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An Approach Paper on Methodology for Determining the Quality of Service at Transport Interchanges (Mobility Hubs)

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***ABSTRACT**: Transport interchanges (Mobility Hubs) are critical component of the Public Transport System, since they are the key-elements for a seamless travel chain. In spite of obvious benefits of inter modality, transport interchanges are necessary to coordinate local, regional, national and international levels of the transport system. This paper aims to explore the concept of passenger inter modality and the quality of service at the Interchanges. The scope of this paper is to analyze the relationship between passenger satisfaction about overall service attributes at the Interchanges and to deliver a methodology to assess Level of service (LOS). The methodology can be used across the regions to provide consistency in determining the LOS and to assist in the development, delivery, monitoring and evaluation of transport interchange project interventions. The proposed methodology has been validated through the application to Interchanges in the metropolitan city of Kochi, Kerala. As application of the study a web based or a mobile application can be developed to find the accessibility and seamlessness of travel at transport interchanges based on the theory put forward.*

KEYWORDS: Transport Interchanges, inter modality, Level of service (LOS)

1. INTRODUCTION

People interchange when there is no direct, convenient through service or route for the journey they wish to make; or if interchanging offers the superior speed, comfort or convenience of a particular mode of transport for part of the journey. Interchanges are therefore both an inconvenience inflicted on passengers, and an opportunity which passengers willingly use in order to reduce their travel costs/ times. In a network comprising different modes of transport interchanges provide the opportunity to move between modes. There is usually a hierarchy between the modes ranging from intercity rail travel

– offering fast services with few stops and therefore operating at some distance from many destinations – to local bus services offering a finely grained pattern of stops at a reduced speed. Interchange does not however have to take place at purpose-built facilities, such as train or bus stations, but can also take place at informal interchanges, for example where two bus stops are close to each other on the street. Transport Interchanges are, therefore, the physical spaces where passenger interchanges occur. Thus, Transport Interchange is an important key element in modern transport network and also a part of infrastructure which involves multi-modal activities. Multi–modal transport system relates to single trip consisting of combination of modes i.e. vehicle modes (bus, metro, car, tram, etc.) Or service modes (private/public) between which the traveler has to make a transfer and thus transfer is an essential part of multi– modal trip and traveler has to change modes at transfer nodes/interchanges and seamless travel has become a necessity of urban transport system.

Multi–modal transport planning is an important component of integrated transport strategy in urban transport which comprises of two basic components, integration and interchange.

Integration of transport: Integration is a key to sustainable and need responsive public transport. Integration of different modes is required at various levels. New modes of public transport i.e. metro, monorail, LRT etc. must be properly integrated

Transport interchanges: An interchange is one of the starting points of any public transportation ride and the first point of interaction the user has with the available public transportation service and it is one of such infrastructures which promote seamless travel across the modes.

2. ASSESSMENT OF SEAMLESSNESS AT TRANSPORT INTERCHANGES

This paper aims to improve knowledge on the concept of Quality of Service at transport interchanges, focusing on passenger's perspective. A methodology is developed to analyze the relationship between passenger satisfaction, about overall service and service quality attributes. The proposed methodology

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is validated through the application to passenger transport interchanges in the metropolitan city of Kochi, Kerala.

3. IMPORTANCE OF RATING QUALITY OF SERVICE

Text BoxThe Performance of Service has been object of intensive research activity in recent times (Diana and Daraio, 2010). The use of indicators is the most popular tool, given its several practical advantages, including the easiness of use and the intuitive meaning, to assess data collected through quality audits and reviews. Indicators allow cross-site analysis and document the fulfilment of targets. Case studies have been done to find out the parameters which influence the level of services.

Figure 1 indicators to find LOS of interchanges

(source : Author)

Figure 2 presents a list of indicators that can be used to assess public transport service quality, mainly from the physical and operational point of view. Detailed calculation of indicators is attached as Annexure I. It can be noted that there are quality aspects which are assessed in a direct way on an analytical point of view, such as "Service Capacity", while there are other issues which do not involve mathematical operations and are based on auditors/ reviewers personal perception, such as "Accessibility for disabled people".

4. METHODOLOGICAL APPROACH

SEAMLESS TRAVEL INDEX (S) =
COMPOSITE INDEX(C) + INTERCHANGE INDEX (I)....(i)

Where

(I) I= INTERCHANGE INDEX
= ∑ I/ n N=NO.OF INTERCHANGES

(II) C= COMPOSITE INDEX
= A.I + ∑PTAL INDEX $_{MODES}$

(III) A.I= ∑VNij/Aij

Nij = Peak frequency of buses on route "I" passing through zone "J" (bus/hr)

In order to rate the seamlessness, travel a seamless travel index has been defined. For validation the study area can be divided into different zones for which Seamless travel index has been calculated using the formula. For finding the peak frequency public transport routes of the city buses has been considered.

Aij =Area of zones (Sq. Km)

(IV) ∑PTAL INDEX $_{MODES}$ =∑PTAL INDEX $_{SERVICES}$ (EDF)

Equivalent doorstep frequency (EDF) =30/Access time

Access time=Walking time to the station or stop+ Average waiting time for the next service

Average waiting time= (k/2) x (60/scheduled frequency)

K refers to the reliability factor for rail-1 ferry -1 metro -1 bus-2

5. CALCULATION OF INTERCHANGE INDEX

To calculate interchange index 25 parameters have been derived based on the primary opinion survey. A weightage has been given to each parameter based on the desired LoS of users from the primary survey. Each interchange can have a maximum value of 25. A weightage is given to each parameter based on the opinion survey conducted at each interchange. The final score out of 25 is an indicator to compare between interchanges and its accessibility. A weightage can be applied to each parameter based on characteristics of the study area.

6. LEVEL OF SERVICE (LOS) OF TRANSPORT INTERCHANGES

A statistical tool, Normality test can be used to find out the normality of the values of interchange index of all interchanges and found to be normally distributed. As an example, based on the Interchange Index calculated for Five interchanges in Corporation of Kochi, Kerala the average value of interchange index is 12.576 having 49.97 % of user satisfaction. Based on this, LOS has been defined for each range of user satisfaction. Also, from the analysis of user satisfaction, interchange values has been classified into each LOS.

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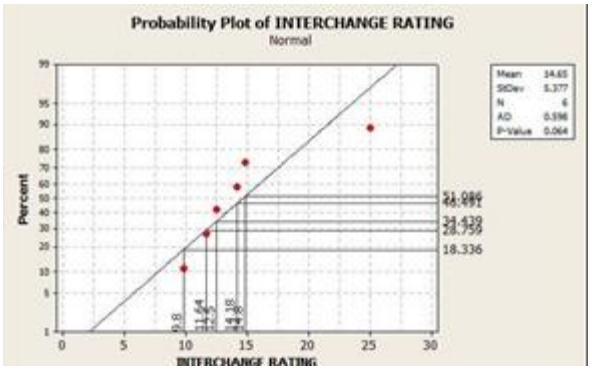

Figure 2 Graphical represe ntation of the Normality Test showing the Values of Interchange in the city of Kochi(source : Author)

7. LEVEL OF SERVICE (LOS) OF SEAMLESS TRAVEL

To find the normality of the values of Seamless index of all interchanges Normality Test can be used. As an example, in the case of Kochi the average value of seamless index is 36.72 having 38.23 % of user satisfaction.

Based on this four LOS has been defined for each range of user satisfaction as defined in the Table 1. From analysis, existing interchanges in Kochi offers only LOS of D with 38.23% user satisfaction. An increase of Seamless indicator to LOS A will increase the number of users by 22% with 90 % user satisfaction.

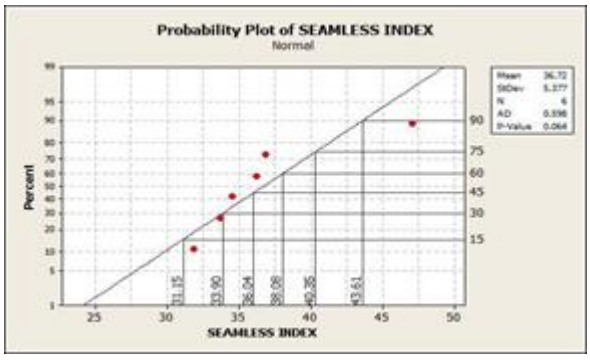

Figure 3 Graphical representation of the Normality Test showing the values of seamless index in the city of Kochi (source: Author)

Table 1 Table showing the classification of LOS and percentage of increase of passengers for each level of LOS (source: Author)

LOS	PERCENTILE	SEAMLESS INDEX RANGE	NO.OF PASSENGERS	% OF INCREASE
LOS A	>90	43.61-47.06	705413	22
LOS B	75-90	40.35-43.61	662810	14
LOS C	60-75	38.08-40.35	627699	8
LOS D	45-60	36.04-38.08	600335	4

8. RELATIONSHIP BETWEEN SEAMLESS TRAVEL INDEX AND PASSENGER FOOTFALL AT INTERCHANGES

Based on regression analysis a relationship has been established between total number of passengers and seamless index as defined below. In the case of Kochi, the relationship is as follows;

Total number of passengers = 507.93 x seamless index+ 5189.5

The analysis shows that for an increase of seamless index by one unit which will increase the no of passengers by 5697.

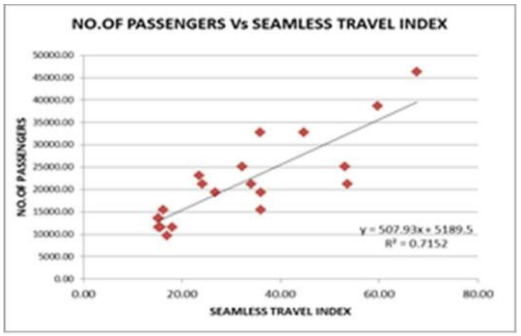

Figure 4 Graphical reresentation showing the relationship between seamless travel index and passenger footfall at Interchanges in Kochi (source: Author)

9. CONCLUSIONS

Transport Interchanges are significant to improve the public transport of a city, increase passenger comfort, better connectivity, cover greater distance with less time, seamless travel, less environmental pollution along with the increase in revenue, increase in the employment opportunities, increase in land price and commercial activities along the location of the transport interchanges. Transport interchanges also changes the network pattern of a city, modes of travel and the distance covered by passengers. It was observed that public transport interchanges need a clear image and identity so that arriving passengers get a sense of having arrived at a specific place and can easily access available transport modes. Local identity

can be expressed through architectural design and community space, public artworks and natural landscaping. Allocating public space or town squares as a pedestrian zone around stations or interchanges sometimes assists in creating activity nodes and integrating the center with public transport infrastructure. Thus the key objectives for interchange design are the integration of public transport interchanges with local town centers. Integration allows decisions about local land use to lend support to and gain benefit from increased accessibility provided by improvements to public transport.

In India the concept of Transport interchanges is in its budding stage. The interchanges are conceived in isolation rather than in a macro scale. Major thrust has to be given to segregate between vehicular and pedestrian movement which should be maintained at all levels. Proper zoning should be done between different regions like intra city; intercity, private vehicles etc. Universal accessibility has to be provided for all sidewalks, crossings, parks, public spaces and amenities. In order to minimize the boarding alighting time level boarding on all concourses should be given.

This paper aimed to derive a methodology to explore the concept and attributes for seamless travel at interchanges and henceforth to compare and derive standards for level of service (LOS) at interchanges. Based on the case study of Transport Network of Kochi, the methodology has been also validated. This methodology can be used across the regions to provide consistency and to assist in the development, delivery, monitoring and evaluation of transport interchange project interventions. Based on the analysis guidelines can be developed to review the present transportation network, transport infrastructure, to plan for optimizing the existing transport system by co-relating with the future development.

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ANNEXURE I

	Indicator	Method of calculation
1	**Operational parameters**	
1.1	*Accessibility to the feeder station*	*(acceptable time for walking to access the feeder station / (average time taken by a passenger to access the feeder station)*
1.2	*Accessibility to the main haul*	*(acceptable time for walking to access the main haul / (average time taken by a passenger to access the main haul)*
1.3	*Availability of feeder*	*(peak hour availability of feeder)/ (total no of feeder/operational time of the feeder)*
1.4	*Availability of trunk line*	*(frequency of main haul during normal hours) / (frequency of main haul during peak hours)*
1.5	*Acceptable walking time*	*(expected time for walking)/ (average time taken by a passenger for walking inside the terminal)*
1.6	*Acceptable queuing time*	*(expected time for queuing)/ average time taken by the passenger for queuing)*
1.7	*Acceptable waiting time*	*(expected time)/(average time taken by the passenger for waiting)*
2	**Planning parameters**	
2.1	*Parking availability*	*Total no. of available parking in peak hours/ total no. of parking*
2.2	*Vehicular movement*	*Total no. of vehicular movement links without conflicting links /total no. of movement links.*
2.3	*Pedestrian movement*	*Total no. of pedestrian movement links without conflicts /total no. of movement links*
3	**Build infrastructure parameters**	
3.1	*Quality of build infrastructure*	*It is the ratio of the total buildup area per peak load to the standard area per head*
3.2	*Quality of plaGorms*	*It is the ratio of no. of plaGorms with the specified width for each mode to the total no of plaGorms*
3.3	*Ease of accessibility within the terminal*	*Ratio of the number of plaGorms accessible from the ground level to the total number of plaGorms*

ANNEXURE I contd.

	Indicator	Method of calculation
3.4	*Pedestrian accessibility within the terminal*	*Ratio of the number of grade-separated and protected roadway crossings (zebra or traffic signals) to the total number of walk links between plaGorms within the interchange*
3.5	*Accessibility for disabled within the terminal*	*Ratio of the number of plaGorms accessible for people with physical disabilities through elevators escalators, ramps at the entrance leading to the plaGorm to the total number of plaGorms*
3.6	*Accessibility for visually impaired within the terminal*	*Ratio of the number of plaGorms accessible for the visually impaired people through the tactile markings, warning tiles, audible signals at the crossing leading to the plaGorm to the total number of plaGorms*
3.7	*Spatial integration*	*It is the ratio of weighted average distance between plaGorms to the average distance between plaGorms*

3.8	*Spatial orientation*	*It is the ratio of the number of plaGorms that are visible from each other plaGorm at level 0 to the total number of plaGorms on same level.*
4	**Passenger information System (PIS)**	
4.1	*Indicator for real time PIS*	*Ratio of the number of plaGorms with real-time passenger information panels to the total number of plaGorms in the interchange.*
4.2	*Indicator for passenger movability plan*	*Ratio of the number of plaGorms with tariff information and interchange plans to the total number of plaGorms in the interchange*
4.3	*Indicator for signage*	*Ratio of a sum the total number of directional signs (such as arrows, sign posts) on the walk links to the total number of turns in the interchange.*
5	**Passenger Safety**	
5.1	*Indicator for passenger safety*	*No. of plaGorms with CCTV/security to the total no. of plaGorms*
6	**Passenger comfort**	
6.1	*Comfortable walking area*	*Total movement area per person/ standard space per peak load*
6.2	*Comfortable queuing area*	*Total queuing area per person/standard space per person during peak hour*
6.3	*Comfortable waiting area*	*Total waiting area per person/standard space per person during peak hour*