Solving the traffic congestion around Azrou taxi station

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SOLVING THE TRAFFIC CONGESTION AROUND AZROU TAXI

Student Statement:
I hereby affirm that I have applied ethics to the design process and in the selection of the final proposed design. And that I have held the safety of the public to be paramount and have addressed this in the presented design wherever may be applicable.”

_____________________________________________________
Salwa Enezari

_____________________________________________________
Dr. N.N.Sheikh
ACKNOWLEDGEMENTS

This work is done with the help of many sources that document a number of theoretical solutions as well as ones that illustrate solutions to similar congestion problems around the world.

This project owes its progress to my supervisor Dr. Sheikh whose supervision has been a great help and Mr Adil Kental who helped me with surveying drivers in the Azrou taxi station and inspecting the area. I also thank Mr Cherrat who gave me information about costs for various construction procedures related to roads and pavement.
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The aim of this project is to solve the problem of traffic congestion in and around the Azrou grand taxi station. It will include some literature review to help understand congestion problems in general and to compare this situation to previously solved congestion issues with similar factors. It will also include an analysis of the situation in an attempt to identify what causes the congestion, following which a suggestion of few possible solutions. Cost analysis and feasibility study will be conducted for each proposed solution. A final comparison of advantages and disadvantages of each one
will be included. The solutions presented should be economically feasible and should take into account legal, environmental and ethical considerations.
1 INTRODUCTION

Making a correct assessment of traffic congestion of road network in the immediate vicinity of the Azrou taxi station has great significance in improving the traffic condition of the road network and ensuring smoother experience for the passengers. This project proposes an analysis of the situation backed by maps data as well as survey questions answered by local workers, mainly cab drivers. Following the analysis of the situation, we attempt to solve the problem giving three possible solutions accompanied by a feasibility study and cost analysis.

1.1 Context of the project

The area to be studied is the roads surrounding the grand taxi station in the town of Azrou. Azrou is a small town with a population of about 50,000, and located 17 kilometers southwest of Ifrane. In Morocco, taxis that transport from one town to another are called grand (“big” in French) taxis, whereas petit (“small” in French) taxis are for transportation within a town. The grand taxi station in Azrou itself covers 750 square meters and is situated in the heart of the town. Cabs arrive at and depart from the station from many nearby cities: Fes, Meknes, Ifrane, Hajeb, Mrirt, etc.

It is linked to the main road by an entrance passage measuring 64.3 meters in length and 5 meters in width. An informal market lies at the back of the station on unused land. It measures approximately 3571.6 square meters.

The Azrou grand taxi station usually suffers from congestion at the entrance which causes time delays to cabs and other vehicles in the vicinity. Following an on the field study and a survey of cab drivers, the conclusion is that this congestion problem mainly happens after 2PM due to the traffic caused by the daily informal market right next to the station. The station itself has only one entrance that serves as an exit as well. This exacerbates the scale of the problem at hand.
A view of the place on Google Maps indicates a usually slow traffic around the area as can be seen in the image below.

1.2 Project Scope

The purpose of this project is to investigate the reasons behind the recurrent traffic congestion near and around the Azrou taxi station and to come up with possible solutions for the issue. These solutions should be able to solve the problem at a reasonable cost and should be legally and ethically feasible. The different solutions should then be compared for the various pros and cons, including costs of implementation.

Methodology

Working on this project requires four main steps. The first step is gathering background information in order to accurately assess the situation. This involves a literature review of available sources that deal with urban traffic management and similar congestion problems in small cities. The following step is an analysis of the studied area using maps to get the dimensions and an on terrain study to help visualize the roads and the particularities that are not illustrated on available maps. This step also includes surveys of both the workers at the
Azrou and Ifrane grand taxi station. Next the problem at hand is to be clearly identified and the parameters involved in this specific situation are to be found. After these two steps, comes an evaluation of three possible solutions to the issue at hand. These propositions are to be presented with a detailed description of the implementation and a feasibility study. The final step is about planning.

**Planning requirements**

A principle of good planning is that individual, short-term decisions should support strategic, long-term goals. This requires comprehensive evaluation and negotiation to help people accept solutions that may seem difficult and costly in the short-term. Comprehensive transport planning provides a foundation for more integrated transport services, fares and ticketing, user information, infrastructure provision and management, institutions transport and land use planning, and other public policies such as road, parking and fuel pricing.

**Accessibility concept**

The concept of accessibility refers to the extent to which desired locations, destination, goods and services are easily reachable. Opportunities are defined as the latter targets. In the scope of this project the main opportunity is destination. Accessibility is mostly impacted by four factors:

- Mobility, availability, speed and quality of travel
- Connectivity
- Land use
- Mobility alternatives

**Guidelines**

- Defining the issue at hand and identifying shareholders
- Collecting data
- Sharing a clearly specified problem statement
- Coming up with possible solutions
- Evaluating the solutions and classifying them from efficient to less efficient.
- Study the economic and legal feasibility of the solutions
- Find contingent plans
- Review the plan made and modify what needs to be changed

**Background Information**

Traffic congestion is a phenomenon that occurs when the number of vehicles using a certain road approach or exceed its capacity or when intersections are not designed in a proper way to avoid unnecessary delays.

In this project the main focus is the area around the Azrou grand taxi station which means that our main focus concerns traffic in intersections with a little focus on traffic on a given road.

For this purpose, background information on traffic flow and intersections design is needed for an efficient study of the situation.

I start this section by an overview of traffic congestions and various historical methods for solving it.

Traffic congestion is a term used to describe the increasing costs that result from the involvement of vehicles on a road. This is usually problematic when the volumes of traffic near the capacity of the road, a condition referred to as the urban peak condition.

Traffic congestion can cause many problems such as impairing the mobility of road using agents as well as a waste of time, problems of pollution and accidents.

1-Increasing the capacity of roads. This solution requires the addition of lanes to an existing road. On the negative side, this is a relatively expensive approach. It also may not be feasible or difficult to implement due to buildings on the sides of the road.

Another major problem with this solution is the fact that an increase in capacity leads to an increase in demand for the road. It is statistically proven that adding to the capacity of a road makes travelers more likely to choose it as a route for transportation. Therefore, adding to the capacity does not resolve the traffic congestion in the long term.

2-increasing the connectivity of roads. Often the problems with roads that lead to traffic congestion may not be the width but the destination. Increasing the connectivity of a network refers to building new roads that directly lead to specific places.
3 Closure. This solution is a bit counter-intuitive. Closing off parts of roads decreases demand on the other parts. Sometimes slightly disconnecting the network, helps decrease the flow on certain parts and alleviates traffic.

4 Controls. This one is an obvious solution. managing traffic helps in decreasing congestions and adds more order to circulation which avoids unnecessary road blockage. Control methods include the use of traffic light, roundabouts, ramp metering and road signs, etc.

**Parameters**

All kinds of flows are governed by a number of parameters. Similarly, traffic flow is also controlled by its own parameters. Understanding these parameters and their impact on congestion helps in the analysis of the situation. Traffic flow is considered non-uniform because agents that control the flow and human behavior is rather difficult to predict. Traffic regulations however make it easier to predict drivers’ behavior and it is relatively safe to assume that drivers will follow the rules. Parameters are classified as macroscopic, if they describe the stream as a whole, and as microscopic parameters if they focus on the conduct on one agent and how it affects the flow.

**Speed**

Speed is regarded instead of the design aspects of traffic since road users are more concerned with the speed of their journey. It is calculated using the following formula:

\[ V = \frac{d}{t} \]

Where \( V \) represents the speed in meters per second, \( d \) is the distance traveled during the period of time \( t \).

Speed can be categorized into spot speed, running speed and journey speed. The first refers to the instantaneous speed of a vehicle and is calculated at a specific point in time. This variable is usually taken into consideration when trying to figure out how to build a road in terms of elevation and curvature. Running speed, refers to the average speed of a vehicle over a specific distance. It can be simply calculated by dividing the whole distance traveled by the
time it took to travel it. Any stops are included in the time interval and so a journey speed that is considerably smaller than the running speed is an indication of many stops. Finally journey speed refers to the average speed excluding any stops.

**Flow**

In order to calculate the number of vehicles on a given road, one can use flow volume, a quantity defined as the number of vehicles that cross a single point on a specific lane during a given time interval. It is described by the following formula:

\[ q = \frac{nt}{t} \]

where \( q \) refers to the volume flow, \( nt \) the number of vehicles and \( t \) the time it took for those vehicles to pass by that given point we’re studying.

**Density**

Density is defined as the number of vehicles on a specific portion of a road. It is calculated by dividing the number of vehicles \( nx \) on the distance covered \( x \). The formula for density \( k \) is as follows:

\[ K = \frac{nx}{x} \]

The estimation of a road’s density helps us determine the average closeness of vehicles on that road. It is a parameter that is mainly useful when checking the safety of a given road. An illustration of density is given below.

In contrast to other engineering disciplines, situations in traffic engineering cannot be reproduced or simulated in order to be studied, as many decisions involved in it depend on human agents which behavior cannot be predicted with a high degree of certainty. As a result,
traffic flow characteristics have to be studied directly in the field. For this, road data is to be collected. This has various requirements and methods. The most crucial data to collect involves speed, time of travel, flow and road density. Sometimes, spacing and headway can be directly measured. Another important variable is the occupancy: the ratio of time a particular point of the road is occupied by vehicles. A classification of measurement processes, into five classes, on the geographical extent of the surveyed area is:

- Measurement at one point
- Measurement over less than 500m
- Measurement over more than 500m
- Measurement over a number of locations in an area
- Measurement along the traffic stream

Data

Survey

In order to gather data for this project, both empirical data and user data were required. Due to the lack of data concerning Azrou in general and the area to be studied specifically I had to rely on a direct study that required my presence at the place and a survey of the locals and station workers. The goal was to gather information about the usual traffic flow and inspect whether the magnitude of the congestion problem.

I questioned four taxi drivers, a taxi owner and two station workers. One of the station workers attested to there being no serious problem of congestion and that no solution was needed. The other six confirmed the existence of a serious problem and all agreed that problem mainly occurs in the afternoons after 2pm, due to the daily informal market, and lasts till about 8pm when the market starts to close.

I conducted another little survey at the Ifrane taxi station since it used to suffer from the same issue a few years back. The problem was solved by transferring the station from the Slaoui area to the outskirts of town near the road to Meknes. The main purpose of the survey was to identify the advantages and disadvantages of this solution and how it solved the problem.
I asked five workers who all confirmed that the solution was indeed effective and that the only disadvantage to this solution according to them is the distance problem it created for the users of the station which is not really a high cost to pay for solving the traffic congestion inside of town. For this reason, I considered transferring the station as a possible solution to the Azrou station congestion problem. More on this solution is discussed in a different section later.

Maps

In order to assess the exact layout of the place and the scope of the traffic congestion problem, this project relies on maps and satellite views taken from Google maps. Here below, are illustrated a few shots of the area, on both maps and satellite view. This project also uses the maps to calculate distances and come up with possible modifications of these maps that match every solution it proposes.

Problem Identification

According the results of the surveys, visits to the place and the available maps, the problem only seems to arise after 2pm and seems to be concerned with the opening of the daily informal market. The informal market itself cannot be moved elsewhere for various logistic and regulatory reasons. Another reason that seems to be prominent is the existence of a single road that serves as both entry and exit to the station. The road’s width was measured using Google maps to be five meters which means a limited flow capacity.
Proposed Solutions

Building a second entry

The first solution I propose is building a second entry to the station from behind the informal market. This potential solution can be divided into two in terms of where the new entry will be located. Either road will have to be built on the land behind the station, which is a non-used land. And so the costs will include the preparation of land for road construction.

The first suggestion takes into consideration the cost of the new road as its main priority. In order to minimize the cost, the length of the road has to be minimized. The building process itself will not significantly affect the traffic or the work at the station as the land is unused which means the time required to build the road is not really an important consideration. Additionally, according to Mr Cherrat who works at X institution, the cost of building a single meter square of road in Morocco on a similar land is Dirhams.

The table below illustrates the detailed price of building the road.

<table>
<thead>
<tr>
<th>No.</th>
<th>Designation des prestations</th>
<th>U</th>
<th>Prix unitaire en Dirhams</th>
<th>Montant total en Dirhams</th>
</tr>
</thead>
<tbody>
<tr>
<td>B-1</td>
<td>Devies pour ouverture d’assiette des chaussées et ouvrage de jonction</td>
<td>m²</td>
<td>200.00</td>
<td>40.00</td>
</tr>
<tr>
<td>B-2</td>
<td>Première couche de béton ou couche de 25cm sur épaisseur de décharge publique</td>
<td>m²</td>
<td>200.00</td>
<td>25.00</td>
</tr>
<tr>
<td>B-3</td>
<td>Préparation et compaction de fond de forme</td>
<td>m²</td>
<td>200.00</td>
<td>160.00</td>
</tr>
<tr>
<td>B-4</td>
<td>Couché de fondation GNF</td>
<td>m²</td>
<td>165.55</td>
<td>2650.00</td>
</tr>
<tr>
<td>B-5</td>
<td>Couché de base GNA</td>
<td>m²</td>
<td>160.74</td>
<td>260.00</td>
</tr>
<tr>
<td>B-6</td>
<td>Couché d’imperméabilisation</td>
<td>m²</td>
<td>783.58</td>
<td>2650.00</td>
</tr>
<tr>
<td>B-7</td>
<td>Rabotement supérieur au sommet dans un champ de 12 degré d’espacement</td>
<td>m²</td>
<td>500.00</td>
<td>100.00</td>
</tr>
<tr>
<td>B-8</td>
<td>Bandeau de montée type T4</td>
<td>m²</td>
<td>90.00</td>
<td>18.00</td>
</tr>
<tr>
<td>TOTAL HORS TAXES</td>
<td></td>
<td></td>
<td>149,099.56</td>
<td></td>
</tr>
<tr>
<td>I.T.A 20%</td>
<td></td>
<td></td>
<td>29,801.91</td>
<td></td>
</tr>
<tr>
<td>TOTAL GENERAL T.T.C</td>
<td></td>
<td></td>
<td>178,811.47</td>
<td></td>
</tr>
</tbody>
</table>

Building a second entry will alleviate the load on the already existing one and on the road directly leading to it.
The smallest distance as calculated using Google Maps is of 40 m and the minimum width of the road to be designed for one lane is 5m. This gives us a total area of 200 meters squared to be built. Which means the total price is to be around 178 811.47 dirhams.

The new road model is illustrated in the map below as a grey line.

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**Advantages and Disadvantages**

**Advantages**
- relatively low cost
- construction process does not hinder traffic
- relieves congestion on the preexisting entry

**Disadvantages**
- Takes time to finalize
- does not relieve congestion in the long term
The second alternative will allow the second added entry to intersect with a traffic light. This second alternative requires a longer road and thus will cost more to build and maintain. The main focus of this potential solution is for the new entry to be free of congestion problems at the intersections.

This road’s length is 80m. The minimum width is as before 5m which gives a total area of 400 meters squared. This leads to a cost of construction of 196811.47 dirhams. A detailed cost description is provided below.

**Advantages and Disadvantages**

**Advantages**
- The new entry intersects with the main road on a traffic light which relieves congestion
- Construction process does not hinder traffic
- Relieves congestion on the preexisting entry
- Medium cost
Disadvantages
- Takes time to finalize
- does not relieve congestion on the long term

5.2 Building a roundabout next to the entrance

Intersections are areas where two or more roads meet. Vehicles can usually turn in different directions in order for them to get to their different destinations. The main function of an intersection is to orient different road users towards these destinations. Traffic intersections are very complex locations as various vehicles will simultaneously want to occupy the same space. Furthermore, pedestrians will also want to cross and thus are also willing to occupy that same space at the same time. All these agents will have to make decisions in a very short period of time and any mistake can result in either accidents or a traffic congestion due to delays. This has the potential of obstructing the capacity of roads. Different types of intersections have different numbers of conflicts. In a normal four-legged intersection the number of conflicts point are 32 as is illustrated below.

The road leading to the Azrou taxi station is located at an intersection. A good way to control traffic flow at intersections without any useless delays caused by traffic lights and without the need for the cost of employing traffic policemen, is building roundabouts or traffic circles.

A roundabout, or a road circle, is a traffic junction in which all vehicles drive in the same direction around a central circle. A large-scale study conducted by the Oregon
Department of Transportation indicates that roundabouts are mostly efficient when designed so that the vehicles entering the circle must yield to vehicles inside.

The advantage provided by traffic circles compared to conventional intersections as is the case at the entry of the Azrou cab station, is that of reducing the number of traffic flow lines. This is outlined in the figure below. This feature is more advantageous the bigger the number of roads that intersect at the given junction.

Roundabouts replace the need for having traffic lights which are less efficient in big intersections as they do not adapt to the existent traffic at every moment and require the need for human interference such as traffic police to help alleviate congestions.

Building a roundabout at the entry of the station is illustrated in the map prototype bellow.

**Advantages and Disadvantages**

**Advantages**
- relatively low cost
- Safe
- relieves congestion

**Disadvantages**
- High cost
- Takes time to finalize
5.3 Displacing the station to a better location

Ifrane’s taxi station serves as an example of another station that used to suffer from traffic congestion. It used to be located in the slaouï area which is a residential and commercial district in Ifrane. Following the traffic problems, the station was displaced to the outskirts of town. This solution seems to have resolved the problem of traffic congestion.

For this reason, I conducted an oral survey at the station to ask the workers for their experience with the change of location of the station and how it affected them. I interviewed 5 Taxi drivers. The general agreement is that the change of location indeed solved the problem of congestion and alleviated the traffic inside of town as well. However, this made the station less accessible to citizens wishing to use the taxi services.

Following this example, the third proposed solution to Azrou’s traffic congestion around the cab station, is displacing the station to a more suited location.

One of the possibly well-suited location in Azrou is the Meknes road. A map for the area as it currently exists is provided bellow.
A satellite image is also provided:
Advantages and Disadvantages

Advantages
- construction process does not hinder traffic
- relieves congestion

Disadvantages
- Takes time to finalize
- Makes it hard and costly for citizens to reach the station
- high cost
STEEPLE Analysis

Societal: This project will help people in Azrou and people traveling to and from it as it will potentially help alleviate the traffic congestion that blocks the road several times in the day.

Technological: The issue is a usual issue that plagues many cities around the world, and is not necessarily impacted by technology. In other words, the solutions rely on usual road-building approaches and not any new technologies.

Environmental: One of the motivations of the project is to reduce gases emitted by cars while they’re stuck in traffic congestion.

Ethical: There are no particular ethical issues we could identify here.

Political & Legal: The project falls in line with the Moroccan government’s goals and will not be implemented without being legally approved

Economic: Reducing traffic congestion will reduce the time of travels which will economically benefit the grand taxi sector.
CONCLUSION

This project is dealing with the reduction of traffic congestion near and around the Azrou cab station. We drew inspiration and ideas from other such projects in different places around the world.

In order to solve this problem, we proposed three potential solutions:

- Building a new entry to the station.
- Building a roundabout at the intersection of the entry.
- Displacing the station to a new location.

For each proposed solution, we identified advantages and disadvantages. In the final analysis, since the costs for the projects are different, the winning proposition might be a function of budget limitations for the city of Azrou.
7 REFERENCES
