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Travel Time Reliability to Airport: Review and Assessment

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Abstract

Researches related to travel time reliability (TTR) and variability were commenced in the late 90s and still are regarded as few of the indefinite fields in travel time related studies. Former outlines the probability of reachability and the latter, one of the least explored areas, highlights the inconsistency of travel time. According to the definitions of reliability stated in different studies, researchers always preferred to rationalize it as measure of user perception. This paper reviews the existing researches on network TTR, user based TTR, variability, and travel behaviour with special reference to airport access. It also compares mean variance and scheduling models, studied and assessed by various researchers, in addition to other models used in the evaluation of TTR. The results and conclusions of models on the respective networks are critically investigated as well. The study findings brought about a substantial evidence on the importance of Value of time (VoT), value of reliability (VoR) and reliability ratio (RR) on different networks such that the user perception changes substantially upon the change in network characteristics. It is also found out that researches have very little contribution towards reliability in accessing airports where purpose of the trips become significant.

Keywords: Travel time reliability; Index, VoT; VoR; Reliability Ratio

1. Introduction

The advent of utility theory in the early 60s unlocked user oriented transportation researches, as most of previous studies were based on probability theory and related models. Priority given to users' choices rather than discrete probability aspects were introduced into the research domains since then. Scheduling and Mean-variance models were theorized, based on choice modelling, which effectively laid the path to extensive researches on reliability. This advancement is primarily attributed to various time variability studies carried out in the previous decade.

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Assessments on travel time variability (TTV) in urban and regional networks were initiated in late 1970s. Richardson and Taylor (1978) estimated TTV in urban level commuter journeys, while Jones (1989) analysed commuting corridor. Similar study was undertaken by Taylor (1982) with a comparative study of two public modes based on the variable travel time. An empirical study was conducted by Jackson and Jucker (1982), in relation with the travel behaviour choices exhibited by commuters. Polak (1987) completed an extensive work on variability in travel times with respect to departure time choices while its effect on time of day choice for work trips was spawned out by Bates, et al. (1989). Few important researches were also steered in 1990s, majorly on the effects of TTV on value of time and route choices like Senna (1994) and Abdel-Aty et al. (1996).

The concept of TTR was initially addressed by Asakura and Kashiwadani (1991), by examining the daily traffic flow fluctuation on the network. Asakura (1999) has also established reliability measures in a deteriorated link for an OD pair with variable traffic flow parameters. Ebeling (1997) made a remarkable contribution to the domain of engineering reliability and reliability modelling. Noland and Small (1995) explained the relationship among the uncertainty in travel-time, departure time choices, and the commute cost, where uncertainty brought about a new term ‘unreliability’. Noland et al (1998) have also simulated travel reliability to verify its impact on congestion and to predict all associated uncertainties for policy formulation. A valuation of reliability was piloted by Bates et al. (2001) for the personal travel options in rail, bringing upon huge empirical and theoretical data base. However, early researchers couldn’t generate a significant literature on TTR exclusively for travel to specific destinations, like airports, transit terminals, etc.

2. Reliability

Reliability is terminology that is always related with a system, primarily attributed to its performance or efficiency, in various fields of Engineering and Technology. In transportation, reliability is side-lined with travel time, it plays a significant role in making fast and seamless mobility. Recently published Indo HCM (2017) has taken into account of reliability as a performance criteria for the assessment of network links as well as public transport.

Table 1. List of researchers and significant parameters

S.N.	Researchers	Year	Area of Research	Parameters
1	Noland et al.	1998	Travel reliability	Mean, SD, Probability of lateness
2	Hoel	1998	Airport landside access	Scheduled departure time
3	Timothy et al.	2002	Travel time measures	Travel time
4	Jong et al.	2004	Scheduling model, Mean Variance model	SD, 90th percentile TT, Arrival time, Departure time
5	Small et al.	2005	Value of time, Reliability	Probability of delay
6	Recker et al.	2005	TTR & TTV	Travel cost, Avg. TT, traffic flow
7	FHWA	2006	TTR, Buffer time	Travel time, free flow time
8	De Jong et al.	2007	VoR, Reliability	Expected TT, travel cost, departure time, arrival time, fare
9	Fosgerau et al.	2008	Congestion, TTV	Cost, mean, SD, departure & arrival time
10	Batley et al.	2008	Scheduling model, Mean Variance model	Departure time, Arrival time, Probability of lateness, mean and SD
11	Koster et al.	2011	TTV, Airport Accessibility	Willingness to pay, departure time, travel cost, arrival time
12	Börjesson et al.	2012	Scheduling model, Mean Variance model, TTV	Mean, SD, departure time, fare, arrival time, delay length, delay risk
13	Mahmassani et al.	2013	Network TTR, traffic flow	Weighted SD, travel time rate, flow and density
14	Lu	2013	Network TTR, Route choice	Departure time, arrival time, mean, SD, probability of lateness, travel rate,
15	Sekhar et al.	2013	TTR, Simulation	Travel time, free flow speed
16	Kouwenhoven et al.	2014	VoT and VoR	SD, arrival time, Departure time

FFT- Free flow time, Tavg- Average Travel time, TT- Travel time

2.1. Definition

Reliability may be defined, by the Oxford dictionary (2010), as “the degree to which the result of a measurement, calculation or specification can be depended on to be accurate”. It is a likelihood that a trip between a given O-D can be made effectively inside a given time interim with a specific level-of-service as specified by Asakura & Kashiwadani

(1991). Ebeling (1997) defined reliability as the chance that a component or framework will perform a required work for a given period of time when utilized under stated operating conditions. Quantitatively, it is the variation in the expected travel time and actual travel time. Smaller the variation, higher the value of reliability experienced.

Jackson (2000) defined trip time reliability as the range of travel times experienced amid large number of daily trips. Florida DOT stated reliability on a highway segment as the percent of travel that takes no longer than the expected travel time plus a certain acceptable additional time. DOT (2000) defined three major components of reliability: travel time, expected travel time, and acceptable additional time. Wakabayashi (2010) explained reliability "either as the probability of reaching a destination within a certain travel time, or as the upper or allowed travel-time limit for a given probability".

Recker et al. specified xp (t), a vector of all measurements as,

$$x_p(t) = \left[T_p(t), R_p(t), C_p(t)\right]' \tag{1}$$

Where, Tp (t) attibutes to route travel time, Rp (t) travel time reliability and Cp (t) cost factor

Although all of the above inferred to general reliability of the network, when access to airports are concerned, home/work to airport trips are commonly subjected. Thus, the practical definition of reliability, in this scenario, may be defined as the probability of reaching an airport in a particular perceived time, varying from user to user and airport to airport. Hoel (1998) advocates that user perception of reliability is entirely different from the actual performance and creating repeated high reliable experiences to travellers would resolve its shortcomings.

2.2. Reliability Index

For the purpose of computing the empirical values of the uncertainty or unreliability caused, various indices have been developed by researchers from time to time. Most of the indices were calculated using travel time as the major independent parameter. Cost is also been used for analysis of few parametric functions.

Travel time index, Buffer index and Planning time index have been first used by FHWA (2006) when TTR was an increasing concern for businesses and logistic transfers in United States. Kittelson et al (2012) defined travel time index is the ratio of the average travel time over the free-flow travel time achieved in a link or a segment of network system. It also determines how long it takes to travel during a peak hour. The buffer index (BTI) suggests the additional time travellers need to ensure their arrival on time, calculated as the difference in 95th percentile and average travel time upon average travel time as explained by Lomax and Schrank (2002). Lyman and Bertini (2007) described Planning Time Index (PTI) is the ratio of the 85th or 90th percentile travel time upon free flow travel time. It is suggested that BTI is beneficial to commercial vehicle users and freight carriers in delivering their services, whereas PTI is favourable to assess personal travel and urban corridors by Sekhar and Asakura (2008).

Misery Index (MI) is a degree of centrality of travel time in a distribution (Milliken & Young, 2015). Lomax and Schrank (2002) used this to accumulate the delay length of all the worst trips in a distribution. They stated MI is calculated by taking the average of the highest five percent of travel times and dividing this by the free-flow travel time. Ming Lu (2013) elucidated MI as a 'feeling' parameter which displays how miserable the trip can become. MI is also stated by Martchouk and Mannering (2009), as the difference between top 20% trips and average travel time upon average travel time. ITF (2010) calls this 20% users as 'unlucky' travellers.

Wakabayashi (2010) proposed new indices to understand the implications of reliability on operators and users separately. He analyzed majorly 6 indices namely, λskew, λvar, P(Tave + ATTV), P(Tave - DTTR), TT80- TT20 and TT70-TT30. He also classified the first 2 indices in operator side and shown tendencies similar to BTI. The next 2 indices, P(Tave + ATTV), P(Tave - DTTR), are validated to be user side indices, however, the last 4 of them have similar tendencies in behaviour.

Kouwenhoven (2016) termed congestion index (CI) for finding reliability and defined it as the ratio of mean travel time and free flow travel time. He validated a power-law function to relate CI to the coefficient of variation of travel time established by Arup (2003). At a high congestion level, Eliasson (2006) witnessed a drop in the coefficient of variation, after it was constant for low congestion state and slightly increased for a shorter period.

2.3. Value of Time (VoT)

Though the concept of VoT was kick started in the early 60s after the introduction of utility theory, Small (1982) evidently compiled a framework for scheduling of activities for the morning commute of the people. He incorporated a value of time delay into the utility equation that behaved like a shadow price for the delayed time caused during the commute which was validated by De Jong, et al. (2007). Carrion and Levinson (2012) brought about an elaborate review on VoT, defining it as a monetary value commuters worth on bringing down their travel time. They reviewed the basic concepts prevailing, since the inception of VoT, followed by the contribution in utility theory, dispersion and scheduling theories. They also elaborated the empirical evidences estimated by all researchers till date.

Table 2. List of Reliability Indexes

Sl.No.	Reliability Index	Definition	Relevance
1	Planning Time Index	$\frac{90/95^{th} Percentile}{FFT}$	Personal trips and urban travel
2	Buffer Time Index	$\frac{95^{th} Percentile - T_{Avg}}{FFT}$	Commercial trips, logistic services, carriers etc.
3	Travel Time Index	$\frac{T_{Avg}}{FFT}$	Used as a congestion measure
4	Misery Index	$\frac{5\%\ worst\ T_{Avg}}{FFT}$	Used as a tool to measure how bad the worst trips are
5	λ skew	$\frac{TT\ 90\ - TT\ 50}{TT\ 50 - TT\ 10}$	Operator side Index
6	λ var	$\frac{TT\ 90\ - TT\ 10}{TT\ 50}$	Operator side Index
7	P(Tave + ATTV),	Percentile when TT is ATTV above Tave	User side Index
8	P(Tave - DTTR),	Percentile when TT is DTTR below Tave	User side Index
9	TT80- TT20	---	Range of average TT
10	TT70-TT30	---	Range of average TT

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VoT is expressed as the ratio of partial differentiation of utility w.r.t. expected travel time upon partial differentiation of utility w.r.t. cost (Recker, et al., 2005). Jong calculated VoT by using the ratio of coefficient of time upon coefficient of cost (Jong & Bliemer, 2015). In the Netherlands, an empirical study to understand the benefits to the community was conducted by Batley, et al. (2008), involving VoT, which was later used for a cost-benefit analysis.

2.4. Value of Reliability (VoR)

VoR is a new thought evolved 20 years back, used as a tool to evaluate extend of unreliability caused by delay and congestion. In view of Carrion and Levinson (2012), VoR represents the vulnerability of the commuters to unreliability of their cost constraints, which is estimated through the ratio of reliability and cost parameters. Lu (2013) explained that model formulation is highly depended in the definition of VoR, such as it assumes to be the ratio of marginal value of travel time variance and travel cost in Mean-Variance model. While Scheduling models describes VoR as value of reliability early (VoRe) and value of reliability late (VoRl).

$$VoT = \frac{\partial E(u)/\partial E(T)}{\partial E(u)/\partial C} = \frac{\beta t}{\beta c} \tag{2}$$

A Dutch study of ‘The Value of Travel Time and Travel Time Reliability’ by De Jong et al. (2007) made a clear understanding of VoR and survey design to yield the perceived time and costs associated with the Scheduling Method. Relevance of VoR would be perceptible when we attempt to reduce travel time volatility, which zeroes down both uncertainty and implicit costs due to schedule delays. Jong (2015) endorsed VoR in the estimation of cost-benefit analysis befitted with TTV in various transport projects, appraisals and policy making. In a value pricing study in

California State Route 91, involving estimation of VoT and VoR, users' choice probability to adopt higher reliable route by paying toll was validated by Small, et al., (2002) and later by Recker, et al. (2005).

$$VoR = \frac{\partial E(u)/\partial Vr(T)}{\partial E(u)/\partial C} = \frac{\beta vr}{\beta c} \tag{3}$$

2.5. Reliability Ratio (RR)

Reliability ratio is formally defined by Black and Towriss (1993) and Small (1999) as the VoR upon VoT of travel time. Lu explained (2013) the variation in reliability ratio can occur due to geographical regions, in addition to adopted methodology and disparities in the absolute VoT and VoR.

$$RR = \frac{\partial E(u)/\partial Vr(T)}{\partial E(u)/\partial E(T)} = \frac{\beta vr}{\beta t} \tag{4}$$

Studies proved that RR value is higher for non-commuters than that of commuters by Carrion and Levinson (2012). According to the recommendations for the practitioners, it is advised to use RR approach for road based modes rather than mean-delay method. Following that, Batley, et al. (2008) adopted value of reliability ratio is 0.8 for cars and 1.2 for public transportation, irrespective of trip purposes.

3. Theory

The reliability is based on two components, network and user, characterized as mutually exclusive to each other. When the network reliability is governed by traffic, user reliability is relied on behavioural perception. Even though they exist in two different platforms, few factors like delays, uncertainties, congestion, etc. can impact the change in both. Most of the existing studies cited network and users as 'urban/city network' and 'random users' or 'commuters' respectively. However, this paper discusses about airport access network and airport users in detail in the following sub-sections.

3.1. Network

Network travel time unreliability is, in general, determined by the traffic flow. The more the delays caused by congestion, road blocks, weather changes, construction and maintenance, the more the unreliability experienced. Mahmassani, et al (2013) understood network TTR declines drastically after the maximum flow rate in the network.

The characteristic dissimilarities of airport access network and the whole network (including all nodes and links) attribute to daily/hourly peak and off peak traffic volume. The variation, duration and number of peak hours are distinctly reflected in both networks. Airport access network is characterized by a number of peak hours determined by daily flight schedule at the airport. In metro airports, majority of domestic flights operate at day time and international flights at night time. Thus, hypothetically, traffic on airport access network will be lesser than overall network at day time but on higher side at night. At the same time, the morning and evening peaks on airport access network are due to the nature of traffic on the overall network. The comparison is shown in figure 1.

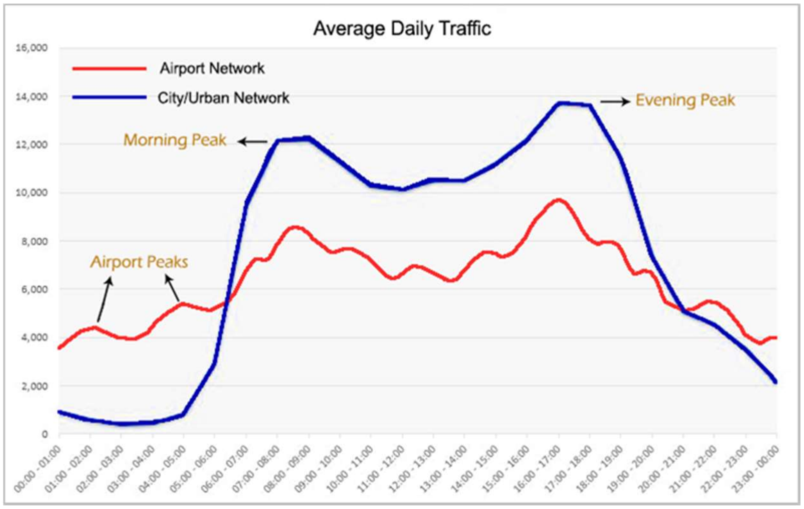

Fig. 1. Comparison of Traffic in Airport Network vs Urban Network

3.2. User

Dynamic changes occur on the network are due to the users' choice and travel behaviour. TTR is currently envisaged as a user perception. When it comes to delays, waiting time and arrival time, users visualize them as perceived delays and perceived time of waiting and arrival at the destinations. Hoel and Shriner (1998) validated that passengers' perception plays a crucial role in the variation of access time.

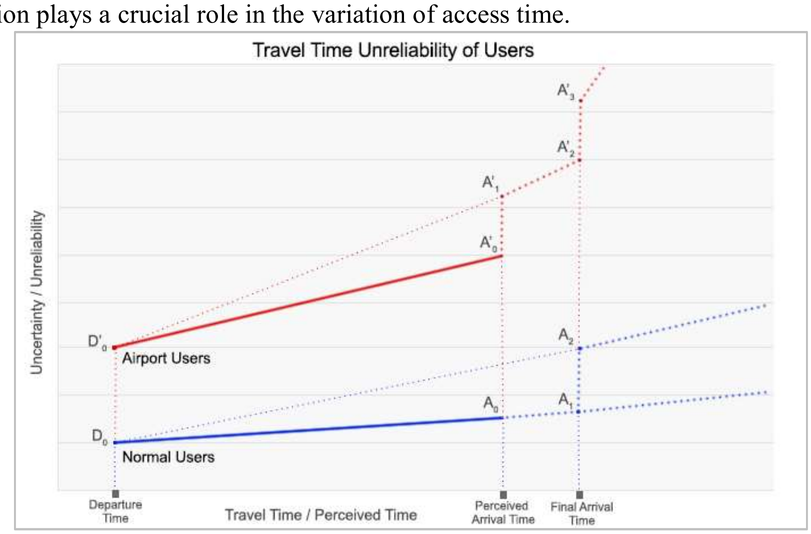

Fig. 2. Comparison of Unreliability caused by Airport users and other users

The uncertainty of travel time experienced by airport users and random users (eg: commuter, etc.) is shown in Figure 2. Airport users, considering the chance of missing the flight, tend to have more unreliability of travel time than random (normal) users due to perceived future cost and other human factors (anxiety, behaviour, etc.). Uncertainty increases rapidly when user fails to reach airport at perceived time and experience maximum uncertainty, with penalty, upon missing the flight. Whereas, random users have the freedom of reaching destination at the final arrival time with same uncertainty level. However, some users may involve in a higher levels of uncertainty when he or she arrives after the final arrival time.

4. Approach

Researchers have acknowledged different approaches in defining, evaluating, proving and validating TTR in the past years. Few of them like Asakura, Verhoef, etc. followed both approaches, whereas Mahmassani, Ravi Sekhar, etc. prioritized network reliability and Small, Noland, Polak, etc. focused on utility based user reliability. Kim, et al. (2013) proved network reliability approach requires a space domain ranging from network to link level including O-D and path level measures. Latter one discusses about the combined disutility of uncertainty or unreliability taking into consideration of perceived delays in travel time as studied by De Jong et al. (2013). Few other approaches have been espoused by researchers in various fields of reliability studies. These approaches are discussed in detail.

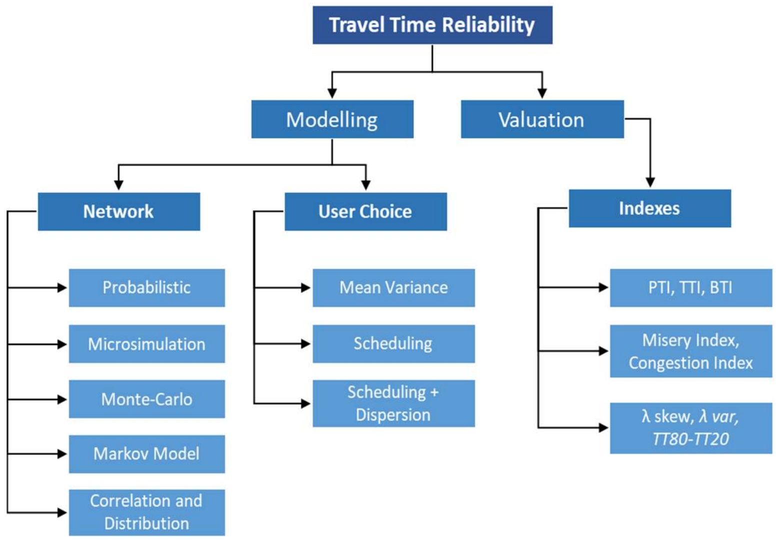

Fig. 3. Structure of TTR evaluation

Review and assessment of TTR covers valuation and modelling done by various researchers in different aspects. Figure 3 explains the relevant models and tools used for determining the existing theories on reliability.

4.1. Network Travel Time Reliability

Network based reliability measures turn out to be significant research domain when we started to witness increase in travel time and cost due to congestion, increased traffic volume and inefficient demand management in the late 1990s. This had majorly affected most of the urban networks and few important regional networks, still unanswered in many of the cities.

The major component on which the network reliability is analysed is traffic flow, which is a causative factor for congestion, delay, capacity, accidents, etc. Capacity fluctuations on links were critically analysed by Chen et al. (2002) proving it a major reason for unreliability. Hou and Jiang (2002) stated reliability of a road network was tested by traffic simulation proving that, maximum unreliability was caused by the marginal traffic added on achieving intersection capacity. It was also analysed by Kim, et al. (2013) through a scenario based approach to predict the likelihood characteristics of travel time using the same model.

Clark and Watling (2005) modelled Network TTR through analyzing link travel time,

$$W_a = V_a \, t_a(V_a) = \sum_{j=0}^{m} b_{ja} V_a^{j+1} \tag{5}$$

Va – flow on link ‘a’ (random variable),

Wa – total travel time on link ‘a’

Using microsimulation techniques, Sekhar et al. (2013) found out TTR of an urban link, estimated under different demand and supply side parameters. In a similar study by Kumar, et al. (2013), reliability and congestion measures (indexes) were developed through traffic flow variations on an urban road in Delhi. However, Lint and Zuylen, (2005) proved micro simulation methods have few shortcomings to calibrate the data.

Dong et al. proposed a new travel time estimation model which essentially involve traffic conditions with spatial correlation. Various distribution tools such as Weibull, gamma, normal, and lognormal were formulated by Dong, et al. (2016) to assess segment level as well as corridor level TTR in different weather conditions. Wakabayashi (2010) compared 8 indices for TTR in his study, those exhibited diverse characters for assessing actual reliable route.

Kov et al. (2006) evidently studied on the mixed traffic condition with an assumption that the each mode has its own specific performance utility in the daily variability of traffic flow. They allowed drivers to know in hand about the network condition with the help of Advanced Traveller Information System (ATIS). The method was based on the study done by Lam et al. (2003), where they practically worked out generalized travel cost with the help of forecasting techniques. Kov et al. (2006) also modelled travel time distribution (Normal distribution) using mean, variance and covariance to find out path TTR and O-D TTR by means of different statistical tools. They concluded that reliability is inversely associated with the market penetration.

None of these methods and tools were used on an airport access network to predict the network TTR and link TTR at different peak and non-peak hours of traffic. Since the flow patterns are different on airport access, it could prove to be a vital evidence to conceptualize dissimilarities of both networks.

4.2. Network Travel Time Reliability

User choices in the travel options were modelled based on the random utility theory by Daniel McFadden. Similarly, researchers in the past years focused on different choice models to interpret TTR from users’ point of view. Noland and Polak (2002) had conducted several studies and came up with few empirical assessments for the values of travel time and reliability. Even though, there are 3 approaches/models for reliability evaluations, most preferred ones are Mean-Variance and Scheduling models. Scheduling delay is rarely used by researchers due to its lack of relevance in the applicable scenarios.

4.2.1. Mean-variance model

Mean Variance model by Jackson and Jucker (1982) measures unreliability caused by TTV using standard deviation or variance of the distribution. Travel time distribution is prepared from a RP/SP user survey. Kouwenhoven et al. (2014) also defined it as mean-dispersion model, where the function includes travel time, cost and standard deviation (dispersion factor). This approach addresses the inconvenience caused by travellers due to variability in travel time majorly owing to uncertainties in their travel by Fosgerau et al. (2004).

Batley, et al. (2008) said traveller chooses the appropriate departure time in reference to TTV and the linear summation of mean and variance (mostly replaced by standard deviation) results in the expected utility. They stated the expected vNM utility function as,

$$W_a = V_a \, t_a(V_a) = \sum_{j=0}^{m} b_{ja} V_a^{j+1} \tag{6}$$

However, few researchers like Fils (2012) argues that mean and variance cannot offer perceptions from the distribution and more often skewness and width speak better. Furthermore, Carrion and Levinson (2012) stated that mean variance is a simple approach which considers only daily fluctuations in travel time distribution. Due to this reason, user perception in the airport access keep on changing upon the daily and seasonal variation of air traffic.

Polak (1987) reconsidered it as E(U) by the addition of simple identity of Var(X),

$$E(U) = \gamma_1 E(T) + \gamma_2 E(T)^2 + \gamma_3 Var(T) \quad (7)$$

4.2.2. Scheduling Model

Small (1982) pioneered Scheduling model, fostered from the study on congestion theory by Vickrey (1969), which estimated unreliability from perceived departure time, scheduled arrival early and scheduled arrival late time in addition to cost and journey time attributes. Their utility function was in the form of,

$$U = \beta_C . C + \beta_T . T + \beta_{Early} . Early + \beta_{Late} . Late + \varepsilon \quad (8)$$

Where, β_{Early} - Coefficient of Early Arrival, β_{Late} - Coefficient of Late Arrival,

Scheduling approach is believed to be the most researched method in determining the TTR and its empirical values. Noland et al. (1998) framed an econometric demand model for morning commuters in California, which made predictions on users' scheduling choices. Their model ascertained that Scheduling plays a major role in variation of travel costs and improving congestion on the route. However, Börjesson et al. (2012) suggested that a part of disutility (anxiety, decision making, emergency alternatives costs) caused by the travel time variability were not apprehended by the model.

$$E(U) = \beta_T T + \beta_{SDE} SDE + \beta_{SDL} SDL + \beta_L D_L + \beta_C C \quad (9)$$

Where, DL is a dummy variable and C is the cost factor.

The most significant research on airport accessibility using scheduling approach was carried out by Koster et al. (2011) at Amsterdam International Airport Schiphol. Study aimed to assess the cost of TTV for travellers who accessed the Airport by car. Cost factor included travel time costs, Scheduling costs and cost of missing a flight. The analysed VoT and VoR by anticipating users on their departure time choice. The results revealed that 3-36% of total access cost attributed to cost of TTV for business travellers and 3-30% for non-business travellers.

4.2.3. Dispersion-Scheduling Model

There had been applications of a mixed model, where mean-variance and scheduling approaches are combined, by researchers to make a desirable true fit model. Scheduling model couldn't predict consequences of travel time uncertainty causing various inconveniences to travellers. Noland et al. (1995) defined 'planning cost' along with scheduling utility form so that uncertain travel time Tr (probability density function) is measured. Bates et al. (2001) validated this theory with more statements and further proved by Fosgerau and Karlstrom (2010). As suggested by Börjesson et al., (2012) a reduced form model can be used after Scheduling model, values may be derived using its transferable nature. Thus, dummy variable and cost variable are replaced by the uncertainty variable expressed as PL in the equation.

PL estimates the cost of unreliability in the form of travel time distribution.

$$E(U) = \beta_T E(T) + \beta_{SDE} E(SDE) + \beta_{SDL} E(SDL) + \beta_L P_L \quad (10)$$

4.2.4. Other Approaches

We have been using different online platforms like Google Maps, Bing Maps, Apple Maps, etc. to predict the travel time for a trip. They use travellers GPS data and make speed profiles for relevant links. In recent years, the accuracy in prediction have been improved significantly. Woodard et al. (2016) framed 'TRIP', supported by Microsoft, a method to predict travel time and frame travel time distributions using GPS data. They were successful in making deterministic predictions of trips made by user. Kouwenhoven and Warffemius (2016) made a different approach underlining mean delay as the prime indicator with a combined linear and logarithmic functional form.

5. Findings

The models and methods used to evaluate TTR in this paper, both traffic and user sides, came up with similar as well as distinct empirical values. As stated earlier, the influences in this variation attribute to researchers' approach, regional distinction and range of data used. This paper has included only relevant findings of all the literature it has reviewed so far.

Table 3. List of selected Researches with VoT, VoR and RR values

Study/Researcher	Value of Time (VoT)	Value of Reliability (VoR)	Reliability Ratio (RR)
Small et al. (1995)	---	---	2.30
Noland et al. (1998)	---	---	1.27
Small et al. (1999)	---	Kr 56-87	---
Lam & Small (2003)	$ 5.33	$ 6.19	1.16
Recker et al. (2005)	$12.81	$ 20.63	1.73
Jong et al. (2007)	€11.15	€ 10.15	0.91
Fosgerau (2007)	---	---	0.84
Small et al. (2010)	$ 27.44	$ 24.31	0.89
Carrion & Levinson (2010)	$ 8.00	$ 7.28	0.91
Mahmassani (2011)	---	---	0.80 – 1.10

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A study by Lomax and Schrank (2002) in Texas Department of Transportation shed light on the methodology, stating that reliability cannot be determined by a single measure or tool, so that multi-approaches may be adopted to satisfy all the needs. In 2006, FHWA (2006) markedly studied on reliability in user friendly terms and derived indices those users can understand and manipulate them to make their travel better and faster. Wakabayashi (2010) revealed new reliability indexes favouring user and administrator side contextually, in addition to comparison with the existing indices. A Dutch model was implemented to find the reliability values by deriving an empirical relation between standard deviation, mean delay and route length. They further unified this model in the guidelines of CBA in Denmark.

In fact, very less researches haven been carried out in the airport access trips, more subjective of the paper, where VoR becomes the prime factor. Koster et al. (2011) proved the application of value of reliability in the airport accessibility for car users by anticipating departure time choice and estimating cost of travel time variability. He also estimated the change in access cost for car users upon the alteration of actual departure time.

6. Conclusion

Travel time is the most sensitive parameter of any trip irrespective of its character. Evaluation of travel time depends upon user, purpose of trip, cost, mode, etc. When any trip has a future consequence or unpredictable cost involved, the value of travel time and reliability increases. Commuter trips are more valuated than social trips because late arrival may invite salary/pay cut whereas missing a social meeting may not. Studies, so far, have gone past general work trip analysis w.r.t. TTR or network/link specific scrutiny based on traffic.

This assessment essentially urges a deep investigation into the reliability (user and network) of high-end access trips like Airports, where travel time becomes the utmost parameter. Characteristics of airport access network and behaviour of air travellers are entirely different from that of the whole network and random users respectively. Reliability ratio always tends to be on increasing side along with value of reliability in the context of airport access trips. Research into these fields can shed some light on the elasticity exhibited by traffic and users on an airport network. As TTR gets more attention in the current scenario, it is quintessential to have an extensive study on airport access trips since the VoT and the cost of missing a flight are highly intrinsic factors for every air traveller.

The literature of airport accessibility due to travel time reliability leaves a huge research gap on the user perception aspect, how preferences change upon mode, departure time, cost and route, are to be addressed in future. Accessibility benchmarks may be set after the 'acceptable values/standards' are calculated for each and every parameter. As of now, studies couldn't capture true behaviour of airline users in Indian airports. This is the reason for the disparities in demand assessment of Indian airports conducted by organizations like IATA, AAI, etc.

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