INSTITUTIONAL POLICY REFORMS FOR URBAN LAND USE PLANNING: MIXED USE OF LAND IN BIG CITIES OF PAKISTAN AND ITS IMPACT ON REDUCTION IN COMMUTING AND CONGESTION COST ON ROAD

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ABSTRACT

This study seeks to emphasize the institutional policy reforms for the mixed use of urban land planning for commercial and residential purposes because land use planning is directly related to transportation and environmental problem. In this study the mixed use of urban land for commercial and residential purpose in the large cities of Pakistan has been measured by using the indices of measurement for mixed use of land. The data collected by Urban Unit of Pakistan and some previous research done for the big cities of Pakistan for measuring mixed use of land is used for this study. To analyze the impact of mixed use of urban land for commercial and residential purpose on reduction in commuting and congestion cost, the current level of mix-use land by using data for main cities of Pakistan, has been analyzed. Lahore is on top of mix-land use index while Rahim Yar Khan is at the bottom. To test the hypothesis, whether mixed use of urban land leads to significant reduction in commuting and congestion cost, a survey was conducted from the two markets in the same area of Islamabad. One market by construction and design had features of mix-use land while the other had commercial use. The exploratory data analysis and non-parametric analysis of survey indicated that there was significant reduction in commuting and congestion cost due to mixed use of urban land for commercial and residential purpose. So, the conclusions suggest that there is a great need for institutional reforms regarding mixed use planning in the big cities.

Keywords: Mixed use of land, smart cities, institutional reforms, Lahore, congestion

INTRODUCTION

Pakistan is facing serious problem of urban land scarcity due to rapid urbanization as there is large number of rural-urban migrants and inefficient urban land use. At least 40% of the population of Pakistan is living in cities and it is estimated that this ratio will reach up to one half in 2030. Urban population in Pakistan is 63.1 million and it is estimated to go up to 110 million in 2030. Some other studies (Raza, 2013) even state that currently the urban population of Pakistan is more than 60%. Although land area remains the same but the population of cities increases because of urban-rural migration as well as population growth. Therefore, judicious land use and institutional policy reforms for land use planning are important aspects and there is a great need for use of efficient urban land. The consequences of inefficient land use in the big cities are traffic congestion, high commuting cost, pollution and other hazards.

Now a days mixed-use of land (MUL) (a concept in which the same land is used for residential and commercial purpose) is a key component of urban planning both in developed and developing countries, as cities are growing very rapidly. This is considered as the way forward for new urbanism and compact cities, but this concept is not new as one looks at the past when there were no automobiles and people walked to schools and offices. There howerver, a difference between historic application and modern mixed-use of land. Historic all mixed-use development evolved gradually with time without any planning due to absence of automobiles. Modern mixed-use development has developed in a short period of time with proper planning (Ong and Hess, 2001) .

There are also two ways in which designers can use mixed land use. First is to plan mixed use vertically like it was done in Singapore and Hong Kong in Mei Fu Sun Chuen development; and secondly to use the urban land mix horizontally, like in U.S.A, Canada and other European countries (Ganeson, et. al., 2005). It is also an important

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component of the smart growth policies which can lead to more sustainable urban development (Choi, 2008). Furthermore, urban planners suggest mixed-use development to gain access to greater densities and its benefits, and overcome health, environmental and commuting cost issues (Herndon, 1965). This awareness about the efficiency of urban land use is increasing day by day and city planners are also thinking about this concept to optimize the use of urban land and cost solutions.

There are several indices which have been used previously for measuring mixed use of land and market concentration. Initially Atkinson index was used to measure the income inequality and market concentration (Atkinson, 1970). Later on many indices were introduced based on the criteria of percent/proportion, like Balance Index, Herfindhal-Hirschman Index, Entropy Index, Cluster Index, Dissimilarity Index, Exposure Index, and Gini Index. All these measures are different in the sense that some of them measure proportions and some measure percentages of the landuse for the commercial and residential purposes. Some of the measures are integral measures and some are divisional measures. In that sense all these measures differ from each other (Song, et. al., 2013). The Herfindhal-Hirschman Index has been used to measure mixed-use of land in this paper.

The significance of introducing the concept of mixed-use of land is to reduce traffic congestion, distance between work and job place, automobile dependency and carbon emissions caused by heavy traffic (Herndon, 1965). This study debates efficient land use patterns, viable traffic solutions, low population and other related issues. When cities are built without mixed use of land, two parallel cities need to be built at a time, one part of the city only contains commercial area and offices, while the other part of the city contains residential areas. The current rate of urbanization in Pakistan is 3 percent and if people are unable to make cities sustainable in next few decades, citizens will face enormous problems of congestion, pollution and chronic health issues. Henlls professionals need to plan cities for sustainable development.

The policies of relevant institutes are more focused towards engineering solutions and a gap is seen with regards to urban development. This results into induced demand, when supply increases, consumer demands increase too. So, there are more cars and congestion and commuting problems remain the same. This research is an effort to start a debate on policies to overcome problems of congestion and commuting through efficient land use patterns.

The term “mixed-use” was introduced in the field of urban planning in 1960s and later there was no importance given to this term. When cities faced problems of pollution, congestion and commuting, city planners thought about designing, sustainable cities. In this era there has been a rapid increase in urban population due to high economic growth. This creates problems in cities which also contribute to the revival of mixed-use development.

In the historical perspective there was no motorised transport, and walking was the basic means of mobility. It was the need of time that people built such environment in which there was less distance between residence and work place in towns and cities (Morris, 1994). Furthermore, company towns and model towns developed in the US in 1640s and later in the UK there were Garden cities during 1920s which carefully balanced the distance between industry and residences.

There is vast empirical literature which proves that mixed-use of land can play an important role to overcome the problems of congestion and commuting faced by cities today. With the change in landuse mix from diverse to homogeneous, the probability of owning an auto decreases by 31 percent (Ong and Hess, 2001).

Whereas Litman, (2002) finds out that there is huge cost of automobile dependency in USA. Similarly Miller and Tsang, (2010) finds the relationship between job, housing and commuting. This study shows that in mixed use neighbourhood vehicle miles travelled reduces by 28 percent and travel time reduces by 13.3percent according to the national household transportation survey data for Virginia. In another study of landuse impact on transport use it is shown that mixed use of land reduces vehicle travel and increases the use of alternative modes, mainly walking. Mixed use areas normally have 5-15 percent less vehicle travel (Litman, 2014).

Theoretically and empirically it is suggested that mixed-use of land has significant impact on reduction in congestion and commuting cost. The literature suggests that there should be integrated land use transport policies to avoid the problem of congestion in the cities. Literature also suggests that mixed-use of land is the key component of smart growth and a necessity of cities today.

DATA

Two sets of data is used in the study. One is secondary data which is basically percentage of landuse for the commercial

and residential purpose in big cities of Pakistan. Other set of data is primary data for measuring commuting and congestion cost from two markets located in close proximity in Islamabad. One market by construction and design has features of mixed landuse, while the other is only for commercial use

Secondary Data

The source for the secondary data is from Urban Unit of Pakistan in Lahore (Table 1).

Table-1: Land area use
Source: Urban Unit of Pakistan 2013

Cities name	Residential Area(Square Km)	Commercial Area(Square Km)
Karachi	1851.675	64.191
Lahore	1086.236	62.02
Faisalabad	494	52
Peshawar	653.64	50.28
Rawalpindi	2943.2448	143.7792
Gujranwala	764.6418	108.4122
Islamabad	498.3	45.3
Multan	2077.0622	42.4194
Bahawalpur	126.1904	4.744
Quetta	1496.5573	67.3862
Gujarat	1596	95.76
Sargodha	3161.16	134.642
Jhang	3789.6318	131.2541
Shekhupura	2122.952	53.044
Abbottabad	285.8988	22.2497
Kasur	787.814	35.156
Rahim yar khan	1351.35	142.56
Sahiwal	1002.2331	56.3376
Dera ghazi khan	2548.3	154.6968

In Table 1 the land area uses for commercial and residential purposes in major cities of Pakistan are listed along with the percentages given for commercial and residential purposes.

Survey Data

The primary data used in this study, has been collected via qualitative research and through surveys through designed questionnaire from people living in the buildings having mixed use of land for commercial and residential purposes, and from an area which is not mixed use. The study was conducted on a sample of one hundred and fifty people from both areas. The sampling type, which is used in this study, is stratified sampling. Selected people were shortlisted and questions regarding their choice of living were asked.

Description of Variables

Table 2 lists down the different variables which were used in the analysis.

METHODOLOGY

This study uses two methodologies, one is for measuring mixed use of land by using Herfindhal-Hirschman Index (HHI) and the other is a basic tool of exploratory data analysis for the qualitative data collected. Non-parametric approach is also used for further analysis.

Methodology for Measuring Mixed Use of Land

For the measurement of mixed-use of land the HHI is used. The reason for using this index is that it is least affected index by size and geography of the city. The details of HHI are given below.

Herfindhal-Hirschman Index (HHI):

It is considered as the index of market concentration which is widely used in the field of economics, and using same concept of distance measurement, one can also use this index for the measurement of mixed-use of land.

Mathematical Formulation

Let l^j be the percentage of residential land use in town over the total land of town j and let k be the number of land use types Mathematical formulation of the index is given below:

$$\text{HHI} = \sum_{j=1}^{k} (100 * l^j)^2$$

The values range of this index varies from 0 to 10,000 and higher. The value of HHI refers to greater mixed-use of land

Methodology for Measuring Commuting and Congestion Cost

In this study the tools of exploratory data analysis have been used for the descriptive analysis, which are five stats summary for finding the deviation of data from the median and

Table-2: Description of Variables

Variables	Description and Measurements
Travel distance	It is the distance travelled by the people on a daily basis from work place to their residence. The unit of the variable is kilometre.
Travel time	It is the time which people take in travelling from work place to their residence, the unit of the variable is minutes.
Time Delay due Congestion	It is the time delay due to congestion during travel from work place to residence. It is measured by multiplying delay time with the value of time of a person.
Maintenance Cost	The cost people bear of own vehicle in terms of wear and tear. This cost is measured in Pak Rupees. The social cost is not included in it.
Commuting cost	It is cost of travel of the people on a daily basis. It is measured by the cost of travelling from work place to residence. This cost is measured in Pak Rupees.
Congestion cost	The congestion cost is measured by different costs which are time-cost, fuel-cost and maintenance-cost. The unit of variable is measured in Pak Rupees.

dispersion in the data. Non parametric approach and contingency table is used for hypothesis test done on the p-value and chi-square values.

The comparison between variables values has been done in the case of people living in mixed use settlements and people not living in mixed use settlement.

RESULTS

Mixed Use of Land for Commercial and Residential Purpose in Pakistan

In Figure 1 the results show the extent of mixed-use of land in big cities of Pakistan, using the HHI.

From Figure 1 it is observed that the values of HHI varies between 130.830 and 3769.585. Highest value is for Lahore because this city has mixed-use of land and many old developed areas. The lowest value is for Rahim Yar Khan located in northern Punjab which is a major city developed after Independence. It is interesting to note that the HHI shows great diversity of landuse in Pakistan.

Rawalpindi has also some trend of using mixed-use of land and it is not because of recent planning but because of traditional areas which usually have mixed-use development. This mixed-use development in Rawalpindi has evolved traditionally, thus the value of HHI is much higher as compared to other cities of Pakistan.

If one looks at the HHI of Islamabad it is slightly higher as compared to other cities of Pakistan, because this city is well planned but does not have mixed use development. If one looks at other values of the index it is not encouraging because of segregated developments of commercial and residential areas, particularly in the last three to four decades.

Impact of MUL on Reduction in Commuting and Congestion Cost

Travel Time (Mins)

Figure 2 gives a comparison of daily time consumed by people using mixed use of land (MUL) for residential purpose and those who are not using mixed use of land. The black doted bars show the travel time of people who are not using MUL of land and the other bars show the travel time of people who are using MUL. Most of the people using MUL have travelling time of ten or twenty minutes, but the majority of people not using MUL are travelling thirty to sixty minutes.

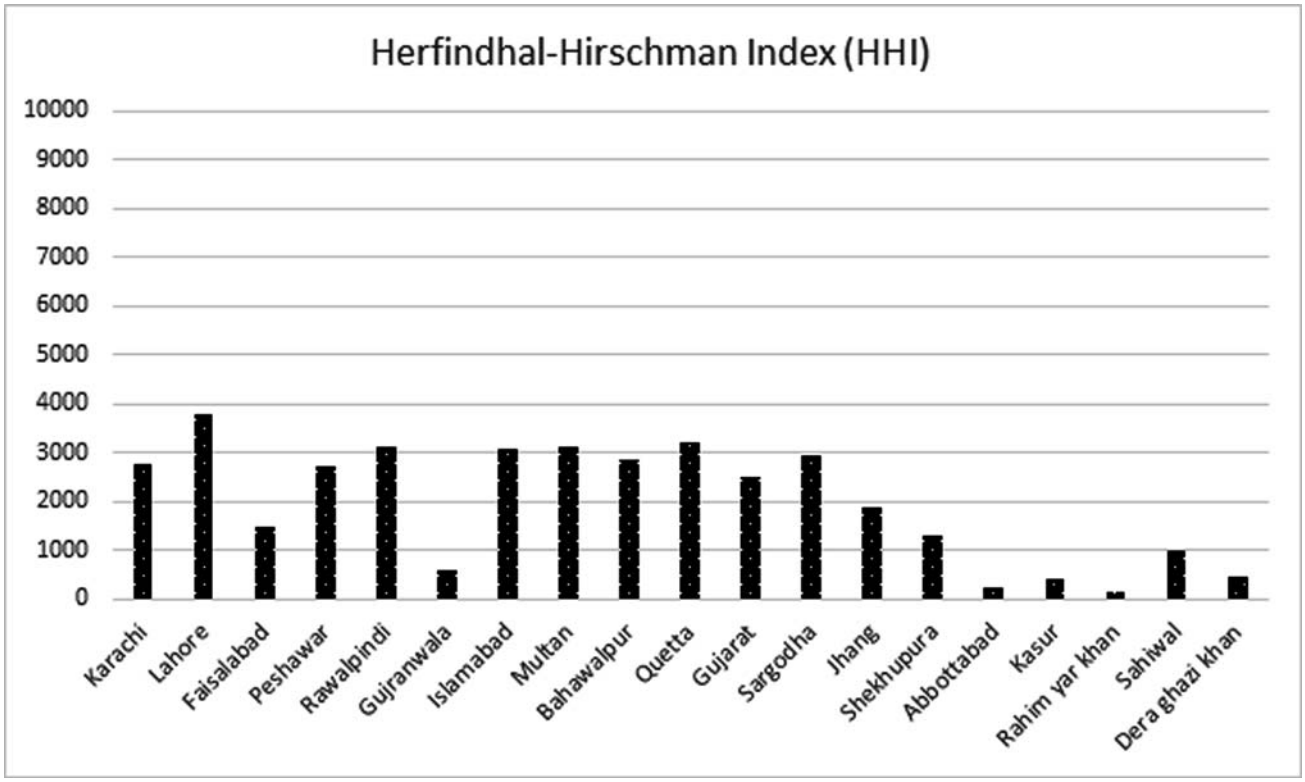

Figure-1: Graphical presentation of mixed-use of land in big cities.

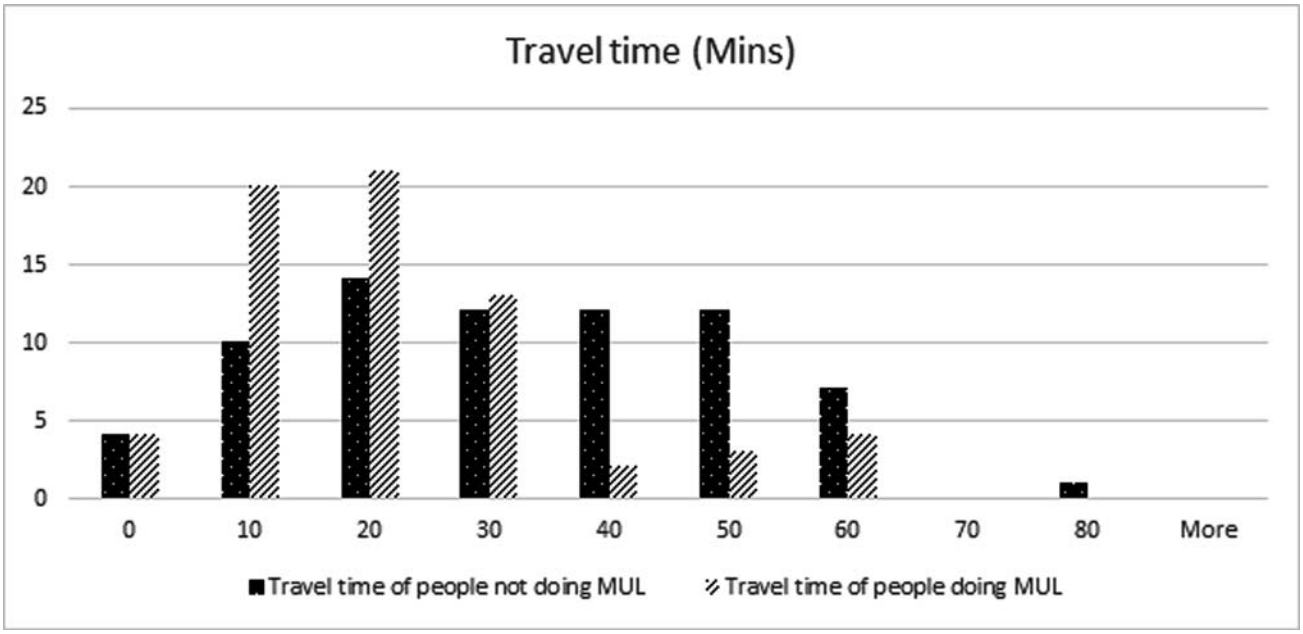

Figure-2: Graphical presentation of travel time with and without MUL.

Table 3 shows the summary statistics of travel time for both groups of people. It can be seen from the table that the average time consumed by people who are using MUL for travelling is twenty minutes and average time consumed by people who are not using MUL for travelling is twenty three minutes.

Travel Distance

Figure 3 shows the comparison of daily distance travelled by people residing in mixed use areas and others. The blue bars show the travel distance of people who are not using MUL and the red bars show the travel distance of people who are using MUL. It is interesting that as the distance traveled by people increases, the number of people using MUL decreases.

Table 4 shows the travel distance for both groups of people. From the table it can be seen that the average distance travelled by people who are using mixed use of land is six kilometer per day. Average time consumed by people who are not using MUL for travelling is eleven kilometers.

Commuting Cost

Commuting cost is the cost borne by a person daily for travelling. This has been measured in Pak Rupees for this research. Figure 4 compares the cost of commuting borne

Table-3: Data summary of travel time

	Min	Mex	Q1	Median	Q3	Mean	SD
With MUL	0	60	10	15	27.5	19.64179	14.92339
Without MUL	0	75	10	20	30	22.33333	16.97302

Table-4: Data summary of travel distance

	Min	Mex	Q1	Median	Q3	Mean	SD
With MUL	0	20	1	1	12	6.80282	6.1937
Without MUL	3	50	14	15	27	20.7419	11.1354

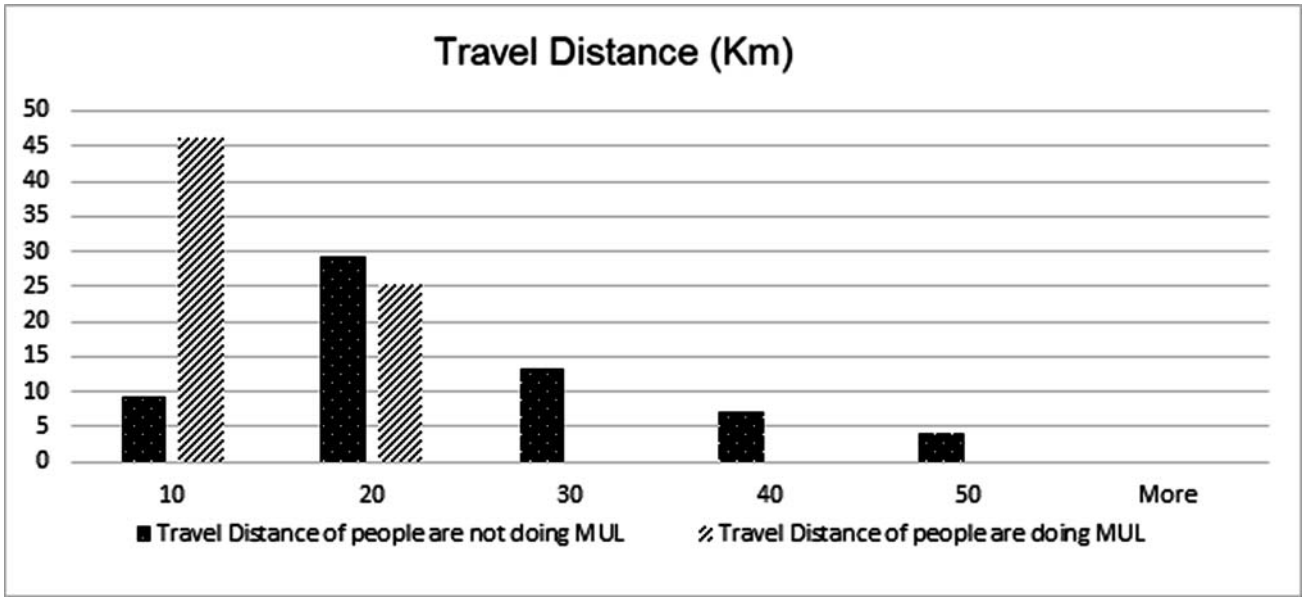

Figure-3: Graphical presentation of travel distance with and without MUL.

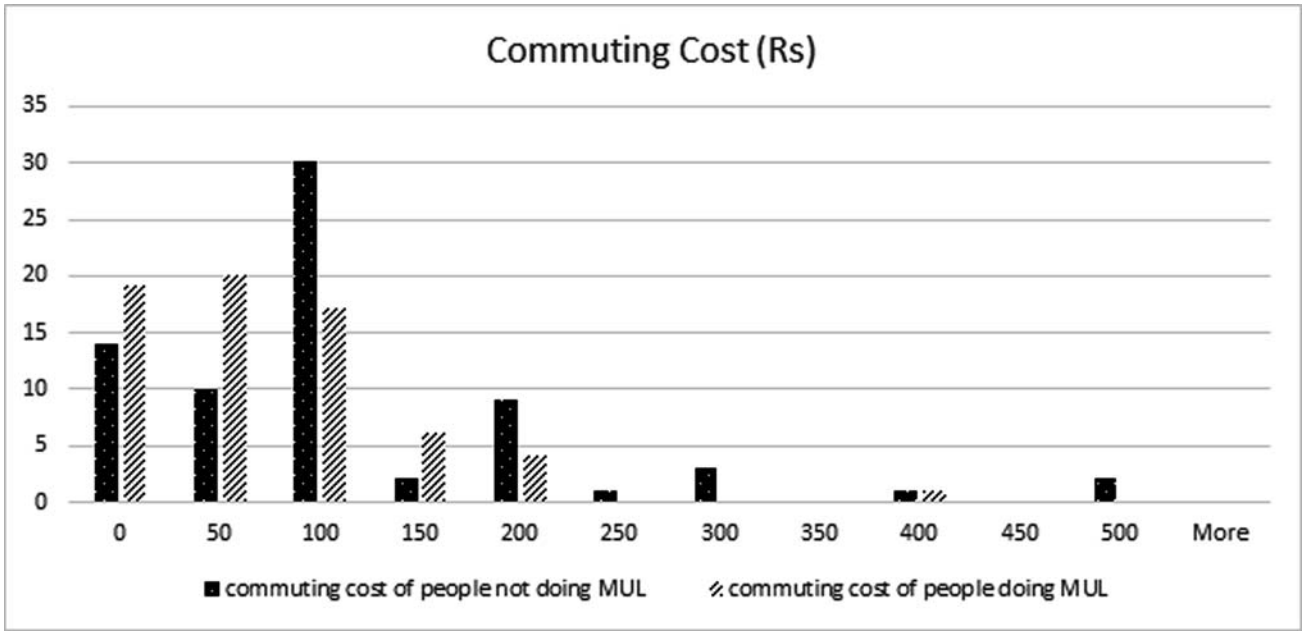

Figure-4: Graphical poresentation of Commuting cost with and without MUL.

by people travelling who are using MUL for commercial and residential purposes and those who are not using MUL. In the figure black bars with dots show the commuting cost of the people who are not using MUL and the bars with diagonal lines show the commuting cost of the people who are using MUL. By comparison of both bars, it can be seen that the majority of people using MUL have low commuting cost, whereas people who are not using MUL have high commuting cost.

Table 5 shows the summary statistics of commuting cost for both groups of people. It can be seen from the table that on an average the commuting cost of people who are using MUL is Pak Rs. 67 per day. While, average commuting cost of people who are not using MUL for travelling is Pak Rs. 110/-. It can also be seen that twenty five percent of people above median are using MUL spent Pak Rs. 100 per day while for other groups commuting cost is Pak Rs. 110/- per day. The difference between lower and upper quartile

Table-5: Data summary of Commuting cost.

	Min	Mex	Q1	Median	Q3	Mean	SD
With MUL	0	400	0	50	100	67.16418	70.29906
Without MUL	0	500	50	100	109.388	110.4085	105.8506

from the median shows that the data is not uniformly distributed from the right and left.

Time Delay due to Congestion

Figure 5 shows the comparison in the time delay due to congestion on a daily basis by people using MUL for commercial and residential purposes and those not using MUL. The black bars with dots show the delay time due to congestion on a daily basis of people who are not using MUL and the other bar shows the time delay due to congestion by people who are using MUL. Generally the time delay due to congestion is less for majority of people who are using MUL as compared to the other group.

According to Table 6 the average time delay of people who are using MUL is twenty percent. While, average time delay for people who are not using MUL is twenty five minutes per day. It can also be seen that twenty five percent of people above median who are using MUL have time delay due to congestion which is thirty minutes per day, while for the other group it is forty minutes per day.

Maintenance Cost

In Figure 6 a comparison of maintenance cost borne by people using MUL for commercial and residential purpose and those not using MUL is shown. The black bars with dots in the figure show the maintenance cost of people who are using MUL and the bars with lines shows the maintenance cost of people who are not using MUL. It can be seen that the majority of people who are not using MUL have high maintenance cost as compared to the other group.

Table 7 shows the summary statistics of maintenance cost for both groups of people. It can be seen from the table that on an average the maintenance cost of people who are using MUL is Pak Rs. 940/- per month. While the average maintenance cost of people who are not using MUL is Pak Rs. 1428/-.

Congestion Cost

The congestion cost from three variables has been calculated as follows:

Figure-5: Graphical poresentation of time delay due to congestion with and without MUL.

Table-6: Data summary of delay due to congestion.

	Min	Mex	Q1	Median	Q3	Mean	SD
With MUL	0	45	15	17.5	30	20.36765	12.5533
Without MUL	0	70	15	27.5	40	25.88571	18.66742

Table-7: Data summary of maintenance cost.

	Min	Mex	Q1	Median	Q3	Mean	SD
With MUL	0	4000	0	500	1000	940.2985	1118.109
Without MUL	0	7500	0	1000	2750	1428.571	1795.402

Time cost = Time delay due to congestion on a daily basis × value of time for individuals.
Fuel cost = Extra fuel consumed due to congestion.

Maintenance cost = Wear and tear cost of people who own vehicles.

Congestion cost = Time cost + Extra fuel cost + Maintenance cost.

Figure 7 shows the comparison of congestion cost borne by people during travel who are using MUL for commercial and residential purpose and those who are not using MUL. Black bars with dots show the congestion cost of people who are not using MUL and the bars with lines show the congestion cost of people who are using MUL. This figure also shows that people who are using MUL and those not using MUL have significant difference in their congestion costs.

Table 8 shows the summary statistics of congestion cost for both groups of people. It can be seen from the table that on an average the congestion cost of people who are using MUL is Pak Rs. 1007/-. Average congestion cost of people not using MUL is Pak Rs. 1659/-. It can be also seen that twenty five percent of people above median who are using MUL incur a cost of Pak Rs. 1618/, while for the other groups congestion cost is Pak Rs. 3000/-

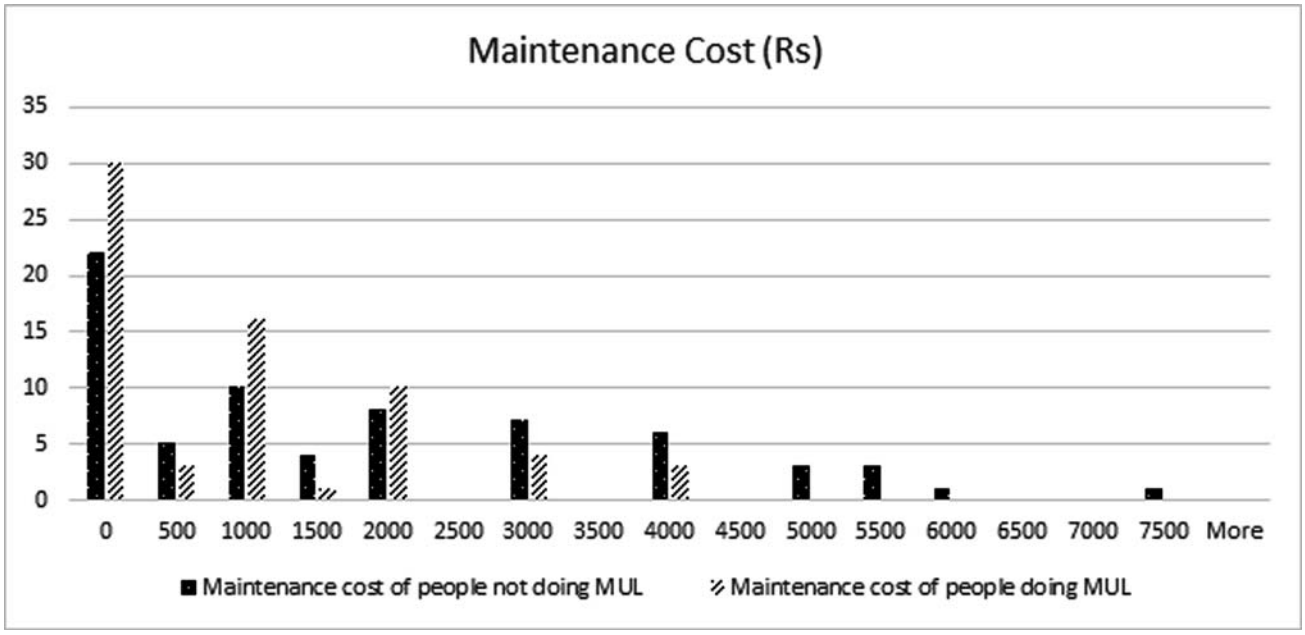

Figure-6: Graphical presentation of maintenance cost with and without MUL.

Table-8: Data summary of congestion cost.

	Min	Mex	Q1	Median	Q3	Mean	SD
With MUL	1.933333	4136.914	97.95875	723.8392	1618.008	1007.878	1049.988
Without MUL	0	7836.464	154.9771	374.175	3053.527	1659.224	1576.023

Table-9: Coefficients of significance in Chi-Square Test and Wilcoxson Sum Test.

Variables	Chi-Square Test		Wilcoxon sum rank Test	
	Calculated Value	Tabulated Value	T-Statistics	P Value
With MUL	17.053429924	3.84	2.785613816	0.00309466
Without MUL	7.86219573	3.84	2.733233117	0.003640665

Non Parametric Tests

Two non-parametric tests were used in the analysis for the significance of the variables. One is Chi-Square Test and other is Wilcoxon Test. These two tests measured the significance of the hypotheses by T-Statistics, P-Value and Chi-Square values. For both tests following hypothesis were used.

Ho = Medians of commuting and congestion cost are identical for both groups

H1 = Median of commuting and congestion cost for both groups differ by non-zero

Table 9 explains the significance of the variables of Chi-square Test and Wilcoxon Sum Rank Test. It can be seen that the Chi-Square Value is greater than the tabulated value. So, the null hypotheses is rejected, which means that the median of commuting and congestion of people who are using MUL for commercial and residential purpose and people who are not using MUL it is not the same. Table 9 also shows that the P-value is highly significant in the Wilcoxon Sum Rank Test thus the null hypotheses is rejected, which means that the median of commuting and congestion of people who are using MUL for commercial and residential purpose and people who are not using MUL is not the same.

It is further concluded that people who are not using MUL for commercial and residential purpose bear more commuting

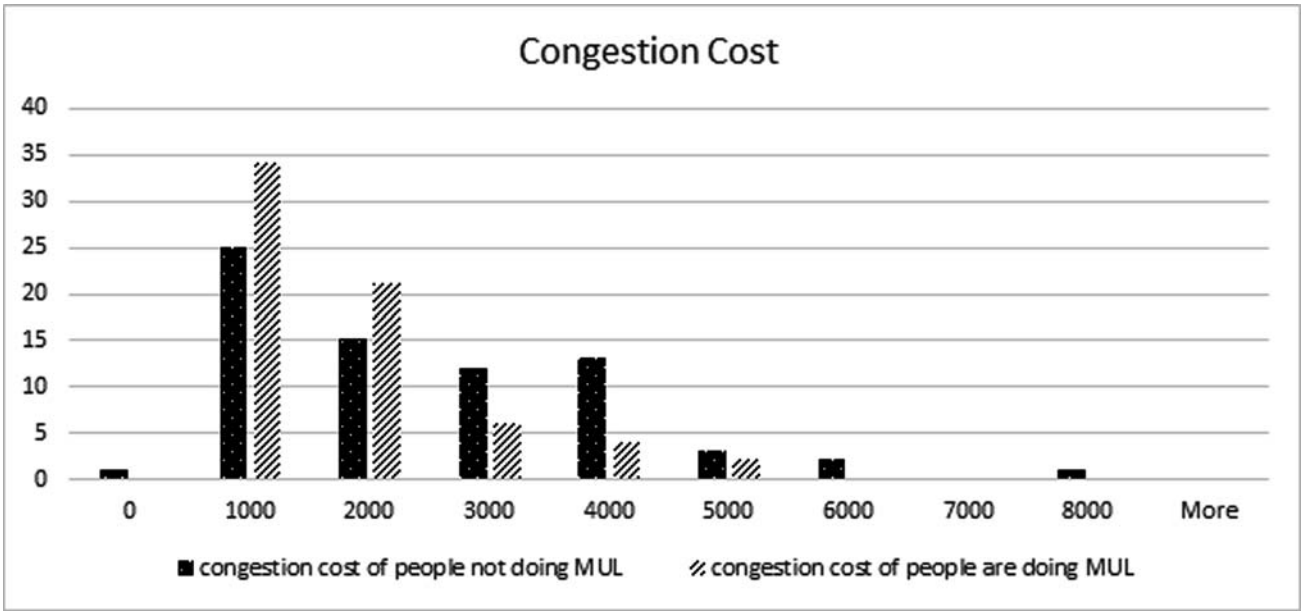

Figure-7: Graphical presentation of congestion cost with and without MUL.

and congestion cost as compared to people who are using MUL for commercial and residential purpose.

CONCLUSION

The relationship between economic growth and land use pattern of cities has attracted significant attention among the economists all around the world in recent years. Economic growth and efficiency can be achieved by the institutional policy reforms for efficient use of urban land. Urban land is the key component for the production and urban land efficiently should be used by adopting mixed landuse pattern, which will reduce commuting and congestion costs.

The data for this research was collected from Urban Unit of Pakistan and some previous researches for big cities of Pakistan. The percentages of land use for commercial and residential purpose in the cities of Pakistan as an input for the indices was acquired from the document of cities crafted by Urban Unit, Government of Punjab. The results indicated that most cities of Pakistan do not use land efficiently despite that there is land scarcity in the cities.

After measuring mixed use of urban land it was found that there is a great link between MUL for commercial and residential purpose and reduction in commuting and congestion cost in walkable communities. To test the hypothesis, that due to MUL there is significant reduction in commuting and congestion cost, a survey was designed from two markets in the same area in Islamabad. The analysis was done by using non parametric approach. The findings confirmed that there was significant reduction in commuting and congestion cost due to MUL for residential and commercial purposes.

On the basis of the findings it is suggested that there is a need to explore the issue of MUL not only for commercial and residential areas in the cities of Pakistan but also for different income groups, to enhance the contribution of cities in the economic growth of country through efficiency. The results also suggest that one needs to adopt MUL to avoid the problem of high commuting and congestion cost in our cities. One has to introduce institutional policy reforms and even incentivize MUL to get benefit of efficient use of resources. The findings need further investigation to have evidence based policies for making our cities as hubs of sharing ideas, innovations, having economies of scale and benefits of specialization. Otherwise, it is feared that our cities can be hubs of crime, pollution, unemployment, congestion and disease. Since, this is a very preliminary maiden study there is great scope for future research in this field in other dimensions of MUL. These dimensions include the impact of MUL for environmental protection and resource use, utility services and infrastructure investment.

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