ₹ 500 (£ 5.95). This has reduced the overall transaction costs to the ULB. These initiatives formed the part of a flagship programme of 'zero waste' and were driven due to poor waste management activities by the private sector. This zero-waste concept used short-term contracts, thereby reducing the procurement period, the ex-ante transaction costs related to the front end planning and providing timely solutions and services to the public agency and the public. Around ₹ 18 lakh (£ 21,429) (averaged for the year 2018) was paid for the treatment operations every month to the private operator in PPP mode. Ultimately, in the decentralised form, this expenditure has been reduced, however at the risk of a breach in contract.

These evidences show that transaction costs have been reduced in the collection and transportation components. Treatment and disposal activities have increased the transaction cost due to delay and operational difficulties. Hence, the ULBs' strategy of not bundling the treatment and disposal components with the collection and transportation components is strongly supported by the perspective of economizing the transaction cost.

Uncertainty

The project had encountered two major instances of uncertainty. The first one is relating to uncertainty regarding the technology proposed to be adopted in the project. ULBs were clearly aware that technological maturity in energy from waste projects was

not up to the mark on account of typical characteristics of the waste being generated in the Indian context. In view of this, it had been specified in the concession agreement that ULB or its associates will deliver mixed waste to the treatment facility. The motive was to reduce the effect of waste characteristics on technological uncertainty and to allow a better understanding of the performance of those technologies. The ULB expected that private sector would propose a suitable design in line with the waste characteristics. The main motive of ULB in proposing such kind of requirement was to promote adoption of such treatment technology that the ULB themselves will not be able to bring in services.

The second uncertainty is regarding the demand for the unit price of power, as it has not been standardised in India. For this project, State Regulatory Commission (an independent body related to power purchase) assured the tariff to be around ₹ 6.16 (£ 0.073) per unit instead of the intended price of ₹ 7. 59 (£ 0.09) per unit. This uncertainty of the unit price of power produced had caused a delay in establishing the composting and RDF processing plant. As a result of this, the private operator failed to honour the concession agreement of setting up the power plant within the stipulated time. These evidence point out that the effect of these technological uncertainty and demand uncertainty is hedged due to the unbundling strategy adopted by the ULB. In other words, this strategy allowed for two-fold benefits. One, the collection and transportation activities were not affected. This prevented the possibility of opportunistic behaviour by the private sector to suspend the service and put pressure on the ULB for demanding an agreeable rate. Two, the private sector was allowed to honour the concession agreement and prove their competence and expertise.

7.3.6 Case DIAMOND (D)

Performance measures for innovation

The project adopted the strategy of setting separate performance benchmarks for collection and transportation. First, the collection systems had been modernised by ULB-D through outsourcing and by adopting 700 routes through micro-planning. Each route consisted of 1500-2000 dwelling units. The collection in seven zones of the city had been given to seven contractors through short-term service contracts with a tipping fee as a payment mechanism for every tonne of waste collected. The ULB-D insisted that all vehicles should have a vehicle tracking system using GPS. The contracts had

specified these measures in a prescriptive manner. The performance monitoring had been handled by the ULB-D employees' by the usage of the Internet of Things (IoT) through a central monitoring system. Secondly, transfer stations adopted performance measures such as compensation for delay is ₹ 10,000 (£ 119) per day for the delay in execution for each work order and limited to a maximum of ₹ 5 lakh (£ 5,952). If the global positioning system was found not to be working, a penalty of ₹ 1000 (£ 11.90) per day has been charged, till it starts functioning.

Thirdly, the treatment activities adopted in this project included composting and RDF generation. All the four treatment project specified that the rejects/ash from the plant should not be more than 20% of input waste. Apart from this, the emission standards were according to the PCB and MSW Rules. Also, the plastic treatment unit was a BOO contract and was separated from the rest of the MSW supply chain. Traditionally, plastic waste is mixed with plastic waste. However, ULB-D had adopted advanced waste management to separate plastic waste. The ULB obligated the operator to install plastic collection centres in seven zones of the city and near stores and malls, generating a massive amount of plastic waste and treat them. The plastic waste treatment had to follow Plastic Waste Management Rules, 2016 and the industrial standards. On the whole, various treatment units had different compliance requirements as per the pollution control board norms, and as per the specifications set in MSW Rules 2016. There is no evidence to performance measures that can promote lifecycle innovation and thus bundling strategy is not suitable.

Innovation externality

With the experience of management of MSW, the ULB realised that product and process-related innovation in MSW normally brings instances of negative externality i.e. there is no direct operational saving should the investor perform such innovations. Accordingly, attention was paid to the efficient operation of each component through individual outsourced PPP contractors. The emphasis of innovations was placed with the ULB itself in the framing of contract documents. The collection system was completely linked with app-based tracking and complaining system. ULB-D employed a company that specialises in vehicle-tracking systems for trucks transporting goods to set up integrated solid waste management-monitoring systems. Around 4,000 garbage collection bins were connected with a global positioning system (GPS) based tracking system provided by a speciality firm.

However, the concessionaire of SPV1-D of treatment projects did not bring any innovation product or process innovations with positive externalities in treatment technologies, though the concession agreement had such provisions. The concession agreement of SPV2-D specifies that "*...CONCESSIONAIRE has agreed to work in the field of treatment, processing, and recovery of fuel pellets and organic manure from MSW at DIAMOND using suitable technology".* Similarly, the concession agreement of SPV3-D specifies that *"... the concessionaire shall have the right to develop the plant using such technology that it considers suitable and commercially viable for the purpose of implementing the project*". Nevertheless, only composting was being practised since its inception.

In contrast, the ULB had come up with an innovative idea called "Mobitrash" which is a mobile treatment unit. This method was able to support waste processing by decentralising it at the ward level. The ULB had planned smart bin collection systems in the selected locations of the city to ensure a superior level of MSWM. These underground smart bins work with sensor-based technology for knowing when the waste was full facilitating unloading only when required. These systems adopted separate contracts that make the concessionaire construct the facility, operate, and maintain for five years. These innovations were having characteristics of a negative externality. Since stipulations and contractual provision were required to compel the private sector to innovate, the authorities did not perceive the necessity to bundle to bring innovation. For instance, ULB representative said, "*...if all the vehicles have to be linked to the GPS and monitored...it is better that we do and monitor than leave both the key and lock in private sector's hand.*" Instead, innovations were facilitated by ULB-D through unbundled contracts. The ULB-D expressed that optimisation of cost and the operational cost savings were not favoured in the bundling strategy.

Quality specifiability

The specification of the projects followed input specifications for the whole supply chain except for the treatment facilities. Product specifications were followed for the vehicles used for collection. One of the concession agreement of the door-to-door collection contract specifies that "…*VTS (vehicle tracking system) / GPS (global positioning system) shall be installed on each vehicle including spare vehicles by his own cost and shall be maintained by the contractor at its own cost*." The collection

activities were paid per tonne of tipping fee while the secondary transportation was paid on the basis of per tonne per kilometre of waste transported.

In contrast, service specifications were followed for the work of transportation i.e. the rate per day of the complete job. The scope of transfer station contract was to provide close body containers sufficient for incoming waste, provide stationary compactors, and provide the hook lifter sufficient to transport the MSW to the landfill. For instance, the bid document of one of the refuse transfer stations specifies the requirement of two stationary compactors, four hook loader vehicles, and 21 numbers of 20 Container Mounted Truck (CMT) containers. Also, item rate contracts with asset/construction specification were followed for the construction of the sanitary landfill. The sanitary landfill is constructed in compliance with the asset specifications mentioned in MSW Rules 2000/16. For treatment facilities, the ULB-D followed output specifications where the extent of waste given to ULB-D for landfilling was restricted to less than 20% and the emission standards were prescribed by the CPCB and MSW rules 2000/16. This evidence shows that specifying the overall quality of the service is neither feasible nor beneficial and thus quality/output is specified accordingly in each of the components.

Maturity of markets

The collection and transportation efficiency in terms of quality and cost in DIAMOND clearly show the superiority of the market in handling the corresponding operations. The presence of repeated bidders suggests the expertise and the competency to handle the work. However, ULB-D faced trouble in managing the acquisition of energy from waste treatment facilities due to poor market maturity. The ULB apparently perceived this situation and hence had not provided any upfront to the concessionaires of SPV1-D and SPV2-D with an intention to be driven by the market instead of being driven by the ULB. Apart from the bidder participation in SPV3-D, the subsequent tendering that happened in 2014 and 2016 did not get necessary participation from private sector players. In the third attempt of tendering carried in 2019, only one company submitted a bid to build, operate and maintain the plant. The company also demanded ₹ 540 (£ 6.42) per tonne as handling charges for waste which worked out to be ₹ 7-7.5 crore (£ 0.83 – 0.89 million) per annum. ULB-D official said that instead of paying ₹ 7.5 crore (£ 0.89 million) per annum to a private player, ULB-D can build its own plant in ₹ 60 crore (£ 7.14 million). Hence, the lack of a matured

market to execute a successful project might have caused an increase in cost to the public sector. Concerning sanitary landfill, EPC mode of procurement was used by the ULBs and since sanitary landfill construction was technically less complex with fixed technical specifications and not operationally intense, sufficient private players were available to construct the landfill. Hence, there is necessary evidence to conclude that treatment projects have poor maturity of markets while the rest of the components have mature and competent players. This supports the ULB-D's decision to unbundle and procure the assets and services in DIAMOND city.

Economies of scope

Economies of scope are looked from the perspective of expenditure and possible saving in the operation of MSWM in the DIAMOND city. First, the ULB had perceived different functional motives for each component of the MSW supply chain. ULB had intended for decentralised waste management, reduction of waste, and treatment at the source. The reason for this is to reduce the costs of MSW activities. For instance, in 2014, the estimated cost for secondary transportation from the transfer station to the disposal site was around ₹ 4.25 crore (£ 0.50 million). The constructed cost of each transfer station was averaged at ₹ 3.5 crore (£ 0.41 million) spread over 1.5 acres (6070.28 square meters). The tipping fee for door-to-door collection in September 2017 was ₹ 903 (£ 11) and ₹ 912 (£ 11) for the south and south-east zone. ULB-D had also got the services of secondary transportation from the transfer station to the treatment site at a lower price. For instance, some of the contractors offered a discount of 5% as the number of TPD increased. ULB representative opined that these provisions cannot be implemented in a bundled project. The payment mechanism is also very specific such that ULBs are clearly able to monitor the cost expenses. Out of the tipping fee, 30% of the cost was linked to the wholesale price index (WPI) of diesel to ensure that any kind of productivity shocks to both the parties are eliminated. This mechanism of WPI linked price revision is carried quarterly to counter the productivity shocks. This is supplementary to the 5% annual tipping fee increase. Using innovation measures and schemes, the ULB-D was successful in reducing the waste requiring treatment and saved the costs to be incurred.

Second, the ULB sought for revenue generation to cover the costs. For instance, the unsold manure produced during localised treatment under GRANT scheme was purchased by the ULB-D. This was further sold by appropriate packing leading to

additional revenues to the ULB-D. This activity also increased the involvement of people in the MSWM. The fines and spot administrative charges also increased the revenue for waste treatment and had promoted the polluter pay principle. These can be seen as economies that are generated when projects are designed only according to their scope. Besides, the ULB-D was offered to earn revenue of ₹ 1.33 crore (£ 0.15 million) per annum by selling at least 600 metric tonne per day waste to the SPV3-D.

Concerning collection, the micro-planning exercise increased customer satisfaction and the reduction in cost. ULB-D conducted a detailed micro-planning exercise to design routes and collection schedules by doing exercise at the ward level, identifying waste generators and bulk waste generators, and estimating the quantity of waste generated at street level, inventoried roads and road widths. This exercise is believed to be an iterative process of evaluating and modifying. This also requires much flexibility which a bundled project would not offer due to lack of flexibility in PPP contracts (Demirel et al., 2016). As evident in every stage i.e. collection, transportation, treatment, and disposal, the evidence (reduction in the prices, increase in quality of service, and measures to prevent productivity shocks) strongly suggests that economies of scope are not possible in a bundled project but when components are unbundled. This is because of the diversity of the competencies required to achieve economies of scope and lack of cost advantage for the firms to achieve the same.

Tendering to subsidiaries

The MSW activities and services were procured using different procurement methods. There was no subsidiary tendering in the projects executed in connection with MSW services through the private sector (PSP). For collection, refuse transfer stations and secondary transportation; the bidders who had participated in the bidding were small to medium scale contractors from various states of India. Besides, NGOs and registered trusts also had participated in the collection and transportation activities of the MSW supply chain.

In treatment projects, the ULB-D had taken measures to prevent subletting of works and had limited the joint ventures to two members. For instance, the RFP of SPV3-D stated that "*Joint venture will be allowed only with technology supplier and not more than two JV members allowed*." This also indicates that unbundling can promote only speciality contractors for treatment.

Competition

The level of competition observed in the projects of DIAMOND varied from one component to another component of the MSW supply chain. For collection, the door-to-door collection system through private operators was practised from April 2004. The ULB adopted a practice of gradually adding zones to the administrative regions through separate contracts. Initially, it was implemented for three zones and it was reviewed and extended step by step to the whole city as of now. The analysis of the competitive landscape of the tendering between 2003 - 2018 shows that a high number of bidders participated in the tendering of collection activities carried as per the zones - ranging from 3 zones in 2003 to 7 zones in 2017 (as shown in Table A2.0.2 of appendix). The highest number of bidders observed was for collection and the construction of transfer stations in 2008.

Data indicated that, except for the treatment facility, the rest of the components of the supply chain, namely, collection, primary transportation, secondary transportation, construction of smart bins showed good competition in the market. To promote competition, the tender document fee was very nominal at ₹ 6000 (£ 71.42) in case of the door-to-door collection contracts and had 2% as the security deposit. SPV3-D had no document fee and had an Ernest money deposit of only ₹ 10000. The performance guarantee was only ₹ 0.5 crore (£ 59,524). Hence, the ULB-D was able to get the assets and services at competitive prices. Very often renegotiation with the L1 bidder resulted in a reduction of tipping fee. A maximum of 36% reduction in the tender cost was observed. This benefit is a result of increasing competition. Notwithstanding, few instances of retendering were observed.

Concerning the treatment facilities, a low level of competition was observed, indicating the fact that the lack of enough private players with competency. The selection process of SPV2-D and SPV3-D did not achieve any competition (as shown in Table 7.3.4). Authorities expressed that since the treatment of waste was inevitable, they had to accept the best available bidder during that bidding process. This step is in pursuance of implementing the Supreme Court guidelines on controlling the environmental quality through MSW Rules. The number of bidders who had participated for construction of scientific landfill facility procurement is not available for analysis.

Table 7.3.4 Competition in all components in MSW activities of DIAMOND city

Activity	Year[&]	Scope	Type	Duration	Tendered/ Qualified	Repeated L1
Collection						
Door to door	2003	3 zones (400 TPD/900 TPD)	SC	7 years	10/5	
	2011	7 zones	SC	5 years	15/12	Y
	2017[@3]	7 zones[@3 zones]	SC	5 years	20/06	
	2017	2 zones (retender)[#]	SC	5 years	10/9	
Secondary Transportation						
	2006	Four TS's	SC	1 year and renewed yearly	68/8	
	2006[@]	5th TS	SC	1 year and renewed yearly	3/3	Y
	2007	1 TS	SC	1 year and renewed yearly	6/5	Y
	2009[@]	1 TS	SC	1 year and renewed yearly	1/1	Y
	2010	1 TS	BOO	10 years	6/6	Y
	2011	1 TS	BOO	5 years	8/6	
	2012	1 TS	SC	1 year	6/3	
	2012[@]	1 TS	SC	1 year	1/1	Y
	2012	1 TS	SC	1 year	7/6	
	2012	1 TS	SC	1 year	4/2	Y
	2014	1 TS	BOO	10 years	2/2	
	2014	1 TS	BOO	10 years	2/2	
Treatment Technology						
600 TPD	2007	Compost/RDF	BOOT	20 years	NA	
600 TPD	2011	Gasification	BOOT	20 years	4/2	
1000 TPD[∞]	2019	any	EPC/ SC	NA	1/1	NA

Legend:

@- negotiation resulted in discounted prices from tender;
25% and 36% reduction in tender price as earlier tendering observed only 1 price bid but from technically disqualified bidder.
[&]Year of tendering is considered;
[#] is reorganized or divided into different zones. The number of zones and the jurisdiction varied over time. 4 transfer stations are upgraded in 2012 and operated for 1 year;
~ are part of West Zone.
NA –not available;
Y- shows the presence of repeated bidder;
∞ in procurement is in the pipeline

Information asymmetries

At least three instances of information asymmetry were observed in these projects mainly on the part of the public sector. Firstly, the ULB signed concession agreement, but the land was not made available to the concessionaire of SPV3-D. The dumpsite was allocated for a commercial establishment by the state government in 2015, a new site for the SPV3-D power plant is yet to be finalised. The constructed sanitary landfill site had also been allocated for that commercial project. Secondly, the local authorities had failed to perform segregation of waste at source satisfactorily. The rate of segregation of wet and dry solid waste is poor. For instance, among the 12 lakh households in the city, the extent of segregation in 2012-13 was 11.57% and it is below 40% as of 2019. Similarly, the objective of turning organic waste into manure was also not fruitful. Waste converters set up the ULB-D are working correctly at vegetable and fruit markets but the concept has not appealed to housing societies. Not even 10 per cent of the housing societies have installed waste converters despite numerous appeals by the local authorities (apart from the GRANT scheme). This point to the fact that enforcing segregation has not been successful in the city and, thus, the private party cannot be expected to collect segregated waste or treat the same.

As ULB-D or its outsourced operators carried the handling of collection and transportation, the information asymmetry that is likely to occur due to poor segregation at source has been nullified by the ULB-D while opting treatment technologies and methodology. The current contracts of treatments that are under execution were designed for unsegregated waste but can be appropriately revised in the future as collection and transportation are carried through short-term unbundled contracts. For instance, the ULB started to promote source segregation and had opted to procure an EfW project through National Thermal Power Corporation (NTPC) Limited (a government of India undertaking). An MOU has been signed with NTPC to own and operate EfW plant where the ULB-D has to supply 1000 TPD segregated inorganic waste. NTPC will bear transportation cost for carrying solid waste from DIAMOND city to plant. Thirdly, since the responsibility of landfilling lies with the ULB, the possibility of illegal and unethical dumping of unprocessed or partially processed waste in the landfill is prevented. The disposal responsibility of the rejects still lies with the ULB-D. ULB-D did not resort bundling strategy considering the sources of huge information asymmetries on both the parties. In this way, the unbundling strategy and

the royalty-based payment mechanism of the EFW project prevented the effect of the information asymmetry on the MSW activities.

Asset specificity

The ULB has successfully handled the procurement of collection and transportation-related assets and services for 12 years (2003-2015) through their in-house expertise and without deploying any external consultant. They have followed a practice of trial and error such as tendering the contracts of collection and transportation for one year initially. Based on the experience of services provided by the agents, they have strategically adopted either 5-year or 10-year contracts, depending on the conditions and suitability. Such short term contracts were mainly tried when there is a change in the contract norms from the usual. Moreover, the ULB followed their usual practices related to estimation in contracts and procurement methods, and this has caused quicker lead times and project completions. For instance, in door-to-door collection procurement of 2011, the approval of tendering committee was issued on 03/06/2011. The work order was issued on 16/06/2011 while the date of commencement of work was 30/09/2011. So the lead time was 75 days and total procurement period was six months. Also, the completion time of the transfer station was only nine months for the contract procured in 2012.

Each component of the value chain such as collection, primary transportation was monitored by low-level management of the ULB with the help of IT-enabled monitoring mechanism. For secondary transportation, a different operator looked into monitoring with the direct link to ULB-D office. Due to break in the supply chain in the operators, the ULB opined that there is an increased chance to catch mal-practices at any component. For instance, there was a double-check of the waste transfer between different operators and there was no possibility to dump the waste illegally. The IT-enabled monitoring mechanisms prevented the chances of collusion during the operations. Concerning the procurement of treatment projects, the ULB recognised that the support of external agencies as required. The existing treatment by the private operator was monitored by middle to top-level management. The disposal was again in the hands of ULB, preventing the chances of collusion or malpractices of the operators.

The ULB expressed that human asset specificity needed for a bundled project cannot be achieved for two reasons. Firstly, if a bundled project transfers the information management entirely to a private independent agency, the human asset specificity of the ULB would further decrease and lead to a detrimental situation for future MSW services from this perspective. ULB expressed that bundling is not an appropriate strategy in the current level of expertise in both the public sector and the private sector. The human asset specificity of this MSW services had been built over more than ten years, by gradually adding suitable monitoring mechanisms and partnerships, as and when required. These evidence show that the ULB exhibited a nature of using the expertise, i.e. the human asset specificity according to the complexity involved in the component. The evidence also affirms the optimisation of the human asset specificity while procuring the projects and the gradual increase of the human asset specificity of the ULB.

Transaction costs

The initial years of PPP procurement for treatment projects have seen a low internal capability in the ULB. Gradually the ULB gained expertise in handling in the collection, treatment and disposal segments. Concerning these three segments, the procurement approach of the ULB has resulted in quicker procurement times and reduced the search and bargaining costs when the services are required from the private sector. Moreover, under an innovative society GRANT scheme, ULB-D provided financial aid to society for cleanliness. The ULB-D paid 60 paise per square meter to have cleanliness activities within its premises. This about is ₹ 1200 (£ 14.28) to ₹ 4200 (£ 50) per society. For industrial setups, this is 0.65 per square meter. There were nearly 771 beneficiaries under this scheme at the expense of ₹ 1.6 crore (£ 0.19 million). Records of the ULB-D showed that it would cost ₹ 8.2 crores (£ 0.97 million) when the ULB does the same activities. This scheme resulted in a cost savings of ₹ 6.64 crores (£ 0.79 million) per month. The ULB also purchased the leftover manure. The ULB sold this manure by appropriate packing and generated additional revenues. To increase reach and spread the success, the ULB-D resolved in 2019 to increase the payment. ULB-D decided to pay at the rate of 80 paise per square meter for the residential and non-residential area and 65 paise per square meter for the industrial and industrial-cum-residential area, respectively. So, on account of maintaining cleanliness, a minimum of ₹ 1,600 (£ 19) per month is paid to each society. The ULB-

D opined that this scheme has reduced the costs by treating the waste close to the point of generation. The ULB-D does the financial management of various components. This has facilitated the ULBs to raise revenues by collection spot fines. This also had offset the costs of MSWM.

Concerning the treatment segment, the execution of SPV3-D was delayed. The concession agreement of SPV3-D stated that "*the concessionaire shall commence operations of the project within a period of 9 months from the date of signing of the land lease agreement and hand over of the possession of project site."* The concessionaire failed to establish because there was a delay in handing over the site to the concessionaire. However, the delay did not increase the ex-post transaction costs to the ULB-D. There were no recorded issues such as terminations, dispute resolution, or the interest burden for the private sector deployed assets and services. Unbundling has prevented the occurrence of opportunistic behaviour. This is because there was neither upfront grant nor financial support by ULB-D to the concessionaire. This has prevented the ex-post transaction costs to the ULB-D. This is because of the reduced complexity of each project and the amount of information and scope that needed to be handled by the concessionaire in each project. ULB-D expressed that bundling collection and transportation facilities and decentralised treatment had reduced the ex-ante transaction costs.

Uncertainty

The procurement of MSW services in DIAMOND city clearly followed sequential decision-making, specifically by adopting separate contracts in the treatment of waste. The proposed technology for the treatment segments includes composting, RDF to power, and gasification. The RDF to power and gasification technologies are yet to be proven in the Indian conditions and the ULB-D is also procuring these projects for the first time with little technical know-how. Though the ULB faced uncertainty in the treatment technologies, the effect was hedged due to the unbundled mechanism. For instance, the concession agreement of SPV3-D states that "…*ULB-D shall supply the assured waste quantity at the receipt point either by itself or through its nominated agencies at no cost to the concessionaire*." Apart from the supply of waste, there is no obligation of ULB-D in this project. This moved the technological uncertainty outside the purview of the MSW activities of ULB-D. The private sector is fully responsible for the operational failures as that would jeopardise return on private sector investment.

Given this situation, SPV2-D is operating at a near about 90% capacity i.e. every day around 300-400 TPD of waste is treated against the planned capacity of 500 TPD. On the other hand, composting had low demand uncertainty. The ULB had taken over the risk of quality and marketing of the produced compost. Besides this, the plastic waste treatment facility had been provided by a speciality contractor with backhand support by the ULB-D. This was the first ULB-D to procure plastic waste treatment project and is operational. Thus, the ULB-D had adopted strategies such as controlling the demand uncertainty, flexibility with individual treatment units, and trust of the PPP contracts as measures to reduce the uncertainty. Unbundling has facilitated the circumventing of technology uncertainty and leverage to manage the demand uncertainty.

7.4 DISCUSSION OF RESULTS AND VALIDATION OF FRAMEWORK

7.4.1 Introduction

This section deals with the discussion on the aspects that have been identified from the case study, and comparison of the findings and corroboration of the same with the extant literature. And, the validation of the bundling framework, which developed from literature review, through analysis of the six cases. Seven interviews were performed to verify the generalisability of the findings. The details of the validation interviews are shown in Table 7.4.1.

Table 7.4.1 Interviewee Details

Interviewee	Management Level	Years of PPP Experience/Project involved
Public 1	Higher	10 years (2 projects)
Public 2	Higher	8 years (3 projects)
Public 3	Middle	7 years (2 projects)
Private 1	Higher (front line employee)	13 years (6 projects)
Transaction Advisor 1	Middle	5 years (2 projects)
Transaction Advisor 2	Middle	8 years (6 projects)
Transaction Advisor 3	Senior Management	21 years (32 including non-PPP)

The interviews have captured both qualitative and quantitative data. The analysis of the quantitative information collected is presented through micro-interlocutor analysis, structured as per the constructs of the framework based on the suggestion of Onwuegbuzie et al. (2009). This analysis is shown in Table 7.4.2. Such

a method is considered to increase rigor in the qualitative research (Onwuegbuzie et al., 2009).

Table 7.4.2 Micro- interlocutor analysis of validation interviews

Sno.	Construct/Case	Public 1	Public 2	Public 3	Private 1	TA 1	TA 2	TA 3	Average
1	**Motivations for bundling or unbundling**								
	Likelihood of integration	– –	– –	– –	++	– –	–	=	–
	Available Funds	–	++	– –	+	++	+	++	=
2	**Innovation**								
	Importance of innovation	=	++	–	–	++	+	0	=
	Private sector financing innovation	–	++	0	0	++	+	+	–
	Private sector product innovation	+	+	+	++	++	+	+	+
	Private sector process innovation	–	+	+	++	++	–	++	+
	Private sector quality innovation	–	+	0	++	++	–	+	+
3	**Performance measures**								
	Meeting performance measures by private sector	0	–	– –	++	++	– –	0	–
	Innovations to meet performance measures	+	0	0	++	++	–	+	=
	Importance of MSW performance measures in comparison to other sectors	–	++	++	+	++	++	++	++
4	**Innovation Externality**								
	Private sector is able to reduce the costs by innovation within the scope of services	++	– –	–	+	– –	–	– –	=
	Private sector passes on the cost of innovation to the public sector	++	+	=	+	++	+	– –	+
5	**Maturity of Markets**								
	Private sector competency in collection	+	– –	–	0	0	++	0	–
	Private sector competency in transportation	0	+	+	0	+	++	0	=
	Private sector competency in treatment	– –	+	+	–	++	0	0	+
	Private sector competency in disposal	+	+	+	– –	++	0	0	+
	MSW sector maturity for single PPP concession	– –	–	– –	–	++	– –	0	–
6	**Economies of Scope**								

Sno.	Construct/Case	Public 1	Public 2	Public 3	Private 1	TA 1	TA 2	TA 3	Average
	Reduction of transaction costs in single contracts	+	– –	– –	+	++	– –	+	=
	Reduction of financial bid values in unbundling	0	++	++	– –	++	+	0	=
	Better quality services to public sector due to unbundling	0	++	+	– –	++	+	+	+
	Ingress of better technology based services to public sector	–	++	+	0	++	+	+	+
7	**Tendering to Subsidiaries**								
	Prevalence of subcontracting in MSW	+	+	++	++	++	0	+	+
	Increase in cost to public sector due to subcontracting	–	– –	++	–	– –	+	+	+
	New Technology as a reason for subcontracting	+	+	+	++	++	+	++	++
	Bigger size of project for private sector as a reason for subcontracting	++	+	+	++	++	–	–	+
	Lack of expertise as a reason for subcontracting	+	++	++	++	– –	+	++	+
8	**Quality Specfiability**								
	Ability to meet air quality standards in treatment and disposal	–	++	+	+	– –	+	– –	=
	Ability to meet leachate quality standards in treatment and disposal	– –	++	–	– –	– –	0	– –	–
	Ability to meet compost quality standards in treatment and disposal	+	++	0	++	+	+	0	=
	Quality specifications are followed by collection and transportation	0/+	–/+	– – /++	+	–	– –	+	–
	Quality specifications are followed by treatment and disposal	0/– –	++	+	+	– –	+	++	++
9	**Competition**								
	More than 8 bidder participation in C&T and T&D (separated)	– –	++	++	++	++	++	++	++
	More than 8 bidder participation in collection and transportation	0	+	++	++	++	+	+	+
	More than 8 bidder participation in treatment and disposal	0	++	+	– –	–	++	0	=
10	**Information Asymmetry**								

Sno.	Construct/Case	Public 1	Public 2	Public 3	Private 1	TA 1	TA 2	TA 3	Average
	Private sector hidden action causing loss of public money	0	++	++	– –	++	++	+	+
	Private sector hidden information causing loss of public money	0	++	++	– –	0	++	0	=
	Public sector hidden action causing loss of private returns	0	++	+	++	++	++	– –	+
	Public sector hidden information causing loss of private returns	++	++	++	++	++	++	– –	+
	Public sector having more bargaining power	– –	– –	– –	++	– –	– –	0	–
11	**Asset Specificity**								
	No time/cost impact if government sector to replace default firms individually in a supply chain	0	++	++	+	– –	++	–	+
	Bundled PPP projects have long and complex negotiations	+	++	++	+	++	++	++	++
	Bundled PPP projects have delay in project delivery	+	++	++	+	–	++	0	+
	Transaction Costs								
	Demands for increase in price/fee to private sector	+	++	++	++	++	++	++	++
	Distress in profit margin of private sector because of performance of technology	+	++	++	+	++	++	0	+
	Un-adoptive technologies for various quantities of waste	+	++	++	– –	++	++	+	++
	Uncertainty								
	Availability of reliable sources (of data on waste characterizations, seasonal variations, number of households, willingness to pay assessment) with public sector	0	++	–	++	++	++	–	+
	Private sector is competent to build and operate the technology.	+	++	– –	++	0	++	+	+
	Incidence of shut down of treatment plant and operational failures	+	++	–	++	+	++	+	++
	Incidence of poor collection by private player	0	+	+	0	+	++	+	=
	Incidence of poor compliance of norms set of pollution control board	+	+	+	+	+	+	++	++

Sno.	Construct/Case	Public 1	Public 2	Public 3	Private 1	TA 1	TA 2	TA 3	Average
	Uncertainty of performance of technology effecting the target cost of operations	–	0	+	++	–	0	–	=

Legend: ++ strongly agreed by the experts
+ agree
= neutral
– disagree
– – strongly disagree
0 not within the expertise of interviewee

7.4.2 Motivations for Bundling

Four reasons were found as the motivation for opting bundling scenario both in the case studies and the validation interviews.

Firstly, the lack of funds was posited as the reason for opting bundling strategy. Public representatives suggested that, since they do not have enough funds for execution, they expect that the private sector should bring all the necessary finances and execute the project on behalf of the public sector. This motive is also further strengthened by the TA who also stated that when the financial position of ULBs is weak, they are more likely to opt for bundled PPP project in MSW. Another representative from public sector opined that private finances are still a trap. This is grounded on the argument that a ULB should be still capable of repaying the private investment and asserted that only a short-sighted person would think about the temporary financial relief provided by the PPP mode in MSW projects. Moreover, PEARL project shows that finances are not the prime reason for opting bundled project. The financial position of ULB-P has been sound enough to provide the necessary funding for establishing the assets and services related to the supply chain of MSW. However, the ULB did not use the allocated funds effectively even before the adoption of PPP mode. Concerning the unbundled concession of E, the participating ULBs does not have necessary funds to finance the treatment and disposal facilities but sought to pay a tipping fee for the same with the expectation of grant from central of state government.

Also, the lack of manpower at the disposal of the ULB has played a role in the bundling decision. For instance, the ULB of Case CORAL assumed that instead of acquiring manpower, the private sector in a bundled PPP can necessarily compensate

the lack. Besides manpower, all the cases are in dire need of the treatment and disposal and thus private sector participation in these segments is considered inevitable. On the other hand, only some cases are yet to meet the necessary benchmarks in the door-to-door collection.

The third motivation reveals the ease of managing the contract with the single private operation. For instance, ULB-G intended to procure the services on the MSW supply chain from a minimum number of private entities by using well-defined objectives. This approach was perceived as a measure to avoid instances such as disputes, coordination problems, and blame passing incidents while dealing with multiple parties handling the different components of the supply chain. In contrast, it is observed from E, S, and D that interaction and coordination for collection and transportation need to be retained with the ULBs and only treatment can be optimally given to the private sector. The ULB that had adopted unbundling strategy such as E, S, and D had believed that there is a need for ULBs' control on the collection and transportation activities. Bad experience with the past private operator is suggested as one of the reasons. Therefore, NGOs are regarded as the better risk-takers of door-to-door collection. The strategy also meant a better understanding of the costs and expenses in these services. The role of NGOs also dictated in the bundling decision of S. The bundled projects seem to forgo the leverage and the contention that NGOs can play a crucial in waste collection systems particular on the objectives such as education, segregation, informal sector integration which has been a festering issue in MSWM (Besley and Ghatak, 2017; Forsyth, 2005; Kumar et al., 2017; Rajamanikam et al., 2014; Rathi, 2006). More control and quality of services by replication, co-option, and communication has steered the D (Forsyth, 2005). In this vein, there was no evidence why ULBs (such as the G, P, and C) cannot take up the responsibility of providing some services in the MSW supply chain. This is apparently affected by the lack of public sector comparator while procuring these services in India (Grimsey and Mervyn K. Lewis, 2005).

The fourth motivation was that the public sector tends to pass on the responsibility to the private sector such that the private sector can be held responsible for poor compliance. Given that MSWM is socially and politically sensitive issues, the ULB representatives perceived bundling as a safer option particularly if the instances of poor performance arise. In this regard, the private sector representative noted,

"…Private sector does well …in the sense… they do better than government but not that they are able to do 100%. Private sector is able to do 10 or 20% better than the public sector. Moreover, I tell you, only in the initial stage any private contractor is working. After some time, public sector has someone to pass the blame instead of taking responsibility. They will say…" we are following up…and by next time they will clean it up". Then the public sector will pressurize the private sector. Then they will do better. After a few days' situation is back to square one. And the cycle goes on… Nothing more than this happening in reality anywhere in India."

This study did not find evidence to assert that the ULBs can provide the MSW services at a cheaper cost. This should be interpreted in light that value for money should not be equated with lower costs. It seems that the practitioners have missed the important link between accountability and value for money (Demirag and Khadaroo, 2011). Optimal performance needs to assume account this link that personal and institutional forms of accountability would affect the decision of procurement in PPPs. One expert noted that

"Whether private sector is able to do better than the public sector in collection and transportation? Private sector does well. They do better than government but not that they are able to do 100%. Private sector is able to do 10 or 20% better than the public sector [referring to bundled projects]. Moreover, I tell you, only in the initial stage any private contractor is working. After some time, public sector has someone to pass the blame instead of taking responsibility. They will say…" we are following up…and by next time they [private sector] will clean it up". Then the public sector will pressurize the private sector. Then they [private sector] will do better. Nothing more than this happening in reality."

This shows the importance of coordination and also the lack of continued performance measures.

It is essential to classify the suitability of a bundled or unbundled contract based on the financial and available manpower situations in a particular city where MSW services are sought from PSP. Private sector respondent mooted that they are capable of executing bundling project and, in only in such cases, they can earn good profits.

Nevertheless, this study and interviewees' did not provide justified reasons for the possibility of a reduction in transaction costs. This might indicate that it is a mere assertion. Nonetheless, the respondents of the private sector, the public sector and the transaction advisory agreed that bundling of MSW supply chain is unlikely in the current scenario. One expert noted that "*Ideally, bundling mode is the best but given the current circumstances it is not practical*."

7.4.3 Innovation

Innovation is perceived to be very much critical in the MSW sector. The findings of the case study showed that unbundled cases have witness process innovations related to collection and transportation. ULBs achieved these innovations in addition to the typical responsibility of specifying the routes and the frequency of the collection and transportation. Some of the innovations are concerned with the reduction of waste and reducing the cost of treatment. This is particularly seen in unbundled projects but not in bundled projects. The innovations performed by the ULBs of D, G, and S are not achievable by the private sector due to lack of legitimate power (Clegg and Haugaard, 2009). This is because "governments are most influential in bridging communication and resolution efforts" (Walters, 2016: 10). Nevertheless, most of the ULBs had adopted various IEC activities subsequently to enhance the collection, especially the source segregated waste but with abysmal results (for instance P and D). Though not to the extent of 100%, these ULBs have shown better control of motivating the waste generators.

Concerning treatment, on one hand, innovation is predominantly looked for in the technological solution with which the waste can be treated (observed in all the cases). In contrast, the treatment projects employing other than the conventional technologies are subjected to huge financial and operational risks. Given the high failure rate in the past energy from waste projects through various technologies, the lenders would find risky to fund the projects. Technology neutral bidding process did not yield expected benefit to the projects irrespective of bundling and unbundling strategy. Nevertheless, few EfW projects structured on a royalty basis as opposed to the typical tipping fee model provide a hint for the procurement of future projects. When the treatment projects are separately procured, the unit price of electricity

supplied to the grid becomes the bidding parameter. Many recent projects in Nagpur, Patna, and a few cities in the state of Andhra Pradesh are structured in this manner.

Performance measures

Performance measure required for life cycle integration is found to be weak in this MSW sector. Bundled projects do not provide the incentive to the private sector to promote lifecycle innovation particularly to reduce the costs or increase the efficiency. Comparison of bundled and unbundled projects clearly showed this contrast. Each component of the supply chain have individual performance measures and are often governed by the MSW rules 2000/2016 and the emission standards of the pollution control board. The ULBs such as D focused on the performance measures for each component, recognising that micro-level performance measurement is more important in the MSW sector. The concession agreement of E documented efficient performance measures relevant to the treatment and disposal components. The performance measures were specified instead of expecting innovations from obscure clauses. In contrast, though the concession agreements of bundled projects such as C, G, and P provided flexibility for adopting any kind of innovative measures, the performance of the concessionaire suggests the failure in meeting the basic performance measures. This is far from being innovative to surpass the standards. Moreover, the public sector entities of S, E, and D in their experience did not find that unbundling is detrimental to innovation. This view is supported in the validation interviews.

The private sector has often provided poor and mediocre services. The observed penalty clauses in the concession agreements also did not support the objective of achieving the life cycle innovation to enhance or performance or reduce the costs of operations. The perception of the public sector on the performance of the private sector is consistently poor across the cases. Very often, the lack of continuous monitoring mechanisms and excessive dependence on the project management consultants had resulted in the poor services and hidden actions by the private sector. This is sharply pointed out by the public sector interviewees. This is also verified strongly from the audit of the performance of the case study projects irrespective of whether they are bundled or unbundled. Though the public sector acknowledged that the private sector is able to provide services, the level is not to the expectation. Output-based contracts are not effective because there is no proper monitoring system that is tamper-proof. This requires measuring through IT-enabled mechanisms for monitoring purposes.

MoUD (2009) clearly notes that there is a lack of reliable and updated performance information with respect to services such as MSW (MoUD, 2010). Hence, the public sector and the transaction advisory strongly advocated that IT-enabled performance monitoring mechanism can only be the solution for better MSW services across the supply chain. Additionally, when every component of the supply is monitored through IT-enabled mechanisms, the payment mechanism and the procurement can support the bundled projects. However, unbundled projects have better verification mechanism due to change of responsibility and independent payment mechanisms. This reduces the possibility of 'cutting corners' in the provision of services. MSW supply chain demands for measures that can have multiple checks of verification if it has to delegate to the private sector and connect to payment. In this vein, bundling is a needless strategy since there is evidence to conclude that performance measures that can promote lifecycle innovation to enhance operational productivity or reduce the costs are absent.

Innovation externality

Innovation is perceived in terms of bringing a technology suitable for the treatment of waste and other secondary mechanisms such as GPS enabled monitoring of waste transportation. These are observed in the case study projects and exhibit effects of a negative externality. These mechanisms are mandated in the contract documents of E and D. Thus, unbundling has allowed the private sector of D to internalise the negative externality and to quote their bids accordingly. In contrast, some innovations that are observed in the bundled concessions (C, G, and E) had increased the project cost. ULBs recognised that there is a need to design the collection component for segregated waste and achieve 100% door-to-door collection. For this, typically ULBs specify that their vehicles should be linked with GPS tracking and other possibilities such as which waste bins are collected and which waste bins are not collected. Nevertheless, the private sector considers these options with negative externality because there is no operational saving for the private sector but rather it increases the strictness of monitoring by the public sector. Public sector asserts that the private sector is not very prompt currently to bring in such a monitoring mechanism on them and hence they tend to avoid doing such mechanisms if left to their choice. The respondents also reported this need for monitoring mechanism in the treatment process.

The private sector is not very keen to set up treatment-related sensors which will facilitate the monitoring of the gases that are emitted from the EfW plants. Very

often they are either not installed or left defunct. In fact, the EfW projects can have such a monitoring mechanism designed by the technology providers. But the currently operational plants show that they are not functioning to meet the purpose. For instance, ISWM Jabalpur has SOx and NOx monitoring sensors need to be available online and linked with the SPCB. But verification of the data revealed that their sensors are not reporting any data on the compliance standards with respect to the emissions of SOx and NOx. This problem is relevant to both the bundled and unbundled procurements. In this regard, the transaction advisor said that

> *"...no private sector will make promises to check them on IT-enabled mechanisms. It is the public sector or their advisors that need to stress on it. But remember these investments will be at the cost of the public sector expenditure. We have no choice but to bear the costs either directly or indirectly."*

Moreover, the garbage collection and management system needs to ensure optimal collection, transportation, and processing and disposal of waste to have precise control on the mass balance and understand where the waste is going. However, these interventions require heavy costs. For instance, in Jabalpur, vehicle tracking and monitoring system (VTMS) for coordinating the MSW vehicles costs ₹ 13.76 crore (£ 1.63 million) (2017 prices) while door-to-door collection, tracking and monitoring of waste through RFID tags on household garbage bins requires ₹ 169.57 crore (£ 20.18 million). Though these initiatives are innovative, they are quite negative in their externalities as it does not offer any cost-saving unlike in the case of positive externalities. The ULBs which have meagre funds would find it difficult to adopt innovations in collection and transportation due to its nature of negative externality. For instance, around ₹ 80 lakhs (£ 95,238) is required to incorporate smart mechanisms for the collection and transportation segments that are carried by in-house and outsourced workers in S. A similar theoretical prediction is made for road and hospital PPP projects by Garvin (2009: 4) as

> *"...investment in technology can reduce labour requirements such as automated tolling which eliminates the need for toll collectors. Innovations may also be associated with increased costs, which they term a negative externality. For example, investments in technology can improve service quality but can increase operating and maintenance costs such as improved*

HVAC and lighting systems in a hospital that lead to better clinical service but are more costly to operate and maintain. The former innovation is likely associated with bundling since the positive externality is internalized whereas the latter innovation may be more likely in unbundling."

On the whole, the predictions of Hart (2003) that a lack of positive externality should support the unbundling strategy is verified in these bundled and unbundled concessions.

7.4.4 Maturity of Markets

The maturity of markets is often talked in the context of the ability of the players available in the market to provide the services effectively (Henjewele et al., 2014; Zhang and Chen, 2013). Due to lack of maturity in the market to handle projects in bundled mode, the level of competition was deficient in G, P, and C and this had adversely affected the initiatives by the private sector for bringing in innovation and provided an opportunity for the private sector to engage in opportunistic behaviour. It is also part of the 'adverse selection' problem in principal-agent theory. Usually, bidder pre-qualification is used to avoid this. However, Unbundling would have increased the competition in the procurement stage. The ULBs such as C, G, and P failed to account the maturity of the market that has resulted in selecting bidders who are less competent relating to the collection supply chain of the MSW. There is a dearth of competent bidders who have successfully handled the MSW projects in PPP mode. Such restriction on the bidder participation will lead to suboptimal results and can endanger the long run results of the PPP program (Hueskes et al., 2019). More often, this failure is observed in the projects that are procured in bundled mode. For instance, the winning bidder has faced criticism in collection and transportation service quality in a neighbouring project of the EMERALD. Also, one of the bidders for collection activities in ULB-D was a poor performer in a bundled project (GAMET). This company has participated in tendering for three zones to secure door-to-door collection in 2014. However, the tender scrutiny committee made remarks as " *...[the bidder is] qualified for three zones, however, as their performance in other cities is not up to the mark, the committee decided not to open their technical bid and price bid."* This casts doubt on their ability to perform and shows that unbundling has allowed getting more serious and competent players. More number of bidders could have participated in the

bidding process had it been procured in unbundled manner. This is also true for subsequent procurements which are again procured in bundling mode as in the case of C. The findings also confirm the assertion of Carbonara and Pellegrino (2019) that market is vital in determining and using PPPs and is strongly needed to achieve innovations. For collection and transportation, outsourcing contractors and NGOs are available to choose the type of services as required by the ULB (for instance in G, S, D).

The private sector in itself cannot be considered as an effective and competent player to carry out the collection and transportation services. The IEC activities are very much needed for stimulating the behavioural change in the generators of waste. It is further observed that, in case of Delhi, the programs that aim to motivate the public in collection and segregation are successful as long as there is an NGO that is actively involved through campaigns and drives specifically in the high and middle-income dwelling places (Talyan et al., 2008). These drivers are found to be missing in the bundled projects. Additional responsibilities such as the collection of user charges by the public sector often face stiff resistance from the waste generators. Instead, a better alternative is to let the ULB or its authorised agent for collecting the user charges. Similar practices have started in many cities of India where the ULB has authorised private agencies to collect various taxes on its behalf. The primary collection agents can recover MSW user charges and this is suggested to give better results over time than allocating it to the bundled contractor. Repeated successful bidders in the collection and transportation segment in D suggest that the likelihood of future work from a source (ULB in this case) is an indication that goals, expectations, norms and power are systematically converted into successful influence attempts by the successful bidder (Bresnen, 1991).

The price of diesel is found to be an important variable affecting costs related to transportation of the waste. This component has a different cost structure. These services can be provided by a local non-specialist contractor or through contractor specialising the transportation fleet management. A similar situation is seen in the case DIAMOND. For treatment, the current market and technologies to treat waste are emerging in India. The treatment component has seen poor competition which is again a reflection of poor maturity of the market. Indian companies that are active in MSW treatment projects typically have MOUs to foreign technology providers. For instance,

M/S Zosen Hitachi has provided mass incineration to the Indian companies which are currently operational in India. Three major firms of India have MOU with this technology provider. Unbundling has empowered to get private players with relatively better technical expertise and capability. This also enabled the availability of competent bidders in the market. In view of these reasons, the experts opined that the current market is not yet mature to handle the bundled MSW.

One expert opined that

"...PPP mode, people come say that this (assets of technology) will come that will come and that is how they will show. Then, they will show to bank that in 20 years we will earn this much and we will make this much payment to you. They will put money based on asset value. After taking the project, they will say, the project has gone to loss and what I should do. They will file the tax showing the loss. If there is a loss, what bank can do? Things are happening like this only. Only the bank loses the money. Company may not make any loss."

This reflects the situation of many MSW PPP projects across the country. Moreover, such defunct projects which are classified as non-performing assets become a liability to the Central and state governments. The non-performing assets in India rose to ₹ 9,179 crore (£ 0.19 billion) at 16.31%, till Dec 2018. This has been causing banks to take a conservative stand on financing infrastructure projects and they are reluctant to advance project loans that have long-gestation periods. Also, loan restructuring schemes are scrapped recently by the Reserve Bank of India. The findings challenge the typical norm to involve private section in all tasks and phases, which is reported concerning the US (Garvin, 2010). Hence, ULBs should consider bundling only when they find enough number of competent and sufficient number of bidders during pre-market and market feasibility studies.

7.4.5 Quality Specifiability

The components of MSW supply chain would follow asset specifications corresponding to the type of assets required except treatment component that has service specifications of performance. The ULBs followed the conventional asset specifications and inputs specification for the collection and transportation activities in the projects of E, S, D, P, C, and G. Nevertheless, they were found to be unsuccessful

in imposing segregation on the waste generators. The assets specifications used in the collection and transportation activities are marked with low chances of innovations. This is in line with the previous suggestion by Kumaraswamy and Zhang (2001) and Dulaimi et al. (2010) that PPP projects must make full use of private-sector technologies and managerial skills for innovations and improved efficiencies. For the waste treatment of E, D, and post unbundling in G, quality specifications are specified, leaving enough room for the concessionaire to choose the technology and methodology suitable to the mixed waste characteristics. This indicates dissonance in the ability to specify the terms in a bundled contract.

Specification on quality is found to be tedious, difficult to specify and to quantify. The current nature of quality specifications is very subjective as in case of PEARL. This brings less objectivity in decision making. In comparison to other sectors of Infrastructure, for instance, road projects quality specification is clearly user-oriented and specification oriented. Service specifications are highly quantifiable, for instance, pothole maximum depth is up to 75 mm should not be more than 2 numbers, the maximum permissible limit of roughness is 3000/km, deflection can be up to 0.80 mm (Boeing and Kalidindi, 2006). This nature is missing in the MSW activities when considered in a bundled manner due to the non-verifiability of the performance, quality shading, cost-cutting measures on day-to-day basis such as adding boulder instead of waste, missing to collect the waste from some pockets, not rectifying in defunct assets related to treatment, and the subjectivity in assessing the performance as opposed to objective data. For road projects, the life-cycle approach induced by the PPP contracts is a leading factor behind the relatively high quality as well as the higher construction costs for PPPs (Singh, 2019). There is a desirable absence of quality-shading/cost-cutting incentives under the road PPP contracts (Singh, 2019).

When the ULB is not equipped towards this competency (as observed in the cases of PEARL, contractual hazards such as poor understanding to identify and differentiate innovation type of investments and quality shading kind of investments by the public sector tend to occur (Hart, 2003). Moreover, when the public sector is unable to verify the costs of doing the operations, the proposition that concessionaire would bring value for public money becomes dubious (Hart, 2003). Similarly, contracting on building is easier than on service for sectors having subjective contractual operations such as prisons, schools and hospitals (Hart, 2003; Roehrich et al., 2014). By this

rationale, it is can be safely inferred that components such as collection, transportation and disposal of the supply chain of MSW would fall into the category of ease in the quality of building instead of the quality of service (Hart, 2003). In the current context, unbundling supports this rationale more strongly than a bundled scenario.

7.4.6 Economies of Scope

According to the extant literature, diseconomies of scope is expected to occur in three situations. First, if the cost of bundling project does not get reduced; second, if private sector ability is diverse among various components of supply chain but not on all the components of supply chain particularly when there is no cost advantage for a firm in adopting bundling approach; and third, presence of information asymmetry among the members of consortium in joint ventures.

The diversities of competencies prevented the economies of scope in D and C. Interviewees noted that achieving the economies of scope is possible through integration. Public sector respondent noted,

> *"...If the same contractor has been given the work of both the components, then if in one component, he makes loss, there is a possibility of earning profits in other components."*

They also ground this proposition on the existence of competent of private players to handle all the supply chain very effectively. The private sector stated that

> *"...When collection is given in separate contracts, the contractor will focus on tonnage and he will look only on the profit part or he may divert and does not handover properly to the treatment operator. If there is delay or problem in collection and transportation, if the waste is not delivered on time to the treatment operator, it will a problem to the operator. From all the transfer stations, the waste should come without any delay to the treatment plant. There are 2 or 3 intermediate stops for the waste and there will not be much space for the transfer station to store the waste ...thus transfer of waste without any delay is essential."*

This suggests that bundling assumes to facilitate the uninterrupted flow of waste across the supply chain. However, the case study data reveal that private sector participants were not able to achieve such theoretically promised levels, making those

private contractors no better in the bundled scenario. This treatment component, moreover, qualifies to be called as 'troublesome activities' (Teo and Bridge, 2017). Such activities which are provided by thin markets, proprietary in nature, and costly to imitate would cause diseconomies of scope. This is verified from all the cases. The consequence is that they tend to increase the overall bid price (Teo and Bridge, 2017). Overshoot in cost of operations in the treatment component suggests that it cannot contribute to the economies of scope in MSW supply chain and should be separated.

On the other hand, unbundling would reduce financial bids and companies. This is because companies would apportion less risk to the low-risk components such as collection and transportation instead of the apportioning risk overhead on the overall project bid value. Similar observation was made in the extant literature (Laryea and Hughes, 2008). The experts also mooted that the need for good quality of services dominated the economies of scope. One expert said,

> *"…if you give me two situations that have an equal level of services, then I would rather think of which is economical. But we cannot compromise the level of services with economies of scope as reason and imagining that services will still be very good."*

This is particularly true in large cities. One expert noted "…*An 80 km hauling expense is one factor which we wanted to reduce by opting it as a decentralized plant*." Moreover, when the treatment and disposal are separated from the collection and transportation, the private sector can exclusively focus on the technology in the given conditions and the cost of the technology to suit the purposes. This is suggested as a measure to reveal the real prices of the services instead of adding to fuzziness to cost structure due to bundling. The findings from Case CORAL are in agreement with the theoretical prediction that the probability of buying-in specialized inputs is low if the production technology is very specific, and there are no economies of scale or scope (Lyons, 1995).

The assertion of revealing the cost structure due to unbundling is more strengthened when the functioning EfW plants of India are considered. As per the data available till December 2018, only 5 EfW plants, which have been commissioned, are in a trial run in India whereas the rest of the plants are either under construction or terminated/defunct. The details of those projects are shown in Table 7.4.3. Majority of

the plants have opted for treatment technologies to handle mixed waste and this assumption has proved to work out well.

Table 7.4.3 EFW projects in operations/trial in India

S. No.	Plant Commissioned/Under trial	Installed Capacity (MW)	Average quantity of MSW utilized / processed (Tons/day)	Levilized Tariff	Procurement Strategy
1.	M/s Ramky Group at Narela-Bawana, New Delhi	24.0	756	7.03	Unbundling
2.	M/s Jindal Urban Infrastructure Pvt Ltd. at Okhla ,New Delhi	16.0	1,818	2.833	Unbundling
3.	M/s IL&FS Environment Infrastructure and Services Ltd. at Ghazipur, New Delhi	12.0	502	3.667	Unbundling
4.	M/s Essel Infra at Jabalpur , Madhya Pradesh	11.4	1140		Mixed bundling
5.	M/s Solapur Bio-energy Systems Pvt. Ltd at Solapur , Maharashtra	3.0	300	4.88	Unbundling
	Total	66.4	4516		

Source: adopted with modification from (MNRE, 2017)

Other EFW projects that assumed segregated waste have failed due to technology unsuitability or the costs becoming higher. The failure after segregation at the plant is due to the low calorific value of the waste and has necessitated the usage of auxiliary fuel. Moreover, these projects are provided with upfront support due to the dire need for technological options. Experts agree that unbundling strategy could reduce the upfront grant requirements in these projects.

7.4.7 Tendering to Subsidiaries

Bundled concessions had necessary evidence of subcontracting and interviewees' agreed that this is prevailing in most of the cases. In contrast, there is no evidence of tendering to subsidiaries. Rather, the unbundled concessions had joint ventures with foreign technology providers for the treatment components. Since speciality firms were employed in an unbundled manner in D, there was no evidence for subletting of works to subcontractors. This has eventually led to high competition in the procurement of the component except for treatment.

However, a few instances of tendering to subsidiaries are observed in bundled concessions. This is because of the output heterogeneity, use of intangible assets and capabilities (González Díaz et al., 2000). Among the various reasons for opting to subcontract, securing access to specialised services seem to be more prominent in the MSW treatment component (Choudhry et al., 2012). Each component of the MSW supply chain has a different output. For collection component, extant literature also stresses the need to incorporate informal waste collection systems. This turns out to be equivalent of subsidiary tendering particularly in MSW sector and begs the same attention. The responsibility of the collection has been carried by NGOs widely across the country for more than 2 decades and has delivered the services at a lower price. The experts note that there is a possibility of increase in overall costs to the public sector on account of bundling and the subsequent subcontracting to NGOs. They also attributed the lack of cost minimisation due to the nature of services. One TA noted,

> *"…not every component in MSW services can be cost-optimized. When you have to provide collection and transportation services, how can you reduce the cost unless you pay less to the workers, you cut corners and avoid doing the services better. The kind of expenses are very clear, and they require management of resources both the human resources and machinery well. The price of diesel accounts to a very significant amount and how on earth will the private sector reduce those costs? I think this is typical in operational intensive infrastructure services and hence the price is best achieved when we separate the components as per their operational styles."*

Moreover, the experts opined that bigger contract size is one reason why private sector opts for subcontracting. This is particularly true for the collection component when a whole city is delegated to the private sector. The private sector aims to achieve maximum profits when they are delegated with maximum responsibility and its associated tipping fee. This typically motivates few private sectors to attempt projects for bigger scale. Thus, bundling is a more appropriate strategy given the tendency to subcontract the services to either local contractors or NGOs.

7.4.8 Competition

This study confirms some hypotheses laid out in the past studies and adds new hypothesis for future testing. For instance, Teo and Bridge (2017) hypothesised that 5-8 bidders are optimum and this explains the failure and poor value for money in some of the case study projects. Thus, *Poor competition may suggest that components should be unbundled.* There is necessary evidence from case studies to assert that bundling would decrease the number of bidders in the procurement process, though imperfect competition prevails in the treatment component even in case of unbundled mode. This study identifies the link between the limited competition due to the low number of contractors (Roehrich and Caldwell, 2012) to the phenomenon of bundling in the MSW sector. PPP projects would see a decline in the number of potential bidders participating in bidding when the projects are procured in bundled mode (Grimsey and Lewis, 2009). As the level of competition reduces, negative results of poor competition would be manifested resulting in lowering of value for money due to poor efficiency in construction and operation. The drastic reduction of firms submitting their technical and financial bids indicate poor competition in the market. The bidders also fall short of showing 'eligible project' concerned with the record of 'successfully' operating for a continuous period of 3 years till the bidding period. One expert notes,

> *"In MSW, there are instances of players defaulting in ensuring sustained operations – hence there should checks and measures to ensure the efficacy of private firm into the qualification criteria".*

The present study findings counter the findings of Teo and Bridge (2017) who stated that EOI would give a clear picture of the competition prevailing for a given project. It may be safe to conclude that EOI may work for sectors which have exhibited maturity or has demonstrated successful project execution in the past. But, EOI cannot be construed as a representation of the competition in case of emerging sectors and emerging nations in which PPP is in a nascent stage. The average level of competition in the projects with the full supply chain is comparatively less than the competition in the projects where only a part of the value chain is delegated to the private sector. Unbundling reduces the risks faced by private contractors (in particular, the financial guarantees of the contractor are lower when the project is unbundled) so that more agents, particularly local companies (with sufficient technological know-how but

insufficient financial capability), will be able to bid for the project. This increases competition on bids.

Moreover, though all the treatment technologies are being imported, international bidders were not directly winning the bids. The government is apprehensive about the suitability of these technologies in the Indian context, considering the different physical and chemical characteristics of the MSW being generated by the Indian cities. As a result, private participants need to demonstrate the suitability of these technologies for local conditions. Comparatively, this is not a predominant factor in international bidding of other sectors such as airports and roads. Some bidders did not participate in the bidding exercise to win the project's bid. One respondent stated that

> *"...it seems some bidders did not take seriously. They just sent some information. Later, a few of these companies asked for another chance. The tendering committee did not agree on it."*

Some companies even failed to furnish details about the projects that they claimed to implement. Such practices were observed in P and E which were high-valued contracts.

As a countermeasure, interviewed experts while acknowledging the poor competition and prevalence of a few private companies, suggest that unbundling collection and transportation will facilitate more bidder participation. Treatment projects need to be considered as independent projects. These measures would let the competition to match with the competition needed in typical infrastructure projects where the participation of at least 5 – 8 technically qualified bidders in the financial stage are regarded as good competition (Harada, 2015). Fuentes-Bracamontes (2016) observed that unbundling the value chain is an age-old proposition. This happened in the 1990s and is governed by the logic that components in the value chain should be separated to allow greater market participation. It is further noted that fragmentation of the value chain would increase transaction costs but private participation and competition would make these activities more efficient and offset additional costs. On the other hand, it is assumed that vertically integrated utilities exist to reduce transaction costs. Some of the motivations of the power sector reform in Africa are introducing competition, i.e. increase participation of more number of players in the market were

to ensure the increased quality of service as well as lower tariffs (UNIDO, 2015). The lack of competition has been asserted as a representation of high-cost solutions to the crippled power sector. Therefore, *when competitive bidders are more, then bundling is the preferred route.*

PPP model in itself cannot be construed as pro-competition but requires stringent and careful actions to achieve the best interests in this procurement. Though competitive dialogue may enhance the value and reduce the time of procurement, however, the existing low level of competition and dialogue being limited to only the L1 (lowest) bidder by the Indian procurement guidelines could become a detrimental factor for making progress in the procurement of PPP projects in MSW sector. OECD (2010) in the context of waste management noted that

> *"Municipalities can also decide to what extent household and commercial waste are sorted at collection points. Municipalities' decisions regarding waste management can have a dramatic effect on how much competition there will be in the market."*

Unbundled projects have seen such a competition in collection and transportation components. There is agreement among the respondents that many players are available for collection and transportation and that bundling is preventing such players to participate in the bidding process. Nevertheless, experts opined that treatment component specifically EfW projects will continue to face less competition, given very few successfully commissioned projects India. On the other hand, since the establishment of the sanitary landfill does not have any scope of innovation but to follow the standard design suggested by the MSW Rules 2016, item rate/EPC contracts and service contracts will also fit for the purpose of establishing the sanitary landfills.

The MSW sector must welcome initiatives such as annual pre-qualification of applicants and e-tendering through a central level nodal agency. Annual pre-qualification is a process adopted by National Highways Authority of India (NHAI) in around 2012. Earlier, developers were asked to submit applications for qualification for each and every project. This not only made the process repetitive and redundant but also resulted in a lot of time being consumed in this task. NHAI, with the advent of a request for annual qualification (RFAQ) process, has released a list of developers who have been adjudged as qualified for the year with the cost of projects for which they

can submit bids. This has reduced a lot of paperwork without compromising the transparency of the bidding process, thereby significantly reducing the transaction costs. Competition Commission of India (CCI, 2019) notes that e-procurement has indeed increased the participation of bidders in the bidding process. National Prequalification System (NPS) for civil (road & bridge) of Australia is also another international best practice for enhancing competent private sector participation. Similar measures will enhance the understanding of market concentration and the availability of competent bidders for MSW sector. This also facilitates the identification of poor performers.

More information has the potential to cause more competition in the bidding process. Due to the lack of maturity in the market to handle projects in bundled mode, the level of competition is very low. This will have an adverse impact on initiatives by the private sector for bringing in innovation and may incite opportunistic behaviour.

7.4.9 Information Asymmetries

Though the unbundled projects such as E, D, and S had seen a few instances of information asymmetries, there is no chance of opportunistic behaviour in the private sector. The few sources of information asymmetry occurred in one of the components could not affect the operations of the rest of the components. In contrast, information asymmetry in G, P and C has caused agency cost to the public sector.

Unbundling is suggested as a measure to reduce the information asymmetry between the public sector and the private sector. In MSW projects, hidden actions and hidden information are observed on both public sector and private sector. Some of the hidden actions of the public sector are non-compliance of the concession agreement in the supply of waste specifically when the wards are split and jurisdictions are changed to another functional ULBs (as in the case of SAPPHIRE). Due to the high importance of the MSW services, the public often ends up with less bargaining power during the post-award negotiations, while termination of the projects is often the last resort of public sector when the services are often not provided. Moreover, when the contracts are framed, the ULB typically assures minimum waste both in unbundled and bundled projects. When external productivity shocks are caused, for instance, a high court intervention or any decision to establish a decentralised treatment plant (for instance, a state PCB ordered that every ULB should go for decentralised waste treatment), the

private sector suffers a loss. Additionally, the non-availability of land and delayed clearances of the public sector are some other reasons that cause the loss of revenue to the private sector. Interview data suggest that both private sector and public sector are criticised of hiding information and doing hidden actions. Normally the hold-up problem is viewed from the economic agent's side (i.e. the private party in a PPP) where the principal (public party) makes a costly or sunk investment and the agent takes advantage of it to increase costs by hiding his or her knowledge. The hold-up from the principal's side is unusual but not rare. Forsythe et al. (2015) reported a case where the public organisation used their superior technical knowledge gained from successful BIM model implementation for their own opportunistic advantage.

The public sector, on the other hand, suffers some loss of money on account of the hidden actions of the private sector such as the amount of waste collected and transported on which the payments are made. In this vein, the public sector has strongly asserted that the private sector has been many times caught on account of unethical violations of waste treatment. The lack of understanding about procurement of the project in bundled mode caused information asymmetry between parties as the ULBs were not able to formulate and share the necessary information. Because of this, necessary contractual safeguards to prevent the private party from engaging in malpractices and opportunistic behaviours to protect the public-sector interests could not be included in the concession design. The current ULBs such as D did not resort bundling strategy considering the sources of huge information asymmetries on both the parties. This verified that only a matured industry is argued to reduce the information asymmetry (Forsythe et al., 2015) justifying the choice of unbundling strategy. The reason being that complexity, size, and a number of tasks to be performed in these projects increase the likelihood of adverse selection.

In the unbundled projects, a new way of procuring treatment projects to reduce the information asymmetry is by using the unit price of power as bid selection parameter for both greenfield and brownfield projects. For instance, in the competitive bidding process, Jindal Urban Infrastructure Limited (JUIL) was selected as the successful bidder and took over a brownfield project named Timarpur Okhla Waste Management Company Limited (TOWMCL). JUIL has quoted the first year tariff of ₹ 2.49 (£ 0.028) and levellised tariff of ₹ 2.833 (£ 0.032) to undertake and implement the project of converting municipal waste to generate 16 MW of power. Similarly, EfW

projects in the state of Andhra Pradesh are procured using levellised tariff as unit price. Such practices may prevent delays in establishing treatment projects. Given the low human asset specificity of the ULBs, these measures would promote ease of procurement.

7.4.10 **Asset Specificity**

The MSW supply chain has observed different human asset specificity requirements. Collection and transportation components have low human asset specificity. The experts opined that collection and transportation components are an easily replaceable contract in case of breach of contracts and virtually it will not prevent the overall collapse of the contract if procured in unbundled mode. This also indicates that these two have low specificity of the provided assets as well. The collection and transportation components require more interpersonal relational mechanisms that are more incremental in results but fragile. This is best spearheaded by the NGOs and contractors that work closely with NGOs for stimulating the behavioural changes as noted in Delhi MSW activities.

Concerning the treatment, the ULBs had no choice but to consider the imported technologies on account of the huge amount of waste generated daily and there are no suitable indigenous treatment technologies that are capable to handle such amount of waste. When the project involves imported technologies, high asset specificity is expected from the ULBs. For instance, public agencies as observed in G, P, and C do not have the competency to procure project in bundled mode and this restricted their capability to structure the project appropriately.

The public sector suffers an attack of losing its competency over a period of time due to privatisation. In contrast to this theoretical proposition, this study finds that there is a need to balance various procurement strategies. The treatment projects can have contractual mechanisms with fewer degrees of freedom throughout the life cycle (Zheng et al., 2008). However, experts opined that a defunct EfW plant will find less number of interested parties and suffer very less valuation if the previous concessionaire could not commission it successfully. Such projects also tend to be seen more critically by the lenders, given the past failures and they typically need funds for revamping all the assets related to the newly proposed technology.

Nevertheless, the long and complex studies are necessarily increasing the human asset specificity of the bundled projects. These projects also tend to have delays, longer lead times of procurement, and the public sector will have difficulty in managing them. Such projects are completely dependent on the services of transaction advisory. Even after such support, the ex-post verifiability of the public sector is very weak and still need to depend on the external agencies. Since these external agencies have limited life span or governed by the short term contracts (Mahalingam et al., 2011), negligence and collusion kind of behaviour would increase the transaction cost of the service provision. This results in the loss of public money. Concerning the human asset specificity of the public sector, it was also noted that PPP is more misused than appropriately used by the public sector. This is due to consistent over-transfer of the responsibilities of the assets and services to the private sector. One expert noted that

> *"...Unfortunately, though the guidelines in the Notification of MSW rule 2000 is available but hardly any civic body, without any exception, had taken any steps to develop ideal landfill site. There appears gross ignorance, apathy with the civic bodies and therefore, the solution always remains an illusion."*

This points to the fact that some essential and core services need to the implemented or closely monitored by the public sector alone. A similar finding is noted in the case of hospital projects (Roehrich and Caldwell, 2012). In such cases, less complex contracts will facilitate conformance to the basic design, time-saving, less demanding documentation, opportunity to benefit from the contractor's expertise in constructability, and reduction of cost overrun problems (Chan, 2000).

There is reasonable evidence that ULBs prevented excess transaction costs due to the unbundling strategy and thus unbundling supports to economise the transaction costs. The public agency tends to have immense experience and competence to handle the various components in unbundled mode (observed post unbundling in G and D). The ULBs need to show an increased level of involvement as opposed to risk-averse behaviour as some of the ULBs (G, C, and P). Additional support has been lent to conduct the operations effectively to the various PPP contractors. This is along with the obligations laid in the contracts. This had built mutual trust between the ULBs and the agents. This had enabled them to bring a high level of competition in the procurement of the components through the restructuring of the project scope, and proper

specifications of the project outputs/services. In contrast, the public entities could put to use the skillsets acquired from managing the components across various wards, thereby playing an essential role in lowering the asset specificity and in economising the transaction costs. This is observed post unbundling in G, D, and S. Thus, the human asset specificity needs to be built over time as exhibited by D in order to sustain bundled operations in MSW sector. Bundling requires a high level of human asset specificity but the current level of competency of the ULBs is not according to the requirement.

7.4.11 Transaction Costs

Theory suggests that when there are low internal capability and high transaction costs possibility, unbundling is a better governance strategy to procure partnerships for the services. Bundling has caused an increase in ex-post and ex-ante transaction costs on the public sector caused by extensive studies due to the complexity, delays in providing services and due to litigations and disputes between the parties. Opportunism is also observed on both parties' i.e. public sector and the private sector. In the bundled projects, the demands for an increase in the price of the tipping fee or the opportunistic behaviour on the revenues are more observed than in the case of unbundling projects. This can be attributed to 'social opportunism' where the public sector cannot risk the interruption of the important social services such as MSW. Bundled projects are also more prone to the profit margin distresses. This is also attributed to the winner curse in some cases. Moreover, if there is any mismatch in the field data from the theoretical assumption proposed technology of the winning bidder, the technology is likely to fail and increase the overall transaction cost to the public sector. More often, the large scale imported treatment technologies are more rigid on the operating conditions. This is due to the optimism bias of the technology proponents to capture the bundled project. One private-sector honestly said

> *"…10 years back no one knows about MSW as an important sector. The machinery that is brought here is all imported machinery which they themselves does not have enough knowledge. This particular technology is first in the country for our company also…I do not know about other companies. The projects that our company has been dealing with different technologies in different places."*

Ex-ante transaction costs and ex-post transaction costs arise due to market failures or aborting the contract before operations and disputes (Teo and Bridge, 2017). More often than not, the existing service provisions in collection and transportation can interfere with a bundled project procurement as witnessed in P. Friction between the public sector and the private sector could cause additional transaction costs due to this interference. The rise in transaction costs could also be prevented if the ULBs had considered a gradual transition instead of a sudden decision to procure the service through a single private contractor. This was particularly observed in P. Additionally, unbundled procurement by giving due attention to waste characteristics as in case of DIAMOND would facilitate better technology procurement than the cases of bundled projects. In the typical procurement, the focus of the procuring authorities is only towards the treatment technology instead of assessing the success rate of the components such as the collection of segregated waste preceding the treatment. This is observed in case CORAL where the private sector failed to maintain a segregated waste collection system. This is because technology neutrality in the bidding process has brought in an additional challenge in the aspects of assessing and comparing dissimilar products for making the final selection. These measures can reduce disputes between parties and terminations. Private sector admitted that

> *"…We (private sector) are doing door to door collection… but private sector takes more money than public sector. The second reason is private sector will not involve as much as public sector in these matters… the moment they find small leverage; they try to push the blame."*

The public grant was used to reduce the risk of private sectors in case of bundled projects, as observed in the case of P and C. A large sum of public grants works against the motivation of PPP mode. The incentive to act responsibly over the project for successful operations decreases if the private sector makes fewer investments in the project. A similar observation of using public funding for the reduction of private sectors risk was noted in the case of hospital PPP projects (De Marco et al., 2012). The unbundled projects also can reduce the debt requirement and make the project bankable as observed in E. Reduction in size and scope through unbundling can potentially avoid failures and save ex-post transaction costs. Moreover, project complexity, terminations and dispute resolution are some of the reasons that are argued to increase the transaction costs of PPP projects (Carbonara et al., 2016; Jin et al., 2017). Project complexity in

bundled projects such as D includes both the design and technology complexity and the managerial complexity in the operating phase. When a bidder has to handle an additional amount of information, the complexity of the project further increases (Carbonara et al., 2016; Jin et al., 2017).

As a downside, bundled projects are found to be negatively affected to have a unit price of power as the bid price. One of the reasons is as follows. The price of electricity is decided by the state and central generation companies. These public agencies are not affected by the ULBs perspective of bundling and unbundling. CERC has given the benchmark project cost of ₹ 15 crore per MW (£ 1.78 million) and ₹ 9 crore per MW (£ 1.07 million) for an MSW based incineration power project and an RDF based power project, respectively. When additional cost components are added to the project scope by bundling, it affects the unit price of power. For instance, the concessionaire of C has been asked to consider ₹ 20.48 crore per MW (£ 2.43 million) for project-specific tariff approval citing the reason that additional components were added to the project scope. This plea was rejected by the CERC. Thus, bundling can increase project uncertainty. Lastly, only the unbundling strategy seems to support the two-fold objective of cost reduction and the principles of 3R namely reduce, reuse, and recycle. In a bundled project, the private sector did not have the incentive to adopt the 3R principles. The more the waste reach the dumpsite, the higher is the tipping fee. In contrast, S and D demonstrated the reduction of costs and honouring of 3R principles through innovative schemes and discounts offered by the private sector. Thus unbundling can allow the market to reveal the actual costs of providing treatment services and contain the transaction costs, both ex-ante and ex-post.

7.4.12 **Uncertainty**

Unbundling is argued to reduce the optimism bias as the exchange conditions in the various stages need more transparency, documentation and subsequently, they reveal the true values for the estimations. Hence, unbundling will contribute to the prevention of ex-post transaction costs resulting from litigation, dispute resolution and terminations. The market for operating the composting technology is mature except a need for efficient marketing of the manure. ULBs need to be proactive in this support as seen in D. On the other hand, not many private partners are capable enough to provide treatment using either incineration based or non-incineration based

technologies. Unbundling would not reduce the uncertainty of operations in the technology but would facilitate the possibility of successful operations in treatment projects as observed in E, S, and D. For instance, there were no incidents of opportunistic behaviour by the PPP agent in these projects due to the flexibility offered by unbundling. In contrast, G has seen clear evidence of uncertainty affecting the project while P and C have a little, but, inconclusive evidence to posit that the effect of uncertainty is due to bundling.

The uncertainty brought in to the projects is also a result of unreliable waste characterisations and seasonal variations, number of households, and willingness to pay. ULB does not have such historical data previously. The ULBs also transfer such responsibility to the bidder during the bidding stage. All the bidders are subjected to the same asymmetry of information on these estimates and hence the bid fare miserably after winning the tender. The private sector is acknowledged to be competent but on narrow space of interventions. In other words, the private sector is capable of handling the hard parameters of the technology but not on the uncertainty caused by the soft parameters. For the MSW services to be successful, the uncertainty of the components should be set low and this is facilitated by unbundling.

Traditional assessments in PPPs are found to downplay the impact of uncertainty (Grimsey and Mervyn K. Lewis, 2005). The cases studied provide ample evidence for this phenomenon. The acknowledgement of Grimsey and Lewis (2005) that value for money calculations need to be seen as merely one factor in the procurement decision is justified. This study has validated bundling analysis as an additional but important variable in the decision making of PPPs besides the value for money calculations.

7.4.13 **Key suggestions**

The effects of the key theoretical constructs from extant literature such as a reduction in transaction costs and life cycle innovation (Buckberg et al., 2015; Lenferink et al., 2013; Trebilcock and Rosenstock, 2015) that should have favoured bundling were found insignificant in this study. Failure stories in MSW management are not unique to developing countries. Many developed countries have noted failures and poor segregation levels. Hence, the onus should be to learn the lessons to structure the projects to allow maturity and success in the future (Vining and Boardman, 2008).

Theories seem to suggest that MSW projects require mixed bundling or unbundling to achieve efficiency. As suggested by TCE, long term contracts are prone to ex-post adaption problems due to unforeseeable events that may arise. Pure bundling can have an increased effect of this phenomenon. The preliminary discussion of the bundling framework in Indian scenario seems to lay a case against pure bundling in present times. When contracted through mixed bundling or unbundling and for a short term, the possibility of the repeated transaction will motivate the contractor to perform well in the collection, operation and disposal components (Chong et al., 2006). These suggestions are in-line with the findings of Jehiel et al. (2007) who stated that for any number of heterogeneous components and bidders, mixed bundling auctions tend to have superior performance over pure bundled and unbundled auctions. Since future competitive auctions depend on the past observations of probable bidders in the market as well as from the disclosure of prequalified bidders during procurement, it is imperative that government should act in ways that proliferate the level of competition (Chong et al., 2006). Increased competition and reduced oligopoly/oligopsony situations for speciality contracts such as EfW treatment projects are some actions necessary to force efficiency into the sector for long term benefit (Teo and Bridge, 2017). The unbundling strategy has potentially made public sector units such as National Thermal Power Corporation Limited to venture into power generation using waste (as seen in D).

An analysis of the delays in Indian MSW PPP projects funded by Jawaharlal Nehru National Urban Renewal Mission (JNNURM) since 2005 across the country indicated that 39% of delays are due to technical causes (PWC, 2017). Treatment component has been the cause of technical delays particularly in cities that have adopted pure bundling. These delays trigger more issues such as blame passing between parties, breach of trust and terminations among others. Examining the present scenario of India MSW sector concerning treatment component reveal that all the operating projects at present fall into the category of mixed bundled or unbundled (MNRE, 2017). On the other hand, all the purely bundled projects have faced failures or time overruns, as they are yet to reach operations on power production (MNRE, 2017). In the case of MSW, due to the unproven nature of technologies and their operations, technology choice also seems to determine the alternative organisation forms among the bundling options. This is unlike the traditional notion of Williamson (1985: 85) that "*rarely is*

the choice among alternative organisation forms determined by technology". Particularly in the Indian context, there is very little evidence of adoption of newer methods for MSW supply chain (except for chemical and thermal treatment projects), in the last two decades which are driven by business models and waste characteristics. It can be understood that the innovation does not have any bearing on the life cycle innovation in MSW sector. More precisely, innovation possibility is not subject to the condition of pure bundling.

The collection and transportation are suggested to be better handled by NGOs (Sandhu, 2016). This nevertheless requires strong coordination mechanisms to implement. On the other hand, the treatment component is procured as an individual PPP project in cities such as Jabalpur, Indore, and Delhi. These treatment projects require speciality firms with relevant skills and expertise. Also, ULB can carry out the disposal project, as the construction of sanitary landfill fits EPC procurement or an item-rate contract as MSW rules clearly specify the specification of a sanitary landfill. Collection and transportation components are characterised by economies of scope, product and process innovation such as usage of RFID tagging and efficient IT-enabled monitoring but with negative externality, lower asset specificity, uncertainty and transaction costs. It also can potentially extract a high level of competition even from non-engineering firms, thereby eliminating the subcontracting need. Information asymmetry has a lesser impact on such contracts as they are less complex than PPP projects with long duration concessions (Massoud and El-Fadel, 2002). In this regard, the public sector may be better off to facilitate the coordination mechanism and suitably revise the policies related to collection and transportation components. Such flexibility may not be offered in case of pure bundling projects. These remarks closely align with the MSW management system followed in Portugal, where unbundling is followed for the various components of the supply chain (Magrinho et al., 2006). Also, the Flemish government always contract recycling activities as an independent private contract (Rogge and De Jaeger, 2012).

One unique challenge of MSW sector in India, as well as the world, is the sustainability perspective. Having one firm with multiple operating divisions and managing every aspect of the system, i.e. (collection, transport, recycling, composting, and disposal) will provide little incentive to divert waste from landfills (with high-profit potential) to recycling, composting, or other waste-conversion pathways (with lower

profit potential). Rather, the scenario should define the sustainability perspective at every stage of the component without comprising the provision of services (Massoud et al., 2003). For instance, reduction of waste does not mean poor operational efficiencies such as the partial collection of waste or incomplete treatment and disposal of waste. Past studies pointed out that the private sector, by and large, failed to deliver the contract and adhere to the MSW rules (Sandhu, 2016). In such a situation, taking the cues from this theoretical framework, empirical validations can be carried, and future projects can be carefully structured to understand the ex-post implications of the bundling strategy. Apparently, as unbundling and mixed bundling projects are the only existing success stories to some extent (MNRE, 2017), a focus on these project can unveil the critical implementation issues that arise during the ex-post governance stage. As a practical implication, market studies (analysis of suppliers; competition; prices of competing products) of the project development needs to consider this bundling perspective to influence the procurement stage. These constructs might have a balancing and reinforcing effects on each other whereby some constructs will become more dominant on the decision and hence further research using case studies, ethnography, among others, is required to derive practical value to support case to case decision making. This bundling framework will address other requirements of government, such as seeking long term benefit by thrusting efficiency. This framework might also formally explain the structural transformation of the public utilities, though with the use of MSW sector as a case.

7.5 SUMMARY

PPP infrastructure projects are hallmarked with the bundling of various phases of a project and bundling of various Component/service of the facility. Extant literature has provided ample guidance to bundling the various phases whereas the influence of component bundling on PPP infrastructure project has not been studied so far. The study has grounded the theoretical insights on the established and prominent theories of economics, organization and procurement namely auction theory, agency theory, and transaction cost theory.

The relationships between the various constructs have been presented in the form of a cognitive map of bundling decision factors where the lines indicate the casual

effect among factors and the dotted lines indicate the possible grouping of factors based on their influence to bundling decision (Figure.7.5.1).

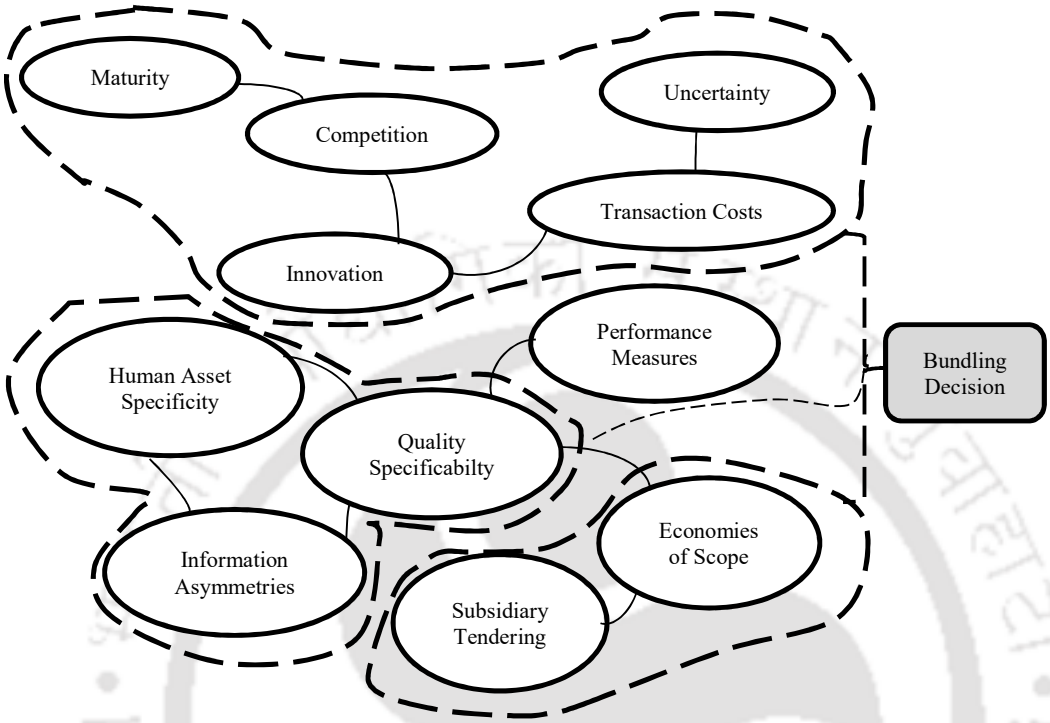


Figure.7.5.1 Cognitive Map of Bundling Decision Influencing Factors

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The conclusion of the analysis of the case is that the decision of bundling and unbundling would be governed by the constructs which are laid down in the current study. The study proposes the following crucial aspects – innovation, quality specifiability, economies of scope, the possibility of tendering to subsidiaries, information asymmetries, competition, transaction economies, as the ones which might have influenced the bundling/unbundling decision in the past projects. There is a need to carefully consider these constructs for any future decision of bundling in the upcoming projects. Bundling various component of any infrastructure supply chain without such careful consideration would be detrimental for the PPP objective. The past decision should have looked from the perspective of what components could be collectively bundled for a PPP contract and what components can be procured as a separate contract to provide infrastructure in a concerned sector. ■

CHAPTER 8

SUMMARY AND CONCLUSIONS

8.1 SUMMARY

Infrastructure projects are of crucial importance to the countries' economic development. All the countries across the globe have paid significant attention to increasing the investment in infrastructure despite their budget deficits. PPP has turned out to be one particular mechanism. This is grounded on the fundamental belief that quality infrastructure will increase the rate of return on such investments. This is particularly true for a country such as India with more than 1.3 billion (130 crores) and in the existing scenario of very meagre funding available for implementing infrastructure. The Indian Government has attempted efficient use of PPP infrastructure. It stands at the top on the number of projects and amount of investment. In such a context, a study on PPP infrastructure provides unique lessons to support the continuing investment in Infrastructure.

Among the sectors of infrastructure, MSW sector has used PPP mode but the results of such investments and their efficacy are less studied and less reported in the extant literature. Some questions that were not properly addressed in the PPP application of MSW sector of India are:

1. What are the perceived motivations to opt for PPP in the MSW sector?
2. Is there any bearing of sectorial characteristics in the way PPP contracts behaves by which the currently used PPP configurations should be reconsidered?

Early PPPs to the recent PPP projects have certain motivations in the hand of the project sponsors. These motivations are different across countries. Also, very often governments have executed the PPP program and are successful in one particular sector. Problems arise when the same experience is applied to a different sector but expect the same or similar response from those contracts in terms of the end result. Hence, it becomes paramount to consider that PPPs are not abused or forced into any sector but rightly understood and configured. The status of infrastructure provision, the

institutional contexts, and sectorial natures add complexity to the expected results when tried with PPP mode adds the strength to the need in this domain.

Existing literature recognises that such motivations of using PPP should be clearly understood. Then, risk understanding and allocation play a critical role in the successful execution of PPPs. However, while a considerable number of studies have focused on the motivations in the international literature, PPP MSW sector is mostly ignored by the researchers. Similarly, while risk allocation studies are plenty in both international and Indian contexts, there exists no study for MSW sector. While carrying the empirical study, it was understood MSW sector has a unique characteristic of bundling which needs an appropriate study using a theoretical lens. To this end, the main objectives of the research were:

A. To identify and study the challenges in the usage of PPP procurement in Indian MSW projects.
B. To understand various risk factors for MSW PPP projects and analyse the risk allocation framework.
C. To develop a bundling analysis model to support the procurement of MSW PPP projects.

A combination of methods was used to achieve these research objectives. Figure 8.1.1 shows the summary of research methods and the context in which they were adopted in the present study. To understand the motivations of PPP, a questionnaire survey was conducted with 52 PPP stakeholders on the literature informed attractive and negative factors of using PPP but in their experience. Secondly, 34 structured interviews were conducted to understand the risk factors derived from the extant literature. These primary data collection exercises validated the results. In order to configure the right application of PPP mode to MSW sector, bundling analysis model that was developed from extant theories were tested on six case studies in Indian context using 3 cases that were procured in unbundled mode and 3 cases that were procured in bundled mode. This satisfied both the replication logic and polar case situations.

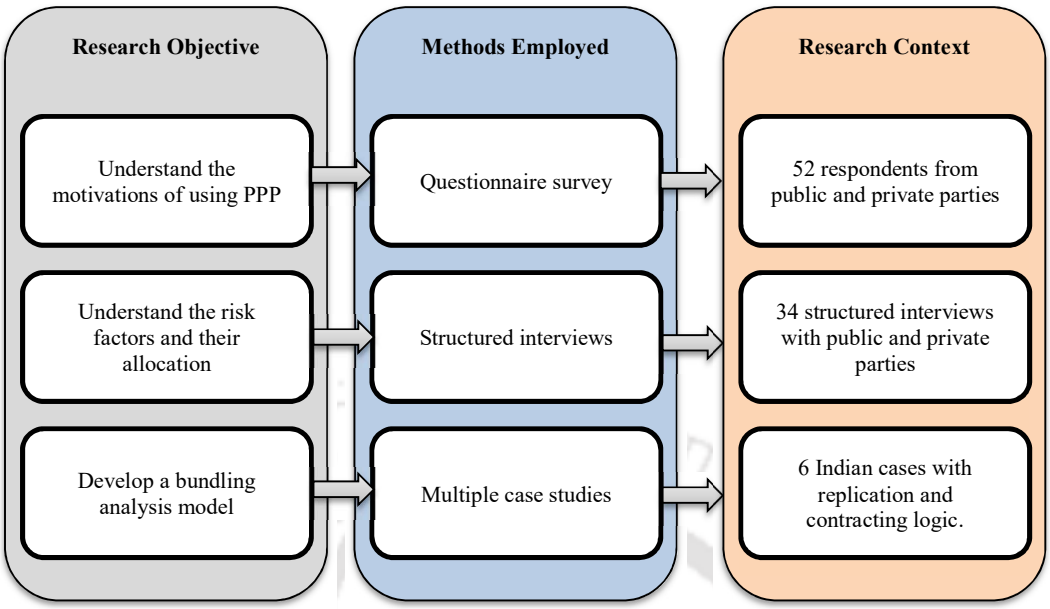

Figure 8.1.1 Summary of Research Methods Adopted

8.2 MAJOR FINDINGS

In the first objective, the perceptions on the preference of PPP mode for implementing MSW projects have been identified by a questionnaire and interviews with the PPP stakeholders. The adoption of PPP in Indian context especially in the MSW sector has been marked with the desire to reduce the capital investment from the private sector. Nevertheless, these projects tend to have a portion of upfront government guarantees, unlike other sectors where the grant is not expected due to a financially viable business case. Indian PPP MSW projects seem to be conceived with a desire to facilitate creative and innovative approaches. PPP is also majorly propelled to improve the buildability and maintainability of the assets/services of the MSW by the integration of functions such as the design with the operation. This strategy has been adopted with the objective to ensure quick delivery of the much-needed infrastructure. For this sake, the public sector tends to transfer risk to the private sector but these results have reduced project accountability and relying on the private sector has made it riskier. This is mainly caused by less involvement and monitoring by the public sector because of the tendency that the private sector will self-regulate and self-monitor even without the involvement of the public sector. The high asset specificity of MSW treatment assets might have affected its project finance commitments. On the other hand, PPP infrastructure development in MSW is strongly affected by negative factors. There are

cases of lengthy delay due to political debate, lack of expertise and appropriate skills with both public sector and private sector, confusion over government objectives and evaluation criteria, the prevailing situation where very few schemes have actually reached the contract stage, and delay due to complex contract transactions. Political debates, in particular, are more relevant in this sector. Biases in the tendering process and regarding the land allotted for treatment facilities are more common instances. Though benefit to local economic development is unlike the other infrastructure sectors such as roads, ill effects due to health and sanitation loss are quite detrimental to otherwise productive health of the citizens. Governments and urban local bodies need to devise strategies to overcome these negative barriers to allow successful projects in the future. The usage of mixed-method showed that there are differences in theory (as perceived in the survey) and practice (as elicited in the interviews).

Though the dire need for infrastructure suggests PPPs, it is advisable to governments to carefully consider the market opportunities that would bring the best value for money and the quality of services. This is particularly relevant due to the condition of poor competencies of public and private sector parties in procuring, operating and monitoring the deliverables. Instead, public authorities need to be more proactively involve in MSW services and use PPPs appropriately with caution. More particular, there is a need to enable a robust monitoring mechanism to reveal the benefit of PPPs for the aid of future projects. This adds to the claim that PPP is no panacea for successful assets and services but must be developed into successful projects. The findings of this study have shown such a framework for development. There seems to be a gap in the understanding of project financial packages for the MSW sector. Particularly, limited recourse nature to public funding is not promising and subsidies and upfront grants are more expected. This must redirect the scale and the scope of services for which PPPs is most appropriate. Subsequently, the complexity of the projects and thereby the delays in transaction and negotiations can be reduced, evaluation by governments can be most specific and focused. These measures will further enhance the attractiveness of PPPs.

In the second objective, this study presents the empirical framework grounded on structured interviews with MSW experts in India. The risk allocation mechanism and relevant risk factors were expounded. It showed how the risk intensity varies with the choice of technology, even though the parameters like waste and scope of the

project remain the same across the technological options. The findings indicate that financing risk, revenue risk, and waste collection/segregation risk should be addressed appropriately before procuring PPP MSW projects, as these risks will decide the course and success of the project. The presence of dissonance on risk allocation preference calls for further probe and warrants caution for future projects. The current study also indicated the need for bundling analysis in PPPs, which is also a crucial theory of risk allocation. These risks should be considered on a case-to-case basis before procuring any project through a structured methodology of factors governing bundling. The presented overall risk allocation framework can be used as a guideline to handle the risks and their allocation mechanism in MSW. It should also be noted that the risks that were described in the solutions and options can only be mitigated through the adoption of appropriate policy, legislation, and support, as their purview of impact is beyond the project operations. The current study is a positive step towards integrating different perceptions and priority of MSW infrastructure stakeholders in the PPP process so as to ensure successful PPP MSW projects.

Thirdly, the focus of the third objective was on the bundling of components over the phases of the project, which has been viewed as inherent characteristics of PPP infrastructure projects. But mixed opinions were expressed by researchers in past on the suitability of bundling of PPP projects. To this end, we examined a few PPP MSW projects of India, Indian policy and experience in this sector. Such a synonymous study is not observed even in the international research arena. The conclusion of the analysis is that bundling of project phases (MSW supply chain in this sector) will not necessarily lead to perceived benefits such as cost savings, efficiency. Instead, it is a threat to social sustainability which is one of the key objectives to be fulfilled in case of this sector. This study adds to the researchers' voice to consider bundling analysis to further the project development in PPPs. These findings are in line with OECD (2012) recommendations that PPPs structuring should be based on market conditions of a particular sector. OECD advocates to unbundle the supply chain by which each component, according to their operations, will have the best risk-takers to manage a project with enhanced competition in the market. ADB (2008) also added that bundling decision should be a mandatory step in PPP analysis.

This study identifies inappropriate bundling as one of the reasons for the failure of MSW PPP projects. This study recommends carrying bundling analysis as a part of

VFM considering various scenarios instead of VFM of the base case of traditional procurement vs bundled MSW project. The study suggests that bundling of phases is restricting not only the competition among bidders but sectorial developments and capacity building in MSW projects. This study recommends unbundling through single speciality contracts even for the long term as a measure to achieve successful PPP MSW projects. Also, bundling assessment should be taken over time and, when the sector seems to satisfy the bundling criteria developed in this study, then integrated projects could be developed. In reality, for a project to be bundled, it is impossible to satisfy all the criteria to opt to bundle. Often, one supporting factor will nullify the benefits of another opposing factor. Hence, it requires a rigorous assessment and then translation of residual factors to the risk management framework is advised.

The onus of this study is not to challenge the structuring and benefits of past PPPs across the world but to enhance its usefulness and success by facilitating the structure of MSW PPP projects in India, even though the findings are largely gathered from the case study and anecdotal evidence. The findings are contextual and relevant to social infrastructure PPP projects, particularly Indian MSW PPP projects, and application to other infrastructure sectors and other countries will need further studies. Having said this, it is expected that, even though the same issues may not occur in other geographical locations, the principles and theory developed would be still applicable in the new project design and implementation in other markets of PPP also. Our findings cast some doubt on the past research that attributes bundling to PPP definition and also suggests that bundling analysis is needed in the preparation stages of PPP projects especially when the sector is in the formative stage. The findings are of crucial importance to other developing countries which have started adopting PPPs and have not yet matured completely to handle the complex transaction of PPP procurement.

Table 8.2.1 recapitulates the three questions of this study and summarises the major findings.

Table 8.2.1 Summary of Major Findings

Research question	Major Findings
1. How effective is the procurement of MSW services by the ULBs through conventional	The findings suggest that MSW services primarily and importantly procured because of the PPP mode is more favoured on account of the dire need of

Research question	Major Findings
procurement and under private sector participation? How suitable is the PPP mode of procurement for assets and services in MSW sector of India?	MSW services in India. The unfavourable results such as failed projects and having high transaction costs, overexploitation by the private sector are attributed to inappropriate procurement process as perceived by stakeholders while using PPP.
2. What are the risk factors pertinent and relevant in this sector and how such risk factors should be allocated?	The findings indicate that financing risk, revenue risk, and waste collection/segregation risk should be addressed appropriately before procuring PPP MSW projects, as these risks will decide the course and success of the project. The presence of dissonance on risk allocation preference calls for caution for future projects. The study of this objective also hints the need for bundling analysis in PPPs which is also a crucial theory of risk allocation
3. What framework is required as affected by the nature of MSW sector having components of the value chain with multiple assets for the delivery of infrastructure for MSW services?	The organisational and economic theories helped to develop a framework to make the bundling decision for future projects. The cases highlighted the complexity inherent in bundling decision, arising out of the relatively scanty rationale by which stakeholders first developed. Poor sectoral developments, hindrances arguably caused to innovation, increase in transaction cost, and a decrease in the competition along with ex-post characteristics such as unfavourable transaction attributes makes bundling a too early proposition to MSW projects.

8.3 IMPLICATIONS

The major implications related to theory, research methods, practice and policy from the present thesis are drawn and discussed below.

8.3.1 Implications for Theory

The theoretical contribution is often measured in terms of "what, how and why?" dimensions of the proposed theory (Whetten, 1989). The three research questions have three distinct theoretical contributions.

Firstly, this study presented the factors in which major projects, particularly in social infrastructure realm, might contribute to failure or might effectively work. These might act as boundary conditions for operationalising PPP projects in the MSW sector. The working of attractive and negative factors in the MSW sector has opened new insights to improve its applicability. From the study of factors affecting PPP, it is unveiled that attractive factors are not always the practical factors of the procurement decisions, particularly in PPPs. There is always a conflict between norms and practice. The reason for this anomaly is the social projects come with a tremendous amount of pressure from various institutions that enforce legitimacy requirements. This forces the public agents to focus on showing various projects paper rather than aiming at sustainable, practical and implementable projects which are sound in legitimacy requirements.

Secondly, the challenges of energy from waste projects are quite a few. Particularly the barriers and risks affecting the project development in the already poorly implemented have opened up the need to understand the behaviour of risks as influenced by the technologies which are a technological issue. The existing theory on risk identification and allocation is extended to the MSW sector. This is an incremental contribution. However, what is more important is that the present study observed contestations among the different actors of the project. This influenced the risk allocation framework, and consequently, there is an incomplete understanding of the right procurement model. This opened a new set of questions related to delivery models.

Thirdly, infrastructure delivery models and their suitability studies are quite a few in the construction management area. Many studies have uncovered the relations of competition, transaction costs, innovation, among others and the likelihood or preference to a delivery model. However, the causal relationship of the factors is either incomplete or irrelevant to the current context. Application of organisational and economics theories to the current thinking and research practice is a unique theoretical

contribution from this study. The developed theoretical framework is expected to be the one which can provide the best understanding or allows precise predictions about the observations. Given the increased interest in the MSW projects in India, this study is timely. The alternative remedial mechanisms of application and its behaviour as discussed in implication for practice also form the theoretical contribution of the present study. There is a consistent and coherent explanation of the bundling influencing factors, including the overlapping path decencies. The case study findings would be quite radical to current thinking which views that only bundled projects are worthwhile and effective considering the multiple perspectives one can consider. When the public sector outsources work, they often become less mature in managing projects. If PPP's are the solution, the public sector needs to be trained on how to be a good 'project owner' as they will lose their capability to manage projects. In this dilemma between pure public and pure private delivery models, there can be mixed delivery systems, i.e. mixed bundling, to reduce the transaction costs (Bel and Rosell, 2016). This theoretical perspective is a new insight which is missing in the extant literature of the MSW sector with the supply chain complexities.

8.3.2 Implications for Methods

Firstly, the strength of the thesis is the systematic way of carrying out a mixed methods research that can be an exemplar of the use of mixed methods in infrastructure projects research. Since both novel and mixed methods usage is widely advocated in construction management research, it has been adopted in this thesis. Recent conversations particularly emphasize that mixed methods are quite necessary to make meaning contributions. Usage of mixed methods is attempted not only at the level of the overall thesis. Particularly, the work done in reporting the case studies to investigate the bundling of projects in MSW projects is based on mixed methods.

Secondly, there are a few studies that have used longitudinal case studies. Researchers have emphasized that phenomenon can change over time due to institutional and organizational changes even in the public sector. In view of this, six longitudinal cases and the operationalisation through mixed methods are novel and can be adopted by the future researchers to perform within and cross-case comparison of problems that demand longitudinal observations. This is when it requires to consider the influence of the policy of the state or country, thus enhancing the applicability and

usefulness of many research contexts. This study specifically focused on bundling in a manner that has not been done before.

8.3.3 Implications for Practice and Policy

The knowledge that will be gained from the study on bundling can be used by decision-makers, especially the urban local bodies and transaction advisory who are responsible for procuring projects having diverse value chain such as sewerage projects, water treatment projects, and solid waste management projects, to design an appropriate governance structure for PPP projects in those sectors. This is more important because central government/bodies are typically well experienced in executing PPPs (e.g. the case of Indian Highways) whereas network infrastructure project governance aspects are yet to be understood by the local bodies.

The mixed bundling strategy is presented in Figure 8.3.1. The black circles represent the interventions related to monitoring and data management managed independently by ULBs or its agent. Shaded and dotted boxes represent the boundary of a PPP project. This strategy requires that performance measures are specified by the ULB independently for the PPP contracts. The ULBs need to have competency building exercise at least to a moderate level for efficient monitoring and control. Eventually, project experiences might bring economies of scope but not in the initial stages of the sector maturity. This strategy assumes that no tendering of subsidiaries is allowed or practically encouraged as bidding will be with speciality contractors only. All the innovations that have a negative externality will need to invest through public funds or grants from the central government instead of adding to the PPP procurement which reduces the accountability and increases the cost. Moderate competition can be expected in this scenario. Mixed bundling may have less impact from the possible information asymmetries. However, ULBs may not suffer holdup problem as in case of a project with pure bundling strategy. The strategy also might reduce the uncertainty of technology and operations and make the private sector more knowledgeable of the whole operations.

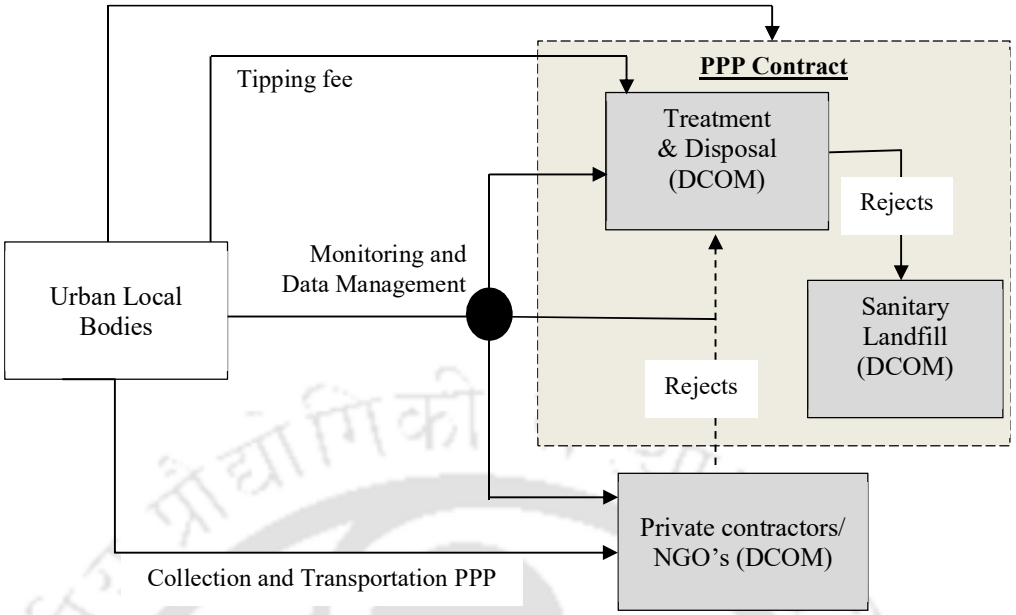

Figure 8.3.1 Mixed Bundling Strategy for ULBs

The unbundling strategy is presented in Figure 8.3.2. In mixed bundling, it can be observed that one PPP contract exist while in the unbundling strategy three PPP contracts are possible as shown in the figure. The unbundling strategy may need more coordination by the ULBs and it has to particularly invest its time and resources of contract management and monitoring. The independent contracts might increase the ex-ante transaction costs but on a whole. However, this strategy will reveal the costs of various components and this knowledge could be used to design effective MSW services for the future. This strategy requires multiple windows for verification of performance and hence multiple inflows and outflows of payments. The public sector would gain experience to identify the troubled pockets of activities in the whole MSW supply chain and can render focus to improve those activities by appropriate measures. The best risk-takers for the components of the value chain will need to be identified if the ULB is small and does not possess much experience in MSW services as shown in Figure 8.3.3. The ULBs need to scope the activities considering economies of scale. For instance, cities with larger waste generations might need multiple treatment projects whereas class II cities might suffice with one treatment project.

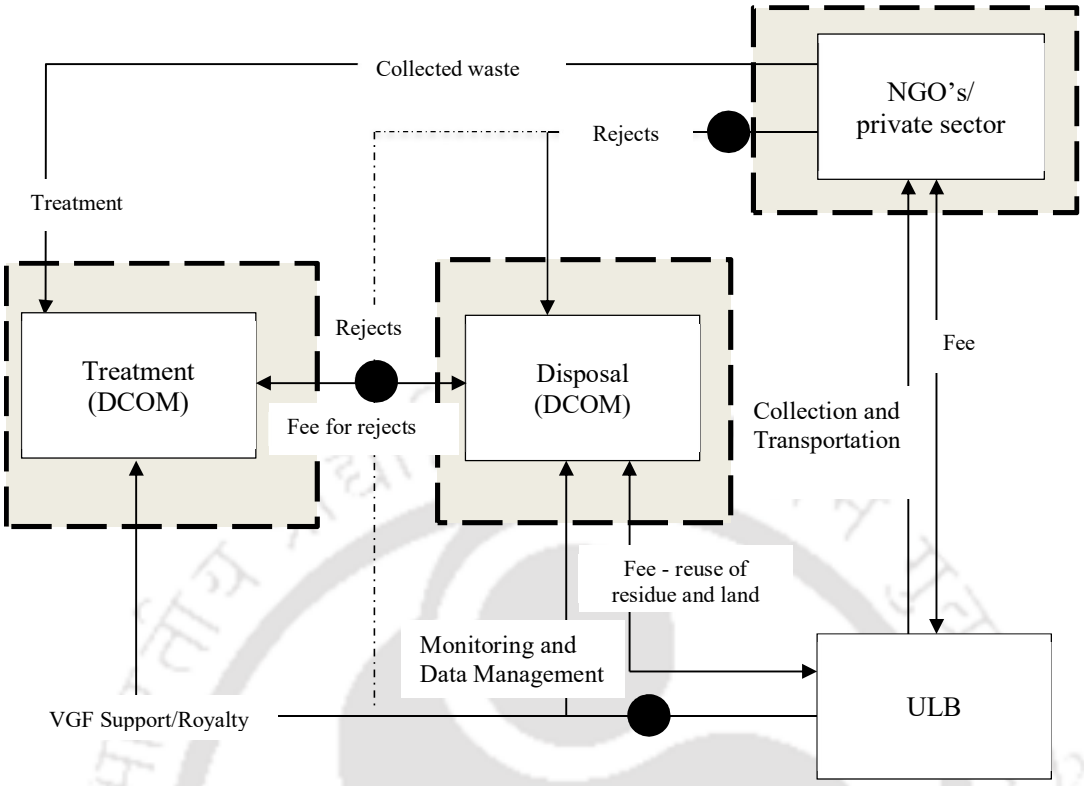

Figure 8.3.2 Unbundling Strategy for ULBs

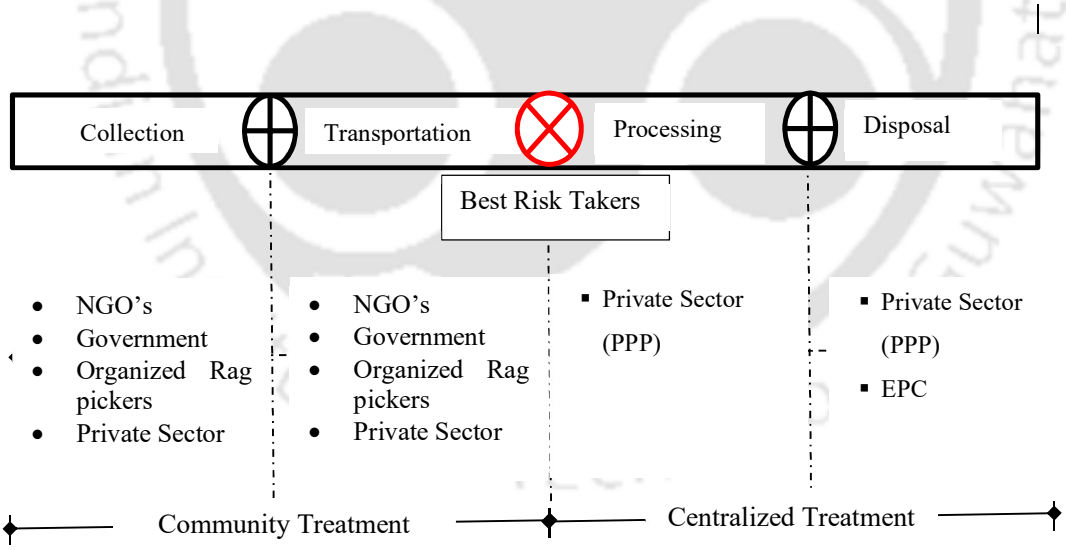

Figure 8.3.3 Proposed Scope for MSW Supply Chain

The thesis provides inspiration and insights into the MSW management sector and opens up the gaps in the policy and practice. Future entrepreneurs might draw on to pitch into these gaps from different markets such as power sector players into

treatment segment, transportation service providers into the collection and transportation segments on a much broader scale.

8.4 LIMITATIONS AND FUTURE SCOPE

There is a potential scope of carrying out further study in this research area, as the procurement process is not a simple topic to deal with, given the complexity it exhibits and diversity that exists in stakeholders. Future research should focus on the empirical analysis of PPP usage in MSW sector concerning its suitability and identify which factors practically drive PPPs and how the negative factors affect the projects through methods such as content analysis of projects or in-depth case studies. The study on risk management has chosen to consider technology as a variable on risk magnitude and intensity but not on allocation preference of the risk. Future studies should address this limitation. Indian PPPs are criticised due to lack of structure methodology for calculating the value for money using PSC. Since, risks are the primary inputs for a PSC, this risk management study can help the calculation of PSC in future projects as well.

This study on formulating an implementation framework for MSW projects with special attention to PPP mode of procurement is restricted to Indian conditions. The results of this analysis can be extended to other national contexts, particularly developing nations, where the conditions are expected to be similar. Present research though has satisfied the validity and reliability requirements, further research in this sector and area would increase the development of theory for this sector if the present findings are repeatedly validated on the suitability of PPPs in any new sector, risk allocation for such sector, and whether bundling analysis is required for that sector. Such research could concentrate on the contextual conditions of the sector, mainly how assets and services are provided before the private sector participation. As far as the findings and recommendations are concerned, the framework will support the Indian context of PPP implementation.

Data collection challenges, non-availability of data, and limited access have prevented probe into many cases. Future studies can focus on the broader set of cases. Particular attention can be paid to the size of the project in TPD and whether this has any influence on the predictions made from this theory related to PPP suitability, risk management and bundling analysis. Moreover, the robustness of the present

methodology is not too innovative. The limitations of the case study and survey methodology apply to this study also. These limitations can be surmounted in future by choosing such appropriate methodologies. Further studies can include data sets from various other countries to improve the robustness of the findings. This will help to account for the legitimacy requirements of the countries and the status of quality in the service provision.

Studies are needed to gain insights to bundling analysis, such as - (i) which constructs have a significant influence in the bundling decision of PPP network infrastructure projects, (ii) what are the interplay effects of one construct over another, and (iii) what conditions can shape and dictate such interplay effect? The present study could not provide cost implications to compare and contrast, and thus, a longitudinal study of cases has been adopted. Empirical studies would be greatly benefited if comparative case studies are compared by accessing more confidential cost details.

There are some more areas that beg further research in this sector. One of the unique characteristics of municipal works sector is that, not doing it well or not doing it at all, can result in issues of poor health and environmental degradation. Therefore, the risk of not doing projects in this sector is a risk in itself. Thus, investing in these projects could be considered as an opportunity which could be factored in to justify these projects' cost. Perhaps a method that is used in Cost of Quality (COQ) calculations might be useful to calculate the financial implications of not doing these projects. Secondly, stalkeholder management and public consultation in the MSW sector in many facets such as increase in cost or user fee, trust on the technological solution and the private sector, political motivations requires further research to anchor the strategies and act as direction for future projects. ■

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ANNEXURE 1 – RESEARCH DESIGN

This annexure presents the research design of the present study. It first details the generic research process and lays the context by reviewing the understanding of research methodology and method. Then it will discuss the purpose of scientific research which is theory building and theory testing. Lastly, this annexure shows the justification of the chosen research methodologies for addressing the three research questions set out in the present inquiry by considering seven different research methodologies namely experiment, survey, case study, action research, grounded theory, ethnography, and narrative inquiry.

1. GENERIC RESEARCH PROCESS

In broad strokes, the research process adopted in this study is derived from Fellows and Liu (2015: 57) as shown in Figure A1.1.1. The research process starts with the identification of research aims, objectives, and research questions. Then to identify the paradigms in the inquiry, a choice is made between theory building or theory testing to shape the hypothesis, if it is relevant to the inquiry. Besides, constructs or variables of measurement are identified from the literature either from grand theories, mid-range theories, or substantive theories that are relevant to the problem under consideration (Saunders et al., 2009). A hypothesis can only be part of a sound conceptual argument and is usually derived from theory (Saunders et al., 2009).

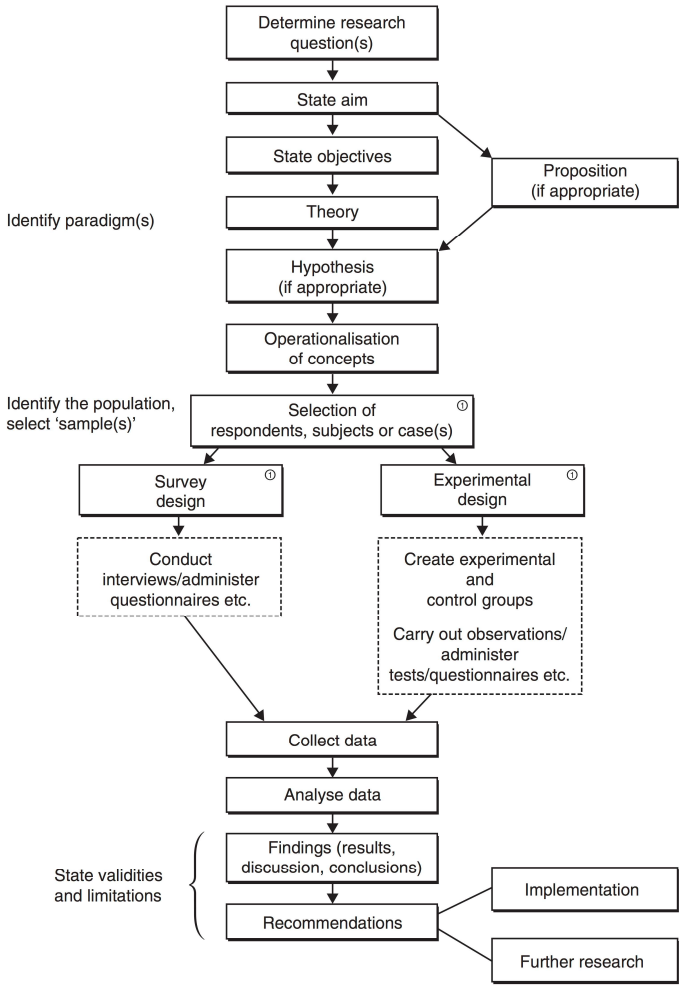

Figure A1.1.1 The Research Process (Fellows and Liu, 2015: 57)

2. RESEARCH METHODOLOGY AND METHOD

According to Knight and Ruddock (2008: 3), research methodology in social enquiry refers to far more than the methods adopted in a particular study and encompasses the rationale and philosophical assumption that underlie a particular study. It employs research methods that are used to investigate a problem and to collect, analyse, and interpret data. Research methods are linked to the ontological and epistemological position adopted by the researchers. **Ontology** refers to the perception of reality where the perception is dictated by assumption such as whether a phenomenon exists independently (objectivism) or depends on the social actions which make the phenomenon dynamic (constructivism) Knight and Ruddock (2008: 3). In simple words, it is the nature of reality. **Epistemology** refers to the study of the

nature/theories of knowledge where the theories attempt to answer questions surrounding the nature of knowledge, its limits, and the path to acquiring it. In simple words, it is the nature of knowledge. After selecting a research method, research design prescribes the ways which the data will be collected, analysed in order to answer the research questions posed and so provide a framework for undertaking the research. The distinction is presented in the figures below. Researchers often used research method (Yin, 2009) and research strategy (Saunders et al., 2009) interchangeably. The overview of research methodologies as presented by Saunders et al. (2009) is shown in Figure A1.2.1.

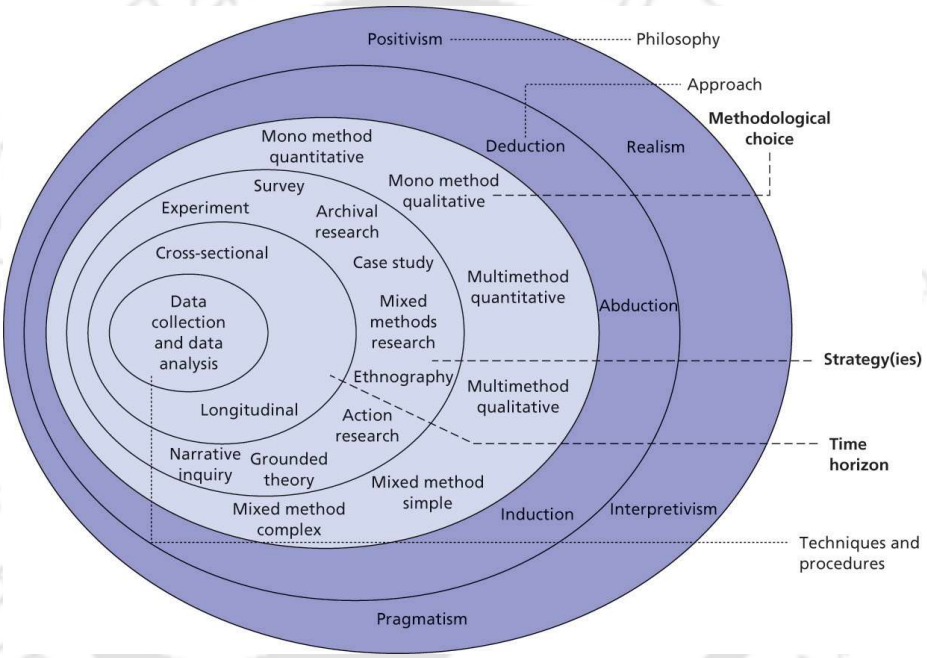

Figure A1.2.1 Research Onion (Saunders et al., 2009: 108)

3. THEORY BUILDING AND THEORY TESTING

Popper (2002) proposed the view that science can never be proved right, but it can be proved wrong. His concept was that science progresses through the falsification of theories, not through their apparent confirmation (Harriss, 1998). The pedagogical approach of theory building lies with the aspects of teaching theory recognition, theory application, and theory development (Byron and Thatcher, 2016). The implication is that before one can actually build theory i.e. theory development, one needs to know the process of theory recognition, and theory application. Gill and Johnson (2002) define theory as '*a formulation regarding the cause and effect relationships between*

two or more variables, which may or may not have been tested.' To help the recognition of theory, Whetten (1989) articulated theory as containing four essential elements:

- ***what*** (the factors in the theory);
- ***how*** (how the factors are related);
- ***why*** (explanation of underlying dynamics); and
- ***who***, ***where***, ***when*** (boundary conditions).

The primary role of research with the three-level schema [epistemic level, theoretical level and empirical level] is to link the theoretical and the empirical. Theories need the support of data in order to remain viable, whereas methods themselves carry assumptions that are theoretical in nature (Rudestam and Newton, 2001). Theory guides the research questions we ask and gives sense to the findings (Van de Ven, 1989). Yin (2009) opines that theory and logical consistency can only advance empirical research but not just mechanistic data collection. Theoretical formulations are accepted only when they are confirmed in a test in the sample from which the propositions were built.

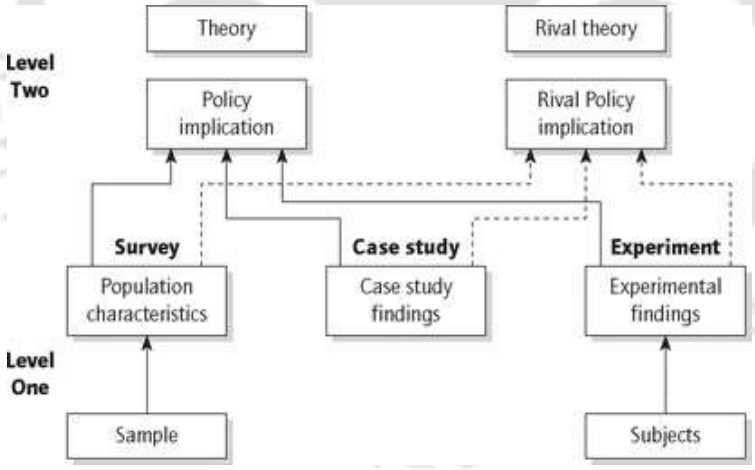

Figure A1.3.1 Making Inferences for Theory and Rival Theory, (Yin, 2009: 39)

Theory testing with cases is the process of ascertaining whether the empirical evidence in a case or in a sample of cases either supports or does not support a given theory. In social sciences, a little distinction can be made between formulating a theory and testing thereof. This is applicable to even the process of discovering theory while evaluating it (Dey, 1993). This could be the possible reason why not many case study theory-building papers are reported in construction management research domain

(Schweber, 2016; Taylor et al., 2011). Taylor et al. (2011) show that case studies that develop new theory are far less frequent than the studies that test a theory. Concerning theory building, various research methods such as survey, case study, and experiment among others can lend support as shown in Figure A1.3.1. Moreover, it is common to use a survey to test theories (cf Tiwana and Bush (2007)). Hence, this calls for choosing the right research method/methodology for answering the research questions identified through literature review.

4. RESEARCH STRATEGIES' SUITABILITY

From the broad spectrum of research philosophies to the data collection and analysis techniques, quantitative and qualitative research approaches are the broadly preferred choices. The distinction is based on the epistemological and ontological orientation as shown in Table A1.4.1 while Table A1.4.2 presents the relevance of different research strategies from the perspective of the research question and contextual situation.

Table A1.4.1 Ontology and Epistemology of Research

Subjection	**Quantitative**	**Qualitative**
Principal orientation to the role of theory in relation to research	Deductive; Testing of theory	Inductive; Generation of theory
Epistemological orientation	Natural science model; Positivism	Interpretivism
Ontological orientation	Objectivism	Constructionism
Example	Survey	Case study

Source: (Knight and Ruddock, 2008)

Table A1.4.2 Relevance of Different Research Methods

Research method	**Form of research question**	**Requires control of behavioural events?**	**Focuses on contemporary events?**
Experiment	What? How? Why?	Yes	Yes
Survey	What? Who? Where? How many? How much?	No	Yes
Archival records	What? Who? Where? How many? How much?	No	Yes/No

History	What? How? Why?	No	No
Case Study	What? How? Why?	No	Yes

Source: (Yin, 2009)

An assessment of the available research strategies and the scope of application are presented in Table A1.4.3. The assessment suggests that the survey would fit the inquiry of research question 1 and 2 while the case study would suit the inquiry of research question 3. Survey does not require control of the respondents or subjects and the problem would still be needed to focus on the contemporary event. On the other hand, a case study also does not require control of the events surrounding the phenomenon but the event should be contemporary in nature. Moreover, survey has more on the breadth of the study while case study has narrow but depth in the study as shown in Figure A1.4.1.

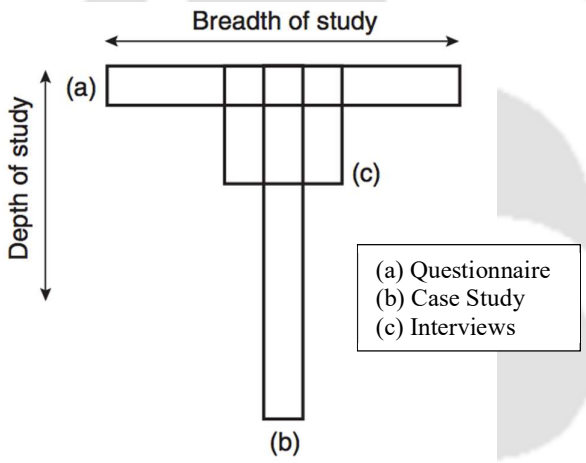

Figure A1.4.1 Research Methods Based on Depth (Fellows and Liu, 2015: 156)

The important decision made for arriving at the research methodology of the present inquiry is presented in Table A1.4.3. Since the RQ 1 and RQ 2 are more shallow but wide, a survey is more appropriate while RQ 3 involves a more in-depth understanding of the MSW projects, making case study as the right choice.

Table A1.4.3 Assessment of Research Strategies' Suitability

Research Strategy	**Scope of Application**	**Suitability**
Experiment	Experiments capture data to prove or disprove a hypothesis and suit the application that has highly structured and artificial in nature (Bernold and Lee, 2010). Game theoretical applications are	X

Research Strategy	Scope of Application	Suitability
	one example of experiment research (Javed et al., 2014). Experiments also require longer times and hence often costly (Hasan et al., 2018). This method fits a very limited kind of research questions.	
Survey	Surveys have a rigid structure, cross-sectional in time and shallow in nature (Fellows and Liu, 2015). This method is extensively used in construction management research (Abowitz and Toole, 2010). Since effectiveness and suitability can be perception-based questions (De Vaus, 2002), a survey with Indian PPP stakeholders is quite plausible using survey research methodology. Also, the risk management studies i.e. identification of risk relevant to Indian MSW projects and their allocation is a contemporary event. Hence, survey may be appropriate for RQ 1 and RQ 2.	√
Case Study	Case study research has a preference for empirical research on real-world events and is often associated with an emphasis on the importance of interpretation of human meaning. It provides flexibility to study both longitudinal and cross-sectional time horizons and with multiple sources of evidence providing a way for rich data analysis (Yin, 2014). The third research question aims to develop a framework (theory) relevant to the procurement of MSW projects and hence case study can be used in an exploratory manner by developing *a priori* theory and using it on select cases for the examination of the constructs forming the theory (McCutcheon and Meredith, 1993)	√
Action Research	Though widely used in other fields, the application of action research is still limited to the need for planned interventions such as experiment and hypothetico-deductive analysis (Azhar et al., 2010). It is often considered as approach as opposed to being called as research method. It is argued to fit new reality instead of problems related to existing reality, and when collaboration with practitioners is essential to building/testing theory (Mahalingam et al., 2015).	X
Grounded Theory	Grounded theory helps to generate a theory based on the inductively collected data where there is no past theory to inform the phenomenon being studied in a naturalistic approach (Corbin	X

Research Strategy	Scope of Application	Suitability
	and Strauss, 1990; Loosemore, 1999). However, they tend to be descriptive over what has happened where the hypothesis and concepts are generated during the course of research (Corbin and Strauss, 2015) and thus limits to only problems of this kind.	
Ethnography	Ethnography involves live observations through participation and hence are suited to a limited number of problems (Javernick-Will and Scott, 2010; Ramalingam and Mahalingam, 2018).	X
Narrative Inquiry	Narrative inquiry uses as its unit of analysis stories told by individuals to understand the meaning and impact of experiences. The telling of the story will also depend on who it is being told to—a personal journal entry will likely contain aspects of an account different from the narrative given in a semi-structured interview to a stranger (Chesnay, 2015). It is predominately used in health research and finds little application in construction management	X

Survey Methodology

A method where the researcher can ask questions directly to participants, through questionnaires and interviews, is known as 'survey research.' Much research in the social sciences and management spheres involves asking and obtaining answers to questions through conducting surveys by using questionnaires, interviews (face-to-face or telephone interviews) and case studies. Among these, a questionnaire survey is easiest and the most suitable option for research-based on time and reliability. The essence of a survey is that it provides information about an entire population. As surveying the entire population or community of interest is very tedious and time-consuming, it is usual for survey to employ sampling such that the size and structure of the sample is sufficient to yield enough reliable data with statistical validity for inferences to be drawn about the population at a required and specified level of confidence (Fellows et al. 2008).

Research in the management sphere involves asking and obtaining answers to questions through a questionnaire survey, structured, semi-structured, and unstructured interviews. The questionnaire survey can include closed-ended questions with appropriate scale of measures and open-ended questions with no scale of measurement.

The responses achieved from the questionnaire survey are subjected to suitable analyses. Survey provide a good representation of population validity and reliability but can often lack ecological validity which means that the respondent can claim different from what they actually do (Gill and Johnson, 2002; Scherbaum and Meade, 2013). However, ecological validity is not per se considered as a limitation of any study (Gill and Johnson, 2002). But, in such a situation, data triangulation or deeper probe into their answers by in-depth interviews can unravel what they actually do. This strategy can ensure ecological validity.

Case study methodology

Yin (2009) suggests case study research as having five steps: problem definition, design, data collection, data analysis, composition, and reporting. The problem definition in a research study is typically translated into research questions which in turn are translated into the theoretical propositions that usually have their grounding in the researcher's observations or theory. Based on the observations or theory, the propositions are framed. The unit of analysis fixes the level of observations or the data that is required as it points to the major entity that is being analysed in the study. ■

ANNEXURE 2 - DESCRIPTION OF THE CASES

This appendix presents the background details of the six case studies related to the inquiry of the third research question. The overview of the cases studied is shown in Table A2.0.1. The current status is that projects are terminated in three cities with no private concession existing now and in the other three cities, projects are at various stage of PPP lifecycle. MSW management has been a controversial topic in India is often is politically sensitive issues. On this ground, many participants and case study organisations were apprehensive about sharing the data and their experience. One of the strategies to maintain confidentiality for when controversial cases are considered is to systematically convert the real identities to fictitious names (Yin, 2009). In the present study, confidentiality agreements are signed with the case organisations and interviewees and thus all the names of cities, public and private organisations, names of special purpose vehicles, bidders, concessionaires are codified with metonymies.

Table A2.0.1 Bird's Eye View of the Six Cases

S.N	Case	Mode	Nature and Scope	Current Status
1	GAMET	DBFOM	Segregated C&T, Compost, SLF and EFW	Terminated
2	PEARL	DBOT	Segregated C&T, TS, Treatment & Disposals, SLF	Operational
3	EMERALD	*ULB*/DBFOT	TS, SLF, EFW	Procurement terminated
4	DIAMOND	SC/BOOT	RDF & EFW	Terminated
5	SAPPHIRE	*ULB*/DBOT	TS, Biomethanation	Commissioning
6	CORAL	DBFOT	C&T, Sanitation, TS, Composting, bricks, SLF	Terminated twice

Legend: C&Tp – collection and transportation; SLF: Sanitary landfill, EFW – energy from waste ; P&D – processing and disposal; TS – Transfer station; RDF – Refused derived fuel;

Table A2.0.2 shows the competition observed in each of the cases while inviting private sector to provide the concerned scope of waste management services. For DIAMOND which used pure unbundling strategy, the competition of all the components is presented earlier in Table 7.3.4 of chapter 7.

Table A2.0.2 Overview of competition in the Cases

Project	Year#	Project Scope Description	Number of bidders during		
			EOI	RFQ	RFP
GAMET	2006	Collection, Transportation, Treatment, and Disposal	13	5	1
PEARL	2009	Collection, Transportation, Treatment, and Disposal	22	6	2
SAPPHIRE	2009	Transfer Stations, Treatment and Disposal	8	5	2
	2012	Transfer Stations, Treatment and Disposal	3	3@	3@
CORAL	2011	Collection, Transportation, Treatment, and Disposal	11	8	5
DIAMOND^	2011	Treatment and Disposal	4	2	2
EMERALD	2013	Transfer Stations, Treatment and Disposal	37	23	1
		Average Competition	**14**	**7.42**	**2.51**

Legend: # - year of procurement; EOI - Expression of Interest; RFQ- Request for Qualification (for technical qualification); RFP - Request for Proposal (for financial bid); @ - technical cum financial proposal; ^ - royalty based project in DIAMOND city.

1. CASE GAMET (G)

An important step towards the rejuvenation of the urban infrastructure was taken up by the Indian government through the JnNURM Programme in 2005. As part of this Programme, GAMET city was selected along with another 63 Indian cities for getting partial federal government financial assistance for urban infrastructure development. Under this Programme, GAMET Municipal Corporation proposed to set up an Integrated Solid Waste Management (ISWM) project on PPP mode for management of municipal solid waste. The city did not have a proper collection and processing system. MSW management was limited to direct and unsafe dumping of waste in a low lying area, prior to this project.

ISWM project at GAMET is the first MSW project developed in India on the bundled mode. The motivation for bundling is attributed to the desire of the public entity to deal with a single entity through well-defined objectives and parameters for monitoring project output specifications. This approach had been perceived as a measure to avoid instances of disputes, and co-ordination problems amongst the various components of the value chain. The ULB of GAMET (ULB-G) initiated the procurement process in 2006 and awarded the concession to the project company, SPV-

G, in 2008. The timeline of activities for MSW in GAMET city is presented in Table A2.1.1.

Table A2.1.1 Timeline of MSW Activities in GAMET City

Date	Event	Remark
2006	Preparation of DPR, Selection of Consultant.	200 TPD Composting Technology was recommended.
2007	Formation of SPV-G, Issue of EOI	In response to EOI, 13 Request for Quotations (RFQ) were received.
2008	Preparation of revised DPR (II)	DPR Vol 2 was prepared and submitted by SPV-G in January. Revised DPR proposed RDF plant and Composting;
	Concession agreement is signed between ULB-G and SPV-G	Contract signed based on unapproved DPR (DPR II) in February.
	Issue of RFQ, Concessionaire selection.	RFQ issued to 9 eligible bidders based on DPR-II (March). Developer was selected (July) and SPV Taken over by developer (September)
2014	Termination of Developer	As on termination in June, Energy from waste was not implemented. Concessionaire implemented 50 TPD compost plant, collection, transportation, and transportation as on termination.
2014	Appointment of NGO's	31 NGO's (for 31 Wards of the city) have been selected for door to door collection of MSW and transportation of MSW to secondary collection points or transfer stations for 2 years from 1st July.
2015	Issue of EOI of dry waste purchase centre.	Dry waste purchase centre and transfer station inaugurated in September
2016	Procurement for 2 bin system for households	2 numbers of heavy-duty waste HMHDPE bins (10 litres) satisfying ASTM standards by ULB-G (January).
2017	Other initiatives	Organic waste converter drying section at a transfer station, Installation of Drum Composting at various bulk organic waste generators.
	2nd-time appointment of NGO's	48 NGOs were selected for primary collection and transport till transfer station in 31 wards for 2 years (Sep).
2019	Issue of RFP for treatment	The ULB-G separated the collection and transportation from treatment and disposal. The RFP is issued for EFW project and disposal of residue in SLF.

2. CASE PEARL (P)

In 2008, the ULB of PEARL (ULB-P) came up with the largest ISWM project in India. The scope of the project includes the door-to-door collection, secondary collection and transportation, transfer station management and tertiary transportation, processing and disposals, remediation and closure of existing dumpsites. Timeline of the MSW activities in the city of PEARL is shown in Table A2.2.1.

Table A2.2.1 Timeline of the MSW Activities in PEARL City

Date	Event	Remark
15 Sep 2008	Issue of EOI and screening	Pre-bid conference is conducted on 11 Nov 2008
12 Feb 2009	Date of concessionaire selection	Evaluation of RFPs is carried on 20 Dec 2008
21 Feb 2009	CA is signed between ULB-P and REEL	The government did not transfer the collection rights to private sector till date.
Aug 2009	Selection of Independent Engineer (IE) out of 9 firms who has submitted their bids.	The initial term of the IE is 3 years.
Oct 2010	Site access provided for initiating development works	Nil
Jan 2011	Master Plan approved by Independent Engineer	Nil
Feb 2012	Readiness certificate issued by IE for 200TPD	Nil
18 Feb 2012	Commercial Operation date of Treatment and Disposal Facility	Revised COD. Totally delayed by around 10 years.
March 2012	Public hearing and environmental clearance	Nil
Oct 2013	Environmental clearance issued for 19.8 MW.	Amendment order to the environmental clearance has been issued by reducing the capacity of the MSW based power plant to 19.8 MW.
2018	Operation of 6 TPD plastic waste in a separate dedicated treatment facility of 15 TPD capacity.	Concessionaire established in partnership with Ventana, a plastic to energy company of India.
Dec 2019	Expected date of 19. 8 MW EFW plant.	Delayed by more than 10 years as opposed to a 2-year time period.

3. CASE CORAL (C)

CORAL is the capital city of a state. In 2006, the ULB of CORAL (ULB-C) planned to improve the civic conditions with a viable integrated solid waste management system. During the last two decades, the ULB-C sought twice to procure the MSW services through PPP mode. The first procurement happened in 2010/11 (hereafter SPV1-C) and subsequently again in 2015/16 (hereafter SPV2-C) due to its failure of the previous project. Two different firms were selection during these two consequent procurements. Nevertheless, both the times, the ULB-C has called the private sector to handle in a bundled mode of procurement. The background of the city before and during the project procurement is shown in Table A2.3.1.

Table A2.3.1 Background of CORAL City

Year	Waste Generated	Collection efficiency of MSW%	Extent of segregation%	Extent of MSW recovered (%)	HH
2011	400 TPD	NA	0%	--	NA
2013	450 TPD	82%	0%	0%	92%
2016	577 TPD	--	0%	--	60%

The financial plan of the SPV1-C project included a capital grant of ₹ 39.99 crore (£ 4.7 million) and tipping fee of ₹ 585 (£ 6.96) per tonne of MSW payable on a monthly basis. The costs as observed in various time periods is as approved under JnNURM is ₹ 51.39 crore (£ 6.11 million), as per technical sanction accorded to revised DPR is ₹ 57.97 crore (£ 6.90 million), and as per agreement is ₹ 60.43 crore (£ 7.19 million). The scope of PPP is to collect the waste from households; construct, operate and maintain the transfer stations; workshop facility for vehicle maintenance; compost plant; brick making plant; and sanitary landfill facility along with the secondary storage depots for all the wards. The financial details of SPV2-C are not accessible due to confidentiality reasons since the project is recently terminated. The timeline is shown in Table A2.3.2.

Table A2.3.2 Timeline of PPP Projects in CORAL City

Date	Event	Remark
August 2006	Preparation of DPR work awarded to MSV International Inc., USA.	
February 2009	Approval of DPR by the Central Sanctioning and Monitoring Committee (CSMC)	
September 2009	Submission of DPR to Urban Development Department (UDD).	
21st August 2010	Notice Inviting Tender	Eight bidders participated and shortlisted for tendering
Nov 2010	Pre-bid meeting	Attended by 08 firms
January 2011	Award of Project	
March 2011	Technical Sanction by UDD	
3rd June 2011	Concession Agreement signed between ULB-C and winning bidder.	Work started on March /April of 2011
June 2010	PMC cum TA selected	Tetra Tech India Ltd.
2014	Termination of Contract	Concessionaire left the project w.e.f Dec 31, 2013, after a three month warning period.
2015	Retendering of a brownfield project	Only one bidder submitted the bid. Hence, procurement is reinitiated due to lack of participation.
08 Aug 2015	Issue of Letter of intent to winning bidder	Had to start operation in 6 months but had delayed by 10 months.
2015		SPV1-C entered into a Concession Agreement with ULB-C on 31st October 2015.

Date	Event	Remark
2016	Start of operations	Concessionaire started their operations from May 1, 2016, with a delay of 10 months from the letter of award.
2019	Termination of Operations	The services were terminated by the ULB-C.

4. CASE EMERALD (E)

The project EMERALD has been procured as a regional treatment and landfill facility for six ULBs where the EMERALD development authority has steered all the project development and implementation responsibilities. The scope of the project is to erect a EFW plant of appropriate technology to handle mixed waste generated from the six ULBs. The project has been procured on Design-Build-Finance-Operate-Transfer (DBFOT) basis for a concession period of 25 Years. The project cost was estimated at ₹ 1000 crore (£ 0.11 billion). It followed the two-stage bidding process. 15 international and 22 national companies responded to the EOI stage. EOI stage aimed to assess the capacity of probable bidders and to take feasible techno-commercial inputs. The timeline of the project development process is given in Table A2.4.1. 18 companies participated when EMERALD development authority invited bids. The project was awarded to the winning bidder consortium comprising of Indian and international partners in May 2013. However, the bid was cancelled citing the reason that the bidder did not have a proven track record. Since then, the authority is planning to construct the plant on its own and outsource the operation and maintenance of the project. However, the project has not been procured thus far.

Table A2.4.1 Timeline of the MSW Activities in EMERALD

Date	Event	Remark
July 2008	Prefeasibility studies report	All India Institute of Local Self-Government submitted the prefeasibility studies report.
Feb 2009	Feasibility Studies	In 2011, NEERI submitted following: 1.Waste Characterization Study (NEERI) 2.Transport Infrastructure Assessment (NEERI + IIT) 3.Techno Commercial Assessment (NEERI + TCE) 4.Financial Plan (NEERI + KPMG) 5.Institutional Mechanism and Policy (NEERI + NSWAI)
Aug 2009	Environmental clearance	Public hearing is conducted and report submitted for environmental clearance.
Dec 12, 2010	EOI for TA services II	
Sep 2010	Appointment of TA	KPMG appointed for transaction advisor for bid preparation and bid process management
2010	Project was initiated	-
Oct 2011 (?)	Environmental clearance	-

Date	Event	Remark
Dec 25, 2011	Initiation of Bid process	Bid process management is initiated with the call for request for qualification.
April 2012	Bids invited	-
May 2013	Award to REEL Consortium on PPP basis	-
May 4, 2013	Approved by EC	-
July 5, 2013	Letter of Award (LOA) issued	-
Late 2015	Termination of project	State government terminated the project even before it is commissioned. Commissioning should happen within 2.5 years after Letter of Award is issued

Legend:
TCE-Tata Consulting Engineers; NEERI - National Environmental Engineering Research Institute; IIT- Indian Institute of Technology; NSWAI - National Solid Waste Association of India;

5. CASE SAPPHIRE (S)

In 2007, the ULBs' have commissioned a feasibility study to identify strategies to improve the MSWM and to meet the statuary requirements. The report of the feasibility study had highly valued and strongly recommended the role of NGOs to achieve 100% door to door collection. Subsequently, report envisaged that separating treatment and disposal components i.e. unbundling strategy might pave way to prepare a cost-recovery formula to the collection and transportation services of the ULBs. The feasibility report posited that such a mechanism can result in better control of collection and transportation operations. The feasibility study also recommended that NGOs can be gradually extended to other components of MSW management and monitoring if they are successful. Accordingly, the ULBs' sought to revamp the existing collection and transportation by outsourcing contracts from private operators and NGOs. The procurement of PPP project for treatment and disposal was initiated.

The project was designed with the capacity to handle 300 tonnes per day. The scope of the project includes development, construction, operation & maintenance of the three transfer stations cum Material Recovery Facilities with a common processing facility of compost plant and any other suitable processing plant(s) such as RDF to power, a non-incineration-based energy from waste technology facility to generate 2.9 MW power and development, construction, operation & maintenance of sanitary landfill facility including post-closure monitoring. The plant was scheduled to complete by mid-2014. The tipping fee was ₹ 500 (£ 5.95) for every tonne of garbage transferred from the towns to the plant site. Timeline of the project is shown in Table A2.5.1.

Table A2.5.1 Timeline of MSW Activities Concerning SAPPHIRE

Date	Event	Remarks (If any)
July 2007	DPR 1st draft	In-vessel composting is the proposed technology
April 2008	Revised DPR submitted to ULB-S	Approved by Central Sanctioning and Monitoring Committee (CSMC).
Jan 2009	Award of project	Project Awarded to winning bidder (30/01//2009) at cost of ₹ 44.21 crore (£ 5.26 million) and formation of SPV on 16/06/2009.
Mar 2012	Termination of project	Breach of contract led to termination on 21/03/2012 as winning bidder did not reach financial closure
Aug 2012	Invitation of bids and Issue of Request for Proposal (RFP)	The RFP has four parts namely 1. Invitation for Bids, 2. Instruction for bidders, 3. Draft Concession Agreements, 4. Project Information Memorandum.
2012	Reorganisation of the project	One of the participant ULBs has been added to a 'city corporation' and is hence removed from this project. So the lead ULB added four more small ULBs to meet the waste volume requirement.
Nov 2012	Award of Contract	4 bidders participated and 1 bidder was selected, The cost of the project is ₹ 99 crore (£ 11.78 million).
2013	Project DPR submitted by concessionaire	
Oct 2014	75% of the Project Completed	The scheduled date of completion is June 30, 2014
July 2015	Receiving of waste	The plant started to receive waste
Oct 2015	Amendment to Concession Agreement dated 19/10/2015	The commercial operation date (COD) is split to COD 1 and COD 2; allowed any suitable technology instead of non-incineration based technology specification in the RFP and concession agreement.
July 2016	Selling of Compost	Tripartite agreement of ULBs with a notable fertilizer company and concessionaire for selling of about 220 tonnes of compost that is produced.
April 2018	Decentralisation of organic waste treatment in SAPPHIRE towards zero waste	Initiation of onsite and micro composting centres by ULBs to handle waste effectively
Nov 2018	Termination notice issued	Failure to begin electricity production from municipal waste has been cited as the primary reason.

6. CASE DIAMOND (D)

The ULB of DIAMOND (ULB-D) adopted unbundling strategy as an approach for waste management as shown in Table A2.6.1. Timeline of various activities and the projects undertaken by the DIAMOND city is shown in Table A2.6.2. As per the unbundling strategy, collection and transportation responsibilities are carried by both

ULB-D and the private operators since 2003 under short term contracts by paying tipping fee per tonne of waste collected. The ULB-D faced a calamity due to poor management of waste in the mid-1990s. Since then, MSWM has been a top priority in this ULB's activities and this is reflected in having a 98% collection efficiency in 2005. The action plans involve all the government, NGOs, civil society and the private sector.

Table A2.6.1 Services Procurement Strategy of DIAMOND city

Project/Scope	**PPP model**	**Concession period**
Primary collection through door-to-door garbage collection	Service Contract	1year/7 years
Construction of semi-closed type transfer station (TS) and transportation of waste to landfill site	BOO	10 years
and maintenance of semi-closed type transfer station (TS) to landfill site	BOO	10 years
400 TPD MSW process plant using composting technology	BOOT	30 years
600 TPD energy from waste plant under Phase II development:	BOOT	25 years
400 TPD integrated waste treatment and management plant in Phase III	BOOT	25 years
Disposal	No	Not applicable

Other supplementary initiatives to the MSW activities of ULB-D are extensive IEC activities by high-level management; 'GRANT Scheme' to promote decentralised waste treatment of organic waste. These coordinated efforts have resulted in good improvement in the collection component of the MSW supply chain. For instance, the collection efficiency of MSW is 99.34%, and the household coverage is 100%. However, these efforts have not resulted in expected levels of segregation and recovery of waste. The total extent of segregation is less than 1% while the extent of MSW recovered is 28.76% as of 2018. The ULB-D gradually wanted to go to the next level of waste management by mandating source segregation and establishing a separate supply chain for wet and dry waste, from 2018 Jan.

On the other hand, transportation from transfer stations till the landfill site is done by multiple private agencies according to zones of the ULB-D. Thirdly, treatment projects are still in the pipeline. Currently, around 600 TPD is treatment through composting (300 TPD) and generating RDF (300 TPD) of the total 1400 tonne of waste generated per day. Three treatment plants are underway and little interest in the private sector is observed in these procurements. The first project is terminated. The second and third project are yet to start commercial operations. The SPV3-D had a capital cost of ₹ 204.48 crore (£ 24.34 million) for 11.5 MW treatment project. This expenditure

is offset by the levellised tariff of ₹ 7.74 (£ 0.09) per kWh of power supplied to the state grid. Sanitary landfill is constructed under EPC contract in a ready-for-use state within the landfill that is spread over 188 hectares of land. The operations of constructing the cells in the sanitary landfill are carried by ULB-D. Once the site is full, The ULB-D aims to float a tender for layer capping, which will cost about ₹ 50 crore (£ 5.95 million).

Table A2.6.2 Timeline of MSW activities in DIAMOND city

Year	Event	Remarks (If any)
2001	Start of d2d services by ULB-D	--
2003	Start of d2d services through private sector	The ULB-D has started to employ private sector and NGOs to carry out unsegregated waste from households on tipping fee basis. 60% of garbage is collected by private sector by 2005
2004	Formation of SPV1-D	The selected concessionaire must establish EfW plant of BOO base for a concession period of 30 years at the approximate cost of ₹ 226 crore (£ 26.90 million) for deriving energy from MSW. This project failed and SPV is currently under process of striking off[5].
2006	Construction of first Transfer station	The ULB-D realized that construction of transfer station is essential for cost-effective waste management. The mode adopted was EPC contract.
2007	Formation SPV2-D	The ULB-D selected the concessionaire for establishing a compost and RDF to power plant in BOOT modal on tipping fee basis with no upfront grant from the ULB.
2011	Formation SPV3-D	The ULB-D selected the concessionaire in which royalty of ₹ 30 (£ 0.4) per tonne of waste is offered to ULB-D. Letter of intent issued on 21/09/2011.
2014	Construction of last existing transfer station	The ULB-D opted BOO model for 10 years' concession for construction and operation on tipping fee basis.
2014	Procurement of fourth treatment plant	Due to lack of bidders who are interested, the procurement is scrapped
2016	Second call for procurement	The project did not achieve enough competition
2017	Commissioning of Centralized Plastic Waste Management Plant of 20 TPD capacity	To handle the plastic in the MSW, ULB-D opted a speciality contractor to treat the segregated plastic waste.

■

[5] removing the name of the **Company** from the **Register of Companies**

APPENDIX A

LIST OF INTERVIEWS AND VISITS

The list of site/office visits carried for the current study is shown in Table A.6.1 and the list of interviews carried for the current study is shown in Table A.6.2.

Table A.6.1 Details of Site/Office Visits

ID	Information Category	Organization	Documents
1	Office Visit	ULB-G	~900 pages
2	Site Visit	ULB-P	--
3	Site Visit	ULB-G	--
4	Office Visit	NGO	~50 pages
5	Office Visit	NGO	~20 pages
6	Office Visit	NGO-G	
7	Office Visit	ULB-E	~500 pages
8	Office correspondence	ULB-C	~ 150 pages
9	Office Visit	ULB-P	~190 pages
10	Office Visit	ULB-S	~600 pages
11	Site Visit	ULB	
12	Office correspondence	ULB-D	~400 pages
13	Office Visit	ULB	--
14	Site Visit	ULB-S	--
15	Office Visit	ULB-S	~100 pages
16	Project Monitoring[6]	ULB	Online
17	Office Correspondence	ULB	~50 pages
			~2800 pages

Table A.6.2 Details of Interviewees

ID	Stakeholder	Position	Duration
1	Academic/TA	Research Professor and MSW Technology specialist	45 min
2	NGO	MSW Collection Manager	20 min
3	NGO	MSW Collection Manager	20 min
4	NGO	Director	20 min
5	NGO	Collection employee	20 min
6	Private	Project Administrator	40 min
7	Private	Assistant Manager - Operations	30 min
8	Private	Assistant Manager - EHS	30 min
9	Private	Plant Head	1 hr 21 min
10	Private	National Head	1 hr 20 min
11	Private	Project Manager and Plant Head	2 hr 10 min

[6] Accessed on Jan 31, 2019; http://www.erc.mp.gov.in/esc.aspx

List of Interviews and Visits

ID	Stakeholder	Position	Duration
12	Private	Project Director - PEARL, GAMET, and other projects.	2hrs
13	Public	Environmental Specialist	30 min
14	Public	Medical officer of Health	20 min
15	Public	Project Officer	1hr 10 min
16	Public	Environmental Specialist	30 min
17	Public	Superintending Engineer	30 min
18	Public	Environmental Engineer	30 min
19	Public	Assistant Engineer	1 hr 20 min
20	Public	Municipal Engineer	20 min
21	Public	Superintendent Engineer – SWM (former)	1hr 20 min
22	Public	Superintendent Engineer	40 min
23	Public	Municipal Engineer	2 hrs
24	Public	Officer on Special duty	1 hr 30 min
25	Public	Chief Scientific Officer	25 min
26	Public	Executive Engineer	30 min
27	Public	Assistant Executive Engineer	1 hr 35 min
28	Public	Municipal Engineer	40 min
29	Public	Superintendent Engineer, SWM	1:30 min
30	Public	Sanitary Officer and Project In-charge	1 hr 20 min
31	Public	Superintendent Engineer	40 min
32	TA	Freelance Consultant & PWC	1hr 15 min
33	TA	Freelance Consultant - MSW	40 min
34	TA	MSW Specialist	1hr
35	TA	MSW Expert	1 hr 40 min
36	TA	Principal Adviser	1hr 20 min
37	TA	MSW Expert	2 hr 25 min
38	Public	Executive Director	25 min
39	Public	Project Director - Energy from waste Projects	30 min

Legend: TA - Transaction Advisory; NA – unknown/not available; Names of the interviewees and organisations are not presented due to privacy agreements.

APPENDIX B

DATA COLLECTION INSTRUMENTS

PART A - Professional Information

We would be grateful if you could share your experiences in the relevant areas. Once again we would like to assure you that this information would be treated **confidential**.

1. Professional information

a. ***Expert's Name*** :-

b. ***Organization*** :-

c. ***Position in the Organization*** :-

d. ***Contact Phone/Cell No.*** :-

e. ***Email Address*** :-

2. Educational qualification (please tick or underline any that apply)

☐ Undergraduate degree ☐ Postgraduate degree ☐ Postgraduate diploma

☐ Doctorate ☐ Other (please specify):

3. Representing which stakeholder in PPP infrastructure projects (please tick/underline any that apply)

☐ Public Sector ☐ Private sector ☐ Financial Institution

☐ Transaction Advisor ☐ NGO ☐ Research/Academics

4. Years of experience in PPP infrastructure projects (please tick/underline any that apply)

☐ Less than one Year ☐ In between 1-5 Years ☐ In between 6-10 Years

☐ In between 11-15 Years ☐ In between 16-20 Years ☐ More than 20 Years

5. Experience in number of PPP infrastructure projects developed (please tick any that apply)

☐ 0 (nil) ☐ In between 1-10 Numbers ☐ In between 11-20 Numbers

☐ In between 20-35 Numbers ☐ In between 35-50 Numbers ☐ More than 50 Numbers

6. Experience in number of Municipal Solid Waste (MSW) PPP infrastructure projects developed (please tick any that apply)

☐ 0 (nil) ☐ In between 1-10 Numbers ☐ In between 11-20 Numbers

☐ In between 20-35 Numbers ☐ In between 35-50 Numbers ☐ More than 50 Numbers

PART B - Survey Questions – *Attractive features of PPP Projects - LEVEL 1 Questions*

Please rate the following statements based on a Likert scale from 1 – 5, where **1 represents the "Strongly disagree"**; **5 represents the "Strongly agree"**;

Attractive Factors of PPP Mode					
1. Please rate the attractive factors for adopting PPP instead of traditional procurement	**1**	**2**	**3**	**4**	**5**
a) Solve the problem of public sector budget restraint	☐	☐	☐	☐	☐
b) Provide an integrated solution (for public infrastructure / services)	☐	☐	☐	☐	☐
c) Reduce public money tied up in capital investment	☐	☐	☐	☐	☐
d) Cap the final service costs	☐	☐	☐	☐	☐
e) Facilitate creative and innovative approaches	☐	☐	☐	☐	☐

f)	Reduce the total project cost	☐	☐	☐	☐	☐
g)	Save time in delivering the project	☐	☐	☐	☐	☐
h)	Transfer risk to the private partner	☐	☐	☐	☐	☐
i)	Reduce public sector administration costs	☐	☐	☐	☐	☐
j)	Benefit to local economic development	☐	☐	☐	☐	☐
k)	Improve buildability	☐	☐	☐	☐	☐
l)	Improve maintainability	☐	☐	☐	☐	☐
m)	Technology transfer to local enterprise	☐	☐	☐	☐	☐
n)	Non-recourse or limited recourse to public funding	☐	☐	☐	☐	☐
o)	Accelerate project development	☐	☐	☐	☐	☐
p)	Comply to the MSW Rules set by the government.	☐	☐	☐	☐	☐
q)	Others (please specify)	☐	☐	☐	☐	☐

Negative Factors of PPP Mode

2.	**Please rate the negative factors for adopting PPP arrangements**	**1**	**2**	**3**	**4**	**5**
a)	Reduce the project accountability	☐	☐	☐	☐	☐
b)	High risk relying on private sector	☐	☐	☐	☐	☐
c)	Very few schemes have actually reached the contract stage (aborted before contract)	☐	☐	☐	☐	☐
d)	Lengthy delays because of political debate	☐	☐	☐	☐	☐
e)	Higher charge to the direct users	☐	☐	☐	☐	☐
f)	Less employment positions	☐	☐	☐	☐	☐
g)	High participation costs	☐	☐	☐	☐	☐
h)	High project costs	☐	☐	☐	☐	☐
i)	A great deal of management time spent in contract transaction	☐	☐	☐	☐	☐
j)	Lack of experience and appropriate skills	☐	☐	☐	☐	☐
k)	Confusion over government objectives and evaluation criteria	☐	☐	☐	☐	☐
l)	Excessive restrictions on participation	☐	☐	☐	☐	☐
m)	Lengthy delays in negotiation	☐	☐	☐	☐	☐
n)	Others (please specify)	☐	☐	☐	☐	☐

End of Interview

PART C - Validation of Technologies' Risk Profile – **Level 2 Questions**

Guidelines: On the basis of earlier exploratory study, we have found that risk profile of MSW project varies with processing technology. The risk profile found out is given below. We would like to seek your opinion on the appropriateness of this profile.

(1) Strike the circle of your choice related to risk intensity in the following matrix of risks. Ex: ⃠

① represents 'Very Low' Risk
② represents 'Low' Risk
③ represents 'Medium' Risk
④ represents 'High Risk'
⑤ represents 'Very High' Risk

You may choose to respond for technologies that you have handled.

MSWM projects risk profile

Sn	Risk	Biomethanation	RDF to power	Incineration	Pyrolysis and Gasification
1	Delays in Land acquisition	①②③④⑤	①②③④⑤	①②③④⑤	①②③④⑤
2	Supporting utilities risk	①②③④⑤	①②③④⑤	①②③④⑤	①②③④⑤
3	Financing risk	①②③④⑤	①②③④⑤	①②③④⑤	①②③④⑤
4	Planning risk	①②③④⑤	①②③④⑤	①②③④⑤	①②③④⑤
5	Permits and Clearance risk	①②③④⑤	①②③④⑤	①②③④⑤	①②③④⑤
6	Design risk	①②③④⑤	①②③④⑤	①②③④⑤	①②③④⑤
7	Technology risk	①②③④⑤	①②③④⑤	①②③④⑤	①②③④⑤
8	Completion risk	①②③④⑤	①②③④⑤	①②③④⑤	①②③④⑤
9	Operations and maintenance risk	①②③④⑤	①②③④⑤	①②③④⑤	①②③④⑤
10	Environmental health and safety risk	①②③④⑤	①②③④⑤	①②③④⑤	①②③④⑤
11	Waste Volume risk	①②③④⑤	①②③④⑤	①②③④⑤	①②③④⑤
12	Revenue risk	①②③④⑤	①②③④⑤	①②③④⑤	①②③④⑤
13	Market risk	①②③④⑤	①②③④⑤	①②③④⑤	①②③④⑤
14	Waste collection and segregation risk	①②③④⑤	①②③④⑤	①②③④⑤	①②③④⑤
15	Handover risk / Terminal value risk	①②③④⑤	①②③④⑤	①②③④⑤	①②③④⑤
16	Force Majeure	①②③④⑤	①②③④⑤	①②③④⑤	①②③④⑤
17	Concessionaire risk	①②③④⑤	①②③④⑤	①②③④⑤	①②③④⑤
18	Sponsor risk	①②③④⑤	①②③④⑤	①②③④⑤	①②③④⑤
19	Indirect Political Risk	①②③④⑤	①②③④⑤	①②③④⑤	①②③④⑤
20	Direct Political Risk	①②③④⑤	①②③④⑤	①②③④⑤	①②③④⑤
21	Insufficient households	①②③④⑤	①②③④⑤	①②③④⑤	①②③④⑤
22	Competition	①②③④⑤	①②③④⑤	①②③④⑤	①②③④⑤

The same survey is also available online at the following link

Please tick in appropriate location for parties bearing risk:

Sl. No	Risk	Gov	Private	Shared	Others Please specify
1	Delays in Land acquisition				
2	Supporting utilities risk				
3	Financing risks				
4	Planning risks				

Sl. No	Risk	Gov	Private	Shared	Others Please specify
5	Permits and Clearance risk				
6	Design risk				
7	Technology risk				
8	Completion risk				
9	Operations and maintenance risk				
10	Environmental health and safety risk				
11	Waste Volume risk				
12	Revenue risk				
13	Market risk				
14	Waste collection risk				[E.g: NGOs]
15	Handover risk / Terminal value risk				
16	Force Majeure				
17	Concessionaire risk				
18	Sponsor risk				
19	Indirect Political Risk				
20	Direct Political Risk				
21	Insufficient households				
22	Competition (exclusive right)				

End of Interview

Semi structured interview question for guidance – LEVEL 3 Questions

1. What were your aims when you are procuring this project? Please elaborate?
2. What was the selection process in your process? Explain? What kind of selection parameters you had?
3. Does private sector perform any waste characterization studies in this project or they relied on the results from DPR?
4. It is observed that contracting parties are only able to structure projects with single bidding parameter in the final stage of financial proposals by which selection is dependent on. What are the reasons of heavy reliance on tipping fee as a single bidding parameter?
5. It is observed that contracting parties are only able to structure projects with single bidding parameter in the final stage of financial proposals by which selection is dependent on. What are the reasons of heavy reliance on tipping fee as a single bidding parameter?
6. How detail were the proposals submitted by bidder(s) in this project?
7. Please briefly explain how the output specifications are set out in the RFPs and how they were arrived? Are they performance based? [yes/no] what factors you consider to finalize the output specifications?
8. Does the private sector ask for a period for testing?
9. The Works Requirements: Authority's works requirements are in relation to civil, mechanical and engineering works. How well is this taken care in Indian project procurement?
10. Do you think that the current tendering process is promoting competition amongst private sector?
11. Is private sector proactive in providing environmentally sound solutions [both in general and specific to your project]?
12. Is private sector given enough flexibility to submit proposal with innovative solutions for treatment of solid waste? Or, private sector has to limit to the

technology recommendations given in DPR or the requirements advocated by the executing ULB? Is private sector given enough freedom in utilizing their expertise in adopting new technology for the project they want to take up?

13. Have you followed the standard guidelines given by MOUD and/or PPP Toolkit? If not, please brief on the problems in following?
14. Are there any penalty clauses such as reduced payments for not meeting or adhering to standards in PPP SWM projects? [Yes/No]
15. How effective are penalty clauses in regulating the private sector to meet the project objectives?
16. Performance based tipping fee [poor collection efficiency or not lifting the waste from households and commercial establishments at designated points of collection will attract penalty]
17. What is the extent of government guarantee in the case of PPP SWM projects?
18. Are there any clauses for rewarding or incentivizing the private sector in general for PPP SWM project? How does it work?
19. What are the sources of revenue in this project? Is there scope for any other source of revenue generation, which can be considered as viable model, in case of your project? Any other viable sources of revenue enlightened you after running the project for some time?
20. Are you aware of the fact that there are tax rebates in the SWM projects?
21. Is there any contractual provision in concession agreements for the development rights of post landfill closure site to make as golf course or public parks etc.? If no, please present your reason if we want to incorporate them?
22. What is the extent of government guarantee in the case of PPP SWM projects?
23. Are there any clauses for rewarding or incentivizing the private sector in general for PPP SWM project? How does it work?
24. What are the sources of revenue in this project? Is there scope for any other source of revenue generation, which can be considered as viable model, in case of your project? Any other viable sources of revenue enlightened you after running the project for some time?
25. Are you aware of the fact that there are tax rebates in the SWM projects?
26. Is there any contractual provision in concession agreements for the development rights of post landfill closure site to make as golf course or public parks etc.? If no, please present your reason if we want to incorporate them?

End of Interview

PART D - ***Implications of bundling in PPP MSW Supply chain – Research Overview - LEVEL 3, 4 Questions***

Research Question:

This Study seeks to ask whether the collection, transportation, treatment and operation should be delegated to single private concession or multiple separate projects under PPP mode.

I. Motivations for Bundling

Please rate the following statements based on a Likert scale from 1 – 5, where **1 represents "Very Unlikely"**; **5 represents "Very Likely"**; and select **"N/A"' if you are uncertain in rating a particular statement**.

1. Please rate the factors favoring the phenomenon of employing single PPP concessionaire instead of traditional procurement or more than single PPP contracts for various components of PPP supply chain	1	2	3	4	5	N/A
How likely it is to integrate the collection, transportation, treatment, and disposal into a single PPP concession project?	☐	☐	☐	☐	☐	☐
Available funds for SWM project with the ULB play role in framing the structure i.e. what components (Collection/Transportation /Treatment/Disposal) will be given to private sector and what components will not be given to private sector (C/T/T/D).	☐	☐	☐	☐	☐	☐
	☐	☐	☐	☐	☐	☐
Others (please specify)	☐	☐	☐	☐	☐	☐

II. Innovation

Please rate the following statements based on a Likert scale from 1 – 5, where **1 represents the "Least Important"**; **5 represents the "Most Important"**; and select **"N/A"' if you are uncertain in rating a particular statement**.

2. Please rate the factors for adopting PPP arrangements for performance measures related to *life cycle innovation*	1	2	3	4	5	N/A
How important is making innovations in MSW sector?	☐	☐	☐	☐	☐	☐
Please rate the innovation capability of private sector in terms of						
○ Financing mechanisms and ability to raise funds for capital and operational investments without expectation of upfront grant from government.	☐	☐	☐	☐	☐	☐
○ Product innovation (such as the kind of technologies for treating the waste)	☐	☐	☐	☐	☐	☐
○ Process innovation (like the way collection and transportation are carried)	☐	☐	☐	☐	☐	☐
○ Quality innovation (such as the way they are able to comply to the standards prescribed by government in terms of quality of leachate discharge, quality of air emission, quality of compost, ground water quality, efficiency in the collection and transportation system etc.)	☐	☐	☐	☐	☐	☐
	☐	☐	☐	☐	☐	☐
Others (please specify)	☐	☐	☐	☐	☐	☐

III. Performance Measures

Please rate the following statements based on a Likert scale from 1 – 5, where **1 represents the "Least Important"**; **5 represents the "Most Important"**; and select **"N/A"' if you are uncertain in rating a particular statement**.

3. Please rate the factors related to performance in MSW projects and its measurement in connection to bundling of MSW supply chain.	1	2	3	4	5	N/A
How well the performance measures that are usually employed in case of PPP SWM projects are met by the private sector?	☐	☐	☐	☐	☐	☐
How will you rate the kind of innovations by private sector at present?	☐	☐	☐	☐	☐	☐
How important is meeting the performance standards in SWM sector when compared to other infrastructure sectors?	☐	☐	☐	☐	☐	☐
Others (please specify)	☐	☐	☐	☐	☐	☐

IV. Maturity of Markets

Please rate the following statements based on a Likert scale from 1 – 5, where **1 represents the "Strongly disagreed"**; **5 represents the "Strongly Agreed**; and select **"N/A"' if you are uncertain in rating a particular statement**.

4. Please rate the factors related to the current market conditions favoring or opposing the bundling of MSW supply chain.	**1**	**2**	**3**	**4**	**5**	**N/A**
Private sector has successfully exhibited competency in the following components in the past						
○ Collection – *Very low* ①②③④⑤ *Very High*.	☐	☐	☐	☐	☐	☐
○ Transportation – *Very low* ①②③④⑤ *Very High*.	☐	☐	☐	☐	☐	☐
○ Treatment – *Very low* ①②③④⑤ *Very High*.	☐	☐	☐	☐	☐	☐
○ Disposal – *Very low* ①②③④⑤ *Very High*.	☐	☐	☐	☐	☐	☐
When more number of projects are successful, then we can say that the sector is mature! (***maturity***: the state that private sector has exhibited through understanding and good compliance/implementation of projects)	☐	☐	☐	☐	☐	☐
Do you think the MSW sector is mature and the market is mature for single PPP concession projects in MSW across India?	☐	☐	☐	☐	☐	☐
Others (please specify)	☐	☐	☐	☐	☐	☐

V. Economies of Scope

Please rate the following statements based on a Likert scale from 1 – 5, where **1 represents the "Strongly disagreed"**; **5 represents the "Strongly Agreed"**; and select **"N/A"' if you are uncertain in rating a particular statement**.

5. Please rate the factors related to economies of scope that can be achieved if we bundling the components of MSW supply chain.	**1**	**2**	**3**	**4**	**5**	**N/A**
Do you think the cost/tonne of waste gets reduces when the private sector is asked to do all the supply chain as compared to the cost/tonne when collection and transportation are considered as one project while treatment and disposal are considered as separate project?	☐	☐	☐	☐	☐	☐
	☐	☐	☐	☐	☐	☐
Single large private contractor for collection, transportation, treatment and disposal is able to reduce						
○ The cost of collection and transportation.	☐	☐	☐	☐	☐	☐
○ The cost of treatment and disposal.	☐	☐	☐	☐	☐	☐
Separate contracts with PPP contractors						
○ Would reduce the cost of collection and transportation	☐	☐	☐	☐	☐	☐
○ Would reduce the cost of treatment and disposal	☐	☐	☐	☐	☐	☐
Separating the "collection and transportation" from "treatment and disposal"						
○ **will reduce financial bid values** in the bidding process to yield services at cheaper price to public sector.	☐	☐	☐	☐	☐	☐
○ will allow **better quality services** to public sector.	☐	☐	☐	☐	☐	☐
○ will allow the ingress of **better technology based services** to public sector.	☐	☐	☐	☐	☐	☐
	☐	☐	☐	☐	☐	☐
	☐	☐	☐	☐	☐	☐
Others (please specify)	☐	☐	☐	☐	☐	☐

VI. Tendering to Subsidiaries

Please rate the following statements based on a Likert scale from 1 – 5, where **1 represents the "Strongly disagreed"**; **5 represents the "Strongly Agreed"**; and select **"N/A"' if you are uncertain in rating a particular statement**.

6. Please rate the factors connected to subsidiary tendering and bundling in MSW projects.	**1**	**2**	**3**	**4**	**5**	**N/A**
Of often you see the possibility of subcontracting or the bidder is asking some other party or company to perform?	☐	☐	☐	☐	☐	☐
Subcontracting is opted because the technology is new to private sector?	☐	☐	☐	☐	☐	☐
Subcontracting is opted because the size is too big to private sector to handle?	☐	☐	☐	☐	☐	☐
Subcontracting is opted because the private sector is not expert in all those areas and those components are sublet to other private parties/NGOs.	☐	☐	☐	☐	☐	☐
Subcontracting has increased the cost of to the public sector.	☐	☐	☐	☐	☐	☐
	☐	☐	☐	☐	☐	☐
Others (please specify)	☐	☐	☐	☐	☐	☐

VII. Quality Specifiability

Please rate the following statements based on a Likert scale from 1 – 5, where **1 represents the "Strongly disagreed"**; **5 represents the "Strongly Agreed"**; and select **"N/A"' if you are uncertain in rating a particular statement**.

7. Please rate the factors for specifying the quality/quantify in MSW PPP projects.	**1**	**2**	**3**	**4**	**5**	**N/A**
Were the project(s) able to meet the standards and specification of treatment and disposal for instance	☐	☐	☐	☐	☐	☐
○ Air quality? *Very low* ①②③④⑤ *Very High.*	☐	☐	☐	☐	☐	☐
○ Leachate treatment quality? *Very low* ①②③④⑤ *Very High.*	☐	☐	☐	☐	☐	☐
○ Compost Quality? *Very low* ①②③④⑤ *Very High.*	☐	☐	☐	☐	☐	☐
The current specifications followed are mostly of **input specifications of assets** to be built						
○ Collection	☐	☐	☐	☐	☐	☐
○ Transportation	☐	☐	☐	☐	☐	☐
○ Treatment	☐	☐	☐	☐	☐	☐
○ Disposal	☐	☐	☐	☐	☐	☐
The current specifications followed are mostly of **performance specifications**						
○ Collection	☐	☐	☐	☐	☐	☐
○ Transportation	☐	☐	☐	☐	☐	☐
○ Treatment	☐	☐	☐	☐	☐	☐
○ Disposal	☐	☐	☐	☐	☐	☐
The current specifications followed are mostly of **quality specifications** to be maintained						
○ Collection	☐	☐	☐	☐	☐	☐
○ Transportation	☐	☐	☐	☐	☐	☐
○ Treatment	☐	☐	☐	☐	☐	☐
○ Disposal	☐	☐	☐	☐	☐	☐
	☐	☐	☐	☐	☐	☐
Others (please specify)	☐	☐	☐	☐	☐	☐

VIII. Competition

Please rate the following statements based on a Likert scale from 1 – 5, where **1 represents the "Strongly disagreed"**; **5 represents the "Strongly Agreed"**; and select **"N/A"' if you are uncertain in rating a particular statement**.

8. Please rate the factors related to competition in PPP MSW projects	**1**	**2**	**3**	**4**	**5**	**N/A**

Separating the "collection and transportation" as one PPP contract and "treatment and disposal" as another PPP contract will allow more firms to participate in the bidding.	☐	☐	☐	☐	☐	☐
High number of private players (> 8 bidders) would turned up in final bidding stage in case the project is split into parts and called for private sector to do ***collection and transportation*** alone.	☐	☐	☐	☐	☐	☐
High number of private players (> 8 bidders) might have turned up in final bidding stage in case the project is split into parts and called for private sector to do ***treatment and disposal*** alone.	☐	☐	☐	☐	☐	☐
	☐	☐	☐	☐	☐	☐
Others (please specify)	☐	☐	☐	☐	☐	☐

IX. Information Asymmetry

Please rate the following statements based on a Likert scale from 1 – 5, where **1 represents the "Strongly disagreed"**; **5 represents the "Strongly Agreed"**; and select **"N/A"' if you are uncertain in rating a particular statement**.

9. Please rate the factors related to problems occurring during operations of MSW PPP projects.	**1**	**2**	**3**	**4**	**5**	**N/A**
Public sector is least aware of the action of private sector causing hidden actions						
o This has caused loss to public money/good	☐	☐	☐	☐	☐	☐
Public sector is least aware of the action of private sector causing hidden information						
o This has caused loss to public money/good	☐	☐	☐	☐	☐	☐
o Public sector/ ULB asked for compensation from private sector because of hidden action/information.	☐	☐	☐	☐	☐	☐
Private sector is least aware of the action of public sector causing hidden actions						
o This has caused loss to private sectors revenue/profit	☐	☐	☐	☐	☐	☐
Private sector is least aware of the action of public sector causing hidden information						
o This has caused loss to private sectors revenue/profit	☐	☐	☐	☐	☐	☐
o Private sector/ concessionaire asked for compensation from public sector because of hidden action/information	☐	☐	☐	☐	☐	☐
Private sector has more bargaining power in MSW projects	☐	☐	☐	☐	☐	☐
Public sector has more bargaining power in MSW projects	☐	☐	☐	☐	☐	☐
	☐	☐	☐	☐	☐	☐
Others (please specify)	☐	☐	☐	☐	☐	☐

X. Asset Specificity

Please rate the following statements based on a Likert scale from 1 – 5, where **1 represents the "Strongly disagreed"**; **5 represents the "Strongly Agreed"**; and select **"N/A"' if you are uncertain in rating a particular statement**.

10. Please rate the factors related to lock-in of assets related to MSW PPP projects.	**1**	**2**	**3**	**4**	**5**	**N/A**
There is no Impact on project timeline and/or budget if government decides to split the supply chain and replace the firm providing the service for a particular Component when project is given by unbundling mode to PPP concessionaire(s)	☐	☐	☐	☐	☐	☐
Single PPP project for the whole components of MSW have long and complex negotiations.	☐	☐	☐	☐	☐	☐
Single PPP project for the whole components of MSW has delays in project delivery.	☐	☐	☐	☐	☐	☐

X. Asset Specificity

High transaction cost are caused by long and complex negotiations and delays in project delivery	☐	☐	☐	☐	☐	☐
	☐	☐	☐	☐	☐	☐
	☐	☐	☐	☐	☐	☐
	☐	☐	☐	☐	☐	☐
Others (please specify)	☐	☐	☐	☐	☐	☐

XI. Transaction Costs

Please rate the following statements based on a Likert scale from 1 – 5, where **1 represents the "Strongly disagreed"**; **5 represents the "Strongly Agreed"**; and select **"N/A"' if you are uncertain in rating a particular statement**.

11. Please rate the factors related to transaction costs of PPP MSW projects.	**1**	**2**	**3**	**4**	**5**	**N/A**
There were demands on the increase of price/fee to private sector	☐	☐	☐	☐	☐	☐
There were indications of distress on the profit margin of private sector because of performance of technology	☐	☐	☐	☐	☐	☐
The technology is not very adoptive to these unforeseen circumstances such as poor segregation and quality of waste.	☐	☐	☐	☐	☐	☐
Others (please specify)	☐	☐	☐	☐	☐	☐

XII. Uncertainty

Please rate the following statements based on a Likert scale from 1 – 5, where **1 represents the "Strongly disagreed"**; **5 represents the "Strongly Agreed"**; and select **"N/A"' if you are uncertain in rating a particular statement**.

12. Please rate the factors related to uncertainty occurring in PPP MSW projects	**1**	**2**	**3**	**4**	**5**	**N/A**
MSW projects have reliable data sources.	☐	☐	☐	☐	☐	☐
Private sector is able to exhibit competency to build and operate the technologies of SWM projects.	☐	☐	☐	☐	☐	☐
Private sector/Concessionaire has enough historical records on the waste characterizations, seasonal variations, number of households who will provide the waste, number of users who will pay the fees for collection and transportation.	☐	☐	☐	☐	☐	☐
Public sector/ULB has enough historical records on the waste characterizations, seasonal variations, number of households who will provide the waste, number of users who will pay the fees for collection and transportation.	☐	☐	☐	☐	☐	☐
Project has seen Incidence of shut down of treatment plant.	☐	☐	☐	☐	☐	☐
Project has seen incidences of poor collection	☐	☐	☐	☐	☐	☐
Project has seen Incidences of operational failures.	☐	☐	☐	☐	☐	☐
Project has seen Incidence of poor compliance to the norms set of PCB/ CPCB/ Concession agreement	☐	☐	☐	☐	☐	☐
Uncertainty on performance of technology has effected the targeted cost of operations	☐	☐	☐	☐	☐	☐
Others (please specify)	☐	☐	☐	☐	☐	☐

End of Interview

APPENDIX C - PUBLICATIONS

Most of this material was published in 2019. Since the papers were originally written as stand-alone contributions, there is inevitably a little repetition, but the overlaps should be obvious. The papers that have been based on the present thesis are as follows:

I. **Dolla, T.,** and Laishram, B. (2017). "Bundling in PPP Network Infrastructure – A Theoretical Framework." *Urbanization Challenges in Emerging Economies: Moving Towards Resilient Sustainable Cities and Infrastructure, 12-14 December.* The American Society of Civil Engineers and IIT Delhi, New Delhi. 10.1061/9780784482025.039

II. **Tharun, D.** and Laishram, B. (2018), "Performance of Municipal Solid Waste Management Projects in India – An Exploratory Study", 8th International Conference on Sustainable Waste Management, Acharya Nagarjuna University, Guntur, Andhra Pradesh, India.

III. **Dolla, T.** and Laishram, B. (2018), "Governance issues in Public-private Partnerships – A Theoretical perspective", in Sarkar, A. and Gurumurthy, A. (Eds.), *XXII International Conference of the Society of Operations Management*, Indian Institute of Management Kozhikode, India., Kozhikode.

IV. **Dolla, T**. and Laishram, B. (2019), "Perception of Public-Private Partnership Experience in Municipal Solid Waste Projects", in Gopinath, S., Pati, R.K., Padhi, S. (Ed.), *5th PMI India Research and Academic Conference 2019-Project Management in the Emerging World of Disruption*, Kozhikode Publishers (PMI Organization Centre Pvt.Ltd), pp. 448–466.

V. **Dolla, T.** and Laishram, B. (2019), "Competition and Maturity for PPP Procurement - A Tale of 4 MSW Projects", *World Building Congress "Constructing Smart Cities" 17 – 21 June, 2019*, Hong Kong, China.

VI. **Dolla, T.** and Laishram, B.S. (2019), "Governance Issues in Public Utility Public–Private Partnerships: A Theoretical Perspective", *Journal of The Institution of Engineers (India): Series A*, p. In Press.

VII. **Dolla, T.** and Laishram, B. (2019), "Bundling/Unbundling decision in PPP infrastructure projects – The case of Guwahati city, India", *International Journal of Managing Projects in Business.* (In Press)

VIII. **Dolla, T.** and Laishram, B. (2019), "Bundling in Public-Private Partnership Projects – A Conceptual Framework", *International Journal of Productivity and Performance Management*. (In Press)

IX. **Dolla, T.,** and Laishram, B. (2019). Factors Effecting the Public-Private Partnership Procurement for Municipal Infrastructure of India. *International Journal of Construction Management*, 10.1080/15623599.2019.1703085

Under Review

I. Dolla, T., & Laishram, B. (2019). Effect of Energy from Waste Technologies on the Risk Profile of Public-Private Partnerships Waste Management Projects. *Journal of Cleaner Production*, **(Under Review**).

II. Dolla, T. and Laishram, B. (2019), "Framework for Bundling Analysis in Public-Private Partnership Procurement - A Multiple Case Study Approach", *Journal of Infrastructure Systems*, (**Under third Review**). ■

■ END OF THE THESIS ■