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GAUGING THE EFFICIENCY OF PUBLIC TRANSPORT IN KARACHI: AN APPLICATION OF DATA ENVELOPMENT ANALYSIS (DEA)

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ABSTRACT
Karachi is the leading metropolitan in Pakistan with the largest population and some additional attributes, including Transport intensity, and diverse business operations. The rising population increases the pressure on transport demand and to meet such mandates it is the responsibility of the state to ensure the supply of quality transport which is economically feasible and environmentally sustainable. BRTS was initiated to improve the quality of life through value addition in the existing transport. The rising trend of building BRTS is briskly on the rise in emerging countries across the world. The outcrop of shipping in big cities pursues to increase economic growth and alter the city's image for dwellers and interlopers. The goal of this research is to look at the use of the best possible substitute energy-saving methods in public transport. A decision-making efficiency analysis approach is used for the comparative study of both orthodox fuel and hybrid bus systems for Karachi city. In this paper, the application of an energy-based bus system is investigated in comparison to customary public transportation services in Karachi on a specific route. Except for one midway portion, the hybrid Bus system's efficiency remained better or comparable to the conventional value of 1. The study found that BRTs are sustainable solutions for big cities and they can be used instead of the customary bus system and it will serve as an energy-efficient and environmentally beneficial way out of public transport. The government of Sindh should promote such types of projects for the sustainable future of Karachi and its inhabitants.
Keywords: Data Envelopment Analysis, Bus Rapid Transit, Green Line.

1. INTRODUCTION
It is estimated that Karachi's present population is 210 million by 2020 which is predictable to touch 245 Million by the end of 2030 [World Population review (2022)]. This indicates the addition of 35 million people to Karachi city's Population in the next 8-10 years. The largest Urban unit, Karachi metropolis is rapidly growing without planning and High unmet public transport demand reflects the insufficient bus operations that are not aligned with the travel patterns of the population (Gadepalli & Rayaprolu, 2020). Increasing the supply of transport services should not be the ultimate goal but the addition of sustainable transport should be the goal. It plays a significant role in the mitigation of negative externalities for daily users. The extenuation of transportation externalities entails a move in the direction of a sustainable transportation structure, which required a master plan in the case of a big city like Karachi.

Feeling the need for such a transport system, the government officially notified the Plan of Karachi Mass Transit Corridors in 1995. The government understood that the expansion of the city will be in need of the such type of sustainable projects sooner or later. The project is grounded on the Karachi Mass Transit research report developed in 1990 in which high and at-grade bus corridors were proposed

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and these strips were premeditated so that they can be transformed into Light Rail Transit System (LRT) but, upon realizing the financial constraints, at that time the Government decided to initiate Bus Rapid Transit instead of LRT. A number of attempts were made by different government officials to formally implement the full plan, but these corridors were not implemented due to several constraints. Due to a lack of expected Budget, the original concept of the busway was reformed into the railway system with the reduction in Corridor-1 as a BOT (Build–operate–transfer) which was given to private investors at that time but all projects badly failed. As a Plan x, for the time being, Bus Rapid Transit (BRT) system was anticipated in the Private-Public partnership, which turned out to be an environmentally friendly public transport system for Karachi".

The (BRTS) is well-defined as "A cohesive system of resources, that jointly increase the quickness, consistency, and proprietorship of bus services". It is a quality-oriented bus service with a unique infrastructure to reduce traffic congestion and is designed for extraordinary haste, consistency, and protection (Demirtaş & Acar, 2020). The BRTS has a distinct bus route and has few little stops compared to local buses. BRTS is offered as having high speed, high power, increased reliability, compelling travel attraction, and environmental, social, and economic benefits Abbasi, et al,. (2020);, and Carrigan, et al, (2013); making the system friendly and attractive to passengers and service quality that requires efficient, straightforward, and accessible technology (Khumalo, 2019). Bus Rapid Transits enhance the excellence of natural life in metropolises at least in four different substantial ways, which include reducing traveling time, reducing greenhouse gas (GHG) and local air pollutant emissions, improving traffic safety and security, and increasing physical activities Kepaptsoglou, et al, (2020). Structural elements, design features, operational strategies, and all aspects of BRTS can vary from system to system, to land use patterns, investment plans, and environmental considerations [Guo, et al, (2018)].

This BRT turn out to be highly widespread among transport specialists and engineers in Karachi. Initially, the anticipated scheme was designed for 16 BRT strips, 21 subordinate roads, and alternative feeder routes. After a little interest from ADB, the project was dropped in 2007 once again. An assessment study entitled Karachi Transportation Improvement Project (KTIP) was conducted by Japan International Cooperation Agency (JICA) in collaboration with Karachi Mass Transit Cell (KMTC), CDGK from April 2010 to June 2012. This was a step closer to the implementation process and KTIP consisted of the master plan stage and feasibility study stage. The assessment report was a predicted success story for big cities' transcities'

Due to the extensive resource utilization, this master plan study, conducted and prepared by JICA projected a new insight into the Karachi Circular Railway (KCR), and 6 BRT passageways. Each passage was given a distinctive name of color so that the passangers can easily comprehend the infrastructure and access their respective services in time. This master plan was more effective and practical with identification and decleration of 2 BRT corridors, namely Green Line and Red Line. It was once again important to recognize the economic and environmental feasibility of the proposed reforms. After the submission of successful feasibility reports on both the proposed lines, It was proposed to build out-and-out bus tracks in the middle of highway beside the proposed Green Line. This was inticipated to be constructed from starting point M.A. Jinnah Road all the way to the Guru mandir and to Labella to A.O. Clock. From there this line will go on directly to Surjani and Red Line Regal Chowk. It was also proposed that a People's Roundabout on University Road to the end location as Model Colony.

The project Proposed another route for Green Line, which was suppose to start from Municipal Park with a U-turn lane for the buses. The plan arrangement outspreaded along M.A Jinnah Road in the direction of northeast up to Guru mandir, and after Guru mandir, towards northward Business Recorder Road, Nawab Siddique Ali Khan Road, Shahrah-e-Shershah and Shahrah-e-Usman passing by some of the major landmarks such as Numaish, Board Office and NaganChowrangi and others. Whereas, Green Line BRT also shares the mutual passageway with Blueline flanked by municipal Park and Guru mandir.

For the Karachi public transport system, the BRT system is not the best solution because of its several problems such as low power than the train and the use of existing road infrastructure (Mustafa, 2020). However, the cost of investing in the rail system is prohibitive to acquire in Karachi, and only the Karachi Circular Railway (KCR) shows progress with funding from JICA. It remained the only option at that time. A growing city cannot wait for the mass transportation system until the city's

economic level is high enough to introduce an expensive and comprehensive procedure. To improve the public transport system in Karachi, BRT is a leading project corridor in terms of cost-effectiveness and available resources. Traffic congestion in Karachi city gridlocked primary street halls and corridors Rao, et al, (2014). The roads of karachi has turn out to be flowing floods of motercycles in these days. Large oil exporters and carriers who drive in other unacceptable ways, determined sound of emergency car horns, mother drivers on the streets, employees dumped at overcrowded and official bus stations; in addition, due to lawlessness in transport sector, the uncontrolled anger is a normal part of life in Karachi.

In addition to overcoming welfare and environmental hazards, the city of Karachi loses R6 663 million (£ 4.07 million) equally due to gridlocks (Raza, 2016). Separate inspections, paper articles, media reports, and interviews recommend that Karachi's traffic problems are linked to component changes as well as the social and financial availability of its residents. These problems similarly do not fully define and guide important human health decisions that include accommodation and the tendency to open up skills. In 2006, the then Karachi Strategic Development Plan 2020 by the then City Government indicated that there were 24.2 million men's trips in Karachi consistently, of which at any rate 60% were accepted by the current public transport system (MPGO and CDGK 2007). It would not be counterproductive to point out that with the construction of more people they will undoubtedly increase in value. This study aims to identify the most efficient transport solution for the city of Karachi for a specified route while comparing Green Line Project with other conventional urban networks available. It will help policy maker to get confidence on bold desicisions making for the sustaunable transport services in big cities, which are safer, smoother and better transport services as per the past reviews are avaible. This study highlioghts the effeceincy of BRTs in comparsion with other public transport services through utilizing the DEA analysis on primary data, which is collected through a survey from Drivers, transport experts and owners in Karachi.

Orgnaization of the paper

The study follows emprical research design, starts with introduction, follwed by lietarture reviews of past work and methdology. Before conclusion a detailed section on results and discussion is provided to undertsand the evidence base findings and last but not the least recommmendations for future work are openly mentioned to keep the research growing in this area of study.

2. REVIEW OF LITERATURE

The provision of public transport has become a challenge and managing its demand is a greater one Jahan, et, al (2022). Efficient and effective distribution of goods and services relies on mobility and quality transport system. The trend of BRTS is on the rise these days, especially in developing countries. developing nations are more curious to introduce rapid transit systems in order to improve transportation environments and form a more equatible and relaible transport system for smooth mobility of the citizens. These countries are experiencing rapid motorisation and ever falling traffic sceneries which calls for invesments with fully dtermined intentions to develop a high capacity and high performance transit systems.

Moreover, fiscal consequences of massive car-dependency and long-term environmental effects alongwith global concerns to curb carbon emission add to the need of expanded transit services. In such cases, options available at lower cost include Light Rail Transit (LRT) and Bus Rapid Transit (BRT). Various studies have attempted to identify the efficient public transport system; some of them focus on the BRT concluding that it is the most efficient one in multiple aspects But deniers are not zero.

The study emphisised that there has been a massive diversion towards private vehicles use in recent years, which has aggrevated environmental trepidations (Redman, et al, 2013). These are associated with increasing level of tempreture, that makes is more challneging to travel in a public congested transport, indicating the rising demand for public transport, which has already crossed the limites. The BRT system carries some essential aspects of public transport including cost effectiveness. It improves the quality of life in ways, like, reducing greenhouse gases release, reduction in the local air pollution and also reduces the travel time. It increasing physical activities alongwith improving traffic safety and security (Carrigan et al., 2013).

Available modes of commute remains connected to the wellbeing and monetary thriving that relies on an effective, fair, comfortable and affordable transport framework. In case of the cities of

Jogannesburg and Tshwane, BRT has been found to be safe, accessible, reduces congestion and travel time along with lower pollution [Khumalo, (2019)]. BRT systems are intensively used in Guayaquil, Guadajalara, and Istanbul on the basis of riders per bus (Hidalgo & Carrigan, 2010) and Yazici,et al,. (2013). BRT is considered to be a form of "adaptive transit" by the Transit Metropolis because of its capability of serving largely market-pushed and spread-out development patterns [Montero, (2015)].

Hensher, et al, (2015) studied the resident preferences of BRT and LRT to find out whether a bias exist within and between geographical jurisdictions of Australia. Their study found that comparatively, BRT involves lower construction cost and provides service coverage to a larger population. BRT Lite buses frequently have a low-ground or kneeling formation that allows same-degree boarding and alighting at simple curbside stations. Higher-cease buses that prevent at raised platforms or full-service stations, such in Quito and Bogotá, have ramps which fasten the flow of passengers. Some structures, including in Beijing and Hangzhou, integrate low-ground buses with barely raised station platforms (Kepaptsoglou et al., 2020).

Curitiba in Brazil is considered to be the pioneer of BRT and its mayor at that time this sytem as "surface metro" that has features of a subway but with lower cost. [Wang, et al,. (2015)]. A study was conducted in the city of Bucaramanga, Colombia comparing BRT and motorbike taxis for daily commute. Márquez, et al, (2018) found out that travelers' mode preferences are influenced by monetary returns and safety concerns whereas comfortable transport is not much sustantial determinant. Moroever, transport cost was not opted by study respondents as important for choice of mode. However, safety concerns were not found to be significant factor behind the mode choice by Kepaptsoglou et al., (2020); although, traffic accidents leads to considerable mortality and morbidity in the developing economies. BRT has combined features of LRT including velocity and reliability, and a traditional bus with operating flexibility and lower fares (Deng & Nelson, 2011).

Road traffic congestion has advanced in past years with increasing population, particularly in developing countries, owing to the poorly planned road network (Olagunju, 2015). In case of Nigeria, the participants had suggested climate protection to be a fundamental concern of environmental politics in terms of lower number of private vehicles and sustainable transport system. The study suggested that BRT helps in reducing emissions that damage environment. Olagunju (2015) described the guidelines asserting that drivers using cars out of necessity can be motivated towards alternatives of driving in order to serve common interest. However, ones using by choice, the coverage implications are lots extra extreme (Ashkrof, et al. 2020). Redman et al., (2013) has highlighted the use of public transport together with cycling and walking as substitutes to private vehicle use. In this regard, it should be noted that users' travel habits are influenced by personal characteristics alongwith local land use and infrastructure; moreover, the time of availing the facility also matters. Shifting to more sustainable urban transport system does not mean to eradicate private motor vehicle; however, the pattern of trade-offs among individual mobility, environmental degradation, emotional benefits, undisputable convenience and quality of life must be changed. The commuters need to be encouraged for modal shifts from private vehicles to public transport with the common interest of having a transport framework that optimises price, environmental, temporal, affective and social costs and benefits.

BRT vehicles may be driven through electricity but commonly the sources of natural or purified diesel are used; where the former's quantity of emission depends on quality of gasoline, riding behavior and local geographic and topoligical capabilities (Pojani & Stead, 2015). Additionally, factors like noise, climate trade, effect on plant life and emission of various pollutants contribute to the choice of fuel (Abbasi et al., 2020). Not only the environmental degradation, private vehicle use also leads to social issues including adverse health outcomes due to noise pollution, accidents, visual instrusion, network severance and traffic congestion (Batur, 2015). Although, private vehicle provides convenience to owners but it gives a challenging competitive environment for transit. Whereas, public transportation not only promotes fairness but also complements accessibility sustainability in metropolitan cities.

Despite the option of sustainable, cost effective and eco-friendly transit system, policymakers in underdeveloped countries are observed promoting motorized transport framework. Commuters are encouraged to private vehicles by presenting tax exemption to non-public car usage, growing high road infrastructures etc. (Motta, et al,. 2013). There is another substitute and unorganized form of regular public transport system that is "informal" public transportation which includes jitneys, wagons, and different paratransit modes (Guillen, et al., 2013). Urban transport in most of the cities across the arena is developing in unsustainable ways and are becoming harsh on environment, causing congestion and

emissions. This can be observed in the form of air pollutants caused due to individual motorization and increase in site visitor's congestion (Cohen, 2016). These quality concerns can only be adressed through developing an extensive transport community, which cares about the environment and economy. There is a possibility to ornament the general public shipping machines, which are beautiful and sustainable. It all about is the implementation of a Bus Rapid Transit (BRT), as it's far less costly as compared to the development of a rail transit and it has a shorter construction time as compared to rail transport system [(McDonnell & Zellner, 2011)].

There are tons of papers, which highlights the importance of transport system and effeciency of transport but as per our knowledge, none of the study has been published on effeciency comparsion of BRTs of Karachi against other transport services runing on roads of Karachi city. This study will contributre to literature by adding a new lens of effeciency studies, especially the case sustainable transport services in big cities. This study will be ground breaking contribution to the literature of sustainable transport system by exporing effeciency and consumers aspects of offordability and economic feasibility.

3. MATERIALS AND METHODS

Methodology: The research is quantitative research which aims to study the foremost effeciency of BRT transport system in comparison with other transportation services in Karachi. It is specifically design in such a way that, it will measure and compare all the transport system, including BRT, on the way from Jama Cloth market to Nagan-Chowrangi. Based on siuation analysis, it is decided to use different modes of transportation in this empirical research on a specific route to estimate accurately and precisely the future impact of Karachi's roadway and transport system in presence of BRT and other conventional transport positions.

Variables: The Variable in our research which are used is Fair structure, fuel consumption, Number of trips, seating capacity, Travel time. All the variables are Perceived either by the Credibility of Sindh Infrastructural Development Company Limited (SIDCL), and specifically by bus driver, Ching-chi rickshaw through survey questionnaire of the selected route.

Technique: In light of a legitimate concern for rationality, to describe this approach through DEA Model, depicts a valid methodology for the clarity of readers. Data Envelopment Analysis Model is often used the study of Efficiency Analysis and it is one of the resourceful techniques for the enactment analysis of transport systems. (DEA) is one of the non-parametric approaches developed by Chames, Cooper, and Rhodes in 1978. in which the association between all the inputs and outputs are taken into account instantaneously elastic and additional consistent measure of efficiency [Romero-Ania, et al, (2021)].

The study has used DMUs, which maximizes the Ratio between weighted outputs and inputs. Which are comparable across all the selected public transport services because all the inputs and outputs are same in terms of nature, features, measurement units. The argument that efficient DMUs produce higher outputs with same level of inputs as compared to the less efficient or not well-organized DMUs. The efficiency score of a DMU varies from 0 to 1. A DMU with a productivity score of 1 is reflected to be the most competent. To express this technique in the formal mathematical function or expression it can be written as,,

Equation (1):

$$\sum_{-}(i=1)\hat{}m \blacksquare ViXio \text{ Subjected to: } \sum_{-}(i=1)\hat{}s \blacksquare \ 〚UrYrj = 1,〛$$

$$\sum_{-}(i=1)\hat{}m \blacksquare \ 〚ViXij - \sum_{-}(i=1)\hat{}s \blacksquare \ 〚UrYrj = 0, (j = 1, \dots\dots, n)〛\ 〛$$

⇨ UrVi ≥ 0, where r=1, . . ,s (i=1,m)

Using performance analysis outcome and exposure varaibles, this method of DEA model calculates the efficiency. In this case the efficiency is designed by make best use of output and minimalizing of the input. It looks like an applicatuion of douality in production but it only relates that concept and doesn't reflect the theory of douality concept. The simplest form of calculating Efficiency by:

Equation (2): ∑f Efficiency = weighted sum of output / weighted sum of input.

⇨ Max Output / Max Input

Equation (3): $\sum f \text{ Efficiency} = \frac{U1Y1j+U2Y2j+\ldots+UkYkj}{V1Y1j+V2Y2j+\cdots+VijYij}$

Or….

∑f Efficiency = No. of trips + Seating capacity / Fuel + Cost + Time

Total Content of OUTPUT, INPUT and DMU's: **DMU's = Output = Input. 5=5.** the DMU's includes all the local/conventional and new operating vehicles where the output and input unit direct all the variables used in this study to provide the required estimation for analysis such as fuel consumption, fare structure and others mentioned above. DAE Model, the total unit of input and output are required to be equal to the entire team of DMU's in case for the fair results and conclusion. If not equal, then the results might be un-realistic and Baised. The following DMUs are considered across all the availible options. This Table shows that data that has been taken for all the five DMU's and input variables i.e. travel time of all transport system as well as the fair structure, no. of trips, seating capacity and fuel consumption. Each varaible is taken for all the DMUs under the study.

Table 3.1 Variables/Inputs/Outputs

Output/Input	BUS (4K) (1)	CHINQUI (V1) (2)	BRT (3)	SWVL (4)	AIRLIFT (5)
Fair Structure	70	60	50	180	200
Fuel Consumption	45	25	40	40	40
No. of Trips	11	9	20	8	8
Time Travel	1	1:20	50	1	1
Seating Capacity Per Trip	45	8	13000	16	16

4. RESULTS

This section of the papers highlights the major findings of the study supported with results calculated by the authors of this paper from a survey based data. The analysis of data shows that BRT has the highest passenger capacity and lowest fare estimation which seems economically feasible and efficient. This indicates that more persons can be transported in less space with public transport modes of a higher power. Authorities can utilize this study to analyze the performance of current methods and prioritize the ways for future planning.

Figure 4.1 DEA Efficiency score of selected public Transport services in Karachi

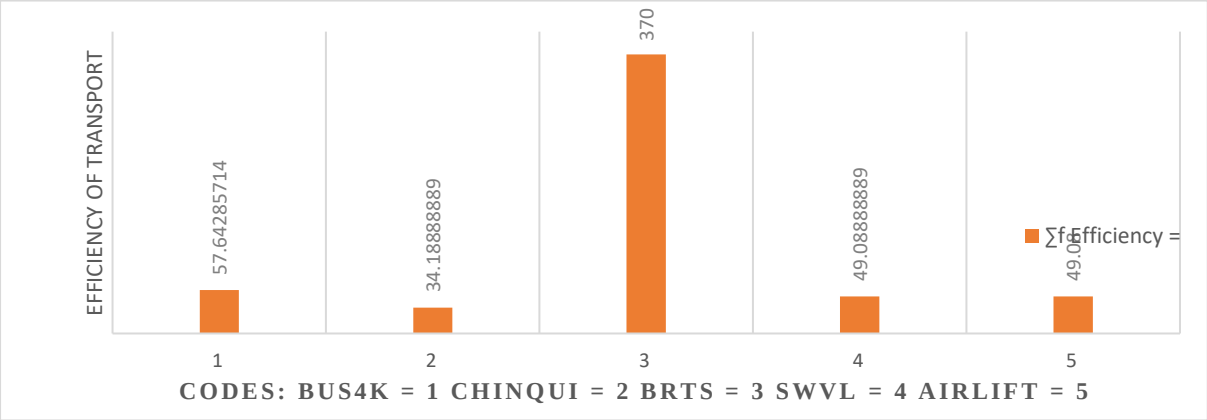

Figure 4.1. the higher rate of efficiency more clearly and according to this estimation BRT seems to be the effective and efficient way out of the transportation problems in the new upcoming times for Karachi city. BRT has the highest efficiency among all the considered transport system whereas the Bus 4k stands on second reliable option after BRT and Ching-chi has the lowest of efficiency ratio in all whereas the AIRLIFT and SWVL has the has efficiency result as shown above.

Table 4.2

Point	*Row1*	*Rank*	*Percent*
BRT	370	1	100.00%
BUS 4K	57.64286	2	75.00%
SWVL	49.08889	3	50.00%

AIRLIFT	49.08	4	25.00%
Chinqui	34.18889	5	0.00%

Table 4.2 rank and percentile shows the ranking of transport system as per based on efficiency results. BRT holds the highest rank 1 with 100 percent of resulting ratio as compared to other transport operations and Bus 4k stands second and Swvl third for the efficient transport system from Jama cloth to Nagan Chowrangi route. Chinqui transport service is least efficient on the selected route.

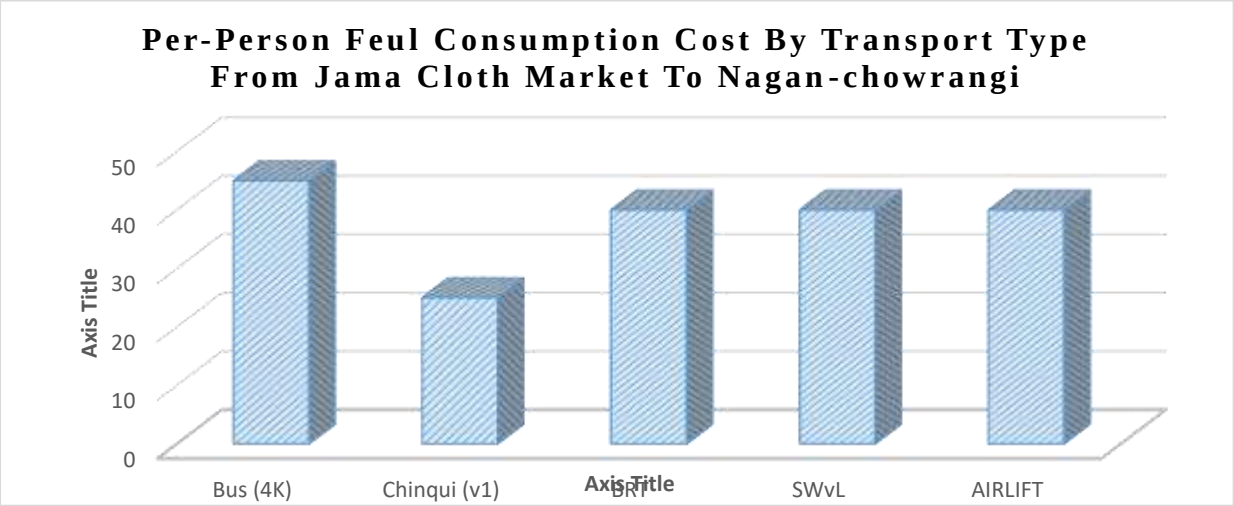

Figure 4.2 displays that Bus Rapid Transit (BRT) is a modern sequestered transportation system with plentiful possibilities of fast traveling, high efficiency and low fuel charges. Nevertheless, when we equated this specific system with the other transports services, the results might be contradictory but quite staisfactory to appreciate these types of projects in cities where it is needed the most. Fuel cost is a substantial part of mass transit. The fuel consumption is rather dissimilar for all the considered modes (BRT and Bus and others), because of the diverse passenger capacity, boulevard level, and road conditions.

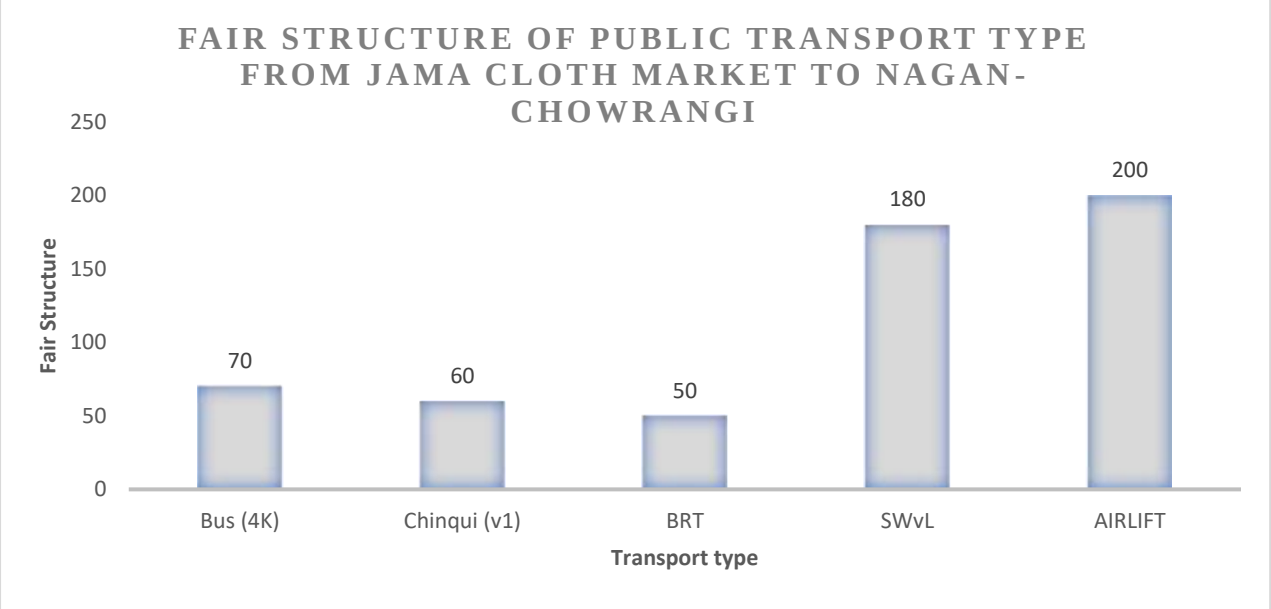

Figure 4.3 shows the fair structures of different transport systems running in Karachi city from Jama Cloth market to Nagan-Chowrangi. Per person, fair charges of airlift and Swvl are highest as compared to other transportation for the route from "Jama Cloth market to Nagan-Chowrangi" whereas BRT seems to be the best of option in terms of the lowest fare among all the other system running on same route. It is important to understand that BRT is a more sophisticated and reliable transport system with lowest cost which indicates high level of efficiency.

4. DISCUSSION

The point of this study was to assess the framework through the investigation of the current arrangement and existing public travel framework for Karachi city. The fundamental conversation of this contextual analysis is to offer responses to the inquiry identifying how well Bus Rapid Transit accomplishes its points toward supportable versatility in Karachi. It was tracked down that the BRT could draw in explicitly private vehicle clients to change the mode decision and our results are supported by avaible literature but from different cities across the world Wang et al., (2015). Our study also support the veiws of other researchers by finding that fast travelling (BRT) awards a higher traveler limits of passengers, which are compratively affordable, easily accessable, agreeable, and adaptable option. In this context, the BRT has logically acquired mindfulness implementation and food for though for the policymakers (Márquez et al., 2018). The significant focal point of this review was to assess the general exhibition of the Karachi BRT framework which has shown a positive sign of the execution of energy-effective fuel-saving transport fast travel frameworks. According to estimation BRT seems to be the effective and efficient way out of the transportation problems in the new upcoming times [Caulfield, et al (2013); Shah et al., (2020)]. It is a staisfactory deduction that BRTs have always been the most successful transport options across the world.

5. CONCLUSION

The escalating residents upsurges the gravity on transport demand in big cities. It is quite costly for the inhebitants of karachi to travel in their private cars due to increasing fuel cost and accessive congestion on roads. It is quite important for the provincial governments to think alternatively, espcially for Karachi, quality transport can add significant value to life of residents. It is the responsibility of the state to ensure the supply of transport which is economically feasible and environmentally sustainable. The transportation projection in big cities seeks to increase economic growth and alter the city's image for both inhabitants and outsiders. The goal of this research is to look at the use of alternative energy-saving methods in selected public transport services in Karachi. This study has been undertaken as case study of specfic route to undertsand the ffeciency of a few transport services. For this purpose, a decision-making efficiency analysis approach is used to compare both the conventional fuel and hybrid bus systems for Karachi city in Pakistan. The study found that BRTS is the most effecint transport system among slected transport services on the same route. Except for one midway portion, the hybrid Bus system's efficiency remained better or comparable to the conventional value of 1. According to the findings of current analysis, the hybrid machinery of Means of transportation is not only replacing a conventional fuel-based system, and it will also serve its inticipated purpose as an energy-efficient and environmentally beneficial economic solutions for big cities. The study concludes that BRTS are economically efficient and runs on low fuel cost because of its hybrid designe which also causes less demages to the environment of city. It improves the quality of life and serves its purpose more effeciently as compared to other transport services.

6. POLICY RECOMMENDATION

It is plausible to think that public transport plays significant role in the daily life of a common man. Based on effeciency score of BRTS the study encourages the governement of Sindh to take bold steps for the transport of very imporant city in Pakistan. Government should promote and plan new projects likewise BRTS to insure the suply of sustainable public transport services.

REFERENCES

Abbasi, M., Hosseinlou, M. H., & JafarzadehFadaki, S. (2020). An investigation of Bus Rapid Transit System (BRT) based on economic and air pollution analysis (Tehran, Iran). *Case Studies on Transport Policy, 8*(2), 553-563.

Ashkrof, P., de Almeida Correia, G. H., Cats, O., & van Arem, B. (2020). Understanding ride-sourcing drivers' behaviour and preferences: Insights from focus groups analysis. *Research in Transportation Business & Management, 37*, 100516.

Batur, İ. (2015). *Social behavioral change for sustainable urban transportation under TDM concept: A case study of Istanbul.* Fen Bilimleri Enstitüsü.

Carrigan, A., King, R., Velásquez, J. M., Duduta, N., & Raifman, M. (2013). Social, Environmental and Economic Impacts of Bus Rapid Transit. *Washington, DC: EMBARQ*.

Caulfield, B., Bailey, D., & Mullarkey, S. (2013). Using data envelopment analysis as a public transport project appraisal tool. *Transport Policy, 29*, 74-85.

Cohen, M. J. (2016). *The future of consumer society: Prospects for sustainability in the new economy*: Oxford University Press.

Demirtaş, E. A., & Acar, R. (2020). Performance Evaluation of Istanbul Metrobus System Through Data Envelopment Analysis. *Transportation in Developing Economies, 6*(2), 1-11.

Deng, T., & Nelson, J. D. (2011). Recent developments in bus rapid transit: a review of the literature. *Transport Reviews, 31*(1), 69-96.

Gadepalli, R., & Rayaprolu, S. (2020). Factors affecting performance of urban bus transport systems in India: A Data Envelopment Analysis (DEA) based approach. *Transportation Research Procedia, 48*, 1789-1804.

Guillen, M. D., Ishida, H., & Okamoto, N. (2013). Is the use of informal public transport modes in developing countries habitual? An empirical study in Davao City, Philippines. *Transport Policy, 26*, 31-42.

Guo, J., Nakamura, F., Li, Q., & Zhou, Y. (2018). Efficiency assessment of transit-oriented development by data envelopment analysis: Case study on the Den-en Toshi line in Japan. *Journal of Advanced Transportation, 2018*.

Hensher, D. A., Ho, C., & Mulley, C. (2015). Identifying resident preferences for bus-based and rail-based investments as a complementary buy in perspective to inform project planning prioritisation. *Journal of Transport Geography, 46*, 1-9.

Hidalgo, D., & Carrigan, A. (2010). BRT in Latin America High Capacity and Performance, Rapid Implementation and Low Cost. *Built Environment, 36*(3), 283-297.

Jahan, N., Khan, M. I., & Naqvi, K. A. (2022). DISAGGREGATING THE DEMAND ELASTICITIES OF RAIL SERVICES AND ITS INFLUENCING FACTOR IN PAKISTAN. *Pakistan Journal of Social Research, 4*(2), 702-716.

Kepaptsoglou, K., Milioti, C., Spyropoulou, D., Haider, F., & Karlaftis, A. G. (2020). Comparing traveler preferences for BRT and LRT systems in developing countries: Evidence from Multan, Pakistan. *Journal of Traffic and Transportation Engineering (English Edition), 7*(3), 384-393.

Khumalo, T. N. (2019). *Comparative Assessment of Effectiveness of Bus Rapid Transit (Brt) Systems of Johannesburg and Tshwane*: University of Johannesburg (South Africa).

Márquez, L., Pico, R., & Cantillo, V. (2018). Understanding captive user behavior in the competition between BRT and motorcycle taxis. *Transport Policy, 61*, 1-9.

McDonnell, S., & Zellner, M. (2011). Exploring the effectiveness of bus rapid transit a prototype agent-based model of commuting behavior. *Transport Policy, 18*(6), 825-835.

Montero, S. (2015). *Mobilizing Bogotá: The Local and Transnational Politics of Inter-City Policy Circulation.* UC Berkeley.

Motta, R. A., Da Silva, P. C. M., & SANTOS, M. P. D. S. (2013). Crisis of public transport by bus in developing countries: a case study from Brazil. *International journal of sustainable development and planning, 8*(3), 348-361.

Mustafa, S. (2020). Comparative Analysis of KCR and BRT: An Exploratory Study Covering the Mass Transit Needs and Policies in Karachi as a Megacity. *Global Journal for Management and Administrative Sciences, 1*(1), 1-24.

Olagunju, K. (2015). Evaluating traffic congestion in developing countries. A case study of Nigeria. *Journal of the Chartered Institute of Logistics and Transport-Nigeria, 2*(3), 23-26.

Pojani, D., & Stead, D. (2015). Sustainable urban transport in the developing world: beyond megacities. *Sustainability, 7*(6), 7784-7805.

Rao, Z. I., Khan, K., Jafri, S. F., & Sheeraz, K. (2014). Public transportation improvement validation model for Metropolitan City Karachi. *Engineering Journal, 18*(1), 55-64.

Raza, M. (2016). *Exploring Karachi's Transport System Problems: A Diversity of Stakeholder Perspectives*: International Institute for Environment and Development.

Redman, L., Friman, M., Gärling, T., & Hartig, T. (2013). Quality attributes of public transport that attract car users: A research review. *Transport Policy, 25*, 119-127.

Romero-Ania, A., De Vicente Oliva, M. A., & Rivero Gutiérrez, L. (2021). Economic Evaluation of the Urban Road Public Transport System Efficiency Based on Data Envelopment Analysis. *Applied Sciences*, *12*(1), 57.

Shah, S. A. R., Shahzad, M., Ahmad, N., Zamad, A., Hussan, S., Aslam, M. A., . . . Waseem, M. (2020). Performance evaluation of bus rapid transit system: A comparative analysis of alternative approaches for energy efficient eco-friendly public transport system. *Energies*, *13*(6), 1377.

Wang, W., Yun, M., & Yang, D. (2015). Research on Method of Urban Traffic Mode Split Forecast in the Case of Introduction of Bus Rapid Transit *CICTP 2015* (pp. 1358-1366).

Yazici, M. A., Levinson, H. S., Ilicali, M., Camkesen, N., & Kamga, C. (2013). A bus rapid transit line case study: Istanbul's metrobüs system. *Journal of Public Transportation*, *16*(1), 8.