Thredbo 16

Public Bus Service Contracting : A Critical Review and Future Research Opportunities

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Outline

- Introduction
- Bibliometric Analysis
- Bus Contracting Model in Singapore
- Research Opportunities and Suggestions

Introduction to Public Bus Service Contracting

- **In-house provision by a *Public Monopoly***
  - Growing deficits and deteriorating service quality due to the absence of competition, swollen bureaucracy and redundant staff
- **Privatization and Deregulation**
  - Private operators are expected to be more efficient
  - Competition are encouraged by entry deregulation
- **Competitive Tendering (CT) Contract vs. Performance-based Negotiation Contract**
  - CT: (i) Regulated entry with quality control (ii) Prospective bus operators (e.g., fleet of minimum 250 buses)) submit their tenders that will be evaluated and selected by regulators.

Debate: Is it suitable to take the free-market mechanism (e.g., CT) for public bus service provision (quasi-public goods)?

Bibliometric Analysis - Summary

- **125 Relevant Publications from 1990 to 2019**

Top 5 source journals

Journal Title	Number of publications	Proportion
Research in Transportation Economics	36	28.8%
Transport Policy	20	16.0%
Transportation Research Part A: Policy and Practice	18	14.4%
Journal of Transport Economics and Policy	7	5.6%
Reforms in Public Transport	4	3.2%

Top 5 WoS categories (not necessarily mutually exclusive)

Category	Number of publications	Proportion
Transportation	104	83.2%
Economics	90	72.0%
Transportation Science Technology	31	24.8%
Engineering Civil	11	8.8%
Operations Research/Management Science	9	7.2%

Publication years

Time span	Number of publications	Proportion
2015-2019	57	45.6%
2010-2014	36	28.8%
2005-2009	18	14.4%
2000-2004	10	8.0%
1990-1999	4	3.2%

(i) Transportation Economics Research Community

(ii) Less attention

(iii) Growing interest

Bibliometric Analysis - Citation Analysis

- **VOSviewer**

Cluster 1: Promoting negotiated performance based contract

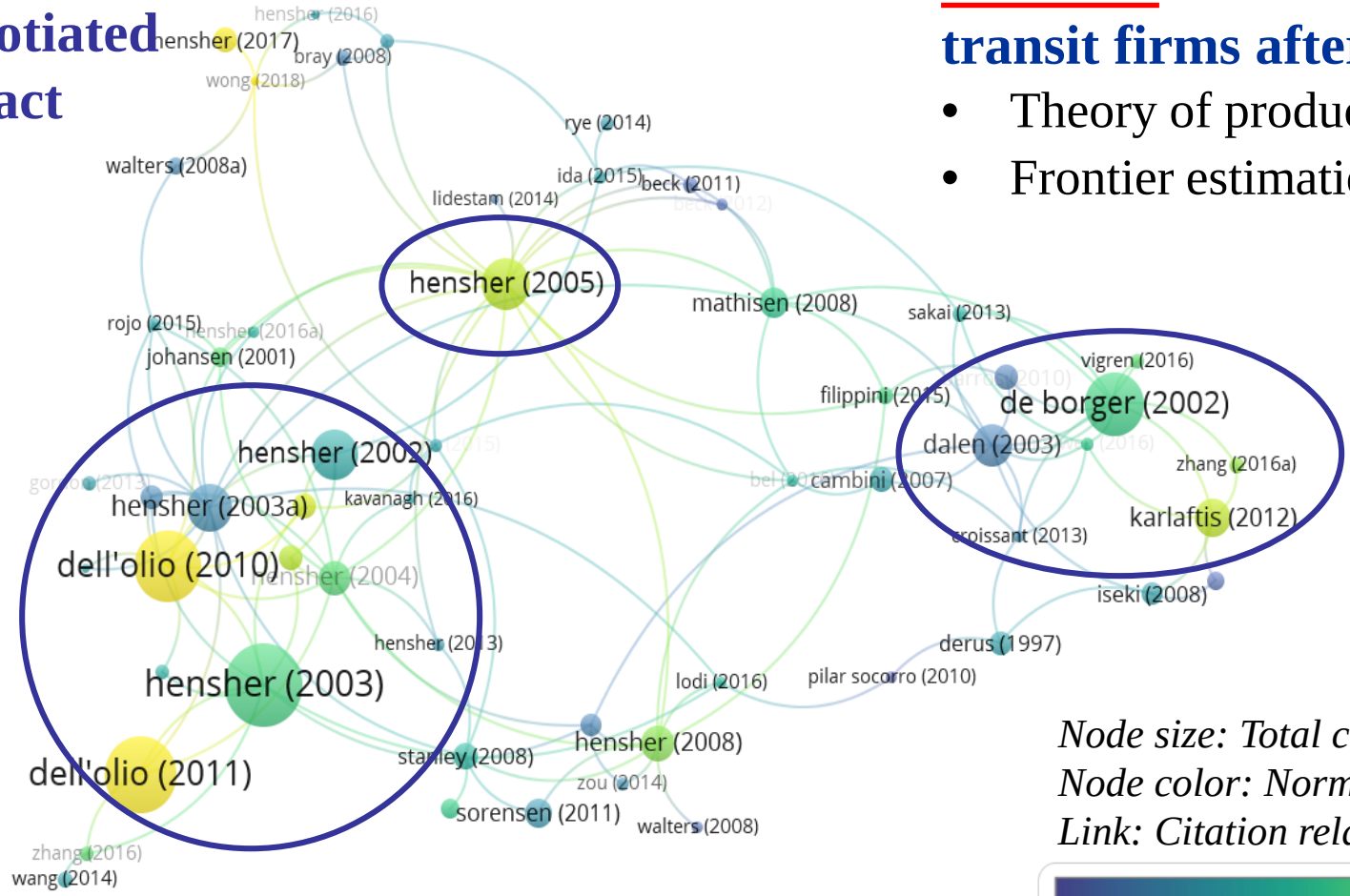
- Cases studies
- Qualitative analysis

Cluster 2: Measuring bus service quality

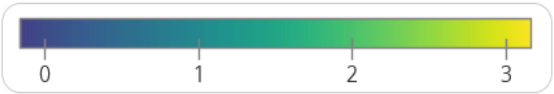
- SP surveys
- Discrete choice models

Cluster 3: Assessing efficiency of transit firms after contracting

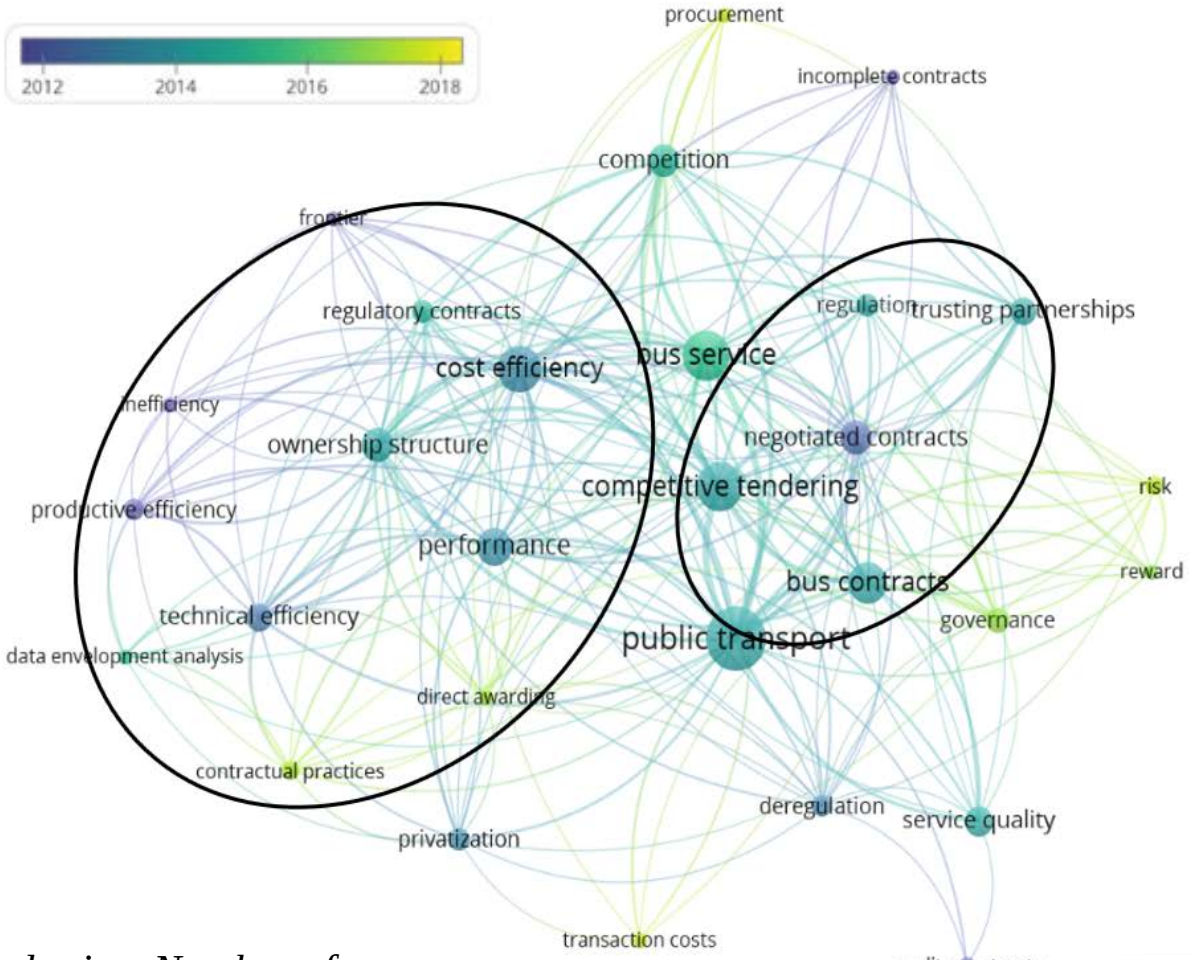
- Theory of productive efficiency
- Frontier estimation techniques



Node size: Total citations
Node color: Normalized citations
Link: Citation relation



Bibliometric Analysis - Keywords Co-occurrence Network



Node size: Number of occurrences
Node color: Average publication year
Link strength: Number of co-occurrences

➢ Impacts of bus service contracting

- From the perspective of authority and operator:
- Impacts on economic efficiency
- From the perspective of riders:
- Impacts on service quality and satisfaction of riders

➢ CT *versus* Negotiation

- Qualitative analysis
- Quantitative evaluation

Cluster #1: Competitive Tendering *versus* Negotiation

- **Sustainability of CT in respect of reducing costs and enhancing bus service quality?**
  - Winner's curse
    - Around 20%-30% operating cost reductions in the first several tendering rounds, however, the subsequent costs might surprisingly increase.
  - Possible reasons (*Hensher and Wallis, 2005*):
    - More informed bidding (e.g., less miss-estimates)
    - Less emphasis on retaining market share at all costs
    - Bidders taking a long-term perspective and demanding high profit margins
    - Decrease in number of bidders

Cluster #1: Competitive Tendering *versus* Negotiation (Cont.)

- Alternative contract awarding mechanisms

	Competitive Tendering	Negotiation
Contract price	**Determined by the bids submitted by competing operators**	Determined by cost benchmarking and negotiation
Transaction costs	Involving relatively high costs	**Involving relatively low costs**
Accountability and Transparency	**Transparent process of tender selection and good accountability for use of public funds**	Less transparency and less accountability
Requirement on regulator expertise	**Less requirement on regulator expertise**	Regulator should have enough knowledge of the benchmark cost and performance standards
Flexibility	Little room for operators in terms of flexibility and innovation	**Allowing for *ex post* adaptation to unforeseen contingencies**
Uncertainty of contract renewal	Subject to competition from prospective operators, including new entrants	**Contract is usually renewed with incumbent operators**
New entrants	**Less entry barriers**	More entry barriers
Long-term investment	Discouraging operators to invest due to uncertainty in contract renewal	**Encouraging operators to make long-term investment for service improvement**
Labour stability	Less stable	**More stable**

Cluster #1: Competitive Tendering *versus* Negotiation (Cont.)

➢ Several Findings

- The SMART contract management
  - Key performance indicators (KPIs) should be Specific, Measureable, Achievable, the Responsibility being assessed and Timely
- Trusting partnerships
  - The ***5C*** conceptual framework (*Stanley and Longva, 2010*)
- Recommended use of CT and NC
  - Use CT as initial market testing to provide information on benchmarking costs and performance standards
  - Use NC later to avoid the considerable transaction costs
  - CT becomes active again when operators fail to comply with the contractual obligations

Cluster #2: Measuring Quality of Bus Services

Dimensions of service quality from the perspective of passengers

	Pre-trip Attribute		Trip Attribute		On board Attribute
1	Information availability	5	Journey time	9	Seat availability
2	Walking time to bus stop	6	Bus fare	10	Safety within the bus
3	Bus stop facilities	7	Bus frequency	11	Driver attitude
4	Deviation from the optimal route	8	**On-time arrival performance at bus stop**	12	Comfort and Cleanliness

Sources: *Hensher et al. (2003); Dell'Olio et al. (2011).*

- SP surveys to reveal the preference of passengers over the hypothetical choice sets
- Weights of attributes are estimated based on the typical discrete choice models (e.g., multinomial logit or ordered probit model)
- The measured overall Service Quality Index (SQI) can be embedded into the contract as a benchmark

Cluster #3: Impacts of Bus Service Contracting

➢ From the perspective of authority and operator

- Examining the economic impacts of various bus contracting practices in different transit markets
  - Cost efficiency
  - Technical efficiency
  - Productive efficiency
- Data-driven research methodologies
  - Ordinary least squares (OLS) regression
  - Data envelopment analysis (DEA)
  - Stochastic frontier analysis (SFA)

- ***Targets***: costs (e.g., total operating cost, cost per vehicle kilometre, cost per vehicle hour) or supply-oriented outputs (e.g., vehicle-kilometre, seat-kilometre) or demand-oriented outputs (e.g., passenger-kilometre, number of passengers).
- ***Explanatory variables***: quantities and prices of inputs (e.g., vehicles, employees and fuel), peak-to-base ratio, average bus speed, network length, population density.

Cluster #2: Impacts of Bus Service Contracting (Cont.)

Representative empirical studies

Authors	Bus Market	Method	Data	Explanatory Variables related to contracting
Piacenza (2006)	Italy	SFA	Operator-level panel data, 1993-1999	Contract types
Roy and Yvrande-Billon (2007)	France	SFA	Network-level panel data, 1995-2002	Ownership structures, Contract types
Iseki (2010)	US	OLS	Operator-level panel data, 1992-2000	Levels of contracting (partial and full)
Karlaftis and Tsamboulas (2012)	Europe	SFA/ DEA	Country-level panel data, 1990-2000	Competitive tendering, Contract types
Amaral et al. (2013)	London	OLS	Route level panel data, 1999-2008	Number of bidders, Contract size, Incumbency
Scheffler et al. (2013)	Germany	SFA	Operator-level panel data, 2004-2009	Ownership structures, Competitive tendering
Zhang et al. (2015)	China	SFA	Operator-level panel data, 2008-2013	Contract types
Filippini et al. (2015)	Switzerland	SFA	Route level cross-sectional data, 2009	Procurement mechanisms
Vigren (2016)	Sweden	SFA	Contract-level cross-sectional data, 2013	Ownership structures, Contract length, Incentive
Rosell (2017)	Barcelona	SFA	Municipality-level panel data, 2007-2015	Ownership structures, Procurement mechanisms
Aarhaug et al. (2018)	Norway	OLS	Contract-level data, 1995-2017	Contract size, Contract types, Number of bidders
Ida et al. (2018)	Israel	OLS	Route-level panel data, 2011-2015	Contract types

1) Research methods dominated by **SFA**
2) Popular in major European cities
3) Varying magnitudes of cost savings are observed
4) Factors found to be **significant**:
   - Number of bidders
   - Package size
   - Level of contracting
   - Contract awarding mechanisms
   - Ownership structures
   - Contract types

Cluster #2: Impacts of Bus Service Contracting (Cont.)

2. From the perspective of riders

- Does the observed cost reductions come at the expense of deteriorating bus service quality or riders' satisfaction?

  This branch of study is scarce due to limited data.

  More evidences are needed to shed light on this debate.

Observations from Previous Studies

- The majority of studies come from the Transportation Economics literature
- The researches are dominated by *ex post assessments* based on either qualitative analysis or econometric models
- Few of them could provide any *ex ante* guidance or decision tools for the optimal design and control of bus service contracts

Call for operations research based models and tools

Bus Contracting Model (BCM) in Singapore: A Roadmap

Planning and Warming Up

2008

Intention to introduce Competitive Tendering (CT) to the bus industry

2012

Five-year *S$*1.1 billion Bus Service Enhancement Program (BSEP)

2013

LTA engages consultant CH2M Hill to study BCM in Singapore

2014

A two-year trial of Bus Service Reliability Framework (BSRF)

Implementing

2016

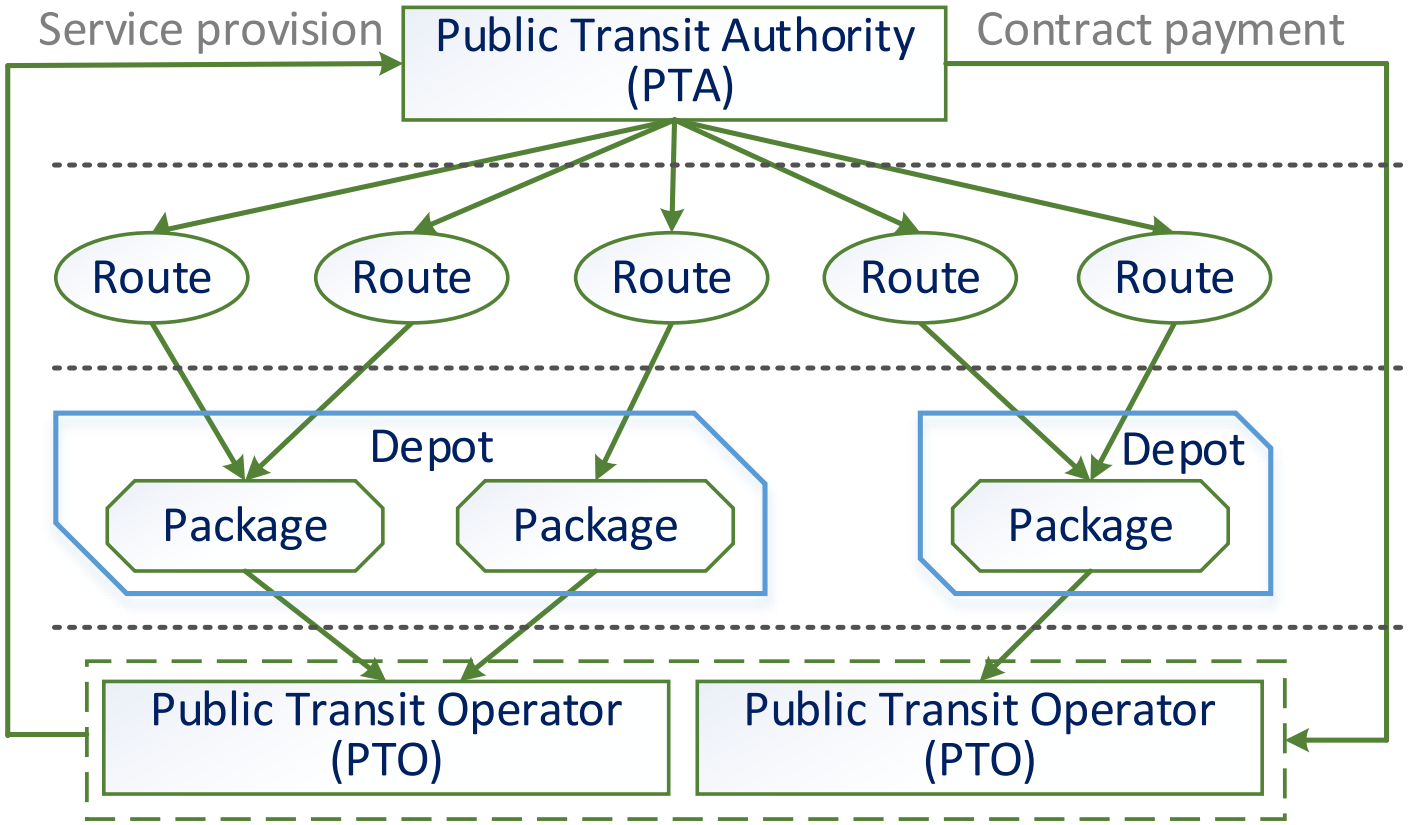
3 packages tendered out & **11** packages awarded via negotiation

2026

Gradually tendering out all packages to **3-5** transit operators

Gradual transition to competitive tendering

Bus Contracting Process in Singapore: An Overview



1. Setting baseline performance indicators

- *Excess Wait Time, On-Time Adherence,…*

2. Bundling bus routes

- *Bus depot location & capacity*
- *Route-Package assignment*

3. Awarding packages

- *Negotiation or Competitive tendering*
- *Contract fee*
- *Quality Incentive Scheme*

Features of Bus Contracting in Singapore

1. Quality Incentive Scheme:

- Reliable bus services to commuters
  1) EWT (Excess Waiting Time) and OTA (On-time Adherence)
  2) First and Last Bus Punctuality
- Good maintenance of the bus assets to government
  1) Buses
  2) Interchanges and Depots
  3) Bus Ticketing System (BTS)

Critical Reliability indicators

EWT

- ***Excess Wait Time*** above expected waiting time
- Measures bus regularity on high frequency services

OTA

- ***On-Time Adherence*** as percentage of departure within specified time window
- Measures bus punctuality on low frequency services

Features of Bus Contracting in Singapore (Cont.)

Baseline values on selected services

Service Type	Operator	Bus Service	Baseline EWT
Trunk	SBST	28	1.4
		58	1.2
		175	1.6
	SMRT	882	0.5
		187	1.3
		858	2.1
Feeder	SBST	261	0.8
	SMRT	800	0.8

Service Type	Operator	Bus Service	Baseline OTA
Trunk	SBST	115	85%
	SMRT	927	85%

Illustration of the Quality Incentive Scheme

Service 858

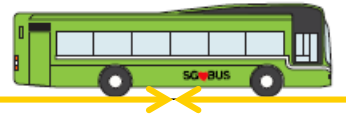
	EWT	Incentive/penalty ($) per month
Incentives	1.5	$30,000
	1.6	$24,000
	1.7	$18,000
	1.8	$12,000
	1.9	$6,000
	2.0	$0 (Neutral zone)
	2.1	$0 (Baseline)
	2.2	$0 (Neutral zone)
Penalties	2.3	-$4,000
	2.4	-$8,000
	2.5	-$12,000
	2.6	-$16,000
	2.7	-$20,000

← Earn $6,000 for each 0.1 min EWT improvement

← Penalised $4,000 for each 0.1 min EWT deterioration

London also adopts a incentive-penalty ratio of 3:2

Approved Working Timetable



2 mins earlier | Arrive on time | 5 mins later

Features of Bus Contracting in Singapore (Cont.)

2. Contract type: Gross-cost contract with Quality Incentive

The roles of LTA

- In possession of all bus assets (e.g., buses, depots, interchanges)
- In charge of bus service planning and standards setting
- Retain all fare revenue

The roles of Operators

- Run bus services in accordance with specified standards
- Receive a fixed contract payment independent of its operational cost
- Up to 10% of its annual service fee will be rewarded or deducted according to the Quality Incentive Scheme

Features of Bus Contracting in Singapore (Cont.)

3. A gradual transition to Competitive Tendering

- Phase One (2016-2026):
  - 100 bus routes are bundled into 4 packages for tendering, with five-year contract and possible extension of two years (5+2)
  - The remaining 254 bus routes, bundled into 10 packages, are awarded to two incumbent operators for 2-10 years via negotiated contracts
- Phase Two (Beyond 2026):
  - The negotiated contracts are expected to be tendered out once they expire

Packages Awarded through Competitive Tendering

Bus route package	Number of bus routes	Depot/construction cost (S$ million)	Awarding operator	Annual contract fee (S$ million)
Bulim	28	Bulim depot/87.5	Tower Transit	111.2
Loyang	27	Loyan depot/61.2	Go-Ahead Group	99.54
Seletar	27	Seletar depot/72.9	SBS Transit	96.06
Bukit Merah	18	Ulu Pandan depot/70.0	SBS Transit	94.40

No.	Company	Country of Origin	Price for 5 Years* (S$)
1.	Jiaoyun Group/ Travel GSH Pte Ltd Consortium	China/ Singapore	418,835,946.60
2.	SBS Transit Ltd (Base)	Singapore	474,965,108.00
3.	SBS Transit Ltd (Alternative)	Singapore	471,965,108.00
4.	Shenzhen Bus Group Co., Ltd	China	449,264,285.00
5.	SMRT Buses Ltd	Singapore	444,925,777.00
6.	The Go-Ahead Group Plc	United Kingdom	518,706,173.00
7.	Tower Transit Singapore Pte. Ltd.	Singapore	483,796,996.00

Lowest bid

Winning bid

Two-envelope bid evaluation process

- Greater weightage given to the quality proposals
- Best-value-for-money proposal without compromising on quality

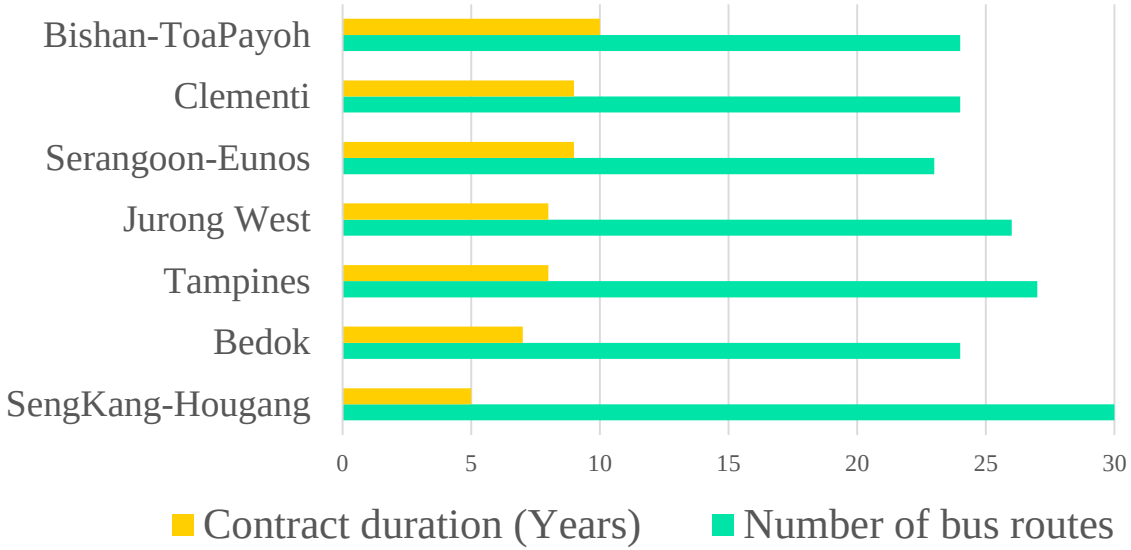
Packages Awarded via Negotiation with Incumbents

Average

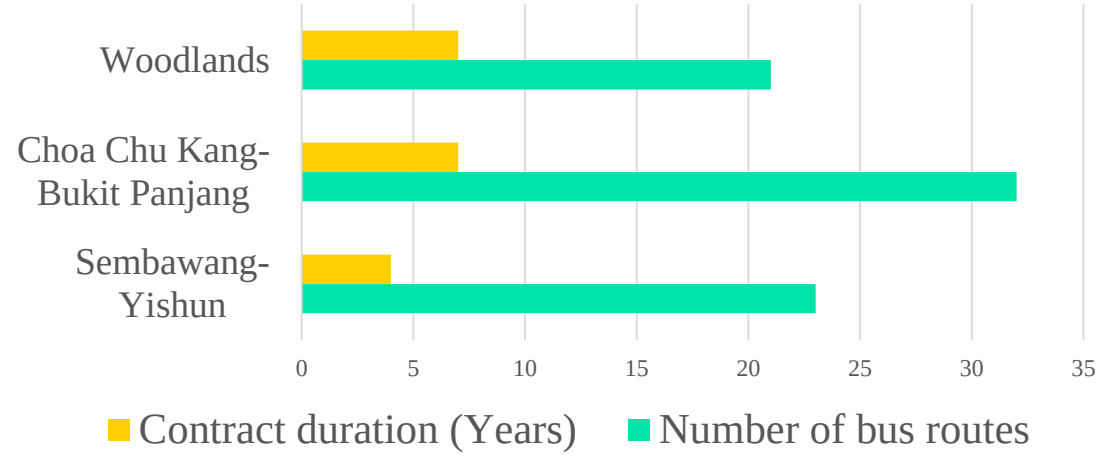
25.4 | 25.3

8 | 6

SBS Transit



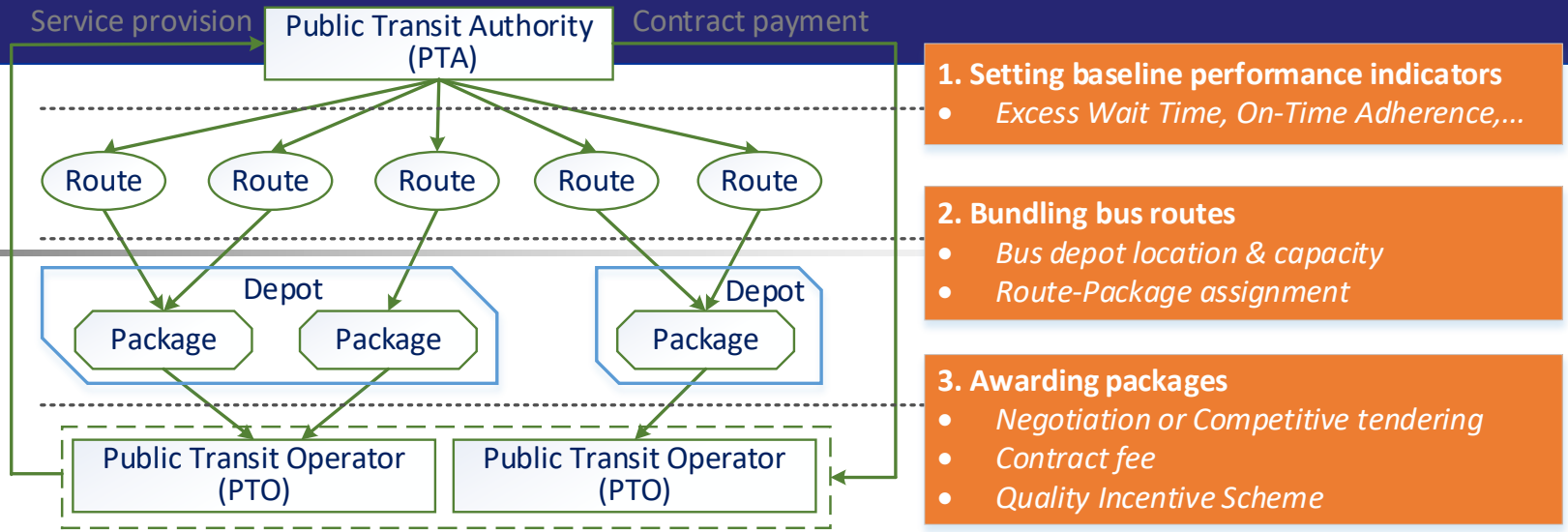
SMRT



5322 | 1865

Total contract fees (S$ million)

Research Opportunities



- **Optimal number of packages and the sizes of each package**
  - Trade-off between the level of barrier to entry and the magnitude of economy of scale
- **Robust route bundling scheme**
  - Each package may involve different levels of unreliability (i.e., EWT and OTA) arising from uncertain bus travel time
  - Some packages are inherently prone to below-average service reliability, making the associated operators disadvantaged in terms of earing performance rewards
  - A robust bus route packaging strategy accounting for overall cost efficiency and the underlying service unreliability

Research Opportunities (Cont.)

- **Optimal design of the Quality Incentive Contract**
  - Regulator has *incomplete information* about the operator's costs of bus service provision and service quality improvement
  - Design optimal baseline performance indicators and reward-penalty schemes
  - Ensure a reasonable profit margin for participating operators while providing appropriate incentives for service quality improvement

Some Suggestions

- More SP surveys and discrete choice studies are encouraged to incorporate emerging reliability indicators (e.g., EWT and OTA) when measuring the overall service quality
- More empirical studies, drawing experience from more jurisdictions with varying bus market conditions, are needed to shed light on the ongoing debate with respect to the **proper contract awarding mechanism**
- More researchers from a broader research community, especially the Operations Research one, should join in to contribute to this body of literature

Thank You !

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