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Research Paper

Improving Service Reliability of Public Transit

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Abstract
In order for a city to sustainably grow, the overall use of public transit by individuals must increase. However, this can only be attained if citizens perceive their public transportation system as a reliable mode of transport. Usually, travelers on public transport value four essential operational attributes which are: speed, short waits, high transport capacity, and most importantly, service reliability. The term service reliability is defined as the ability of a service to perform its functions adequately in a defined environment without failure. Service reliability heavily impacts an individual's decision-making process when choosing the mode in which they will use. Thus, it is vital for public transit agencies to improve the service reliability of their transportation facilities such as buses, trams and metros. The main element which strongly influences the reliability of a public transport service is its headway variance. Headway variance has several causes such as variability in demand patterns and travel time. Furthermore, among the most direct negative effects of headway variance is the increase in the average waiting time and deterioration of comfort. As a result, this causes a decrease in the passenger satisfaction and thus leading to passengers preferring the use of one mode of transit over another. In some severe cases, this decrease in the passenger satisfaction leads to an increase in the use of private modes of transit. In this paper, changes on two levels, tactical and strategic level, were analyzed for their practicality and effectiveness in improving the service reliability of public transit. The tactical level address issues related with the timetable scheduling and planning. The strategic levels address issues related to the transit network line and allocation of resources. The potential of this method was demonstrated in a case study, in which the reliability of a tram network in the Netherlands was examined. Results of this case study show that a drastic change in the service reliability was evident. However, there were some disadvantages of implementing such changes to on both passengers and agencies, which will be further discussed in the paper along with some recommendations.

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I. INTRODUCTION

Public transit is considered as one of the most critical components of urban health. It provides the most essential services for a city to promote its growth, sustainability, and equity. Public transit is defined as a system that provides mobility services to the general public. Transportation systems strive to provide individuals with safe and reliable services that grantee arriving at their daily destinations, such as jobs, schools, and healthcare facilities, in an expected and acceptable time period [1]. In order to provide this ease of mobility, public transportation systems include a variety of transit options, such as buses, trolleybuses, light rail or trams, and metros. These transit options are mainly differentiated by their degree of separation from other vehicles or their right of way (ROW). ROW is the typeof strip of land on which a transit line operates, such as a highway, public footpath, and rail transport[2, 3]. In transportation context, ROW is divided into three different categories: A, B, and C. To elaborate, transit units on a category A transportation path has afully controlled ROW,which means that they have a separated or exclusive path for their operation. This category includes rail rapid transit or automated guided transit, such as metros. Moreover, transit units on a category BROW operate onpaths that are partially separated from other traffic in the longitudinal direction using curbs, barriers, green strips, or tracks. Transit units that operate on such paths include light rail ortrams. Finally, transit modes on category C ROW operate on surface street with mixed traffic without any physical separators from other traffic.For example, buses and trolleybuses operate on category C [3]. Those modes might have different degrees of separations; however, almost all of them operate on fixed routes with precise schedules to serve the society.

II. PROBLEM DEFINITION

Metropolitan areas are centers of diverse activities that require convenient and practical transportation services. Such areas are usually very dense and generate a lot of trips throughout the day. Hence why, several high capacity modes should be provided, such as metros, buses, and trams. Using public transport as a mode for movement through the city could be very beneficial for both the user and the city. In fact, not only are public modes of transport more economical for users, but also, they require much less space in roads compared to private cars, which can reduce congestion significantly [4]. Therefore, transportation agencies are currently aiming to increase the useand access to public transport, in order reduce private vehicle ownership and reduce traffic congestion. However, in order to achieve this goal, public transport agencies should provide reliable services to attract new users and keep existing ones. There are several definitions used to describe the service reliability. Service reliability could be defined as the availability and stability of transit service attributes, where any disturbance in these attributes affect the people's decision-making process when choosing a mode of transit. Such attributes include the expected travel time. Furthermore, there are several reasons why public transit agencies fail to provide a reliable service[5].For instance:

- Regular and irregular disturbances caused by traffic congestion
- Varying passenger demands
- Vehicle breakdown
- Failure of equipment or infrastructure

These scenarios can highly affect the reliability of a service by creating a variance in the headway [6]. In traffic engineering, headway is the time interval between two transit units. As discuses earlier, public transport modes run based on a planned schedule. Therefore, any disturbance in the headway will result in headway variance [7].Meaning that, any variance in headway during a run might result in massive delay and in most cases propagation of delay to the next run.

Service reliability can have a great effect in the satisfaction of travelers using public transport. There are various negative effects of headway variance, and among the most direct ones is the increase in average waiting time. A service with a longer average waiting time affects the punctuality of the service. Another negative effect of headway irregularity is that it increases the variability in demand patterns. Researchers found that as the headway changes, distribution of travel demand over transport vehicles becomes inhomogeneous. Consequently, some travelers will experience extremely crowded vehicles, which leads to a further deterioration of comfort and satisfaction.Therefore, the objective of this paper is to analyze several proposed solutions used to improve the headway variance and increase the number of public transport users.

III. PROCEDURE USED

It is vital to find methods to achieve a more reliable public transport service. Public transportation networks are usually designed and planned based on assumptions regarding future supply and demand of the system. However, the supply and demand of public transit varies with time and introduction of new technologies. Thus, usually these assumptions include inaccuracies that might cause the unreliability of public transportation in the future. Nevertheless, with adjustments to the transit network planning and design, an improvement in service reliability is possible. The main focus of this section is providing methods that could be used to improve network planning or design in order to achieve an improvement in headway variance.These changes can be implemented during to levels, on the tactical and strategic level.On one hand,the tactical level address issues related with the timetable scheduling. On the other hand, the strategic levels address issues related to the transit network line and allocation of resources. In fact, changes on the strategic level can be done during the design and planning of none existing systems,or during the modification process ofexisting systems.With changes on both levels, headway variance can be improved significantly, which results in an improvement in the service reliability[5].

A) Improving Tactical Level of Planning

One method that can be implemented on the tactical levelis adjusting thetrip or route timetable planning to improve headway variance. When planning the timetable for a transportation service there are several measures that can be adjusted to improve the headway variance of a transit unit.Generally, these adjustment measures aim to achieve headway stability by resetting the service schedule. For instance, operators can achieve punctuality in departure time by increasing the layover time, also known as the stopping time,at each station. The increase in layover time allows operators to maintain service time reliability at a high level. This additional layover time can prevent delay propagation for the next run [5].

On tactical level of planning, another solution could beincreasing the slack time on the timetable, which can prevent the delaytime from increasing and reduce the service vulnerability [5, 8].Slack time can be defined as the amount of time a task can be delayed without causing another task to be delayed or impacting the completion date of your project [9]. During the planning process, the slack time can be increased by adding it to the running time. However, the amount of added slack time is dependent on the line characteristics and capacity. Adding the slack time couldespecially benefit areas of the city with crowded junctions as it might result in reducing delay for all of the vehicles on that line [5]. With the aforementioned changes in the timetable scheduling, headway variance is expected to significantly stabilize and thus a more reliable public transit system is experienced.

B) Improving Strategic Level of Planning

Anotherapproach to improve the headway variancecan be implemented on the strategic level. Changes on the strategic level of planning canreduce the vulnerability of the system, increase the redundancy, and create flexibility in the transit network layers. One change which can be implemented is planning independent operational transit lines for transit modes that run shared pathssuch as trams and buses.As mentioned previously, transit units which operate on class B and C paths, such as trams andbuses,usuallyoperate on integrated lines or lines with private and public vehicles.Integrated lines are mostly unreliable since they are highly vulnerable to external factors,such as car crashesand other system failures.However, vehicles operating on class A right-of-way, such as metros, have independent transit lines. This means that there are no other vehicles on this transit line except the metro. Hence, the occurrence ofcongestion is significantly low and is almost none existing compared to buses and trams. By creating separate lines which only buses or trams operate on,the service reliability is expected to improve drastically.However, the option of upgrading a transit path from class B and C to A might be difficult to apply on existing systems due to space restrictions. Thus, it is considered to be more applicable when planning and designingnone existing systemsor lines. *Figure 1* demonstrates thedifferent types of right of way and the type of vehicles on them.

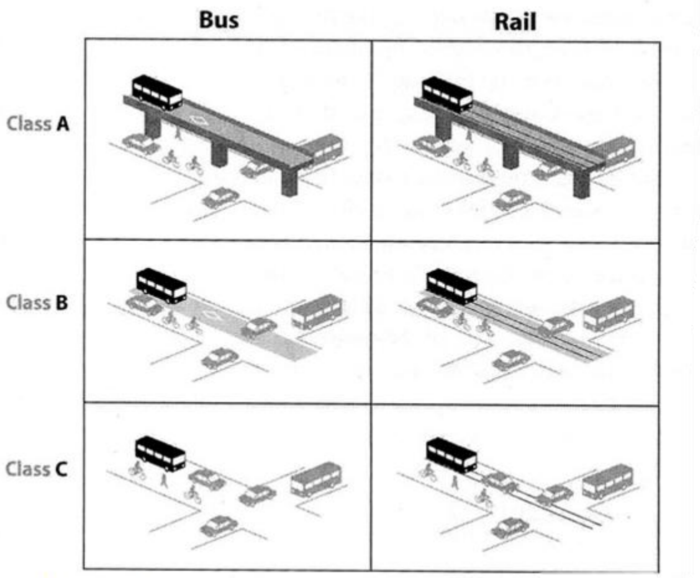

Figure 1: Three types of running way for bus or rail

Creating shorter service lines rather than long lines is also a change that can improve the service reliability. Long service lines suffer highly from service variations, which is an effect of demand and supply fluctuation, when compared to shorter service lines [8]. Moreover, the consequences of failure occurring in long transit lines is far more significant than shorter lines since they are harder to manage. Therefore, by modifying the service lines and making them shorter, it is possible to reduce headway variance, travel time variations and probability of line failures [8].

The last proposed solution on the strategic level is increasing the redundancy in transit fleet. This is doneby assigning reserved vehicles to avoid issues with service variations. In the case of an increase in demand for transit unit, having spare capacity will enable operators to serve the entire transit demand.All of these changes generally have a positive effect on the service reliability since the address several issues that can be improved during the planning process on two levels. A summary of changes on both levels is provided *table 1.*

TABLE 1 Reliability Enhancing Tactics in Transit Networks

Service network design	
Tactical planning	**Strategic planning**
Allocating slack times in the timetable	Planning independent service lines
	Shortening service lines
	Increasing stop spacing
	Planning redundancy in fleet
	Planning the service network with redundancy/ flexibility

In order to demonstrate the potential of these changes, a case study on the tram network of the city Hague in the Netherlands was conducted. The tram network was analyzed for several years in which different types of events took place. The average number of days in which disturbances occurred was approximately 102 days or 28% per year. As a result of these disturbances, 89% of the trips were delayed for a period less than 10 minutes. Additionally, around 1.9 million passenger trips were cancelled due to issues with reliability [5]. The aforesaid measures and strategies were applied to this system in order to improve its service reliability by improving headway variance.

IV. RESULTS& DISCUSSION

After implementing these changes,the overall service reliability of the tram network improved drastically, and the results were mostly positives. For example, the reduction rate inin the total number of cancelled transit trips was around 24% [5]. Furthermore, an analysis of the most vulnerable line wasconducted. This line was split into two shorter lines as its vulnerability was due to it being the longest tram line. The results show that the overall service reliability of that line segmentincreased. Nevertheless, there were several disadvantages of these implemented changes that were not accounted for during the planning process. A disadvantage of splitting or shortening long lines was an increase in the travel time. Passengers travelling on that linehad to transfer to another station in order to reach their destination.In addition, the fare depends on the number of sections for the trip. Hence, since the sections are shorter, this will increase the fare to the passengers. This means that there is a trade-off between the cost or convenience and reliability of the line. Similar to the previous disadvantage, although increasing the slack time improved the reliability of the system, it also slowed down the service. A slow service means that passengers can rely on this mode of transit to reach their destination, but it will take them a long time. If the service is perceived to be slow, many individuals will resort to using private modes of transit rather than public ones. Furthermore, a disadvantage regarding the increasing the layover time was, in some instances, the tram waited more than necessary at some stops. Therefore, the fluctuations in the demand and supply should be studied well before increasing the layover time.

V. CONCLUSIONS

The potential of these methods was demonstrated on a tram line in the Netherlands. It was evident that the changes discussed in this paper, both on the tactical and strategic level, significantly improve the servicereliability of the tram system. Where after implementing these changes the previous value of 1.9 cancelled passenger trips decreased by around 24%. The implemented changes on the tactical level improved the planning process for the timetable. On the other hand, the changes on the strategic level tackle issues regarding vulnerability to external factors, increasing the redundancy to avoid issues with the supply and demand, and flexibility. Furthermore, there is no method better than the other, since each method tackles different issues at different stages of design and planning. Although these improvements are helpful, some of these changes do have some drawbacks.However, the methods discussed in this paper are still substantial and should be considered. In general, the planning team should take into consideration all of the aforementioned and weight the advantages and disadvantages of each change before implementing it based on their constraints and criteria.

REFERENCES

[1] Centers for Disease Control and Prevention, " Public Transportation System Introduction or Expansion," *cdc.gov*, para. 3, Oct. 19, 2018. [Online]. Available: https://www.cdc.gov/policy/hst/hi5/publictransportation/index.html [Accessed: April 2, 2020].

[2] H. Black. (1910). *A Law Dictionary*. [Online]. pp. 1040. Available: https://en.wikipedia.org/wiki/Right-of-way_(transportation)[Accessed: April 6, 2020].

[3] V. Vuchic, " Urban Transit Operations, Planning, and Economics," in *WILEY*, 2005, chapter 1, pp. 4-67.

[4] V. Vuchic, " Urban Public Transportation Systems," *cdc.gov*, n.d. [Online]. Available: https://www.eolss.net/sample-chapters/C05/E6-40-02-02.pdf [Accessed: April 3, 2020].

[5] S. Tahmasseby, " Improving Service Reliability In Urban Transit Networks," *IEEE Explore*, pp. 1-17, 2010. [Online]. Available: IEEE Xplore, file:///C:/Users/USER/Desktop/TRS361/ IMPROVING%20SERVICE%20RELIABILITY%20IN%20URBAN%20TRANSIT%20NETWORKS%20(main).pdf [Accessed: April 9, 2020].

[6] Wikipedia, " Headway," *Wikipedia.com*, para. 1, Jan. 22, 2020. [Online]. Available: https://en.wikipedia.org/wiki/Headway [Accessed: April 9, 2020].

[7] J. Parra, S. Raveau, and J. Muñoz, " The underlying effect of public transport reliability over users' satisfaction," *IEEE Transactions on Image Processing*, pp. 1-8, 2018. [Online]. Available: IEEE Xplore, file:///C:/Users/USER/Desktop/TRS361/The%20underlying% 20effect%20of%20public%20transport%20reliability%20over%20users%E2%80%99%20satisfaction.pdf [Accessed: April 10, 2020].

[8] A. Critchlow, "Kingsway Roundabout – Options Analysis", *Derby.gov.uk*, 2016. [Online]. Available: https://www.derby.gov.uk/media/alluncategorised/RT81175_72_01_iss3%20Kingsway%20note%20incl%20appx.pdf [Accessed: April 18, 2020].

[9] "What is slack time?", *SearchSAP*, 2003. [Online]. Available: https://searchsap.techtarget.com/answer/What-is-slack-time [Accessed: April,18 2020].