CONTRACTING OUT OF BUS ROUTES: IMPLICATIONS FOR SERVICE DESIGN

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Abstract

The mass transport system in any city must offer a comprehensive route network, an adequate capacity, and a range of service qualities (safety, convenience, and reliability) and fares to cater for different income groups. With these objectives in mind, changes in the way mass transport, particularly buses, is planned, organized, and regulated is becoming imperative in many cities of the developing world. Within the various regulatory arrangements that can be used to regulate the mass transport sector, competitive regimes (namely competitive contracting) have demonstrated, if applied correctly, their capability of generating substantial improvements to the operation of urban mass transport. To this end, this paper will focus more on this specific regulatory regime (competitive contracting), whereby the competitive tendering elements that relate to determining the size of the contract to be tendered as well as the allocation of routes among bid packages (referred to as Service Design) will be particularly highlighted. A comprehensive and flexible framework that allows for the systematic packaging of a bus network subject to competitive contracting is developed and applied to the case study of Beirut.

Keywords: Transit; Competitive tendering; Service design; Transit market arrangements; Public transport regulation
Topic Area: H7 Regulation / Liberalization

1. Introduction

The concept of competitive contracting was first introduced in the eighties, with pioneer applications in the United Kingdom and the Scandinavian countries. In the following twenty years, more metropolitan cities have adopted a gradual process of competitive tendering for the delivery of their bus services (Van de Velde 2001), with the objectives of reducing costs and improving the quality of service. The results were very positive in the majority of these applications, namely in the cities of London, Adelaide, Copenhagen, Helsinki, Stockholm, Denver, and San Diego.

The competitive contracting model involves an extensive contract structuring process that covers aspects such as the contract type, contract size and duration, service standards, and system integration policies. There is no typical approach for specifying all these parameters as they depend heavily on the specifics of each case study and some general guidelines that have been set out in the literature (Gwilliam and Scurfield 1996, Cox et al. 1997, Halcrow Fox 2000, Finn 1999).

This paper will present a comprehensive review of the above main contract elements and will attempt to formulate a guiding framework for systematically developing and assessing bid packages of bus routes.

2. Definitions

Sometimes referred to as “contracting out” or “competitive tendering”, this model involves the delegation by the regulatory authority to private providers of the rights to operate the whole or part of the transit services through contracts. This arrangement falls midway between absolute public or private monopolies and full deregulation techniques (Scurfield 1990) and it enables the introduction of competition *for the market*, while keeping certain levels of public control over fares, service quality, and coordination between different operators.

The contracting out model is a synthesis of public and private roles whereby the mass transport Authority decides which routes should be tendered and what specifications should apply to the service. The private sector responds to the requests of the public authority and one or more winning operators are selected through a process of competitive tendering (Salvucci et al.1997). The forms of the involved contracts vary widely, and the items that could be covered in them are numerous.

Within the competitive contracting model, Service Design refers to the structuring elements that relate to determining the size of the contract to be tendered as well as the allocation of routes among bid packages. This aspect is not particularly relevant when tendering is performed on a route-by route basis or an area basis. In this case, the contract size is nothing but either the individual route or a specific geographic area, and there will be no need for any service design. However, when groups of routes are to be tendered together, the Transport Authority is faced with two main questions:

- Given an existing or a designed set of bus routes, how many bid packages can be produced from this network?
- Which routes should be grouped in the same package?

In many of the worldwide applications of competitive contracting, the answers to these two questions were very subjective and none of the packaging approaches was based on a well-structured and consistent methodology.

3. Contract structuring

In the contracting out model, the public authority decides on the degree of control it wishes to have of key attributes of the service by explicitly including their specifications in the contract. For this reason, the contract should be carefully prepared to best agree with the objectives of the public Transport Authority.

When structuring the tender contracts, the transit authority needs to decide on two major aspects of the tendering process:

- Who bears the revenue risk / what type of contract to adopt?
- How to design the contract, particularly in terms of routes to be tendered, contact size and duration, and service integration policies?

The required decisions are not straightforward and they need careful studies of the authority’ objectives and capabilities, as well as of the prevailing transit market, and of the strength and type of transit operators. In the following sections, the general guidelines pertaining to the selection of the contract type and specifications will be presented.

3.1. Types of contracts

The different types of contract mainly vary on the basis of the allocation of risk between the operator and the contracting authority. The main types of contracts are Cost Contracts Revenue (Net Cost) Contracts. However, combinations of these types do exist and have been adopted in many cities worldwide.

3.1.1. Cost contracts

Cost Contracts can be further subdivided into “Cost-Plus” and “Gross Cost” Contracts. In Cost-Plus Contracts, the operator is paid the full operating costs and on top of them a fee covering management costs. The operator keeps none of the collected fares and therefore does not bear any revenue risks. He also doesn’t carry cost risk, and the only incentive for him to keep costs down is the hope of renewing the contract (Shaw 1996). This system has been frequently used in the US, but it remains a little problematic in as far as securing a transparent basis to distinguish between bidders, since cost/price is not a factor.

In Gross Cost contracts, the operator specifies in the bid the full cost required in exchange for provided services, and which will be received irrespective of collected fares. The revenues are also transferred to the transit authority that bears the revenue risks and is responsible for controlling the adherence of the contractor with the service levels cited in the contract (Halcrow Fox 2000, Scurfield 1990). The operator is essentially responsible for meeting his cost targets.

3.1.2. Revenue (net cost) contracts

Revenue or Net Cost contracts, on the other hand, transfer the revenue risks from the transit authority to the private operator who keeps the collected fares. In some instances, the operator could receive additional subsidies in case the operated routes are non-profitable; when the opposite is true, the operator might be asked to pay the transit authority for the “right to operate” (Scurfield 1990).

The operator is responsible for the overall commercial performance of the service and therefore has all the incentives to improve service quality in order to attract more passengers, and thus increase the revenues. In part, this incentive could reduce the need for extensive monitoring from the public authority (Shaw 1996). However, where bus usage is low, operators might be tempted to decrease their costs by reducing the provided level of service, and this would therefore require close monitoring and frequent inspection by the Transport Authority.

3.1.3. Other forms of contracts

Shared Contracts provide a compromise between cost and revenue contracts, whereby the revenue risks are shared by the transit authority and the private operator. This alternative is very beneficial because it creates incentives for both the public and private parties to provide a better service and become more cost efficient.

Some contracts can be only Management Contracts whereby the public authority owns the operational assets and the contractor is responsible for the management of the operations. The responsibilities of the contractor can cover the streamlining of production costs, service quality, ridership, and overall financial performance (Halcrow Fox 2000).

3.2. Contract specifications

Competitive contracting programs should be designed to maintain the policy control of the public authority while fostering a competitive market. The different items to be considered in competitive tendering processes were presented in previous sections and will be discussed in more details below.

3.2.1. Routes open for tender

There are virtually no constraints as to which routes are to be tendered and which are not. The Transport Authority can decide that some routes should be completely excluded from the program (e.g. because they are not profitable and wouldn’t attract enough competition), and then can re-include them at a later stage if deemed in the public interest.

The transport authority can also decide to contract all of its routes either progressively or in a single round, although the first option has been the most widely adopted worldwide such as in London, Adelaide, Copenhagen, and Stockholm (Halcrow Fox 2000, Cox et al. 1995, Radbone 1997, Gargett and Wallis 1995).

When a gradual implementation of the tender process is to be adopted, the need arises to decide which routes are to be tendered first and what criteria should be used to prioritize certain lines over others. Three case studies in London, Uzbekistan, and Surabaya provide good examples of how transit authorities have responded to these questions. In London, the following criteria have been used to select individual routes (Newton 1993):

- Poor financial performance.
- Poor operational performance.
- Resources needed.
- Location.

In Uzbekistan, the first routes to be offered for tender were those served by many private operators and showing a certain degree of competition. The philosophy behind this approach is that more operators would be interested in obtaining the exclusive rights to work on these profitable routes (Gwilliam et al. 2000). The on-the-street competition will thus be transferred to the tendering process leading to a decrease in the bid prices.

In the demonstration route project from the city of Surabaya in Indonesia, the favorable conditions on the pilot routes included (Meakin 2001):

- Dense, trunk corridor, and differentiated market.
- Few parallel or overlapping routes.
- Premium service fares.
- High operating speeds.

3.2.2. Contract size

The size of the contract package is critical because it has an important influence on the level of competition that may be available. In the bus industry, the size of the business package can be as small as a single route and as big as the whole system. Larger contracts usually reduce the level of competition since few operators have the institutional and financial capabilities for handling them (as observed in Stockholm). Route contracts, on the other hand, encourage new market entrants but their operations are more difficult to control. Medium-size packages of routes perhaps seem the best strategy to adopt for it may combine the advantages of both system-wide and individual route contracts (Halcrow Fox 2000).

The participants in the Fifth International Conference on Competition and Ownership in Passenger Transport that was held in Leeds in 1997 (Cox and Van de Velde 1997) supported both route and area competitive contracting. Some favored area tendering because they believed operators would be able to increase ridership. Others preferred route contracting because it would solicit more competition and because they feared that area contracts could eventually lead to private monopoly or oligopoly.

An important factor to be considered when deciding on the contract size is the intended level of integration. In this regard, integration is best achieved when the whole service is packaged as a single entity. The optimum package size for integration considerations is definitely greater than the single route but need not be the whole system (Halcrow Fox 2000). Rather, contracts covering a coherent market area may prove to be very efficient in securing a reasonable level of integration.

When discussing the contract size issue, it is very beneficial to revise what has been actually adopted in the successful application of competitive contracting in the cities of

London, Copenhagen, Stockholm, San Diego, and Adelaide (Gwilliam et al. 2000,Cox and Love 1991, Wallis and Bray 2001).

- London: the network was first contracted out on a route-by-route basis, but later involved groups of routes and extensive networks. The tender size was varied to increase the number of bidders and expand competition.
- Copenhagen: tender packages were small and geographically concentrated, with sizes ranging from 3 to 28 buses.
- Stockholm: packages are relatively large and they generally cover geographical corridors or sectors rather than single routes.
- San Diego: the size of the business packages in San Diego ranges from 10 to 50 buses.
- Adelaide: Adelaide is adopting area-based contracts that are determined primarily with considerations of logical route structures, depot availability, and operational efficiency. Preferred contract sizes range from 50 to 100 buses.

3.2.3. Contract duration

The contract duration should provide a compromise between short-term contracts that enable frequent competition occurrences and thus give more incentives for improved performance, and long-term contracts that provide more incentives for innovation and investment (Halcrow Fox 2000). In Adelaide, the short-term contracts (not more than 5 years) that were adopted in the initial competitive tendering process have discouraged potential operators from bidding. The Transport Authority has thus decided to lengthen the contract duration to the range 7 to 12 years (including renewal periods) in the hope that this would encourage investment, service development, innovation, and keen contract pricing (Wallis and Bray 2001).

The major disadvantage with long-term contracts is that the contractual risks related to cost and revenue estimates will tend to increase with the increase in the contract duration (Halcrow Fox 2000). For this reason, many cities have adopted medium to short-term contracts in the range of 3 to 7 years. In London, the normal contract duration is 5 years but can sometimes vary from 3 to 7 years. In Copenhagen, contracts are usually for 4 or 5 years, and in San Diego, the duration ranges from 3 to 5 years (Cox et al. 1995).

3.2.4. General service standards

The range of features that could be included in mass transport contracts is very wide, and with the exception of very prescriptive contracts, only a few could be required. The Transport Authority needs to decide what attributes it wants to have control over and then include these in the contract terms. Halcrow Fox (2000) presented a comprehensive list of items that could be specified in the contract. The most important parameters are listed below.

- Service Specification.
- Vehicle Specification.
- Fares and Revenues.
- Other Financial Matters.
- Asset Ownership and Use.
- Performance Monitoring.
- Penalties / Bonuses.
- Employment Practices.

3.2.5. System integration policies

Halcrow Fox (2000) presented a complete list of the items required to obtain a fully integrated mass transport system. These included items related to land use, social and economic policies, resource allocation, budgeting and pricing, multi-modal system regulation, interchange between modes and services, common fares and ticketing, coordinated timetables, and multi-modal passenger information. It was noted however that only the last 5 or 6 items are usually used when referring to mass transport integration.

Theoretically, public monopolies would be the best arrangements in providing an integrated bus system. But given that in contracting out models the provision of services is a public task, and if well-structured contracts are applied, the government can still design a comprehensive and coordinated network that produces optimal service quality and remain as coherent as other systems operated by a single entity.

There is however one item from the list that could be relatively problematic when a bus network is being contracted to multiple operators and it relates to fare integration and revenue allocation and distribution between the different operators. At the outset of any further discussion, it is worthwhile to highlight the recent research by Barr (1997) and which provides a good review of mass transit fare integration issues and will be the basis for much of the information presented next.

Fare integration involves ensuring that passengers do not have to pay the full fare each time they board a new vehicle. This could be achieved through unlimited-use passes that are accepted by any vehicle and operator or through transfer discount mechanisms that ensure a free or lower-than-fare transfer. Although intra-operator fare integration is relatively common and easier to implement, integration of pricing between different operators is much more difficult because it requires that each operator gives up some control over fare policy. This is not very simple since the fare policy directly affects the collected revenues and these are very critical for private operators. The problem is particularly important in Net Cost Contracts where the profit of the operators is directly related to the collected fares.

The issue in similar instances is how to allocate revenues to the different operators, knowing that "in almost all cases of fare integration between operators, revenue that belongs to one operator will be collected by another". In response to this problem, a number of aggregate variables have been proposed to provide a starting point for revenue allocation procedures. These could be used independently or combined and they include:

- Cost: allocating the revenues based on the cost of providing service (this would reduce the incentive for cost control).
- Ridership: allocation based on the total ridership of each operator.
- Profit / Loss: allocation to ensure that the profit or loss situation of each agency does not change after the application of fare integration.

None of these approaches is a failsafe solution to the problem, but recent developments in fare technology can allow for an improved collection of system information and thus a more accurate revenue allocation process. These technologies include, among others, stored value cards, ticket-processing units, and Smart Cards.

4. Service design objectives

It is well understood that Service Design needs to take into account the objectives of the different parties involved in mass transport, namely the public transport authority, the operators, and the passengers. In almost all cases, it will be impossible to fully satisfy the sometimes-contradicting objectives, and a compromise will always be necessary.

4.1. Public transport authority objectives

The main objectives that the public transport authority might aim at achieving from a competitive contracting process are to:

- Satisfy the highest fraction of the transit demand.
- Ensure the maximum coverage of demand areas.
- Reduce operational costs in order to reduce the need for subsidies and possibly generate profits.
- Maintain acceptable service levels.
- Increase the level of competition during the bidding process by limiting the contract size in such a way as to allow for the maximum number of operators to participate in the tender.
- Provide a comprehensive and integrated system.
- Reduce on-the-street competition that might lead to aggressive driving behaviors.

4.2. Operator objectives

The objectives of the bus operators are obviously less socially-oriented than those of the public authority since they primarily seek to:

- Reduce the costs by either running at longer headways or operating with lower levels of service.
- Increase the rider ship in order to generate more profits.
- Operate in common or close terminals so as to reduce dead headings.

4.3. Passenger objectives

The transit passengers are mainly interested in having:

- Less walking and waiting times.
- Fewer Transfers.
- Reduced or no extra payments for transfers.
- Higher levels of service.
- An integrated mass transport system.

5. Proposed service design framework

Although a possible link might exist between the packaging framework and the network design process, the authors believe that it might be risky to try to modify the network design process in light of the decision to competitively contract the resulting bus network since this might make the process more cost-oriented rather than demand-oriented. Generally, transit demand remains the single most important parameter in network design, and other objectives such as cost and bus requirement are simply used as constraints. Therefore, it might be more appropriate that a post processor be used to modify the set of existing or newly designed routes based on the developed Service Design framework. The process is illustrated in Figure 1.

The proposed framework for the allocation of bus routes into bid packages in the case of multiple-route contracts involves three main tasks:

- Generation of Routes.
- Selection and Packaging of Trunk Lines.
- Insertion of Remaining Lines in Obtained Packages.

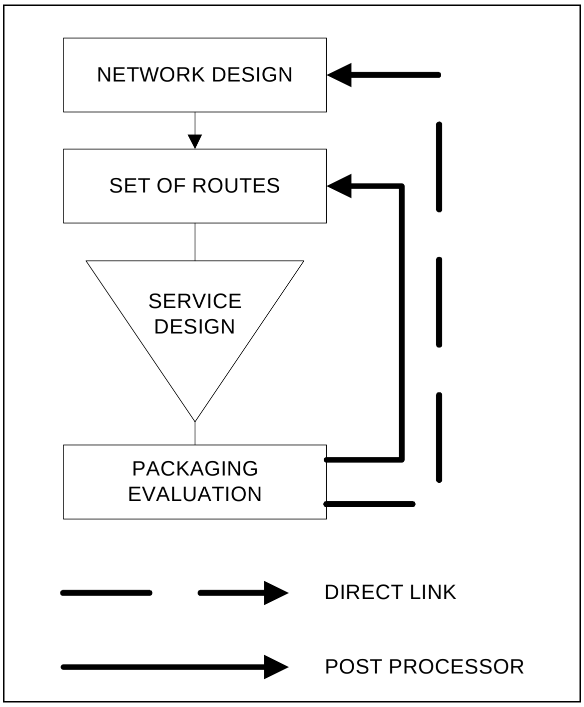

Figure 1. Network design post-processor

5.1. Generation of routes

The set of routes to be packaged and consequently tendered can be obtained from either an existing bus network or a newly designed network. This will mainly depend on the authority’s judgment of whether the existing bus routes (in case they exist) do serve the transit demand or whether a network restructuring is needed. In the latter case, a network design process shall be initiated using any of the available transit network design methodologies.

5.1.1. Selection and packaging of trunk lines

Trunk lines are those lines that attract the highest number of passengers and that exhibit a high level of profitability. Because these lines carry most of the ridership, they basically form the main skeleton of the complete bus network that is going to be tendered. They are the most important routes in the network and therefore these should be differentiated from the other lines and selected first to construct the packages.

These lines define the general trends in the passenger movements within the network, and packages obtained from these routes would therefore truly represent the distribution of transit demand and would be able to satisfy this demand more efficiently.

Another main reason why trunk lines are selected first to form the packages is the issue of competition in the tender process. In fact, the more the packages are profitable, the more operators are interested in obtaining the exclusive rights to operate them, and the higher is the competition in the tender process. Therefore, if the core of the package is highly profitable and attracts considerable competition, then the whole package might end up returning some profit as the highly beneficial routes will cross-subsidize losing lines. Once the packages have been defined from a number of rewarding routes, the less attractive routes can be added progressively to increase the demand satisfaction and the level of coverage.

In previous sections, it was shown that Uzbekistan and Surabaya have adopted similar strategies whereby the routes that were first put to tender were all supposed to attract genuine competition. In Surabaya in particular, pilot routes were chosen specifically from dense and trunk corridors. In Sao Paulo, a similar packaging approach was also adopted whereby bid packages were formed of trunk line bus corridors and a number of feeder lines (Rebelo and Benvenuto 1995).

The proposed trunk lines selection and packaging approach is presented in Figure 2. This figure shows that the network design post-processor presented earlier involves refining the headways and routing of the trunk lines such that average load factor and maximum peak load factor constraints typically adopted by the Transit Authority are respected, and that the itineraries are checked for any modifications that could increase the satisfied demand.

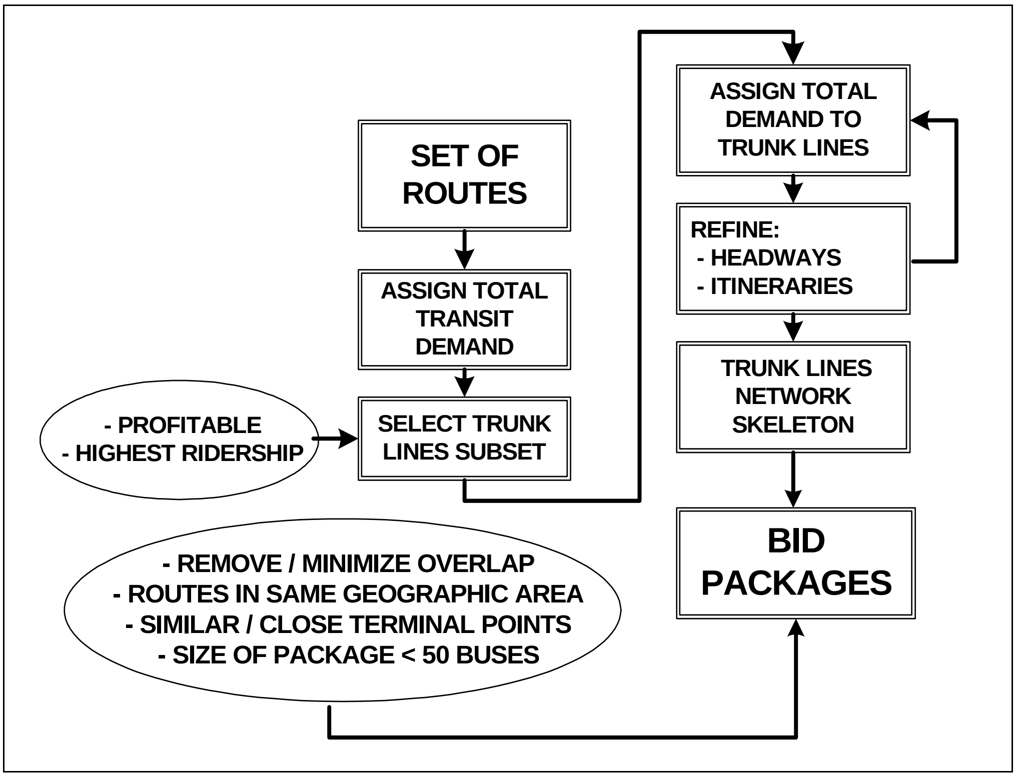

Figure 2. Trunk lines selection and packaging process

The packaging of route is achieved in light of the following four criteria:

- Remove / Minimize Overlap: minimizing or removing overlap between the routes of different packages is very important for both operators and passengers because it helps reduce the on-street competition that otherwise might lead to aggressive and predatory driving behaviors, including blocking, racing, refusing passengers, and turning back maneuvers (Gwilliam and Scurfield 1996). Therefore, and in order to minimize this problem, routes that overlap with each others for a long distance are, in the proposed framework, preferably grouped together in the same package so they can be managed by the same operator. Meakin (2001) has noticed the relevance of this criterion when he suggested that the pilot routes in Surabaya should have few overlaps.
- Package Routes in Same Geographic Area: this is mainly relevant for the operators who are able to manage their human and equipment resources easily and more efficiently when the routes are concentrated in the same geographic boundaries. In such a case, operators can reduce on the number of required depots, garages, and maintenance yards, and therefore can significantly cut off on their costs. Moreover, this gives the operator

some sort of an exclusive franchise area to serve, independently from the other contractors on the ground. Many cities have actually tendered packages of bus routes that are geographically concentrated, including Copenhagen, Stockholm, Adelaide, and Sao Paulo (Cox et al. 1995, Cox and Love 1991, Wallis and Bray 2001, Rebelo and Benvenuto 1995).

- Package Routes with Similar / Close Terminal Points: this requirement results from the operational concern of reducing the possibility of different operators having to share the same terminals, given that they usually find it highly undesirable to share terminals and depots (Wallis and Bray 2001). Moreover, operators will be able to locate the depots close to the terminals, which will reduce the inconvenience and costs of deadheading. This has been a major guiding criterion for the Helsinki Metropolitan Area Council in grouping their bus routes for tender (YTV 2001).
- Maintain the Number of Required Buses per Package below 50: this constraint is imposed to limit the size of the contract packages so that more operators are able to participate in the bid. The value “50” was adopted as a middle point between the small contract sizes adopted in Copenhagen (10 to 38 buses) and the larger contracts of Stockholm and Adelaide (50 to 100 buses) (Cox et al. 1995, Cox and Love 1991, Wallis and Bray 2001). This value is believed to represent a compromise between the benefits of smaller contracts in fostering more competition and reducing the risk of monopolies and oligopolies, and the benefits of larger contracts that permit economies of scale, a more integrated network, and easier contract management.

5.1.2. Insertion of remaining lines in obtained packages

At this stage, the packages would have been defined and what is left is the insertion of the remaining bus lines of the network in these packages. The proposed framework follows a myopic process whereby each route is considered independently, and once it has been inserted in the packages, it is not revised anymore. Moreover, lines that are not inserted in any of the packages will also not be reconsidered at a later stage of the process. Therefore, a prioritization scheme is to be adopted to decide which routes should be considered first. The proposed framework divides the remaining set of lines into the following four categories, listed in order of decreasing priority:

- Profitable Routes Serving New Trip Patterns: these lines reflect a profitable operation (following a demand assignment on the whole network) and serve trip patterns that are not covered by the constructed packages. It is to be noted that new trip patterns do not refer to new passenger Origin-Destination pairs, but rather new areas served by the line. This category of routes is given highest priority because it serves the objectives of all parties involved in mass transit, i.e. the transport authority (they increase coverage by serving new trip patterns and they increase the profitability of the system), the operators (they increase the net revenues of the packages), and the passengers (they serve new demand areas and thus reduce the need for transfer or for the use of other modes of transport).
- Profitable Routes Not Serving New Trip Patterns: these lines are the ones that show a profitable operation but whose trip patterns have been served by other routes in the packages, including the trunk lines and the inserted lines from the first category above. These lines serve the objectives of the transport authority and of the operators in increasing the network capacity and possibly increasing the returns, but really do not add much to the coverage of the network.
- Non-Profitable Routes Serving New Trip Patterns: these lines are the ones that do not show a profitable operation but whose trip patterns have not been served by any other route in the constructed packages. Although these routes do not serve the operator’s and

transport authority's objective of increasing the profits, they remain important in as far as increasing the coverage in the interest of the end users.

- Non-Profitable Routes Not Serving New Trip Patterns: this last category includes the lines that are not profitable and whose trip patterns have already been served by the trunk lines or any inserted line from the above categories. These lines do not serve any of the objectives of the three parties involved in mass transportation and would therefore be ignored instantaneously.

The same process is repeated for each of these lines categories until all the network have been checked and either inserted in the final packages or removed from the network. For illustrative purposes, the process for inserting Profitable Routes Serving New Trip Patterns is presented in Figure 3.

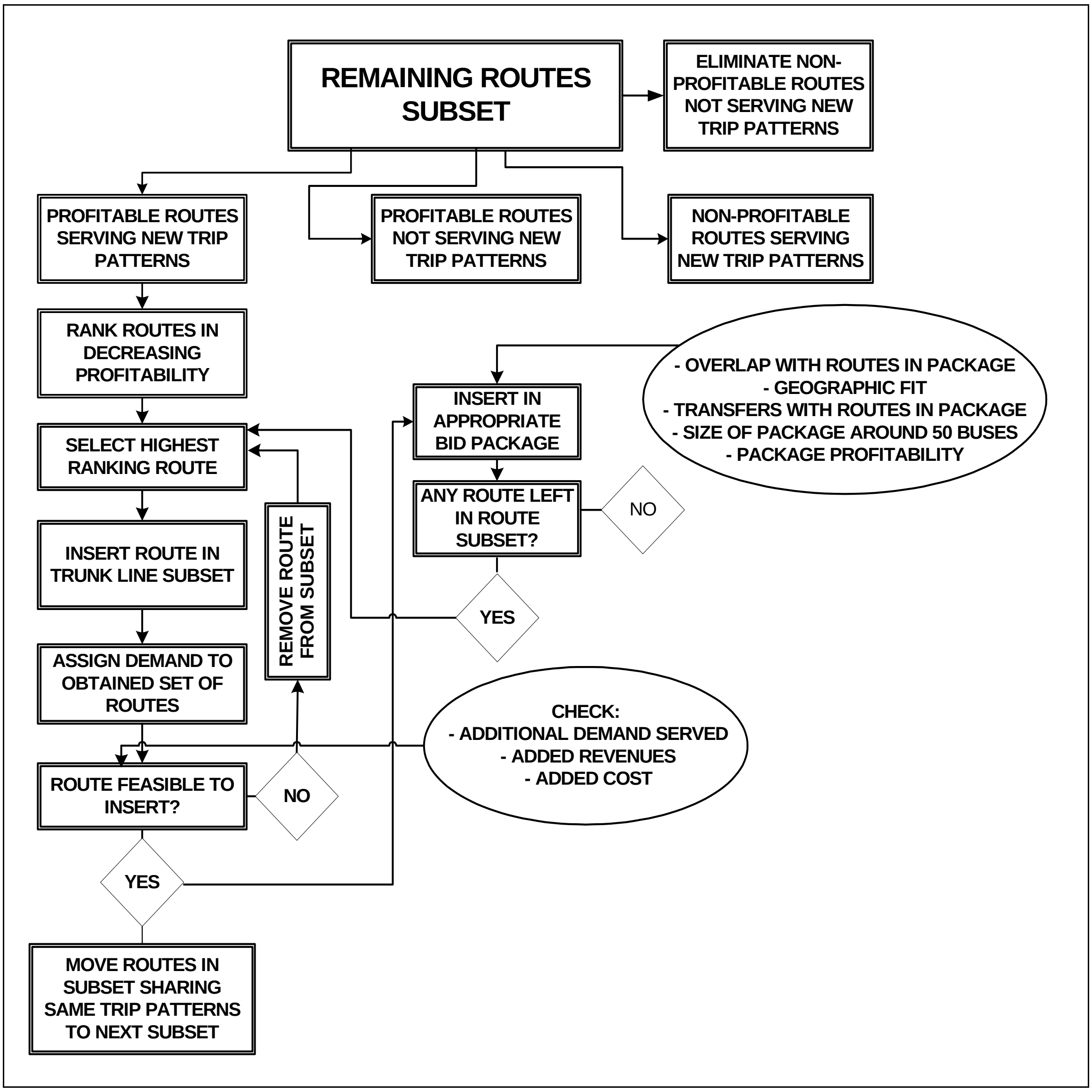

Figure 3. Insertion of remaining lines

As can be seen in the figure, each route is checked to determine whether it should be retained in the network or there is need to remove it totally. In this regard, and based on the results of the demand assignment, three parameters are observed; the additional demand served, the incremental revenues, and the incremental cost. The first factor is the most important since it determines the usefulness of the tested route in serving additional demand, given the added revenues and costs determined from the remaining two constraints.

The insertion of a feasible route in the appropriate package is based on the same criteria adopted while packaging the trunk lines, but with an important additional criteria related to the transfers with the routes of the various packages. The transfers between the examined route and the lines previously inserted in the packages are checked to determine where the maximum transfers occur. The route is rather inserted with the package with which most of the transfers occur. The reason is that transfers by themselves are inconvenient for transit users (Bookbinder and Desilets 1992) because of the discomfort of boarding a new bus and the negative perception of waiting for the arrival of the transfer vehicle. The problem is compounded if the transfer routes are the responsibility of another operator, making it more difficult to coordinate the headways and to provide for some sort of fare integration (Barr 1997). Therefore, in order to minimize the inconvenience for passengers, the route is, if possible, inserted in the package with the routes of which it has the most transfers.

6. Application to the city of Beirut

In this section, the proposed service design methodology is applied to a case study involving the packaging of the Beirut bus network. Beirut provides an appropriate case study for this research because a plan to restructure its existing bus system, involving a process of competitive contracting, has been proposed in a recent government-supported workshop and will be shortly implemented (Baaj 1999).

6.1. Prevailing public transport in Beirut

The public transport system in the Greater Beirut Area (GBA) currently operates under complete deregulation, whereby five different types of mass transit operators compete to serve the limited patronage. These are the publicly owned Railway and Public Transport Authority (RPTA), the privately owned Lebanese Commuting Company (LCC), private minibuses, jitneys, and taxis. Within GBA, RPTA and LCC operate 164 and 185 buses, respectively, and these share the roads with approximately 2000 minivans and 20 to 25 thousand jitneys and taxis (Baaj 1999).

These operators provide a total capacity that exceeds the current demand, which dangerously reduces their revenues, and leads to a serious drop in the levels of service. Moreover, The lack of organization that characterizes the operations of this huge fleet of mass transit vehicles, combined with the high number of private passenger cars operating within the boundaries of GBA, have led to severe environmental, and operational problems (Baaj 1999).

6.2. Existing bus network

Currently, RPTA operates 27 lines in Greater Beirut Area and the suburbs, while LCC operates 11 lines, 6 of which are shared with RPTA. Within the scope of this paper, the proposed framework was applied to the currently operating routes without redesigning the whole network. Accordingly, the application of the first step in the framework to the case study simply meant considering the existing routes. These were obtained by combining the routes operated by RPTA and LCC in one network thus including 32 lines.

The network can be defined as being mainly a radial one, with major peripheral routes within Beirut. Many routes radiate from Beirut towards the suburbs around the city. There are 13 lines that extend beyond the limits of municipal Beirut, 12 lines that connect the city of Beirut with the nearest southern and northern suburbs, while the remaining 7 lines operate within the limits of the city, with some moving in an east-west direction, and others moving in the north-south direction.

6.3. Packaging of Beirut bus routes

The above-presented Service Design framework was applied to the existing bus routes in the city of Beirut. In this respect, the EMME/2 transportation-planning model was used to assign the transit demand to the bus routes, and to obtain relevant figures in terms of ridership, costs, and transfers. The final obtained packages are presented in Figure 4.

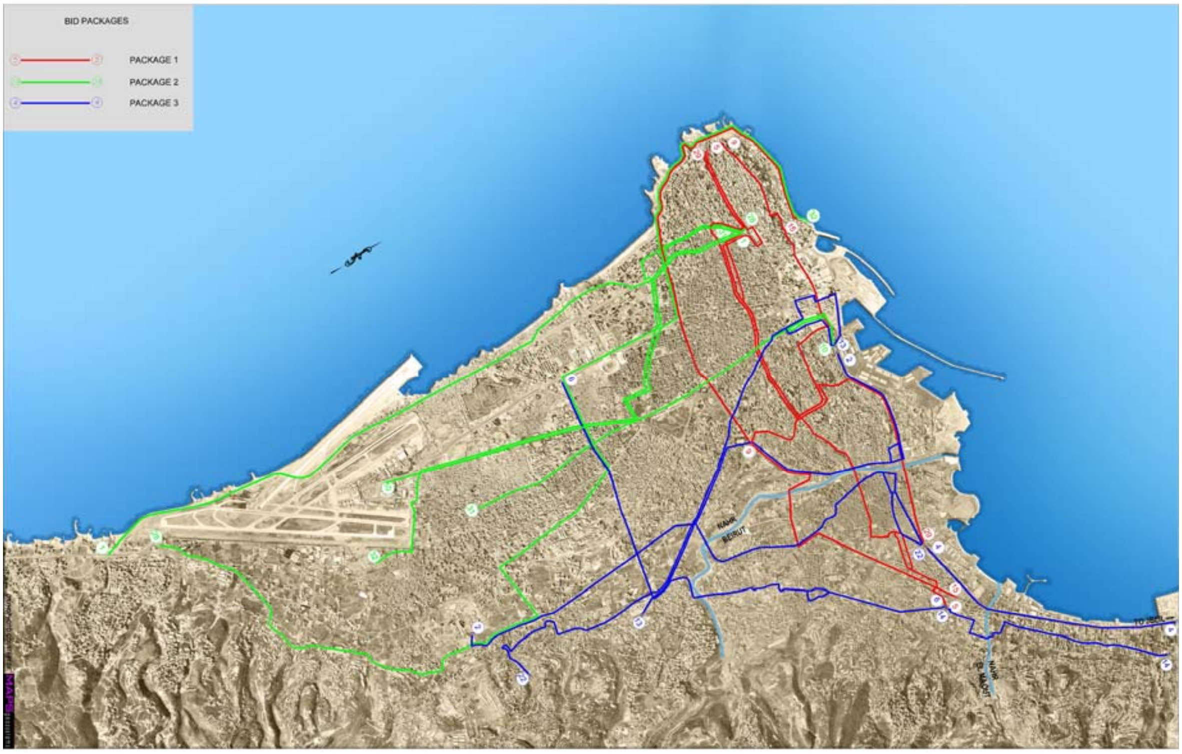

Figure 4. Final Bid Packages

The application of the proposed framework showed that our of the 32 existing lines, only 8 routes were trunk lines, 5 additional lines were profitable, and the remaining 19 routes were non-profitable (8 of each were directly removed being non-profitable and not serving new trip patterns). Three bid packages resulted at the end of the process. These included 15 out of the total 32 bus lines, and they satisfied around 92% of total boarding currently satisfied by the whole network, at a little more than 50% of the cost, and with almost 60% of the full-network fleet (as shown in Table 1).

Table 1. Final obtained packages

Package	Lines in Package	Peak Hour Boardings	% Of Existing	Buses Required	Net Annual Operational Benefits ($ Mill.)
1	4	5085		46	2.12
2	5	3833		55	0.69
3	6	4364		43	1.60
Total		**13282**	**92%**	**144**	**4.41**

The results obtained at various milestones of the application are shown in Tables 2 and 3. These tables show that the trunk lines alone (case 1) satisfy around 66.5% of the total boarding in the existing network (case 6). This is achieved at a 60% higher operating cost recovery and almost 40% of the total fleet.

The packages obtained at the end of the process (case 5) satisfy around 92% of the boardings recorded in the full network at 59% of the cost, a 56% higher operating cost recovery, and only 58% of the fleet. Therefore, the final packages behave almost similar to the existing network in terms of demand satisfaction, but at a little more than half the cost.

Moreover, the packages remain viable even if the incurred capital costs (mainly covering the fleet costs) are included. In fact, capital cost recovery (which accounts for both operating and capital incurred costs) reaches 1.37 in the final packages, a ratio that guarantees a net yearly profit to the operators. However, because there are big discrepancies in the net annual benefits of the final packages, these could be sold to the private operators at different prices so that the Transport Authority guarantees comparable net profits among the various operators.

Table 2. Assignment Summary

Case	Lines in Packages	% Of Current Boardings	Operating Cost Recovery	Capital Cost Recovery
1	8 (Trunk)	66.5%	1.85	1.27
2	8+5 (Trunk + Profitable Lines)	82%	1.67	1.25
3	8+3 (Trunk + Feasible Profitable Lines)	84%	1.88	1.37
4	11+11 (Above Packages+ Selected Non-Profitable lines)	98%	1.55	1.23
5	11+4 (Packages+ Inserted Non-Profitable lines)	92%	1.80	1.36
6	32 (All Lines)	100%	1.15	0.97

Table 3. Assignment Summary – Other Relevant Attributes

Case	Lines in Packages	Fleet Size	Buses / Line	% Trips with no Transfers
1	8 (Trunk)	99	12.4	70%
2	8+5 (Trunk + Profitable Lines)	140	12.7	65%
3	8+3 (Trunk + Feasible Profitable Lines)	126	11.5	64%
4	11+11 (Above Packages+ Selected Non-Profitable lines)	188	8.5	61%
5	11+4 (Packages+ Inserted Non-Profitable lines)	144	9.6	63%
6	32 (All Lines)	250	7.8	62%

7. Conclusions and recommendations

This paper has provided a comprehensive review of the competitive contracting topic, focusing mainly on the contract structuring elements. In this context, it was found that published literature has only marginally discussed the service design step of grouping routes into bid packages, and there has been no real effort to develop an organized and sound methodology for completing this task. Therefore, one such methodology is also proposed, in which a framework for allocating routes among bid packages has been developed and applied to the case study of Beirut.

The proposed framework is formed of three main steps including a route generation process, a trunk lines selection and packaging process, and a testing and insertion algorithm for the remaining lines of the network.

The application of the framework to the existing network of Beirut has resulted in three packages that satisfy 92% of the current boarding with half the existing routes and costs, and almost 60% of the fleet. Discrepancies were found in the net benefits of the different packages, but these could be resolved by selling the contracts at different prices in order to achieve equal benefits for the various operators.

The proposed Service Design Methodology has provided a number of decision variables for packaging the bus routes. It did not however combine these parameters into a multi-criteria approach based on which the packaging could be completed. In fact, the guiding objectives can vary much from city to city, and it may be impractical to generalize the decision-making process.

Therefore, it is advisable that further studies focusing on the relevant importance of each of the decision variables with respect to the transport authority, the operator, and the passengers be undertaken for each case where the framework is to be applied.

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