

UNDERSTANDING THE RELATIONSHIP BETWEEN GROSS POPULATION AND TRAFFIC ACCIDENTS IN JORDAN

توضيح العلاقة بين الكثافة السكانية وحوادث المرور في الأردن

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خلاصة :

إن الإزدياد المستمر في عدد حوادث الطرق في العقد الأخير في الأردن قد تسبب في إزدياد أعداد الوفيات والجرحى. ويعزى الوضع المروري الحرج بالأردن إلى عدة أسباب منها: غياب سياسة واضحة لاستخدام الأراضي تربط بين هذا الاستخدام ونظام النقل، بالإضافة إلى غياب نظام نقل عام آمن يمكن الاعتماد عليه، وتركيز العمل ودوائر الدولة في العاصمة ومراكز المحافظات. تبحث هذه الورقة في العلاقة بين الكثافة السكانية وعدد حوادث الطرق لمختلف محافظات الأردن. ولقد توصل الباحثان إلى أن الحوادث المرورية العالية ذات الحدة القليلة قد وقعت في المحافظات ذات الكثافة السكانية العالية، بينما كانت الحوادث المرورية الأقل عدداً وذات الحدة الأعلى في المحافظات ذات الكثافة السكانية المنخفضة. ولقد توصلوا أيضاً إلى أن حافلات نقل الركاب قد اشتركت في حوادث مرور بنسبة أعلى من نسبتها من مجموع السيارات المسجلة. ومن التوصيات في هذه الورقة إيجاد سياسة واضحة لاستخدام الأراضي للمساعدة في تشكيل نظام نقل في الأردن الأمر الذي يساعد في تحديد الأهداف والغايات التي تساهم في تقليل حوادث النقل وحادثها في الأردن.

BSTRACT

Jordan has experienced in the last decade a continuous increase in the number of accidents, which has resulted in a high number of fatalities and injuries. There are many reasons behind this critical traffic situation in Jordan. Some of these reasons are the lack of well-defined land use policies that relate the development pattern and density to transportation, the unsafe and unreliable transportation system, and the concentration of jobs and governmental services in the center of the capital and governorates.

This paper studies the relationship between the gross population density and the total number of accidents for the different governorates in Jordan. It was concluded that the people of the governorates with high gross population density are involved in more accidents with low severity indices than those of the governorates with less gross population density. On the other hand, the people of the governorates with less gross population densities are involved with fewer accidents but with high severity indices. It was also found that buses are involved in more accidents than their share of total traffic. This paper recommended, among other things, a development of land use policy to shape the future transportation system in Jordan and consequently set the goals and objectives to reduce the number of accidents and their severity.

Key Words: Population Density, Traffic Accidents, Severity Index

INTRODUCTION

Transportation has always been closely related to the shape of settlement and the use of land. Jordan as one of the developing countries lacks defined land use policies that control the development patterns and directly impact the transportation system.

The absence of well-defined land use policies has resulted in scattered development without any control or interference from the local and central government. It should be pointed out that the way we set our activities has a great effect on the transportation system. Concentrated and high-density land use is better than dispersed and low-density activities.

As a result of unplanned and random land development, the private cars become the predominant mode in transportation in Jordan. The number of registered vehicles in Jordan has jumped from 232,367 in the year 1986 to 297,634 vehicles in the year 1996 with an increase of 28 % [1]. The price that society pays as a result of lack of land use policies and in an auto-dominated environment is in the form of injury and loss of life. The total number of accidents in Jordan rose from 13,436 accidents in the year 1986 to 33,784 accidents in the year 1996 with an increase of 151 % in eleven years [1].

The purpose of this study is to examine the implications of density of population on accidents. Recommendations center around formulating a relationship between the population density and transportation accidents in Jordan.

THE POPULATION

The 1996 statistics yearbook [1] showed that the population of the different governorates were re-estimated for the years between 1979 and 1996 based on the 1979 and 1994 census. The number of returnee as a result of the Gulf crises were taken into account in estimating the annual growth rates between the years 1990 and 1992. Table 1 shows the percentages of annual growth based on the previous reference that was used in this study to re-estimate the population.

Table 1: The Annual Population Growth Rates

| Year | annual growth (%) |
|-----------|-------------------|
| 1980-1990 | 3.8 |
| 1990-1991 | 9.8 |
| 1991-1992 | 6.5 |
| 1992-1996 | 3.7 |

It is important to point out that the Hashemite Kingdom of Jordan consists today of twelve governorates as follows: Amman, Ma'raq, Zarqa, Balqa, Irbid, Ajlune, Jarash, Madaba, Karak, Tafila, Ma'an, and Aqaba. Five of them were declared in the year 1994 as separate governorates. They were

originally parts of existing governorates. These governorates are Ajlune and Jarash that were separated from the Governorate of Irbid, Tafila was separated from the Governorate of Karak, Aqaba was separated from the Governorate of Ma'an, and Madaba was separated from the Governorate of Amman.

Table 2: The Population of the Different Governorates of Jordan

| Year | Population In the Different Governorates of Jordan | | | | | | | Total |
|-------------------------|--|--------|--------|--------|---------|--------|--------|---------|
| | Amman | Mafraq | Zarqa | Balqa | Irbid | Karak | Ma'an | |
| 1986 | 1150987 | 121876 | 436641 | 189850 | 663151 | 158671 | 113355 | 2834531 |
| 1987 | 1194725 | 126507 | 453233 | 197064 | 688351 | 164700 | 117662 | 2942242 |
| 1988 | 1240124 | 131314 | 470456 | 204552 | 714508 | 170959 | 122133 | 3054046 |
| 1989 | 1287249 | 136304 | 488333 | 212325 | 741659 | 177455 | 126774 | 3170099 |
| 1990 | 1336164 | 141484 | 506890 | 220393 | 769842 | 184198 | 131591 | 3290562 |
| 1991 | 1467108 | 155349 | 556565 | 241992 | 845287 | 202249 | 144487 | 3613037 |
| 1992 | 1562470 | 166541 | 592742 | 257721 | 900231 | 215359 | 153879 | 3848943 |
| 1993 | 1620281 | 171569 | 614673 | 267251 | 933540 | 223365 | 159573 | 3990252 |
| 1994 | 1680231 | 177917 | 637416 | 277146 | 968081 | 231630 | 165477 | 4137898 |
| 1995 | 1742400 | 184500 | 661000 | 287400 | 1003900 | 240200 | 171600 | 4291000 |
| 1996 | 1806869 | 191327 | 685457 | 298034 | 1041044 | 249087 | 177949 | 4449767 |
| Area in Km ² | 10239 | 26435 | 4080 | 1076 | 2435 | 5331 | 39746 | 89342 |

Therefore and due to the lack of available data for these new governorates before the year of their declaration, and due to the difficulty in estimating their share in the considered accident and other data between the years 1986 and 1996, it was found convenient in this study to keep this data as a part of the data of the governorates from where they were originated.

Table 2 shows the population of the seven governorates (that were existing before 1994) between the years 1986 and 1996. The total population of Jordan in the year 1986 was calculated to be 2,771,894 and increased to 4,4491,767 in the year 1996 with a rate of growth of 60.5 % in a period of eleven years.

POPULATION DENSITY

Population density is the most common measure of population concentration. Gross population density refers to the total population of an administrative or political jurisdiction divided by the total land area within its boundaries. The population density of developed land excludes from the denominator the land that is not in urban use.

This gross population density will be used in this paper rather than the population density of developed land because of lack of information on urban and rural land areas in Jordan. In spite of the fact that travel occurs mostly between buildings, and takes place in streets and other right of way, in Jordan as most of the developing countries, a large number of trips take place between small towns, villages, and the center of governorates every day. This is because of the concentration of jobs and governmental services in the major cities, mainly the centers of the governorates. Jordan like the rest of the world has experienced growth of its suburban areas.

The new urban form is arising due to the astounding land price, lack of parking spaces, and the higher taxes. Suburban population growth has paved the way for growth of business in the suburban areas. Jordan in the last eleven years has experienced an establishment of business and factories just outside the borders of the major cities. For example, a traveler from Amman to the south will notice new factories along the highway that did not exist few years ago. The major industrial cities are not limited to Amman City any more. While there was only Sahab Industrial City near Amman few years ago, other big industrial-city was built in the north near Irbid, Al Hassan Industrial City, and a new industrial-city near Karak in the south is already under construction.

This analysis highlights the importance of the travel between the rural and suburban areas and the center of the governorates, and also between the major cities and Amman, the capital of Jordan. It also presents importance of the gross population density on the travel in Jordan. Table 3 shows the gross population densities for the different Governorates in Jordan for the years 1986 to 1996 in persons/ km².

Table 3: The Gross Population Density in the Different Governorates of Jordan.

| Year | Population Density (Person/km ²) | | | | | | |
|------|--|--------|-------|-------|-------|-------|-------|
| | Amman | Ma'raq | Zarqa | Balka | Irbid | Karak | Ma'an |
| 1986 | 112 | 4.6 | 107 | 176 | 272 | 30 | 3.0 |
| 1987 | 117 | 4.8 | 111 | 183 | 283 | 31 | 3.0 |
| 1988 | 121 | 5.0 | 115 | 190 | 293 | 32 | 3.0 |
| 1989 | 126 | 5.2 | 120 | 197 | 305 | 33 | 3.0 |
| 1990 | 130 | 5.4 | 124 | 205 | 316 | 35 | 3.0 |
| 1991 | 143 | 5.9 | 136 | 225 | 347 | 38 | 4.0 |
| 1992 | 153 | 6.3 | 145 | 240 | 370 | 40 | 4.0 |
| 1993 | 158 | 6.5 | 151 | 248 | 383 | 42 | 4.0 |
| 1994 | 164 | 6.7 | 156 | 258 | 398 | 43 | 4.0 |
| 1995 | 170 | 7.0 | 162 | 267 | 412 | 45 | 4.0 |
| 1996 | 176 | 7.0 | 168 | 277 | 428 | 47 | 4.0 |

The population density for Jordan has risen from 30 person / km² in 1986 to 49.8 person / km² in 1996 [1]. Ma'an has the lowest density of 4.0 person / km² in 1996, while Irbid has the highest density of 412 person / km² for the same year. It is important to show by examining table 2 that about 80% of the population of Jordan lives in three governorates, Amman, Zarqa, and Irbid, which have only 19% of the total area of Jordan.

It is important to point out that 65.5 % of the population of Jordan lives in the center of the governorates that contribute only to 0.82 % of total area of Jordan [1]. As a result of this high concentration, the centers of the governorates experience a much higher density than the rest of the governorates. For example, the city of Irbid has a density of 10,987 person / km², while the Governorate of Irbid has only 428 person / km² [1].

There are two main reasons for the unbalanced distribution of population between the different governorates and the cities of the same

governorates. The first reason as mentioned earlier is the concentration of jobs, governmental offices, and business in the center of the governorate, and the second reason is the complete absence of land use policy in Jordan.

One of the major relationships of the study of transportation is the connection between land use and transportation. The trip-making patterns, modal usage, and volume are largely related to the spatial distribution of land use. On the other hand, the pattern of land use is affected by the degree of accessibility provided by the transportation system. So this interaction is very important for the overall understanding of transportation system. Figure 1 shows this interaction more explicitly [2]. The relationship between land use and transportation is a circular one and can take years to complete a single cycle (figure 2) [3].

The modal usage is directly related to the development patterns and density. The dispersed development patterns and low density encourage the use of private cars, while concentrated patterns and low density are suitable for shuttle busses. However, the dispersed development patterns and high density support the usage of mini busses. On the other hand concentrated development patterns and high density are suitable for rapid transit and taxis. A study prepared by the Real Estate Research Corporation compared the costs of low-density urban sprawl with those of high-density planned development [4]. The study has shown that the high-density planned development would reduce among others, the automobile air pollution by 50 %, the land costs for streets by 40 %, and energy consumption by 44 %. This emphasizes the fact that the type of development has a great effect on the usage of mode of transportation and consequently on the occurrence and severity of accidents.

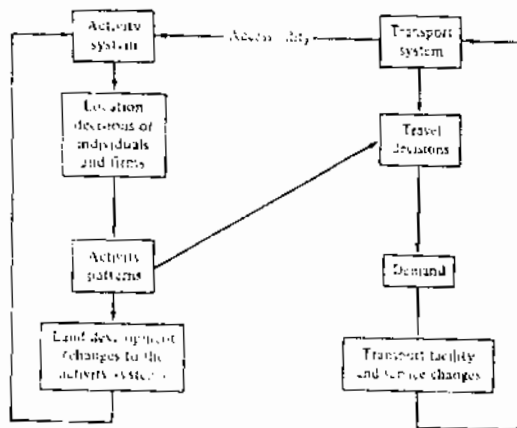


Figure 1 Land Use-Transportation Interaction

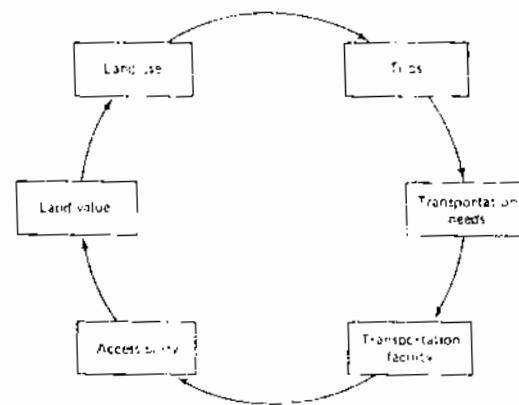


Figure 2 Land Use-Transportation Cycle

ACCIDENT ANALYSIS

Jordan has experienced in the last decade an increased number of accidents especially in the high-density areas. The available road network in the major cities could not accommodate the increased numbers of vehicles that resulted in reducing the capacity of the streets and consequently increasing the number of accidents.

Although, traffic accidents are a worldwide problem, Jordan leads most of the developing countries in the number of accidents and fatality rates in comparison to its share of population and vehicles. The World Health Organization (WHO) statistics show that the fatality rate in Jordan reached about 16.2 per 10,000 vehicles in 1996, while it was only (1.4 - 4.0) person per 10,000 vehicles in developed countries for the same year [5].

Table 4 shows the total number of accidents, injuries and fatalities in the different governorates in Jordan. The total number of accidents has jumped from 13,436 in 1986 to 33,156 accidents in 1996 with an increase of 148 % in just eleven years, while the total number of fatalities has risen from 280 in 1986 to 494 persons in 1996 with an increase of 76 %.

Table 4 and figure 3 show that the total accidents in high - density areas are more than those of low-density areas. Table 5 and figure 4 show that the severity index (total fatality / total accidents) is higher in low-density than those of high-density areas. Comparing tables 3, 4, and 5 shows the fact that the Governorates of Amman, Zarqa, Balqa, and Irbid that have high gross population density, also have a high number of accidents and low severity indices. On the other hand, the rest of the governorates that have a low gross population density have a low number of accidents and high severity indices.

Table 6 shows the total vehicles in the different governorates for the years 1986-1996. It shows that the governorates that have a high gross population density i.e. Amman, Irbid, Balqa, and Zarqa, have a higher number of total vehicles. The increased number of private cars and the small percentage of bus sharing in daily trips have resulted in a high number of accidents in high- density areas (tables 3 and 4). However, the severity indices were low in these areas because of a lower speed of vehicles in already congested streets (tables 3 and 5). By examining the types of accidents for the years 1993 - 1996, it was found that around 44 % of accidents lie under three categories; close-up driving, disallowing priorities to vehicles, and disallowing priorities to pedestrians [1]. These types of accidents usually occur in high-density areas.

Table 7 exhibits the accidents and fatality rates per 10,000 registered vehicles for different Jordanian governorates. It also presents the risk indices (RI = % accidents in group involvement divided by % population in group) for the same governorates. The table shows that the Governorate of Amman, Irbid, and the Balqa, which have gross population density, experienced lower accident rates than those governorates with less gross population density such as Ma'an and Karak.

In general, it is fair to say that the Jordanian governorates that have a low gross population density have higher accident rates than those of high

gross population density except for the Governorate of Zarqa. Table 7 also highlights that the fatality rates for the high gross population-density governorates are as much lower as those governorates of low gross population-density. The risk index calculation shows that the people of Amman Governorates are involved in more accidents than their percentage of population since the Risk Indices are all greater than one.

The lack of reliable, safe, and comfortable public transportation system opened the door widely for the large usage of private cars. Most of the bus services in Jordan run on fixed routes but not on fixed time schedules. A study on evaluating the public transportation performance in greater Amman has shown that the sharing of buses in daily trips was only 14% of total trips, while the sharing of private cars is 51%. The study has found that the waiting time for bus arrival during peak hours reached up to 60 minutes. This time excludes the time the passengers spend in the bus till it fully occupied. The waiting time during off-peak reached up to two hours for some routes. This has resulted in unreliable bus service for the commuters [6]. Most of public transportation fleets in Jordan are owned and run by private sectors, whose major goal is maximizing profits at the expense of good services, bus-owners usually lease buses to drivers so as to guarantee the profit by the end of the day. This caused frequent violation of traffic laws by drivers so as to assure the required profit, which resulted in higher bus involvement in accidents than their share in traffic. The available data show that the percentage of buses was 0.35, their contribution to the total accidents was 13% while their involvements in the accidents has reached 8% [1]. This highlights that buses are involved and contributed to accidents in higher ratio than their percentage of total traffic. It is important to remember that since buses are considered as high occupancy vehicle (HOV), the number of people killed and injured is much higher in a bus accident than private car.

Table 4: Total Accidents in the Different Governorates in Jordan

| Accident Data | Governorate | | | | | | | Total |
|-------------------|-------------|--------|-------|-------|-------|-------|-------|-------|
| | Amman | Mafraq | Zarqa | Balqa | Irbid | Karak | Ma'an | |
| 1986 | | | | | | | | |
| Total Accidents | 7181 | 284 | 1812 | 802 | 2061 | 579 | 717 | 14436 |
| No. Of Injuries | 3284 | 298 | 1155 | 533 | 1584 | 543 | 419 | 7816 |
| No. Of Fatalities | 71 | 15 | 29 | 24 | 63 | 42 | 36 | 280 |
| 1987 | | | | | | | | |
| Total Accidents | 8927 | 247 | 1749 | 858 | 2064 | 546 | 824 | 15215 |
| No. Of Injuries | 3842 | 192 | 1136 | 637 | 1568 | 571 | 430 | 8376 |
| No. Of Fatalities | 106 | 13 | 34 | 25 | 74 | 45 | 44 | 341 |
| 1988 | | | | | | | | |
| Total Accidents | 10148 | 281 | 1825 | 931 | 2335 | 616 | 1012 | 17148 |
| No. Of Injuries | 4492 | 288 | 1117 | 695 | 1664 | 557 | 533 | 9346 |
| No. Of Fatalities | 87 | 10 | 39 | 24 | 74 | 46 | 40 | 320 |
| 1989 | | | | | | | | |
| Total Accidents | 10623 | 241 | 2051 | 918 | 2384 | 551 | 883 | 17651 |
| No. Of Injuries | 4399 | 246 | 1307 | 537 | 1517 | 458 | 468 | 8932 |
| No. Of Fatalities | 105 | 13 | 48 | 21 | 70 | 33 | 21 | 311 |
| 1990 | | | | | | | | |
| Total Accidents | 9985 | 378 | 2037 | 932 | 2427 | 588 | 805 | 17152 |
| No. Of Injuries | 4673 | 386 | 1309 | 624 | 1758 | 533 | 544 | 9827 |
| No. Of Fatalities | 86 | 10 | 36 | 20 | 74 | 32 | 31 | 289 |
| 1991 | | | | | | | | |
| Total Accidents | 10506 | 441 | 2425 | 829 | 2644 | 637 | 694 | 18176 |
| No. Of Injuries | 4343 | 386 | 1582 | 531 | 1778 | 593 | 418 | 9631 |
| No. Of Fatalities | 103 | 22 | 51 | 26 | 71 | 27 | 25 | 325 |
| 1992 | | | | | | | | |
| Total Accidents | 11746 | 496 | 266 | 1024 | 2880 | 642 | 812 | 20264 |
| No. Of Injuries | 4410 | 433 | 1455 | 678 | 1931 | 570 | 570 | 10047 |
| No. Of Fatalities | 102 | 26 | 49 | 20 | 66 | 26 | 41 | 330 |
| 1993 | | | | | | | | |
| Total Accidents | 14615 | 542 | 2928 | 1191 | 3193 | 762 | 918 | 24149 |
| No. Of Injuries | 5041 | 552 | 1609 | 725 | 2115 | 615 | 547 | 11204 |
| No. Of Fatalities | 111 | 28 | 58 | 30 | 81 | 39 | 36 | 383 |
| 1994 | | | | | | | | |
| Total Accidents | 16155 | 457 | 3243 | 1301 | 3330 | 847 | 920 | 26253 |
| No. Of Injuries | 5253 | 419 | 1764 | 689 | 2405 | 795 | 614 | 11939 |
| No. Of Fatalities | 107 | 14 | 51 | 28 | 94 | 39 | 41 | 374 |
| 1995 | | | | | | | | |
| Total Accidents | 17789 | 516 | 3336 | 1563 | 2625 | 903 | 991 | 27723 |
| No. Of Injuries | 5526 | 431 | 1876 | 873 | 1922 | 869 | 566 | 12063 |
| No. Of Fatalities | 103 | 22 | 68 | 45 | 67 | 41 | 32 | 378 |
| 1996 | | | | | | | | |
| Total Accidents | 20527 | 640 | 3737 | 2007 | 4111 | 920 | 1214 | 33156 |
| No. Of Injuries | 6331 | 469 | 2216 | 1143 | 2972 | 822 | 711 | 14664 |
| No. Of Fatalities | 144 | 16 | 89 | 33 | 101 | 54 | 57 | 494 |

Table 5: The Severity Indices of the Different Governorates of Jordan

| Year | Severity Index In the Different Governorates of Jordan | | | | | | |
|------|--|--------|-------|-------|-------|-------|-------|
| | Amman | Mafraq | Zarqa | Balqa | Irbid | Karak | Ma'an |
| 1986 | 0.01 | 0.05 | 0.02 | 0.03 | 0.03 | 0.07 | 0.05 |
| 1987 | 0.01 | 0.05 | 0.02 | 0.03 | 0.04 | 0.08 | 0.05 |
| 1988 | 0.01 | 0.04 | 0.02 | 0.03 | 0.03 | 0.07 | 0.04 |
| 1989 | 0.01 | 0.05 | 0.02 | 0.02 | 0.03 | 0.06 | 0.02 |
| 1990 | 0.01 | 0.03 | 0.02 | 0.02 | 0.03 | 0.06 | 0.04 |
| 1991 | 0.01 | 0.05 | 0.02 | 0.03 | 0.03 | 0.04 | 0.04 |
| 1992 | 0.01 | 0.05 | 0.02 | 0.02 | 0.02 | 0.04 | 0.05 |
| 1993 | 0.01 | 0.05 | 0.02 | 0.03 | 0.03 | 0.05 | 0.04 |
| 1994 | 0.01 | 0.03 | 0.02 | 0.02 | 0.03 | 0.05 | 0.04 |
| 1995 | 0.01 | 0.04 | 0.02 | 0.03 | 0.03 | 0.05 | 0.03 |
| 1996 | 0.01 | 0.03 | 0.02 | 0.02 | 0.02 | 0.06 | 0.05 |

Abu Soud [7] showed that 67.6 % of accidents occurred within the borders of major cities in 1978, this percentage reached 81.9 in 1984. However, the total accidents that occurred in urban areas have also reached 89 % of total accidents in 1993 [8].

One of the reasons behind the severe and low number of accidents in low- density areas is the small number of private cars and high usage of public transportation in these areas. Usually, higher speeds can only be attained in low density rather than high-density areas. Mr. Shagrawi [9] pointed out in his study that a percentage of fatalities due to speeds in 1996 was 20.6 % of total fatalities in Jordan. The passing of the major highways through small towns expanded along the highways is another reason for the high severe accidents in low- density areas. The interactions at these towns between pedestrians and vehicles at one side, and moving vehicles and slowing down vehicles trying to stop on the other side have resulted in high severe accidents [7]. Examples of these towns are many as Mafraq, Abu Alanda, Baqa, and Qutranah. The weak enforcement of traffic laws by police outside the capital city has resulted also in more severe accidents in the less dense areas. While the speed violation tickets issued by the police directorates were 90575 tickets in Amman in the year 1996, however, they reached in Ma'an only 164 tickets, 37 in Mafraq, and 133 in Zarqa [9].

Table 6: Total Number of Registered Vehicles of the Different Governorates.

| Year | Governorates | | | | | | |
|------|--------------|--------|-------|-------|-------|-------|-------|
| | Amman | Mafraq | Zarqa | Balqa | Irbid | Karak | Ma'an |
| 1986 | 191649 | 1441 | 6540 | 2716 | 26534 | 733 | 1749 |
| 1987 | 199590 | 1677 | 6772 | 2926 | 27481 | 1974 | 1796 |
| 1988 | 205403 | 1922 | 7023 | 2980 | 28249 | 2181 | 1832 |
| 1989 | 207034 | 1942 | 7033 | 3006 | 28367 | 2218 | 1847 |
| 1990 | 209973 | 2013 | 7060 | 3030 | 28549 | 2298 | 1854 |
| 1991 | 163929 | 5036 | 10522 | 13277 | 40054 | 7356 | 7344 |
| 1992 | 177527 | 6267 | 12406 | 11873 | 38775 | 7728 | 7926 |
| 1993 | 175153 | 4856 | 9566 | 12820 | 41672 | 6145 | 5272 |
| 1994 | 179524 | 5336 | 11422 | 11174 | 33396 | 6218 | 6348 |
| 1995 | 182425 | 6168 | 10751 | 11894 | 41072 | 6768 | 6155 |
| 1996 | 201379 | 6875 | 11170 | 14663 | 42701 | 7314 | 6213 |

Table 7: Accident Rates, Fatality Rates and. Risk Indices *

| Accident Data | Governorate | | | | | | |
|---------------|-------------|--------|-------|-------|-------|--------|--------|
| | Amman | Ma'raq | Zarqa | Balqa | Irbid | Karak | Ma'an |
| 1986 | | | | | | | |
| Accident Rate | 375 | 1971 | 2771 | 2953 | 777 | 7899 | 4099 |
| Fatality Rate | 3.71 | 104.10 | 44.34 | 88.37 | 23.74 | 573 | 205.83 |
| Risk Index | 1.32 | 0.49 | 0.88 | 0.89 | 0.66 | 0.77 | 1.33 |
| 1987 | | | | | | | |
| Accident Rate | 447 | 1473 | 2583 | 2932 | 751 | 2766 | 4588 |
| Fatality Rate | 5.31 | 77.52 | 50.21 | 85.44 | 26.93 | 228 | 245 |
| Risk Index | 1.44 | 0.38 | 0.75 | 0.84 | 0.58 | 0.64 | 1.35 |
| 1988 | | | | | | | |
| Accident Rate | 494 | 1462 | 2599 | 3124 | 827 | 2824 | 5524 |
| Fatality Rate | 4.24 | 52.00 | 55.53 | 80.54 | 26.20 | 211 | 218.34 |
| Risk Index | 1.46 | 0.38 | 0.69 | 0.81 | 0.58 | 0.64 | 1.48 |
| 1989 | | | | | | | |
| Accident Rate | 513 | 1241 | 2916 | 3054 | 840 | 2484 | 4781 |
| Fatality Rate | 5.10 | 66.94 | 68.25 | 69.86 | 24.68 | 148.80 | 113.70 |
| Risk Index | 1.48 | 0.32 | 0.75 | 0.78 | 0.58 | 0.56 | 1.25 |
| 1990 | | | | | | | |
| Accident Rate | 476 | 1878 | 2885 | 3076 | 850 | 2559 | 4342 |
| Fatality Rate | 4.10 | 49.68 | 51.00 | 66.00 | 26.00 | 139.25 | 167.21 |
| Risk Index | 1.43 | 0.51 | 0.77 | 0.81 | 0.60 | 0.61 | 1.17 |
| 1991 | | | | | | | |
| Accident Rate | 640 | 876 | 2298 | 624 | 660 | 866 | 945 |
| Fatality Rate | 6.28 | 43.69 | 48.47 | 19.58 | 17.73 | 36.70 | 34.00 |
| Risk Index | 1.42 | 0.56 | 0.87 | 0.68 | 0.62 | 0.63 | 0.95 |
| 1992 | | | | | | | |
| Accident Rate | 662 | 791 | 2147 | 862 | 743 | 831 | 1024 |
| Fatality Rate | 5.75 | 41.49 | 39.50 | 16.85 | 17.10 | 33.64 | 51.73 |
| Risk Index | 1.43 | 0.57 | 0.85 | 0.75 | 0.61 | 0.57 | 1.00 |
| 1993 | | | | | | | |
| Accident Rate | 834 | 1116 | 30.61 | 929 | 766 | 1240 | 1741 |
| Fatality Rate | 6.33 | 57.66 | 60.63 | 23.40 | 19.44 | 63.47 | 68.29 |
| Risk Index | 1.49 | 0.52 | 0.79 | 0.74 | 0.57 | 0.56 | 0.95 |
| 1994 | | | | | | | |
| Accident Rate | 900 | 856 | 2839 | 1164 | 997 | 1362 | 1449 |
| Fatality Rate | 5.96 | 26.24 | 44.65 | 25.10 | 28.15 | 62.72 | 65.0 |
| Risk Index | 1.52 | 0.40 | 0.80 | 0.74 | 0.54 | 0.58 | 0.88 |
| 1995 | | | | | | | |
| Accident Rate | 975 | 837 | 3103 | 1314 | 639 | 1334 | 1610 |
| Fatality Rate | 5.65 | 35.67 | 63.25 | 37.83 | 16.31 | 60.85 | 51.50 |
| Risk Index | 1.58 | 0.43 | 0.78 | 0.84 | 0.40 | 0.58 | 0.89 |
| 1996 | | | | | | | |
| Accident Rate | 1019 | 931 | 3346 | 1369 | 963 | 1258 | 2051 |
| Fatality Rate | 7.15 | 23.27 | 79.68 | 22.51 | 23.65 | 73.83 | 91.74 |
| Risk Index | 1.52 | 0.45 | 0.73 | 0.90 | 0.53 | 0.50 | 0.92 |

*Accident rates and Fatality Rates per 10,000 Vehicles

Figure 3: Total Accidents in the Different Governorates of Jordan

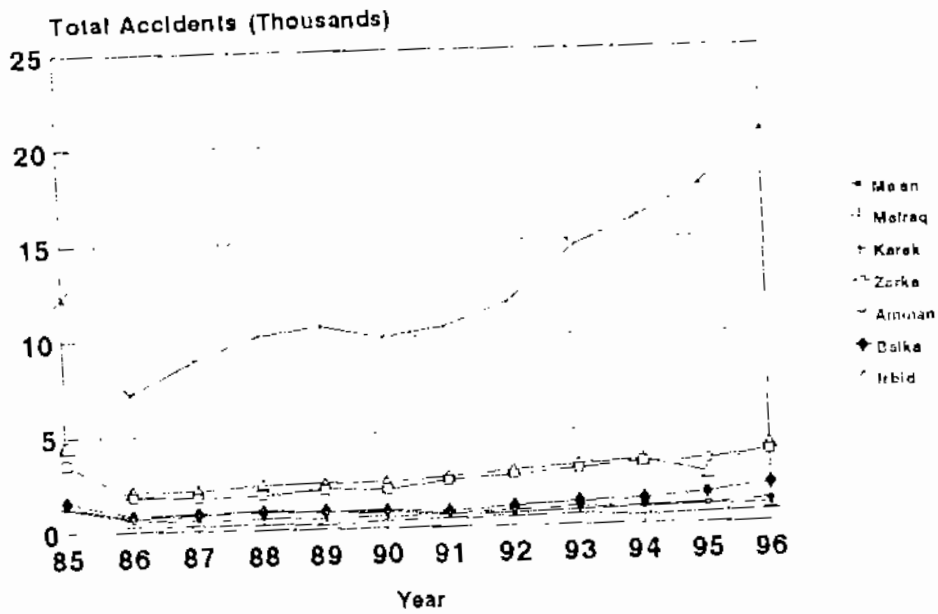
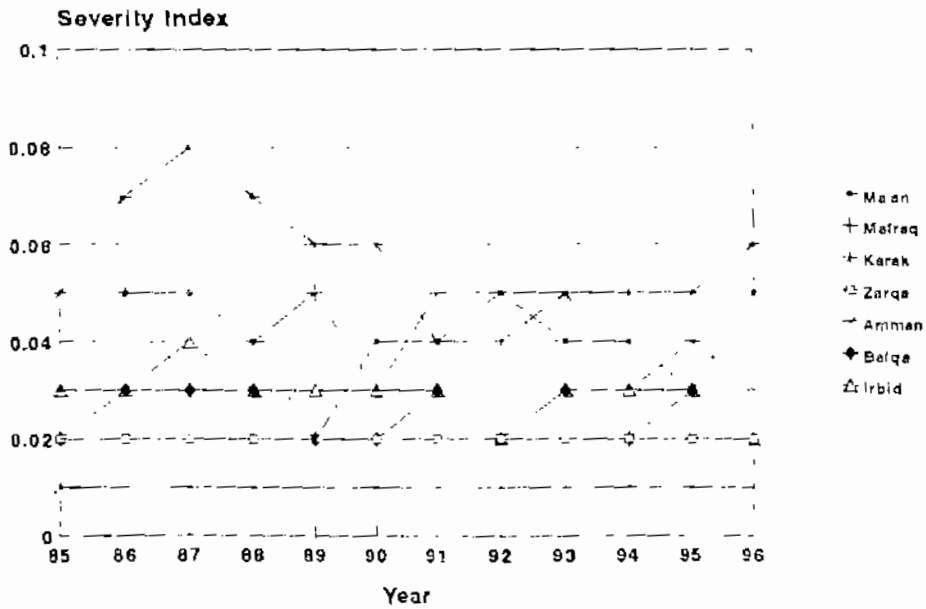


Figure 4: Severity Index in the Different Governorates in Jordan



CONCLUSION

Based on the analysis and findings presented in the study, the following conclusions can be drawn:

1. Jordan could be divided into two groups:
 - i. group I includes governorates with low gross population density. these are Karak, Ma'an , and Mafraq.
 - ii. group II includes governorates with high gross population density: these are Amman, Irbid, Balqa, and Zarqa.
2. Group I has lower number of accidents, higher severity indices, higher accident rates per 10,000 registered vehicles, and higher fatality rates than the governorates of group II except for the governorate of Zarqa which has a high accident rate.
3. A concentrated, high-density settings are better than dispersed and low development patterns from the transportation safety point of view.
4. A complete absence of well-defined land-use policies is a major cause of traffic accidents.
5. High speed driving is a major reason for the high severe accidents in low-density areas.
6. Buses are the most dangerous mode of transportation in Jordan.
7. Weak police enforcement of traffic laws in low dense areas has resulted in high severe accidents.

RECOMMENDATIONS

The following recommendations are suggested bascd on the results of the study:

1. Establishment of National Transportation Council to regulate, set policies, and control the transportation system in Jordan.
2. Development of land use policies, which control the land development type, size, and loeation to set the relationship with the transportation system in order to meet the already defined goals and objectives.
3. A thorough investigation of bus operation in Jordan is needed to find the best solution for the dilemma of high bus involvement in accidents.
4. Transportation System Management (TSM) eonepts must be examined to improve the safety, efficiency, and productivity of bus services and the entire urban transportation system.
5. Development of database for all related transportation information.

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