# Developing Agency Traffic Engineering Guidelines: Lessons Learned from Developing Engineering Guidelines for the Ministry of Municipal and Rural Affairs, Kingdom of Saudi Arabia

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## Introduction

Traffic engineering is a unique field of civil engineering in that physical characteristics dictate the movement of vehicles, but vehicle operation is based on drivers' choices, which in turn are based on their expectations from the cues they receive from the roadway environment. As traffic engineers, we have a significant influence on direction for how drivers should drive. Our decisions are typically based on our experiences and well researched guidelines. The structure of our work is such that when making decisions, we are rewarded for developing status quo solutions and are often criticized for proposing a unique solution to a seemingly typical problem. As a result, we approach problems with a limited toolbox and develop solutions that may be inferior.

As we work to address the concerns of our citizens, elected officials, and clients, we are asked to solve complex problems with diminishing resources. This forces us to find ways to expand our toolbox and look for approaches that are more cost effective. Concepts such as diverging diamond interchanges are the result of innovative thinking. To effectively manage the use of these innovative tools, traffic engineers and agencies seek guidelines to identify what types of scenarios such approaches should be used.

Developing new guidelines requires considerable research to evaluate the conditions a traffic management approach has been effective and how to effectively implement the strategy. During the development phase, it is important to keep an open mind, unbiased by our traditional thinking. If we only look at things the same way, the solution will always be the same. It is important to be willing to challenge our base knowledge if there is proof that by looking at a different solution, our goals can be accomplished.

The Ministry of Municipal and Rural Affairs (MOMRA) for the Kingdom of Saudi Arabia (KSA) identified the need to adopt municipal traffic engineering guidelines. These guidelines were intended for municipalities and their specific needs. A wide range of topics was covered including signing, marking, traffic signals, safety, and operations. Simply applying United States (U.S.) standards to KSA did not make sense because driver expectations and engineering practices are different in the Kingdom; however, traditionally, KSA has used U.S. standards—although as-built designs often differed from the standards.

The project team's first response while identifying practices that differed from U.S. practices (such as near side traffic signals as opposed to far side traffic signals) was to change those practices to make them similar to what we are used to. Instead, we should have been asking why it is like that, and what does research support as the industry best practice. By the time we were preparing the recommendations for the guidelines, we realized this error and asked these questions about the current practices in KSA as well as the recommendations we were making. Ultimately, as traffic engineers we should always be asking: why are we recommending a specific solution or approach and is there something better that we haven't thought about.

This document discusses some of the key areas that significantly differed from U.S. typical approaches that the project team researched and evaluated the best practices. The following areas are discussed in this document:

- Traffic signal design
- Traffic signal operations
- All-way stop control
- Trip generation data

## Traffic signal design

Traffic signals in the U.S. are designed with the signal faces on the far side of intersections. This design ensures visibility of the signal heads as drivers are approaching and entering intersections. In KSA, traffic signals are located at the near side of intersections. Initially, the project team felt this was a terrible mistake; however, during a long layover in Germany, we noted that that the traffic signals were also on the near side of intersections. This variation from our norm was not just something done in KSA, but something others were also doing and presumably for a good reason.

The project team researched extensively for documentation on why one approach, near side or far side, was better than another. Despite extensive research, neither approach prevailed. All of the documentation was based on professional opinion and there was no definitive documentation of why one approach was superior to another for either safety or operations. The following lists some of the primary benefits and disadvantages identified for near side versus far side traffic signals:

| Far Side | | Near Side | |
|---|---|---|---|
| Benefit | Disadvantage | Benefit | Disadvantage |
| Signal is visible in intersection | May have more red-light runners | Reduce encroachment on pedestrian crosswalk | Only protected left-turn phasing |
| Permissive left-turn phasing | | Focus on traffic in intersection | |
| | | Lower speed through intersection | |

Ultimately, the project team determined there was no definitive reason to place signals on one side of the intersection versus the other, especially given how traffic signals operate in KSA—completely split phased with no need to accommodate permissive left turns. Our recommendation was to keep designing traffic signals as they have been to maintain Saudi driver expectations.

With no definitive proof that one method is better than another, it is unlikely and inadvisable to change U.S. standard practice of signal installation. However, when considering unique locations or situations where intersection and pedestrian crossing encroachment may be a concern, it is worth recognizing the benefits of near-side traffic signals to potentially generate ideas to reduce intersection encroachment through design.

## Traffic signal operations

As noted in the traffic signal design discussion, traffic signals in KSA operate completely split phased. In addition to being inefficient, drivers are frustrated by the operation of the signals and make alternative

route choices that may actually take longer. The net result is that major arterials are sometimes underused because of inconsistent and inefficient signal operations, while access-controlled facilities are overused and extremely congested. The project team observed this occurring on two parallel facilities in Riyadh: Olaya Street and King Fahad Road. During peak travel periods, Olaya Street was congested at signalized intersections, while the links between the intersections were fairly empty. The parallel access controlled King Fahad Road was completely occupied and barely moving at the same time.

Through discussion with several municipalities, the split-phased traffic signal operation is used because traffic police operate the signals and this is the easiest way for them to operate the signals. The traffic police are responsible for traffic operations because they interact with the public and are considered responsible for traffic safety and operations. However, based on interviews with the traffic police, they have little or no traffic engineering training and subsequently don't know traffic engineering concepts or understand the capabilities of modern traffic signal controllers.

One component of this project was to identify the organizational structures necessary to improve municipal traffic engineering within the Kingdom. We recommended changing the current organization so that someone trained in traffic engineering is responsible for traffic signal operations. This responsibility could remain within the traffic police or be moved to the municipality—the key point is that there are significant operational inefficiencies because traffic operations are being handled by untrained and inexperienced people to maximize efficiency.

We discussed moving from fully split phasing to consider other options with municipalities and the traffic police. Typically, the response was that it would not work and such a change would create a safety hazard as it would violate driver expectations. Some of the project team disagreed because Saudi drivers are able to safely negotiate driving through intersections with multiple phases while travelling. Furthermore, Saudi drivers are fairly adaptable to changing traffic conditions as demonstrated by the following three examples:

- At the intersection of two multi-lane arterial roadways in Jeddah, there was no traffic control at all. Drivers approached the intersection at a fairly high speed and adjusted their speed and direction as necessary to successfully maneuver through the intersection without crashing.

- On the two-lane highway between Jeddah and Taif, we encountered a passenger vehicle that was attempting to pass a commercial truck while heading toward us through a no passing zone. The truck driver moved to his right, the car driver straddled the double yellow center line, and our driver moved to his right. We all passed each other at the same time at approximately 75 miles per hour.

- Because traffic signals are completely split phased, drivers do not have to worry about conflicts from vehicles on other approaches. As a result, many drivers will execute turning maneuvers from any lane; it is common to witness a driver make a right or left turn from any lane of a multi-lane approach—the other drivers typically tap their horn to let the other driver know they are there and slow to avoid a crash.

Given Saudi drivers' observed ability to adapt quickly to changing and unique traffic scenarios and their experience driving in settings where signals operate with multiple phases, one of the project team members suggested it would be easy to change signal operations to improve efficiency through the use of multiple phases.

While working on another project in Saudi Arabia, the design of the landside transportation facilities for the new King Abdulaziz International Airport in Jeddah, it was necessary to achieve intersection level of service (LOS) C while operating intersections completely split phased. To achieve the operational threshold identified for the project, it was necessary to either build additional capacity, grade separate the intersections, or indentify other alternatives. As alternative intersection control options, such as roundabouts, were ruled out by the project owner's representative, the remaining options eliminated movements so it was possible to remove phases from the intersections. For example, we modified a four-way intersection to be a High-T with a right-in-right-out for the fourth leg. This approach changed the intersection from a four-phase intersection to a two-phase intersection, which operated acceptably even when the impacts of rerouting traffic were considered.

The concept of removing phases from an intersection to improve traffic operations has been a tool that we have employed on projects in the U.S. since working on these Saudi projects. While we considered this approach before, it was one of only a few tools available to improve intersection operations for the Jeddah airport and with considerably more limitations on other phasing—subsequently it was necessary to consider many more options when eliminating movements to remove phases. Considering this approach while working on projects in the U. S. has fostered discussion about alternatives that don't simply add capacity, but consider rerouting traffic to reduce the number of signal phases to improve operations. The result has been development of solutions that balance operational goals with access.

## All-way stop control

While discussing the traffic control hierarchy, the project team noted that no one had seen an intersection with all-way stop control in the Kingdom. After some initial research, it became apparent that all-way stop control is predominantly only used in North America. Generally, other countries have implemented traffic control with more positive control, such as roundabouts, when traffic demand requires more control than minor street yield or stop control.

Based on the findings regarding traffic control practices in other countries and in Saudi Arabia, the project team decided not to recommend use of all-way stop control. Instead, the following hierarchy was developed:

- Minor street approach yield – basic control
- Minor street stop control – when crash history dictates yield control is insufficient, but additional control is not warranted
- Roundabout control – similar to *Manual on Uniform Traffic Control Devices* (MUTCD) all-way stop control warrants
- Traffic signal control – similar to MUTCD traffic signal warrants

The guidelines suggested the lowest level of traffic control should be used unless a higher level of traffic control was warranted and necessary to maintain acceptable levels of operations and safety, based on operational characteristics.

Traffic engineers in the U.S. are continually challenged with the dilemma of all-way stop control. Even though the public often views all-way stop control as a cure-all for speeding and intersection safety, the opposite can be true when the signs are installed at improper locations. While there are many locations where all-way stops have proven beneficial, there are also many examples where all-way stop control resulted in higher link speeds, more crashes, and violation of the traffic control. All-way stop control should not be taken out of our toolbox, but given the relatively infrequent use of this treatment globally,

along with varying positive and negative impacts of this type of control, additional steps should be identified to consider and evaluate other alternatives.

## Trip generation data

There is relatively limited trip generation data found that was relevant to all of KSA. Most of what is used is based on data collected specifically in the city of Riyadh, other Middle Eastern countries, or from the Institute of Transportation Engineers (ITE). While the Riyadh and Middle East data are reasonably representative of typical trip generation and patterns, they lack the diversity and data to truly represent traffic around the Kingdom.

The existing trip generation data for Riyadh and the Middle East are very similar to the information provided in the ITE *Trip Generation Manual*. This style of trip generation data is fairly comprehensive; however, some of the data are dated and may be specific to a region or specific site characteristics. The Trip Rate Information Computer System (TRICS) used in the United Kingdom (UK) is a more dynamic online system that users subscribe to. This system gives users the ability to define site scenarios so they can use the data most appropriate for their site, land use, region, season, and day of week, as appropriate. Information and data in TRICS are updated regularly, which allows users to dynamically select the appropriate information for their specific analysis, resulting in final projections that better reflect what will actually occur once the site is built.

The ITE *Trip Generation Manual* is a great resource, but an Internet-based application such as TRICS might increase benefit to users. As future traffic resources are developed, the ability to improve their accessibility, functionality, and applicability for users by making them Internet based should be considered.

## Conclusion

Recommending guidelines for municipalities in KSA challenged the project team by making the multi-national members question their standard engineering practices and evaluate other options to determine what would be best for the Kingdom. Through this process, each team member grew professionally through the challenges and now look at things a bit differently than at the beginning of the project. Moving forward, four items stand out that we were reminded of during the project:

- **Question if the approach being taken is the best approach.** As engineers, this is what we are supposed to do. It is not enough for us to simply follow guidelines; we need to engineer, which means we need to use the knowledge we have to make things better.

- **Research what we are working on regularly.** Even if we have done things repeatedly a certain way, we should look for information that challenges our approach and makes us re-evaluate what is the best practice.

- **Make information more applicable and more available.** The Internet is an amazing tool; as with our guidelines, we may produce documents and manuals in the same way as always, but if we change these to make them more dynamic, they may be more valuable to the industry.

- **Be willing to be wrong.** By opening our minds and being willing to question if our typical approach to a problem is the best, we were able to come up with best practice recommendations other than the norm.