Concept of ‘Mass’ in Mass Public Transit Systems

Anupam Vibhuti

Abstract:

‘Mass’ of ‘mass transit’ means different things to different stakeholders of mass transit. The ‘policy maker’ looks at ‘mass’ from the point of view of the ‘transport planner’. The ‘operator’ looks at ‘mass’ from a ‘large number, low cost operations’ perspective. The ‘transport planner’ looks at mass from a ‘number maximization, resource optimization’ point of view. The ‘commuter’ looks at a ‘low cost, high speed’ journey.

Transport planning projects & proposals related to ‘mass’ public transportation are finally vetted by policy makers who are usually politicians and accepted by the layperson, both with very little understanding about the ‘technical’ aspects of ‘mass’ consideration of the domain.

When it comes to explaining ‘mass’ to a policy maker or the layman the measurement unit of mass is quoted as ‘pphpd’ (person/passenger per hour per direction) by most experts in the domain. In doing so, the ‘size’ of the elephant is often compared to the ‘size’ of a leopard (with widely differing swiftness abilities) and an ‘animal’ made acceptable for ‘size’ when it may be the ‘reach & pace’ that may be in question.

INTRODUCTION

It may be a mistake when policy makers and laypersons accept ‘pphpd’ as the key unit for transit ‘capacity’ measure whenever available public transport technologies are evaluated for ‘selection’. In the process the meaning of ‘mass’ as understood by one stakeholder is imposed on the other stakeholders without accounting for the ‘effective mass’ considerations from the perspective of all the stakeholders holistically. Perhaps it is practical limitations of braking distance, acceleration & deceleration capabilities of transit systems available today that forces the stakeholders in selecting these technologies not considering the ‘speed’ of a system which otherwise is the ‘most’ important consideration when it comes to the interest of the commuter using the system.

This paper does not debate and discredit the applicability of any conventionally available systems for mass transit like the metro rail, monorail & bus rapid systems and the ‘selection methodology’ from such a limited point of view. It could be said that the ‘traditional’ method of system selection has actually become subservient to the ‘availability’ factor of transit systems.

Without compromising on the practical limitations of braking distance, acceleration & deceleration, the need to consider this very aspect of ‘speed’ necessitates the search for newer ‘technologies’ for transit systems. This paper attempts to highlight the case for ‘system speed’ from the fundamental considerations of the ‘mobility objectives’ of any community and therefore search for ‘new’ transit systems.

It can be demonstrated that the ‘unit’ for measuring the capability of transit systems should NOT be ‘pphpd’ although it has become customary and popular to do so, so much so, that it seems beyond any doubt or question. This predominantly used unit does not account for the distance traveled by the commuter in unit time at all. Therefore this unit does not provide a sense of distance capability of any system in the specified time from the perspective of the ‘commuter’ which is the key participant in the objective towards consideration of ‘mass’ transit in the first place!

It can be demonstrated that several systems theoretically can have, for the same ‘pphpd’, widely different mobility characteristics for commuters. Therefore out of two systems with the same ‘pphpd’ the commuter

1 B. Architecture & M. Planning (Transport), Founder Director, Worxspace Consulting Pvt Ltd, D 113, East of Kailash, New Delhi 110065, India [+91 9810070013]M email: anupam.vibhuti@gmail.com
2 Phpdt (Peak hour peak direction trips) is an equivalent unit of measure, means the same thing and is a measure of ‘line capacity’
‘needs’ a system which can move him faster through his journey. The unit ‘pphpd’ inherently does not reflect this ‘measure’.

On the contrary, ‘Pkmphph’\(^3\) (person/passenger kilometer per hour) is the key unit that can objectively compare different systems of transit from the perspective of a planner, policy maker and the commuter ‘together’. It can be used to evaluate systems from a ‘capacity’ point of view in more holistic and relevant quantitative terms; and thereafter in a comparative matrix of capital cost, energy usage & recurring cost, the three most important concerns to the mobility planner apart from transit capacity itself.

It is time to reconsider ‘pphpd’ as the key unit to compare alternative transit systems OR making it the basis for evaluation of applicable transport technologies. Instead ‘Pkmphph’ should be considered as THE key unit to compare alternative transit systems. It is only after this ‘unit of comparison’ is universally acceptable that ALL other issues regarding system selection become relevant. Therefore it is imperative that this concept be explained & resolved prior to accepting any criteria for transit system selection. This itself is the very purpose of this paper.

MASS TRANSIT – PUBLIC PERCEPTION

The public perceives that ‘mass’ of mass transit is actually the size of the mass transit system. The bigger the carrier the bigger is the ‘mass’ capability of a system. Metro rail system is the biggest ‘mass’ carrier in the mass transit system class in an urban environment. The general perception is that it can take a platform full of people, a ‘lot’ of people at a station at one go.

MASS TRANSIT – OPERATOR’S CONSTRAINTS

The ‘operator’ looks at the ‘number’ of commuters that can be carried by the system at each instance and tries to do so in the given constraints of station distances, braking distances, acceleration & deceleration characteristics. In a given context of these constraints the ‘speed’ of the carrier gets limited by regular stops at fixed intervals and therefore the only way to look at carrying larger numbers is to increase the size of the carrier for each alignment of the system.

MASS TRANSIT – CONSULTANTS BRIEF TO POLICY MAKER

The ‘consultant’ today looks at the ‘number’ of commuters that a technology system can service in unit time and is largely confined to the attributes of readily available tested technology systems available in the market. The ‘number’ of commuters that a particular system ‘claims’ to carry becomes an evaluation constraint in the system selection methodology.

This ‘number’ carrying capacity is what is briefed to a policy maker as the ‘only quantitative’ criterion to compare technology systems for capacity. A suitable match of this ‘number’ carrying capacity is sought for a measured ‘line’ demand on a given alignment and the matched technology system is adopted in the evaluation matrix.

MASS TRANSIT – COMMUTER’S PLIGHT

The ‘commuter’ is not concerned about the ‘mass’ of the mass transit system as long as he can complete a part of his journey and reach his destination the ‘fastest’. ‘Speed’ of transit is the sole criterion which attracts him to a particular transit system apart from ‘comfort’.

This ‘commuter’ is who each of the above stakeholders is interested in serving. However this fundamental requirement is completely ignored in the quest for search of ‘mass’ in the system selection methodology today. This may perhaps be one of the key reasons why public transit systems have not been able to cater to the ‘needs’ of the commuter and been largely unsuccessful in their implementation globally, as public transit systems have never looked at this fundamental need from a ‘fundamental’ point of view at the time of

\(^3\) Pkmphph (Person/passenger kilometer per hour) is a measure of ‘productive capacity’
system selection and provision for technologically. (than being captive to the constraints of the existing ‘technology provider’)

**MASS TRANSIT - MOBILITY**

The fundamental ‘objective’ of any community when it comes to transportation or movement from one point in space to another is to provide ‘efficient mobility’ to everyone. Translating this objective into a tangible format, one can say that the key to achieving this is two fold.

The first is to provide means for ‘movement of large number’ of persons in a given ‘shortest’ period of time at the lowest ‘cost’ from the perspective of the ‘community or an operator’. The second is to ‘move fast’ from the perspective of the ‘commuter’. This second meaning is inherent in the very ‘efficient mobility’ objective and implies that persons travels the ‘fastest’ in the same period since spatial movement is the real focus of mobility and the ‘objective’ thereof.

**REAL MASS IN ‘MASS’ MOBILITY**

The traditional sense of ‘mass’ in mass transit systems is an ‘incomplete’ manifestation of the ‘mobility objective’ that only looks at ‘more numbers’ but ignores ‘swiftness’.

**TECHNOLOGY FOR MASS TRANSIT**

Any technology for ‘mass’ transit needs to service the basic tenets of the ‘mobility objective’ than the other way around. The available technologies for mass transit have become captive of the ‘tested’ & ‘safe’ tag and repeatedly ‘ignore’ the growing requirements of ‘commuting speed’ in most transit system selection methodologies. As a result the generalized cost of travel for most commuters using ‘mass’ transit systems for a part of their journey remains high enough because of journey speed itself apart from easy accessibility to discourage them from using the same.

**UNITS FOR MEASUREMENT OF ‘CAPACITY’ SCALE**

The ‘quantity’ scale of movement of persons, in ‘number’ terms, in a given unit of time is an aspect of consideration and interest in seeking to achieve the ‘mobility objective’. This literally means how ‘many’ persons have been moved from one point to another.

However ‘spatial’ scale of movement of persons, in ‘distance’ terms, in the same unit of time is also an equally important consideration in seeking to address the ‘mobility objective’. This literally means how ‘quickly’ these persons have moved from one point to another.

**DEFINITIONS OF SCALAR UNITS & PHYSICAL INTERPRETATION**

The ‘quantity’ scale of movement of persons, in ‘number’ terms, in a given unit of time is what is represented by the unit ‘pphp’ or ‘Phpdt’, which by definition describes the ‘number of passenger or trips passing a specific point along the transit line in unit time’. This is theoretically known as ‘Line Capacity’ and literally means how ‘many’ persons have been moved from one point to another.

The ‘quantity’ scale of distance covered, in ‘number’ terms, in a given unit of time is what is represented by the unit ‘Pkmphph’, which by definition describes ‘number of passengers carried a unit distance in unit time’. This is theoretically known as ‘Productive Capacity’ and literally means how ‘much’ actual distance has been covered in the given period of time ‘cumulatively’ by all the people or how ‘swiftly’ passengers are moved a given distance.

**COMPLETE Vs INCOMPLETE UNITS**

---

4 Mobility: The quality or state of being mobile., - *Chambers Concise 20th Century Dictionary* Allied Publishers Limited 1990
Any unit of measurement that does ‘not’ give a sense of both ‘number’ & ‘swiftness’ together can be regarded as ‘incomplete’ as that which can give a sense of both, is what can quantifiably measure the ‘mobility objective’ correctly.

COMPUTATION OF QUANTITY: CAPACITY CALCULATIONS

The measurement of ‘Pphpd’ is done by ‘counting’ the number of commuting persons transiting a point along the line of movement in a given unit of time. This is calculated by using a simple product of number of vehicles (transport units) passing the point in unit time & number of persons occupying each vehicle. Thus if 36 vehicles transit a point in a given hour carrying 4 persons each the value of ‘Pphpd’ can be computed as 36 x 4 = 144. Compare 48 vehicles transiting the same point in the given hour carrying 4 persons each with a ‘Pphpd’ = 192. Note that this is possible only if the vehicles would run closer to each other (smaller distance headway at the same speed) or the speed of vehicles is increased (higher speed with the same distance headway).

However the measurement of ‘Pkmphph’ is done by calculating the distance travelled by the commuting person in the given unit of time. This is calculated by measuring the speed of travel and the number of persons transiting a point in a given unit of time.

UNITS OF CAPACITY & SYSTEM SELECTION METHODOLOGY

The ‘traditional’ system selection methodology is based upon an approach that ‘compares’ available system technologies by evaluating them against stated ‘planning’ objectives along observed ‘line’ demand. These objectives help define the required system characteristics, performance measures, criteria & weights for a given context. The system selection methodology, apart from ‘quantitative’ performance and capacity aspects of the requirement also weighs the ‘qualitative’ aspects of the requirement in the comparative analysis matrix.

It is important to note that the ‘only’ quantitative aspect that is considered in the usual evaluation matrix is what is called the ‘Line Capacity’ and measured in ‘Pphpd’. The highest weightage within this aspect is obviously given to a candidate system that claims the larger ‘Pphpd’.

At this point of the argument, it is pertinent to point out the following aspects related to the ‘traditional’ methodology for transit system selection:

1. Both ‘qualitative’ and ‘quantitative’ aspects are considered in the evaluation matrix with respective weights based upon the local requirements.
2. If all other ‘qualitative’ aspects are almost same for all competing candidate systems, the desired system with the highest ‘Line Capacity’ that matches the requirement is selected. This is precisely the practice that is being followed around the world where a higher ‘Pphpd’ is quoted as the most important determinant in selecting a specific candidate system for a so called ‘higher performance’ requirement.
3. The scalar quantity of distance covered in unit time by individual passengers is ‘never’ considered as a parameter in the evaluation matrix, though it is quantifiable. It is however the ‘most important parameter’ from the point of view of the passenger and is the parameter that is a ‘key’ constituent in calculating the ‘generalized cost’ of his trip where the same ‘generalized cost’ is what determines his ‘mode choice’ (a higher time required to travel a given distance is a higher cost on his time) in a matrix of competing modes.

PPHPD - INCOMPLETE ‘QUANTITATIVE’ UNIT TO MEASURE ‘MASS’

It may be stated that ‘Pphpd’ is an incomplete unit to ‘quantifiably’ measure the capacity of a candidate system keeping the aforesaid, ‘twin’ aspects of the ‘mobility objective’ in mind.

In order to explain tangibly why ‘Pphpd’ as a ‘capacity’ unit does not ‘singly’ reflect the best performance of a system, it may be apt to consider the following three case scenarios in sequence. It is assumed, for the sake of simplifying the comparison, that all systems are of the same route length, run along a circular
alignment with an uninterrupted supply of vehicles and the observation represents a time slot after all the systems have completed at least one cycle each (all vehicles have covered the route at least once).

1. The first case scenario looks at the ‘same’ system configuration (same route length, same number of transport units, same vehicle occupancy & same distance headway) but different running speeds trying to match the required ‘Pphpd’.
2. The second case scenario looks at the ‘same’ system configuration & ‘same’ running speed (same route length, same number of transport units, same distance headway and same running speeds) but different vehicle occupancies trying to match the required ‘Pphpd’.
3. The third case scenario looks at ‘different’ system configurations (same route length, varying number of transport units, varying distance headway and varying speeds) where each of the different system configurations have the same ‘Pphpd’ and understand why any one of the candidates be selected or why all may be given the same weights in the system selection matrix.

**Scenario 1: SAME SYSTEM CONFIGURATION: DIFFERENT RUNNING SPEEDS**

<table>
<thead>
<tr>
<th>Series A</th>
<th>Case 1</th>
<th>Case 2</th>
<th>Case 3</th>
<th>Case 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Route Length</td>
<td>1.8 Km</td>
<td>1.8 Km</td>
<td>1.8 Km</td>
<td>1.8 Km</td>
</tr>
<tr>
<td>Headway</td>
<td>100 m</td>
<td>100 m</td>
<td>100 m</td>
<td>100 m</td>
</tr>
<tr>
<td>Rolling Stock</td>
<td>18 nos</td>
<td>18 nos</td>
<td>18 nos</td>
<td>18 nos</td>
</tr>
<tr>
<td>Frequency (Time Headway)</td>
<td>20 s</td>
<td>10 s</td>
<td>6.66 s</td>
<td>3.33 s</td>
</tr>
<tr>
<td>Speed</td>
<td>100 m in 20 s =18Kmph</td>
<td>200 m in 20 s =36Kmph</td>
<td>300 m in 20 s =54Kmph</td>
<td>600 m in 20 s =108Kmph</td>
</tr>
<tr>
<td>Circuit Time</td>
<td>360 s = 6 min</td>
<td>180 s = 3 min</td>
<td>120 s = 2 min</td>
<td>60 s = 1 min</td>
</tr>
<tr>
<td>PpHpD</td>
<td>4 x 3veh/min x 60</td>
<td>4 x 6veh/min x 60</td>
<td>4 x 9veh/min x 60</td>
<td>4 x 18veh/min x 60</td>
</tr>
<tr>
<td>Pkmphph</td>
<td>720 pphpd</td>
<td>1440 pphpd</td>
<td>2160 pphpd</td>
<td>4320 pphpd</td>
</tr>
<tr>
<td>Advantage</td>
<td>12960 Pkmphph</td>
<td>51840 Pkmphph</td>
<td>116640 Pkmphph</td>
<td>466560 Pkmphph</td>
</tr>
</tbody>
</table>

**Key Observations:**
- For a FIXED Space Headway - Speed is inversely proportional to Time Headway OR directly proportional to Frequency of vehicle arrival

<table>
<thead>
<tr>
<th>Series B</th>
<th>Case 1</th>
<th>Case 2</th>
<th>Case 3</th>
<th>Case 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>PAX</td>
<td>4</td>
<td>8</td>
<td>16</td>
<td>32</td>
</tr>
<tr>
<td>Route Length</td>
<td>1.8 Km</td>
<td>1.8 Km</td>
<td>1.8 Km</td>
<td>1.8 Km</td>
</tr>
</tbody>
</table>

Table 1: Capacity comparison of a system with different transit speeds.

**Scenario 2: SAME SYSTEM CONFIGURATION: DIFFERENT VEHICLE OCCUPANCIES**
Table 2: Capacity comparison of systems with different vehicle occupancies.

The first two case scenarios as exhibited in Table 1 & Table 2, follow traditional & conventional understanding of ‘mass’ in transit capacity. Both the cases tell us that higher the ‘Pphpd’ the closer is the ‘mobility objective’ because not only is the system moving ‘more’ commuter persons across the spatial area but is moving them ‘faster’ or ‘swiftly’. Therefore a higher ‘Pphpd’ serves the ‘mobility objective’ very satisfactorily.

However the third case scenario poses a challenge to this understanding and therefore the resultant selection ‘criteria’ in a system selection exercise, because the converse argument may not be true as displayed in the third case scenario. A system with ‘lower’ speeds may indeed have the same ‘pphpd’ as a system with higher speed, both with different system configurations (number of transport units, distance headway, running speeds & vehicle occupancies) and yet have widely different ‘swiftness’ abilities.

Extending the logic several systems can have the ‘same’ pphpd but ‘different’ system configurations and therefore different person moving ‘swiftness’ capabilities towards serving the primary twin ‘mobility objective’ of both ‘number’ and ‘swiftness’. Refer to the following Table 3.

### Scenario 3: SAME LINE CAPACITY: DIFFERENT SYSTEM CONFIGURATION

<table>
<thead>
<tr>
<th>Series C</th>
<th>Case 1</th>
<th>Case 2</th>
<th>Case 3</th>
<th>Case 4</th>
<th>Case 5</th>
</tr>
</thead>
<tbody>
<tr>
<td>PAX</td>
<td>1</td>
<td>4</td>
<td>8</td>
<td>16</td>
<td>48</td>
</tr>
<tr>
<td>Route Length</td>
<td>1.8 Km</td>
<td>1.8 Km</td>
<td>1.8 Km</td>
<td>1.8 Km</td>
<td>1.8 Km</td>
</tr>
<tr>
<td>Headway</td>
<td>37.5 m</td>
<td>50 m</td>
<td>75 m</td>
<td>100 m</td>
<td>225 m</td>
</tr>
<tr>
<td>No. of Vehicles</td>
<td>48 nos</td>
<td>36 nos</td>
<td>24 nos</td>
<td>18 nos</td>
<td>8 nos</td>
</tr>
<tr>
<td>Frequency (Time headway)</td>
<td>1.25 s</td>
<td>5 s</td>
<td>10 s</td>
<td>20 s</td>
<td>60 s</td>
</tr>
</tbody>
</table>
### Speed

<table>
<thead>
<tr>
<th>Speed</th>
<th>600 m in 20 s</th>
<th>200 m in 20 s</th>
<th>150 m in 20 s</th>
<th>100 m in 20 s</th>
<th>76 m in 20 s</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>=108Kmph</td>
<td>=36Kmph</td>
<td>=27Kmph</td>
<td>=18Kmph</td>
<td>=13.5Kmph</td>
</tr>
</tbody>
</table>

### Circuit Time

| Circuit Time | 60 s = 1 min | 180 s = 3 min | 360 s = 4 min | 360 s = 6 min | 360 s = 8 min |

### PpHpD

<table>
<thead>
<tr>
<th>PpHpD</th>
<th>1 x 48 veh/min x 60</th>
<th>4 x 12 veh/min x 60</th>
<th>8 x 6 veh/min x 60</th>
<th>16 x 3 veh/min x 60</th>
<th>48 x 1 veh/min x 60</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2880 pphpd</td>
<td>2880 pphpd</td>
<td>2880 pphpd</td>
<td>2880 pphpd</td>
<td>2880 pphpd</td>
</tr>
</tbody>
</table>

### Pkmphph

<table>
<thead>
<tr>
<th>Pkmphph</th>
<th>2880 pphpd x 108Kmph</th>
<th>2880 pphpd x 36Kmph</th>
<th>2880 pphpd x 36Kmph</th>
<th>2880 pphpd x 18Kmph</th>
<th>2880 pphpd x 13.5Kmph</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>311040 Pkmphph</td>
<td>103680 Pkmphph</td>
<td>77760 Pkmphph</td>
<td>51840 Pkmphph</td>
<td>38880 Pkmphph</td>
</tr>
</tbody>
</table>

### Key Observations:

- For a FIXED Space Headway (Fixed Rolling Stock) - when Speed increases - Frequency of vehicle arrival increases - Time Headway decreases
- For a FIXED Speed - when Space Headway increases (Rolling Stock decreases) - Frequency of vehicle arrival decreases - Time Headway increases
- For a FIXED Frequency of vehicle arrival - when Speed increases - Space Headway decreases and Rolling Stock has to be increased.

### Table 3: Capacity comparison of systems with different vehicle occupancies

If we logically compare the three case scenarios it is evident that given all ‘qualitative’ aspects of two systems being the same and the ‘quantitative’ aspect (Pphpd) also remaining the same, the difference in person moving capability can be attributed to only the ‘speed’ quality of transit when measured in ‘quantitative’ terms is a measure of ‘swiftness’. This is a quality of ‘mobility’ that is left out in any system selection exercise. In other words the second spatial dimension of movement or the scalar quantity of swiftness is never considered in ‘traditional’ system selection methodology.

This scalar quantity is what is the ‘Productive Capacity’ of a candidate system expounded in most books on transport planning, but NEVER given any weight during the system selection exercise.

### PHYSICAL MEANING OF PPHPD & PKMPHPH

Each of the systems (Case 1-5) as exhibited in Scenario 3 has a different cycle time. Consider a similar time period of 24 minutes for all cases. This is the time when all the lead vehicles in each system arrive at the same spatial point together after completing their respective transit cycles. Figure 1 exhibits the space time trajectories of a single vehicle of each system. Figure 2 exhibits the total cumulative distance covered by persons in each trip cycle and in 24 minutes.

![Space Time Diagram](image-url)
The following facts may be observed from Figure 1 & Figure 2.

1. The time required to cover the same distance ‘varies’ for each vehicle in the 5 Cases inversely with their respective speeds.
2. Each system carries the same number of persons in the same time period.
3. The system with lower occupancies requires more cycles to move the same number of persons over the spatial distance.

A two dimensional representation as in Figure 1 & Figure 2 is however a limited graphical method to represent the argument. A simulated\(^6\) comparison is easier to comprehend and is the only way to visually appreciate the arguments.

**WHAT MAKES CONFIGURATIONS DIFFERENT & FOR WHOM**

There are three stakeholders in any transit system selection exercise- the ‘community manager’ (policy maker and transport planner), the ‘operator’ (transport operator) and the ‘commuter’. Any transit system configuration has different meanings for them from their respective standpoints. When an ‘operator’ or the ‘community manager’ looks at any transit system configurations as available options apart from financial, economic, alignment & station criteria, it is only the total ‘number’ of commuter persons he could serve, in a given unit of time, that is paramount, as that is what is ‘also’ related to his revenues and satisfies the ‘community manager’ in terms of ‘numbers’. On the other hand, when a commuter person looks at any transit system configuration as available options, it is only the ‘speed’ at which ‘he’ travels, that is of paramount importance.

‘Pphpd’ alone is not the only capacity unit that is crucial to the system selection methodology as it addresses only a part of the stakeholders consisting of the ‘operators’ or the ‘community managers’ who can claim that

---

\(^6\) Such a animated comparison may be seen at [http://www.worxpace.net/Capacity_Comparison_Series-A.htm](http://www.worxpace.net/Capacity_Comparison_Series-A.htm), [http://www.worxpace.net/Capacity_Comparison_Series-B.htm](http://www.worxpace.net/Capacity_Comparison_Series-B.htm) & [http://www.worxpace.net/Capacity_Comparison_Series-C.htm](http://www.worxpace.net/Capacity_Comparison_Series-C.htm)
the number of persons being moved in a given unit of time is a priority, and therefore ‘ppphpd’ as an aspect in the evaluation matrix is sufficient by itself.

In taking this approach, the mobility needs of the individual commuter person is entirely ignored. Case 3 as discussed above clearly proves that systems can have different ‘swiftness’ capacity with the same ‘number’ capacity. Since it is the ‘speed’ of movement that is crucial to the individual commuter person, ‘Pkmphph’ is therefore the COMPLETE unit to measure not only the ‘number’ but also inherently give a sense of ‘swiftness’ or ‘speed’. ‘Pkmphph’ as a measurement unit combines the ‘quantitative’ measure that is relevant not only to the ‘operator’ or the ‘community’ but also each individual ‘commuter’ in the community.

It is only this approach that has the potential of successfully combining the standpoints of each stakeholder in the system selection exercise and incorporate the crucial aspect of ‘generalised cost’ of travel for an individual commuter at the ‘system selection’ stage itself that is not done so far. (for the same ‘number’ of commuter persons carried in a given unit of time, a higher ‘Pkmphph’ would mean a lower generalised ‘cost’ of travel)

SIGNIFICANCE OF ‘PKMPHPH’ AS KEY COMPARISON UNIT

The arguments for using ‘Productive Capacity - Pkmphph’ as the key unit for comparing systems becomes significant from the following points of views even if the ‘Line Capacity - Pphpd’ is same for the competing modes.

1. The journey time for individual trips is lesser for faster systems.
2. The total trip time can be reduced resulting in a lower generalized cost of travel for each person commuter.
3. It may be worthwhile to consider a faster system even if that means laying two or more tracks for the faster system instead of one for the slower system along the same alignment and ‘Line’ demand as exhibited in Table 4 below. It should be noted that for the same alignment, 2 lines of LRT (Light Rail Transit), 4 lines of Monorail or 6 Lanes of a BRT (Bus Rapid Transit) can deliver the same ‘Pphpd’ yet widely different IVTT (In Vehicle Transit Times) for each commuter person. The highest effective ‘Pkmphph’ relates to the system or an equivalent ‘multi-track’ system configuration that offers the least ‘in vehicle transit time’ for the same ‘travel distance’ for the individual commuter person.

4. It may be relevant to look at many new single track technologies (now available because of technological advancements in propulsion, safety & control) that can offer faster speeds with the same ‘Line Capacity’ as a comparable system in a different configuration of tracks, stoppages, braking distances, acceleration & deceleration attributes.

CONCLUSIONS

‘Mass’ of mass transit systems as perceived today is actually NOT a holistic perception of ‘mass’ in terms of carrying capacity from a technology system standpoint from the perspective of all its stakeholders. Two systems can have the ‘same’ number handling capability yet have different ‘swiftness’ ability hence rendering the traditional sense of ‘mass’ incomplete.
Any transit system can be ‘measured’ for two quantities of ‘capacity’, the capacity to move ‘numbers’ of person commuters and the ‘swiftness’ capacity to move each person commuter over spatial distances. However in traditional system selection methodologies only the former is considered as the only aspect that can decide the applicability of a given system for a specific requirement. A planner or policy maker is interested in two things, number of passengers served in a given unit of time AND the time taken by each passenger to cover a specific distance. A combined measure of passengers, distance and time enables him to verify and confirm his principle planning objective of carrying maximum number of passengers and carrying them to their destinations faster.

The unit that is more relevant to the planning & policy makers is ‘Pkmphph’ in the system selection exercise as it is the key quantitative unit that introduces the ‘speed’ consideration in the evaluation argument. This is theoretically known as ‘Productive Capacity’ and is expounded in most books of transport planning as the key unit that is a useful measure for both the operator and the passenger.

‘Pkmphph’ is the key unit that can objectively compare different systems of transit from the perspective of a planner, policy maker and the commuter and holistically thereafter evaluate systems in a comparative matrix of capital cost, energy usage & recurring cost, the three most important concerns to the planner apart from transit capacity by itself.

‘Pphpd’ as a unit does not account for the ‘time’ required to travel a specified distance by the individual commuter. Therefore this unit does not provide a sense of distance Vs time and thus ‘swiftness’ capability of any system in the specified time, rendering it ‘incomplete’ as the single unit of measuring capacity of a ‘mass’ transit system where ‘mass’ as referred to conventionally, in a system selection methodology, does not provide the ‘true value reflection’ of the ‘mobility objective’ that satisfies all its stakeholders.

The importance of ‘swiftness’ as a key capability of a transit system thus establishes the case for searching for ‘more appropriate systems of transit’ than the ones that are available today and challenges the very myth of ‘Pphpd’ as the only quantitative unit to represent the ‘mass’ in mass transit. As long as system selection methodologies do not account for the ‘real’ needs of the commuter, the ‘key’ stakeholder in ‘mass’ transit projects, many of such projects risk being socially ‘irrelevant’ and as a result environmentally and financially unsustainable for lack of ‘real’ patronage.

ACKNOWLEDGEMENTS

The author acknowledges constructive critique and review by Mr Bharat I Singal, OSD, DIMTS Ltd. from time to time and assistance of Nupur Dube and Trilok Sharma in writing this paper.

REFERENCES

Webpages created by Author
http://www.worxpace.net/Capacity_Comparison_Series-A.htm
http://www.worxpace.net/Capacity_Comparison_Series-B.htm
http://www.worxpace.net/Capacity_Comparison_Series-C.htm

Key Words
Mass Transit, Capacity, PPHPD, PKMPHPH, System Selection Methodology, Mobility Objective, Measurement Units