LEVELS OF SERVICE CONCEPTS IN TRANSPORT PLANNING: REVIEW AND FUTURE PROSPECTS

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ABSTRACT: *The paper reviews the development and application of Level of Service (LOS) Indicators in Transport Planning (mainly in the US). The inadequacy of simple LOS indices is highlighted. The authors favour a return to service performance measures based on evaluating consumers preferences and deriving a ranking of the various LOS attributes using a market segmentation approach. Elements of a framework that provides a user-oriented approach to LOS measurements, and a practical modus operandi , are proposed.*

The views expressed in this paper are those of the authors and do not necessarily reflect those of the Metropolitan Transit Authority.

LEVEL OF SERVICE REVIEW

INTRODUCTION

Although interest in the development of a set of performance measures for assessing the adequacy or otherwise of public transport services goes back more than 20 years, there is as yet no generally accepted package or set of Level of Service (LOS) criteria.

There appears to be growing support for the development of either a single composite LOS index (1) on the one hand or a comprehensive LOS package that can be calibrated to suit particular situations on the other.

Three major reasons why a comprehensive LOS measure is needed, it is argued, are:-

(i) To evaluate the performance characteristics of particular public transport systems either through time or against alternative systems;

(ii) To specify "acceptable" or "desirable" LOS standards as policy objectives and their degree of attainment as funding criteria for suppliers of these services; and,

(iii) To assess the efficiency and/or effectiveness of various public transport strategies, so as to incorporate the concept of community needs as well as public accountability into the provision of transit services, as well as providing managerial techniques for internal performance monitoring.

Our own particular interest in this topic arises from the fact, that as employees of a Metropolitan Transit Authority charged with developing an integrated and efficient system of public transport for a declared region, we are constantly confronted with the need for criteria that go beyond a purely commercial approach so that the public transport system that evolves is responsive to the social needs of the region.

Inherent in this role of meeting the communities needs, comes the necessity to develop methods for setting standards for evaluating public transport systems against broader community goals.

As the gap between operating costs and fare box revenue widens, (our recent projections certainly show this tendency), then it will increasingly become a Government/Local Authority decision, as to what level of funding is approved to provide an acceptable level of public transport services. This creates the need to establish what we loosely term "minimum levels of service", which provides the foundation upon which "acceptable" and "desirable levels of service" can be specified.

(1) Operators of public transit networks, designed to meet a broad range of community objectives, but now facing rising operating deficits, are concerned that funding bodies will place increasing reliance on financial criteria such as "deficit per passenger".

Our subject today then, like the lovely shamrock and the triathalon,(1) is part of an eternal triangle, namely, fares, financial results, and Level of Service. We would initially suggest that far too many people have been excessively excited about cost recoveries from fare boxes and have taken on board quasi-commercial criteria and have tended to neglect or treat Levels of Service (LOS) more as a frequency modulation phenomenon than a useful policy paramater.

We believe LOS is not a simple issue but rather a very complex one involving different consumer markets with different perceptions of LOS, different geographical areas, different system supply attributes etc.

Our review supports the contention, that too many planners/ policy makers and operators have placed the LOS issue in the "too hard" basket, and have attempted to rationalize their way out of this complex interactive maze, by selecting what they consider to be a few key factors, such as frequency and schedule adherence.

Some of the advantages cited in favour of such operations - oriented easily measurable LOS indices are, that they are:

(a) Easily understood;

(b) Modest in their data calibration demands; and

(c) Possess inter-temporal and inter-spatial stability.

Others have gone to the extreme of attempting to develop an all-encompassing single LOS parameter.

Whilst we can determine levels of subsidization and cost recovery levels from the fare box and financial records, we make the strong plea that we should not get involved with financial accounting to the extent that we neglect LOS items that are of fundamental importance and have a great influence on people's use of public transport.

Meanings of the Term "Level of Service"

The term "Level of Service" has been vested with a diversity of meanings which has led to considerable confusion in transportation planning, research and operations.

Part of this confusion is semantic and derives from the use of terms such as "service warrants", "service standards", "service attributes", "performance indicators" and "level of service" as if they are synonymous and therefore interchangeable.

(1) The triathalon,tipped to become the glamour athletic test of the 1980's, consists of a massive swim, followed by the middle-distance run and then a gruelling bike ride. See your friendly G.P. first!

LEVEL OF SERVICE REVIEW

Vorhees and Partners (1979) offer the following definition of LOS:

"'Level of Service' is a collective term which relates to a number of service characteristics such as reliability, comfort, safety, frequency, etc. Many of these characteristics are tangible in the sense that they are measurable, but few, if any, are pecuniary in the sense that they are readily measurable in terms of market prices".

This leads to the distinction between "performance indicators" and the "Level of Service" concept. Performance indicators generally employ cost and patronage data, which are quite distinct from service characteristics, which are influenced by these attributes.

The cost of a good or service, that is, the disutility associated with its acquisition, is quite distinct from the attributes expected to be derived by its consumption.

Level of Service Analysis has to address the various components of these "service attributes" or "service characteristics", positive and negative, quantitative and qualitative, and ensure that financial performance formulae, (consisting of compounded LOS performance measures in some cases), are not misused to the detriment of public transport suppliersin general. The subsequent review will highlight some of the difficulties encountered when an attempt is made to clearly specify the elements of the various LOS characteristics, which are many in themselves, and present different degrees of complexity in different contexts. For practical reasons, it is evident that considerable simplification is required. However, the final result of the necessary screening and refining should not lead to *reductio ad absurdum*.

Aims of Paper

This paper aims to:

(a) Provide a brief critical review of recent research contributions to the LOS topic as well as assessing the implications of applying some of the proposed LOS criteria to actual transit operations; and,

(b) In the light of methodological limitations emerging from the review, advance some proposals as to the direction that future LOS research should follow with a view to providing a useful analytical framework for deriving meaningful LOS criteria.

REVIEW

As early as 1959,Warren T. Adams attempted to isolate the principal factors influencing mode choice, and developed a crude transit service ratio that isolated speed of travel and convenience as the two dominant components of LOS.

Golob et. al.(1972) (1)attempted to define the minimum quality characteristics for a public transport system, (predominantly bus), for different service areas with different economic and sociologial catchment features.

(1) Refer appendix A attached

This was the first major study to combine market segmentation techniques with user evaluation of LOS characteristics. Recognizing that the elderly and low income groups would have different sets of preferences and rankings of attributes from those of the total population,(and therefore different service needs), a weighted ranking of service attributes was sought.

Although subsequently criticised on the basis that the techniques used did not provide a sufficiently fine gradation for the continual evaluation and upgrading of network characteristics, the study struck at the crux of the LOS issue from an operators' viewpoint, viz. how different market segments rank a comprehensive set of service attributes and how these change through time.

The work of Fielding and Glauthier (1976), is generally regarded as the pioneering research effort in the identification of usable performance criteria, and also marks the commencement of the drift away from LOS criteria *per se* in favour of clear-cut performance measures that would, *inter alia*, serve as useful performance criteria for the allocation of funds to ailing public transport systems. Potential performance indicators, they suggest, should be evaluated across a three criteria standard, viz. methodological correctness, data availability and inherent bias. The methodological correctness criterion stresses the strict separation of efficiency measures, related to production, from effectiveness measures, related to consumption, which rules out the use of measures such as passenger/ kilometres.

Talley and Becker (1982), while concerned with this efficiency versus effectiveness distinction, require more precise properties in their performance indicators. Very significantly they note:

Along with the increase in assistance to public transit, concern has also increased in regard to the public return from such assistance. As a result there is a growing emphasis on measuring the performance of transit systems. The American Public Transit Association (APTA) has endorsed this task and urged 'All APTA members to individually develop and implement a system of performance indicators'."

These authors remind us that in evaluating transit performance, the US transit authorities and funding bodies are primarily interested "in establishing minimum tolerable standards for justifying expenditures on transit projects".

Such evaluation measures they argue, should;

(i) Measure positive contributions rather than minimum standards;

(ii) Allow for weighting of different kinds of passenger trips to accommodate special equity and externality considerations;

(iii) Be capable of being used to assess a range of potential improvement actions, not just route extensions or cut-backs; and,

(iv) Permits comparison of new proposals with the best available alternative rather than against some arbitrary standard.

They then propose the following public transit evaluation measure that can satisfy all four criteria, which is simply:

"Transit deficit per passenger"

They then go on to argue that this single measure is consistent with evaluating a transit system from the stand point of efficiency and effectiveness.

Having cited a series of different definitions of efficiency and effectiveness they round off their discussion of these two key concepts with the tautology:

"One plausible explanation for the lack of a better definition of effectiveness and efficiency is the failure of researchers to specify definitive effectiveness and efficiency objectives".

This semantic side-stepping of definitional issues hardly provides a justification for their "deficit per passenger" criterion of system performance.

The criterion "deficit-per-passenger" is a very severe funds allocation criterion; the implication of its rigid application are drastic. No doubt the funding body is looking for improvements in this vital statistic, and no doubt an operator with a lower deficit per passenger will be viewed more favourably than a competitor with a higher deficit per passenger.

But "deficit-per-passenger" may not and usually does not provide a measure of relative efficiency. The operator with the highest "deficit per passenger" could well be the most economically efficient operator where efficiency is defined as a value of output per unit cost input.

Different operations have different cost structures and different scales of operation. Some are more labour intensive than others and some are less able to absorb cost increases than others. They service different catchments with different population densities, different geographic constraints etc.

In addition, money costs and dollar revenue may not reflect real costs and benefits between operators. The use of a criterion such as "deficit per passenger", as a prime basis for funds allocation, would be short-sighted and naive.

A worsening operating deficit could provide the signal for service shaving or service elimination, which would be contrary to the principles of prudent allocation of scare resources in the Pareto sense: when we note that the objectives being served by the networks are now being assessed on purely commercial criteria, were in many instances designed to service a wide range of community objectives, then to apply this criterion is quite misleading.

We find Ross (July 1975) noting that:

"The development of predictive models have progressed from exclusive reliance on travel time through consideration of user cost to concern with such variables as comfort and personal safety."

He noted three of the main problems associated with trying to incorporate these "soft variables" into the transportation planning format viz:

> *"(1) Identify the relevant variables;*
>
> *(2) Measuring them on a scale that permits direct comparison one to the other and to time and cost; and,*
>
> *(3) Integrating them into a mathematical model that has predictive power".*

Eight years later, all three issues are extremely relevant and unfortunately no general consensus exists as to what is the most productive approach to these problems. In some cases there has been an attempt to discard these 'soft variables' altogether.

In California (1977), acting on a mandate to minimize operating deficits, the Auditor General developed a list of "performance measures". Whilst his report professes to address the major public transport issues of the day, its reviewers claim it only addressed a limited number of efficiency measures, eg:

- operating costs per vehicle service hour;
- vehicle service hour per passenger;
- passengers per vehicle service hour;
- passengers per vehicle service mile.

"Effectiveness" is not mentioned. These are 'performance measures' that use LOS data inputs,but could hardly be viewed as a set of LOS measures. Again it will be noted, there is a strong tendency to opt for the "easy end" of the evaluation grid - the commercial performance aspects of the system.

Underlying problems of developing equitable funding strategies is the need to develop LOS measures that will demonstrate two features:

(a) how subsidies are used; and

(b) how efficient the overall operations results are towards improving the inherent quality of public transport services.

Sargions (1977), rightly stresses that before any comprehensive LOS evaluation framework is adopted, there is a prior need for a thorough statement of the broad social and economic goals which public transport is expected to serve.

He advocates the development of an LOS index which planners could use to:

(A) Assess the level of service of existing systems;

(B) Evaluate improvements in existing transporation systems; and,

(C) Evaluate new alternative transportation systems.

The model used by Sargions separates LOS from a user's point

or view into:

1. Performance characteristics;

2. Spatial characteristics; and,

3. Temporal characteristics.

Sargions concluded the utility maximisation approach could be used effectively to develop reliable LOS indices for evaluation purposes and that using such indices in conjunction with orthodox economic analysis, could supply planners and policy makers with valuable information inputs for evaluation purposes. This article underlines the need to propose a formal LOS assessment framework that is adaptable,rather than searching for some formula, that possesses a peculiar degree of stability and precision.

Keck et.al. (1980), in a critical review article, identify fifteen performance measures currently being used by New York State DOT, as a basis for transportation assistance programmes. The authors review "past efforts to link performance measures to funding programmes". They stress that the New York programme, unlike a large number of other State programmes, does not attempt to link funding to operating deficits, rather, it aims to provide incentives for transit use by lowering fares and reducing unit service costs. The paper notes "potential pitfalls in using performance indicators, measures or criteria, to rate or compare transit operations".

The authors do show some awareness of the lack of realism and internal conflict embodied in these directives, and appear to favour the formulation of system-specific relative performance measures. They also concede the need for the dynamic updating of any set of criteria that may be deemed appropriate in particular contexts.

Miller, (October 1980), notes that US DOT conferences have commissioned a plethora of studies and convened innumerable workshops, that have ranged over 100 different transit performance variables, mainly with a view to providing funding criteria, yet, "to date there has been little attempt to understand the use of the various measures that can be applied to funding allocation decisions".

Mark Weisman, in July 1981, notes that, despite the extensive data base available for LOS variables, planners tend to select those that they consider important, on an intuitive basis, and rarely substantiate their assumptions, despite the persuasive influence such premature imposition of constraints has on the mix of services provided. He also notes, that the concepts used are more often than not defined on the basis of data availability, and that they are rarely analysed in a framework that determines the relative influence of each on passenger patronage. He infers that the basic simplifications demanded for modelling convenience detract from the essential complexity of the phenomena under scrutiny and generates over-reliance on a few key LOS concepts.

Benjamin and Sen, (June 1981), apply market segmentation techniques and multi-dimensional scaling techniques, to assess the relative importance of a set of performance attributes from the users' stand-point. The objectives of the research was to explain and evaluate existing services and isolating deficiencies in LOS with a view to improving the performance of the system. The authors conclude that:

"The primary advantage of this method over the more traditional methods used in transit market analysis is that it provides a more comprehensive and representative assessment of both users and non-users viewpoints. It is a cost effective method for identifying groups with different viewpoints, which gives transit providers the opportunity to tailor services to each group with a resulting improvement in the match between users' needs and the services that are provided.

Miller, (1980), reviews the performance indicators recommended by seven (7) separate US studies, (refer Appendix B). He quotes the American Public Transit Association (APTA) as stating:

"The emphasis for performance evaluation must be upon the use of resulting information internally, not for determining funding agency allocation formulas".

He observes that transit managers fear the universal adoption of some performance formula or rule of thumb that will ignore the essential differences between transit systems and thus lead to bias in funding. Miller is of the opinion, that where distinctive features that are system-specific occur, the performance criteria can be modified to ensure equity in funds allocation.

He does conclude, however, (operators' reservations aside), that minimum standards for each performance measure can be specified. Where funds availability is not a serious constraint, LOS standards over and above these minimum standards can become the subject of successive strategic plans. They provide the basis for setting planning targets.

Miller advances a performance measure framework, rather than a rigid index, with the primary purpose of providing a funding criterion; characteristics of this framework are:

"1. *The performance measures must be related both to societal goals for travel and the legislative goals of a funding programme;*

2. *To be workable, the system of measure must be simple;*

3. *The funding agency must view the transit property and the local government as a single policy marketing unit; and,*

4. *Data to measure each variable must be readily available and unambiguous."*

Miller concludes that lack of reliable data and failure to agree and clearly specify the goals of transit authorities and funding programmes, rather than lack of compatability between transit systems, is the reason for failure to agree on an appropriate set of indicators for the implementation of a performance based methodology.

It is interesting to note that, throughout the 1970's, while individual researchers and research teams were singling out particular service attributes for in-depth analysis; *vide* Vuchic (1981) on flexibility, Burns and Gobol (1976), Dalvi and Martin (1976) and, *inter alia* in Australia, Morris et.al. (1979) on accessibility, the large public transport administration agencies and funding bodies were calling for a comprehensive approach to the LOS issue. That is developing a composite index without any clear conception of the exact meaning and

significance of its components.

Commencing with the US (DOT) "First National Conference on Transit Performance" in 1977, the hunt was on, for the elusive formula, that would act as a tool for corporate management, operations control, LOS strategy evaluation, and most importantly, as a criterion for allocating funds to service growing public transport deficits, despite APTA's assurances to the contrary.

Meanwhile, the states of New York, Pennsylvania Michigan and California, had passed enabling legislation that tied the allocating of funds to transit agencies, in one way or another, to criteria based on efficiency and effectiveness.

Despite the extensive research that has been accorded the LOS topice, the simple but drastic "deficit per passenger" criterion was emerging as the prime basis for the funding of deficits associated with public transport operations.

This financial criterion, itself influenced by numerous factors, loses sight of the importance of designing the systems characteristics to meet the community's needs. It totally eclipses the user's perceptions of level of service from having any influences on the LOS provided.

The market segmentation approach, however, addresses itself to the very essence of the choice process, rather than abstracting from it *'ab initio'*.

A clear exposition of this approach, building on the previously cited work of Golob (1972), can be found in Heathington and Barnaby (1977), who after presenting a brief review of traditional urban transportation processes, propose market segmentation as a very useful technique for identifying clusters of users with homogeneous transport needs - hence desirable service attributes. The identification of user preference preceeds system design, which will still be subject to financial and political constraints, but nevertheless, attempts to match system characteristics with sub-area community aspirations. This approach is concerned with the 'effectiveness' aspect of LOS and raises questions of inter-spatial equity.

BRISBANE EXPERIENCE

Wilbur Smith and Associates (WSA) (1970), in their "South East Queensland Brisbane Region Public Transport Study", advocated three prime "Service Standard" objectives viz:

1. shorten the journey time;
2. enhance the passengers comfort and convenience; and,
3. maintain a reasonable cost.

Improvements to quality in these areas, they state, would "benefit the present users and attract additional patronage". "Enhance", of course, has, we believe, various shades of meaning from, new world-class equipment to "let's get away with the least possible improvements" approach. What constitutes "reasonable" costs is not clear either. W.S.A. also state that;

> *"JOURNEY TIME" - The total time required for a public transport passenger to complete his journey is affected by:*
>
> *(1) route coverage, which fixes the time spent in reaching the bus stop or train station;*
>
> *(2) the headway on the route, which determines the time spent waiting for the bus or train;*
>
> *(3) the effective running speed of the vehicle, including the time consumed in making stops to pick up and set down passengers and, in the case of buses, delays due to road congestion; and*
>
> *(4) the speed and acceleration capabilities of the vehicle itself.*
>
> WSA recommended increasing operating speeds:
>
> - for buses by introducing bus priority measures;
> - for trains by introducing electrification and track improvements.

For passenger comfort and convenience, they advocated a variety of initiatives including comfortable in-vehicle seating, air conditioning, good in-vehicle seating, air conditioning, good in-vehicle lighting, protection from glare and smooth vehicle running. In addition they proposed the provision of park-and-ride and kiss-and-ride facilities, bus bays at rail interchange points and shelters and comfortable bench seating at bus stops. The provision of such basic vehicle standards and ancillary amenities, we feel, has too often been viewed as the prerogative of the operator.

The WSA approach showed little interest in canvassing the attitudes of users; it was the case of "like what you get" ie. the dominance of planners preferences.

It is amusing to speculate on what the responses of the Transport Ministers and executives were, when advised that direct operating cost recoveries of 70% - 80% were required and that fares needed to be doubled immediately!

The Brisbane Metropolitan Transit Authority Plan, 1979-84, states:

"There are a number of parameters commonly used to define level of service. These include frequency, route coverage, speed and directness of service as well as factors such as reliability, comfort and convenience."

The prime emphasis was on frequency and clock-face scheduling.

While it is obvious that modern electric vehicles provide a quieter, cleaner, more comfortable ride than their deisel drawn counterparts, to date, no specific studies have been commissioned to assess users attitudes towards these LOS aspects.

In conclusion, then, we observe that here in Australia in 1979/80, we found ourselves in the same situation as the US and UK were four years previously; there was a general recognition that LOS was important but we needed to concentrate on the more mundane aspects of public transport supply before canvassing users attitudes towards schedule adherence, comfort and convenience etc.

In 1979/80, DOT Canberra took the initiative of commissioning a comprehensive study on the nature and relevance of LOS indices. Our conjecture is, that we in Australia now, find ourselves in the same dilumma as the Americans were in 1976. We do not know the answer to the *"Quo Vadis"* question, but rising operating deficits are pushing us into the trap of using accounting type performance indicators.

Our review has attempted to highlight the following central issues of the debate.

1. LOS in the broadest sense is a very complex matter, especially as both operator and user views have to be considered and are often diametrically opposed.

2. There does not appear to be any measure of LOS for urban public transport, that is both simple and useful. The simpler the measure the more bias it imports into policies based on its application.

3. Neither cost per passenger kilometre nor deficit per passenger offer a reliable measure of LOS, as such measures fail to detect those non-monetary benefits to the community that might result from offering higher LOS standards.

TOWARDS A MORE USEFUL LOS FRAMEWORK

Given the foregoing interpretation of the origin and role of "Level of Service" concepts in transportation planning, and an appraisal of the contemporary "state of the art", the remainder of this paper will address the following two LOS issues in some detail: viz.

(A) The impracticality of trying to develop a composite LOS index to embrace the concept defined in its broadest sense.

(B) The need to synthesize the various research probes that have been used to address the LOS issue in its most comprehensive sense, and advance some proposals towards the development of a useful LOS framework.

It will not address the problems encountered in applying various statistical techniques to LOS analysis, but will propose a practical approach that may be useful in broaching LOS issues relevant to an existing transport system or network.

A Composite LOS Index

Most people associated with Transport will concede that there is a general awareness in the industry that from a financial viability viewpoint, the future scenarios for public transport operators look grim. It appears, that if we wish to increase public transport patronage, we will have to face up to the complexities of the LOS issue.

Projections that are founded in fact, point to a continuous worsening of the deficit situation - an increasing reliance on the public coffers as we gaze out towards the year 2000 and beyond.

Even if declining patronage trends are arrested by a combination of market forces and regulatory devices, the broadening gap between fare-box revenue and operating costs, (ignoring sunk capital costs), will continue.

The somewhat naive demand for a simple rule-of-thumb to evaluate the LOS of a network, or market segment thereof, has resulted in the relatively unproductive search for a composite LOS index.

Some credibility is lent to this serarch when only the basis operations - oriented aspects of LOS are considered viz. frequency, schedule adherence and crush loadings. However, when the LOS concept is extended beyond these elementary notions, it becomes clear that no single index can at the same time be simple and still embrace the complexity of all the diverse elements, (objective and subjective), that a comprehensive view of LOS requires.

Some of the most persuasive reasons that can be advanced to establish the impracticality of trying to harness this elusive LOS concept into a single composite index are:

(i) The meanings of terms such as comfort and reliability differ inter-personally and inter-spatially.

(ii) Definitional clarity would have to be so fine as to avoid any overlap between the attributes.

(iii) The various attributes acquire different significance between different modes, between peak and off-peak for different trip purposes, for different socio-economic groups and even between different micro-market segments.

(iv) Accurate specification would require that attitudes towards each component of the index would have to be weighted for each separate application.

(v) Not only inter-modal issues but also intra-modal differences would have to be addressed.

(vi) The weightings given to certain variables would vary by season and by time of day.

(vii) There is the additional complicating factor of the varying degree of inter-relationship between the

various factors entering the matrix.

(viii) There is a causative hierarchy problem also. Unless this is clearly articulated at the outset problems of good correlations not implying causation will have to be addressed.

Despite these and other difficulties associated with the search for a composite LOS blueprint - the elusive hunt can still boast several ardent adherents.

Our conclusion is that any such composite index, would have undergone such mutations and would be so constrained by assumptions by the time it reached a usable form, that it would be a worthless tool.

We agree with Allen and Di Cesaro (1976) that:

"The judicious use of accepted service standards is the only way to evaluate a single transit system on an absolute basis."

We agree that funding bodies prefer simple subsidy allocation formulae based on easily acquired monitoring data such as vehicle-kilometres, passenger-kilometres and catchment area served.

We are aware, however, that such formulae may have Little bearing on the actual level of service, and, as 'level of service' is broadly synonymous with quality we suggest that:

1) Minimum standards for the more important LOS variables should be specified. These may vary between catchments and/or corridors.

2) That strategic plans should state their LOS objectives after conducting market-segmented attitudinal research.

3) The adoption of differential pricing policies between high LOS and low LOS facilities (ie) supply a range of service qualities and price them accordingly.

4) That LOS differentials between different segments in a total catchment should be established and monitored on a continuous basis.

5) That the objective of attaining definitional precision for the various LOS concepts be pursued.

In this regard the type of dissection of attributes performed by Allen and Di Cesare (1976), where for example, convenience is broken down into six sub-components or elements (and some even further disaggregated), is desirable.

The authors are currently undertaking the second phase of an attitudinal study that sub-classifies eight (8) LOS measures into five sub-components and obtains weighted rankings of each sub-component and each attribute. Three market segments, with distinctly different service attributes were surveyed in 1976. A follow up survey in 1982 will attempt to ascertain attitudinal change towards these LOS attributes after each segment has experienced substantial improvements

to the level of service provided. (1)

Towards a More Useful LOS Framework

The LOS debate in recent years has become fragmented, over-simplistic and is devoid of an integrated conceptual framework.

At the Brussels meeting, of the Nato Committee on the Challenges of Modern Society, in October (1976) a very concerted effort was made to provide a universal focus for LOS analysis. A thorough and comprehensive framework for analysis was designed, aimed at highlighting the major inadequacies of present transport and traffic systems. In this respect, proposals for across-the-board improvements in public transport standards were adopted.

This meeting attempted to attain definitional clarity of performance criteria and obtain weightings of the relative importance of a broad range of service attributes which were disaggregated into their various components. The Report of this Committee provided the framework for a synthesis and standardization of LOS research which was both succint and conceptually sound. Its influence to date however does not appear to have been widespread. The study programme launched at this meeting is on-going and is one of the most promising LOS initiatives to date.

This group, under the auspices of the O.E.C.D. in Paris in 1978, again attempted to address the need for an agreed systematic framework for LOS analysis. The study format gave priority to:

1) Reviewing developments with regard to the performance of public transport in the member countries.

2) Providing inventories and assessments of the indicators now in use in the member countries with a view to subsequent comparison and collation.

3) Commissioning two studies in each member country - "by preference, one of a medium sized bus system, the other (if appropriate) of a large multi-modal public transport system...."

4) Producing a recommended package of indicators with discussions of their relevance. This implied obtaining a short list of what were rated as the most significant attributes.

By far the most comprehensive attempt undertaken in the US to encompass all relevant LOS (or Transport Performance Measures, TPM's),into one framework, was that of UMPTA published in December, 1978. The prime listing covered 200 separate measures which were processed and screened to yield eighteen (18) key performance measures.

We see then a similarity between the UMPTA and OECD approaches, in that after reviewing all possible service measures, they both focus on providing a short-list of the dominant measures.

(1) Refer Appendix C attached.

Here we face the problem of the "trade-off" between a comprehensive array of performance criteria that would be extremely difficult to incorporate into a LOS assessment framework, and extremely difficult to endow with operative meaning, and a set of those measures that are deemed to be most important. This is a big improvement however, on a single measure or single composite index.

Weigmann F.J. et. al. (1979), present a very formal framework, which claims to be "a general procedure to match desirable service attributes resulting from a market segmentation study with alternative service concepts to determine which alternative services are appropriate for a local area".

This also is an approach that attempts to synthesize and refine the disparate strands of LOS research, a conceptually sound though complex framework.

The need for this standard format, with its component package of dominant LOS measures, is demanding increasing attention and must be the most hopeful avenue for putting the LOS debate into its proper perspective.

The prime classification must separate the various interested parties; the user, operator, community, Government and/or a funding co-ordinating body classification provides the prime set of sub-headings.

The conventional trip purpose classification provides the next refinement for each of these categories.

The quantitative versus qualitative division could come next (which is somewhat akin to the benefit-cost procedure). The issue of "perceived versus actual" is an important one and could be addressed at this stage.

The resultant array could serve as a check list when calibrating the relevant categories in any network or sub-area segment analysis. Transport service catchments are usually segregated into zones and/or corridors. This can provide a useful prime classification for transit market segmentation. In some cases, in some circumstances catchments and service corridors may have to be devised from scratch.

Application of market segmentation techniques will identify fairly homogeneous groups of users and potential users throughout the entire catchment area. The "system characteristics" for the transport modes servicing these segments should be detailed before the design of the attitudinal questionnaire is commenced. This is done by reference to the most comprehensive array of performance measures available. The elements or sub-components of attributes such as comfort and convenience will differ from system to system, so care should be taken in achieving precision in the specification of system characteristics. This exercise should also reveal deficiencies in the system. The researcher assesses the "as is" of the package provided by the operator.

This knowledge of the systems operating characteristics and standard of service is necessary in order to pitch the attitudinal questionnaire design correctly. Snap questionnaires may have to be administered 'on-board vehicle' to get a feel for what are the major deficiences of the present transport system.

Whatever attitudinal survey technique is adopted, the problem of respondents vesting different attributes with different meanings will arise. The objective is to avoid overlap and ambiguity in order to gain a list of the relevant attributes and a relative ranking of their importance as perceived by users and non-users.

The operator can produce a range of cost/quality mixes, and different market segments will be willing to purchase different cost/quality mixes at various prices. The objective is to best match various cost/quality mixes within a set of budget constraints.

The demands of the users and potential users, as well as the attitudes of non public transport users, can then be incorporated into the framework, as can the feasible options from the operators' standpoint, to satisfy demands and potential demands.

The co-ordinating/funding body then examines the options on the basis of present needs as well as future projected demand. The approach though open-ended at the outset, moves into a more constrained framework by elimination of certain aspects on the grounds of being irrelevant, not feasible or of lesser importance.

The main advantage of this approach is that it is not predicated in a context of premature imposition of constraints, which invariably imports bias into the assessment.

Service design and improvements to meet the LOS standards demanded by the community does not necessarily mean increased deficit funding.

Public transport must compete with the private car, particularly for work trips, by improving the quality of the product along the lines indicated by the potential market. Public transport suppliers and funders alike will have to conceive of LOS in broader and more realistic terms if patronage is to attain a sustained revival.

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APPENDIX A

RANKING OF LOS ATTRIBUTES FOR DIFFERENT MARKET SEGMENTS

a) For Total Population

Factor	Weight
Arriving when planned	1.80
Having a seat	1.65
No transfer trip	1.55
Calling without delay	1.45
Shelters at pick-up	1.43
Less wait time	1.40
Choose pick-up time	1.36
Lower fares	1.35
Longer service hours	1.33
Less walk to pick-up	1.30
Stylish vehicle interior	0.00

b) For the Elderly

Having a seat	2.35
No transfer trip	2.31
Lower fares	2.20
Arriving when planned	2.10
Less wait time	1.90
Less walk to pick-up	1.86
Shelters at pick-up	1.84
Easy entry-exit	1.80
Calling without delay	1.70
Short travel time	1.70
Coffee and newspapers on board	0.00

c) For Low Income Group

Arriving when planned	2.40
No transfer trip, shelters at pick-up	2.28
Longer service hours	2.18
Having a seat	2.08
Calling without delay	2.04
Less wait time	1.99
Lower fares	1.88
Less walk to pick-up, direct route	1.83
Choose pick-up time	1.79
Easy fare paying	1.70
Coffee and newspapers on board	0.00

Source: Golob et. al. (1972)

APPENDIX B

TABLE I -- TRANSIT PERFORMANCE MEASURES SUGGESTED BY VARIOUS STUDIES FOR USE IN THE ALLOCATION OF FUNDS

Measure	Code Number[a] for Study in which Measure was used
Efficiency	
Cost Measures	
1. Cost/Vehicle-Hour	1, 4, 5, 7
2. Cost/Passenger	3, 4
3. Cost/Passenger-Mile	5
4. Energy/Passenger	2
Labor Productivity	
5. Annual Vehicle-Hour/ Annual Employee-Hour	5
6. Annual Vehicle-Hours/Employee	1, 2, 4
7. Passengers/Employee-Hour	5
8. Annual Passengers/Employee	3
Vehicle Utilization	
9. Annual Vehicle-Miles/Vehicle	2
10. Annual Vehicle-Hours/Vehicle	1, 2, 5
Effectiveness	
Accessibility	
11. Percent Population Served	1, 3
12. Percent Employment Served	3
13. Percent Transit Dependent Served	3
Service Utilization	
14. Passengers/Service Area Population	1, 3
15. Revenue/Vehicle Hour	7
16. Passengers/Vehicle Hour	2, 4, 5, 7
Quality	
17. Percent Trips Missed	3
18. Seat Hours/Capita	3
19. Transfer Opportunities/Route Mile	3
20. Vehicle Cleanliness and Condition	6
21. Driver Performance	6
22. Headway	3
Other	
23. Deficit/Passenger Mile	5
24. Revenue/Cost	2, 3, 5, 7

[a]Code number for study: 1. Fielding Glauthier; 2. Drosadt; 3. CALTRANS; 4. California Auditor General; 5. New York; 6. New Jersey; 7. Pennsylvania Department of Transportation

Source: Miller (1980)

LEVEL OF SERVICE REVIEW

APPENDIX C

Within each of the following classifications, rank the sub-characteristics in order of importance as you perceive them in relation to commuter travel.

1. COMFORT

(a) quality of seating
(b) smoothness of ride
(c) shelter & seating facilities at terminals
(d) in-vehicle crowding
(e) opportunity to read/knit

2. CONVENIENCE

(a) frequency of service
(b) location of service w.r.t. home & work place
(c) availability of parking
(e) traffic congestion

3. RELIABILITY

(a) operations "on schedule"
(b) service subject to strike activity
(c) service subject to "breakdowns"
(d) service not subject to frequent re-scheduling
(e) competence of drivers

4. TIME

(a) walking time
(b) terminal waiting time
(c) interchange time
(d) in-vehicle travel time
(e) in-vehicle delays

5. SAFETY AND SECURITY

(a) accident frequency
(b) in-vehicle personal safety
(c) access/egress personal safety
(d) car theft
(e) property theft

6. CLEANLINESS

(a) in-vehicle cleanliness
(b) station/terminal cleanliness
(c) other passengers cleanliness
(d) vehicle exhaust fumes
(e) vehicle appearance

7. FLEXIBILITY

(a) freedom from schedules
(b) ability to pick up goods
(c) ability to change route
(d) ability to avoid congestion
(e) door-to-door service

8. PERSONAL

(a) maintaining privacy
(b) avoiding distasteful people
(c) personal control over vehicle
(d) status, ie. social acceptance
(e) individual freedom

Source: Questionnaire for Brisbane LOS Study (in progress)

Source: Miller (1980)