

Roundabout's Impact on Nearby Businesses

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Abstract

The objective of this study is to determine if installation of roundabouts in a business area or on business corridors can be good for the businesses as well as improve the traffic flow in that area. This objective is achieved by emphasizing on roundabouts located in Kansas cities, particularly Topeka, Kansas. The study concentrates on conducting survey of businesses around the roundabout corridors in different places in the US including Topeka (Kansas), Junction City (Kansas), Newton (Kansas), and Carmel (Indiana). The survey results indicated a positive impact of roundabouts on businesses and traffic movement. Further, as there is no before and after corridor data available for making definite conclusions, a business corridor in Topeka, Kansas is simulated using both SIDRA and VISSIM software to evaluate the impacts of converting several traditional intersections in the corridor to roundabouts. The results from the simulation tasks have showed substantial reductions in vehicle delay and queuing for most of the traffic movements. Therefore, it was concluded that roundabouts on businesses corridor have a positive impact on traffic flows and business.

Keywords

Business Performance, Roundabouts, Traffic Flow, SIDRA Analysis

1. Introduction and Study Methodology

Rural roads are susceptible to a high rate of crashes, and the crash severities tend to be worse, leading to many Roundabouts are fairly new to the United States. In various areas in the US, the general public, local officials, and politicians tend to be polarized about them such that sometimes they are considered beneficial and sometimes they are not considered as a proper system of controlling intersections. Some individuals claim that drivers avoid routes with roundabouts which can thereby adversely impact its adjacent routes; however, oth-

ers claim that they attract more traffic. This kind of driver's attitude could create either negative or positive impact for businesses depending whether they are on the roundabout route or an alternate route. However, it has to be understood that modern roundabouts were proven to be a safe and effective intersection traffic control. Some of the most common types of crashes occurring at intersections with stop signs or traffic signal control are right-angle crashes, left-turn crashes, and head-on collisions. These types of crashes can be severe because vehicles can be traveling through the intersection at high speeds. Therefore, roundabout treatments can eliminate these types of potentially serious crashes as all the vehicles at a roundabout travel in the same direction. Previous roundabout studies conducted have concluded that implementing roundabout control reduces all crashes by 40%, injury crashes by 80%, vehicle delay and stopping by 50% to 80% along with simultaneous decreases in vehicular pollutants [1] [2]. Several advantages of roundabouts over signalized and stop controlled intersection alternatives are better overall safety performance, better management of speed, shorter delays, shorter queues, and opportunities for community enhancement features. In some situations, roundabouts can avoid or delay the requirement for an expensive widening of an intersection that might be necessary with signalization [3]. Further, recent Kansas Department of Transportation studies have proved that trucks have no problems using the roundabouts and roundabouts can be designed accordingly for any special type of trucks [4]-[10].

While the effectiveness and benefits of the roundabouts have been well documented, there is not much research that studied the impact of roundabouts on nearby businesses. In order to evaluate the impact of roundabouts on businesses, a survey of businesses around the roundabout corridors has been carried out in different places in the US including Kansas (KS) cities of Newton, Junction City, Topeka, and Caramel (Indiana (IN)) which is well known to have a number of roundabouts and is called roundabout city. While the surveys with business owners were designed to gather some important insights, the survey results are not used to determine a definite conclusion about the impact of roundabouts on the businesses due to its limitations. Hence, heavy reliance is not made of the results of the surveys.

Further, as there is no reliable before and after corridor data available for making definite conclusions about the impact of roundabouts on traffic flow and consequently on the businesses, a simulation task was added to the study on the business corridor, Wannamaker Road in Topeka, Kansas. The Wannamaker business corridor is simulated using both SIDRA and VISSIM software to understand how the traffic flow would change if several intersections with signalized traffic control treatment were replaced with roundabout treatment. It is commonly believed that businesses and business regions that have good vehicular and pedestrian traffic flows should succeed and grow compared to the regions which are hard to access.

2. Survey with Businesses near Roundabouts

Surveys have been conducted to evaluate the impact of roundabouts on traffic flow and on businesses and their performance in the vicinity of the roundabouts. In this regard, different places in the U.S. including Topeka, KS, Junction City, KS, Newton, KS, and Carmel, IN were considered for the purpose of analysis. However, the survey results are not used to determine a definite result about the impact of roundabouts on the businesses due to its limitations. For example, it can be difficult to find locations of a roundabout corridor or a series of roundabouts in a specific business area where the existence of the roundabouts could clearly be linked to business prosperity. At the time of implementing this project (2009 and 2010), the United States was definitely in a period of recession and instead of roundabouts, this period might be considered the reason of negative impact on the businesses.

A survey questionnaire was prepared to enquire about various situations encountered after roundabout construction such as traffic volume, traffic flow, customer vehicle access, and delivery truck access. A total of 55 survey forms were distributed to 55 different businesses in Topeka, Kansas and 13 survey forms (23.6% response rate) were returned with responses. Similarly, 17 survey forms were distributed in Newton, Kansas and 6 survey forms (35.3% response rate) were returned; 10 survey forms were distributed in Junction City, Kansas and 2 survey forms (10.5% response rate) were returned; and 51 survey forms were distributed in Caramel, Indiana and 14 survey forms (27.4% response rate) were returned. A summary of survey responses for all the four cities considered are presented in **Table 1**. It has been observed that most of the respondents in Topeka, KS (46.2%) and all the respondents in Caramel, IN (100%) felt that roundabouts have improved the aesthetics of their neighborhood; however, respondents from Newton, KS didn't feel roundabouts have improved the aesthetics of their neighborhood.

Table 1. Summary of survey conducted with businesses near roundabouts.

Characteristics of the Surveys		Topeka, KS	Newton, KS	Junction City, KS	Carmel, IN
Number of survey forms distributed		55	17	19	51
Number of responses received		13	6	2	14
Response rate (% respondents)		23.6%	35.3%	10.5%	27.4%
Improved aesthetics with roundabout installation (% respondents)	Agree	46.2%	16.7%	-	100.0%
	Disagree	23.1%	83.4%	-	0.0%
Overall positive impact on traffic flow and access to neighborhood	Agree	61.6%	16.7%	50.0%	85.7%
	Disagree	23.1%	66.7%	50.0%	14.3%
Traffic on street with roundabouts (% respondents)	More	7.6%	0.0%	0.0%	42.9%
	Same	46.2%	50.0%	50.0%	42.8%
	Less	30.8%	50.0%	50.0%	14.3%
Customer vehicles access to business with roundabout (s) (% respondents)	More	0.0%	0.0%	0.0%	28.6%
	Same	15.4%	76.4%	50.0%	57.1%
	Less	84.6%	23.6%	50.0%	14.3%
Delivery trucks access to business with roundabout(s) (% respondents)	More	0.0%	0.0%	50.0%	7.1%
	Same	61.6%	60.0%	50.0%	78.6%
	Less	38.4%	40.0%	0.0%	4.3%
Business has: (% respondents)	Increased	38.4%	0.0%	0.0%	0.0%
	Same	53.8%	50.0%	50.0%	78.6%
Perception regarding overall opinion of business's customers regarding the roundabout(s)	Decreased	7.6%	50.0%	50.0%	21.4%
	Like	30.8%	16.7%	50.0%	71.4%
	Neutral	15.4%	0.0%	0.0%	21.5%
Perception regarding overall opinion of business's suppliers regarding the roundabout(s)	Dislike	38.4%	83.4%	50.0%	7.1%
	Like	23.1%	40.0%	0.0%	30.8%
	Neutral	53.8%	0.0%	50.0%	40.1%
	Dislike	7.6%	60.0%	50.0%	23.1%

Newton, KS was the only city in which more than 50 % of respondents disagreed on positive overall impact on traffic flow and access to neighborhood with roundabouts. In Junction City, with only two responses, conclusions cannot be made because it is a small sample which can bias the result of the survey. However, it is believed that there would have been high number of negative responses received about the roundabout's performance if the roundabouts really hurt the businesses.

In Carmel, IN respondents were more positive than the respondents of other cities regarding the positive impact of roundabouts on traffic flow and access to the surrounding streets; 85.7% of the respondents mentioned that roundabouts have been good for traffic flow and access to the street or neighborhood.

Business owner's opinion of the effect of roundabouts on traffic on the streets in Topeka had indicated that the sum of the respondents who indicated the traffic is more (7.6%) or same (46.2%) outnumber the respondents who indicated that the traffic is less (53.8% versus 30.8%) (Table 1). Though the business owners reported that the access to delivery trucks and customer vehicles is less or same as before a roundabout construction, a majority of the business owners in Topeka, KS reported that their business has been either increased (38.4% of respondents) or remained the same (53.8% of respondents) (Table 1).

In Newton, KS, 50% of the business owners indicated that the traffic is less on their street (50% of respondents) and 50% indicated it was the same (Table 1). Further, responses from Newton, KS businesses indicated that access to customer vehicles and suppliers (delivery trucks) is either less or the same and that business has not increased. However, with the small sample size of six responses for Newton, KS, firm conclusions should not be made.

For Junction City, KS, the survey results were summarized based on only two returned survey responses which is not a significant number of responses to make a reliable conclusion. However, the survey results were included in Table 1 to make the point that very few survey responses can widely vary opinions about roundabouts.

In Carmel, IN, 89.7% of the business owner’s opinions about the roundabouts showed that the traffic is more (42.9%) or the same (46.8%) on their street which means only 10.3% of the business owners felt the traffic had decreased. Further, survey respondents in Carmel, IN also reported that access to the delivery trucks and customer vehicles has either increased or remained the same. Although no increase in the business performance was stated, 78.6% of the businesses reported that the business performance was same and only 21.4% of businesses reported a decrease, which could have caused from the state of the economy in United States the past couple of years during the study. According to the business owner’s perception in Carmel, IN, only 7.1% of their customers and 23.1% of their suppliers disliked the roundabouts. Again, it has to be noted that these numbers indicate the perceptions of the responding business owners and not from the results of an actual customer or supplier survey, but they have a positive indication. Figure 1 shows the business owners’ overall feeling of the roundabout/roundabouts added to their street or neighborhood. Most of the business owners (61.5% of survey respondents) in Topeka, KS felt roundabout addition to their street or neighborhood is either “very good” or “good”. On contrary, more than half of the business owners in Newton, KS felt negatively (50% of survey respondents felt “very bad” and 16.7% felt “bad”) toward the roundabout added to their street or neighborhood. In Junction City, KS, about 50% of the business owners felt “very good” for the roundabout added to their street or neighborhood and the remaining 50% of respondents felt “bad”. In Carmel, IN, 35.7% of the business owners felt the roundabout was an “excellent” addition to their street or neighborhood and 35.7% of business owners felt very good, *i.e.*, a total of 71.4% business owners felt either excellent or very good about roundabouts being added to their streets or neighborhoods.

3. Simulation of Business Corridor

As there is no before and after corridor data available for making definite conclusions, a business corridor in

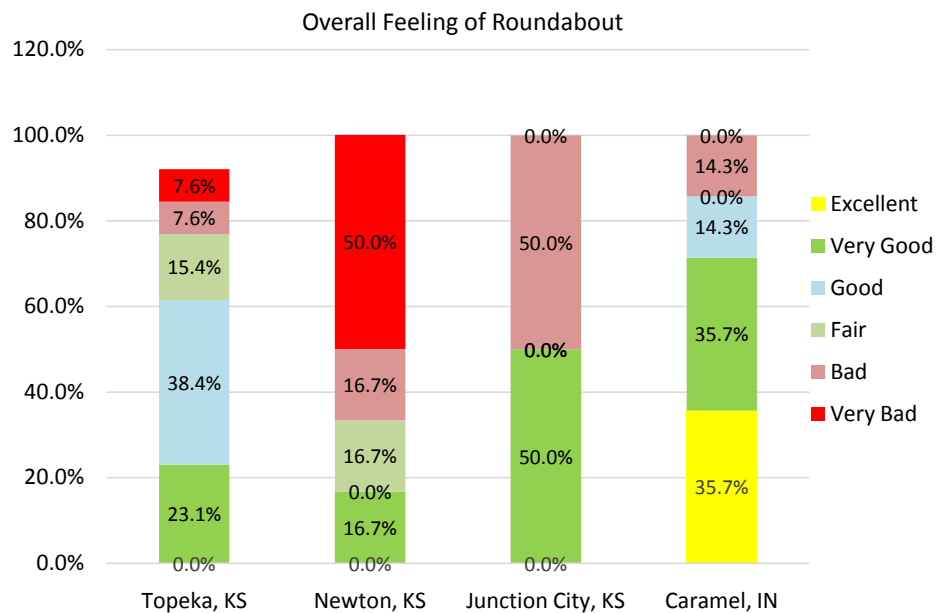


Figure 1. Business owners Responses about the overall feeling of the roundabout added to their street or neighborhood.

Topeka, Kansas is simulated using both SIDRA and VISSIM software to evaluate the impacts of converting several traditional intersections in the corridor to roundabouts. A simulation task of a business corridor is conducted to compare the travel along a corridor with signalized intersections to travel along the same corridor when signalized intersections are substituted with roundabouts. Ariniello have analyzed the impact of construction of four roundabouts along a commercial corridor in Golden, Colorado on businesses and observed a continued growth along the corridor showing that roundabouts are good for businesses [11]; businesses along this corridor however were initially skeptical about the positive impacts of these roundabouts construction. As the Wannamaker corridor has similar development patterns in Topeka, KS, it was considered for the task of simulating a business corridor. The Wannamaker corridor (shown in [Figure 2](#)) is highly developed with some signalized intersections of Wannamaker Road with other arterials and many unsignalized intersections of Wannamaker Road with local streets and entrances to businesses. Since a before and after study could not be conducted on the Wannamaker corridor, the “after” condition was simulated using both SIDRA and VISSIM software to evaluate the impacts of converting several traditional signalized intersections in the corridor to roundabouts.

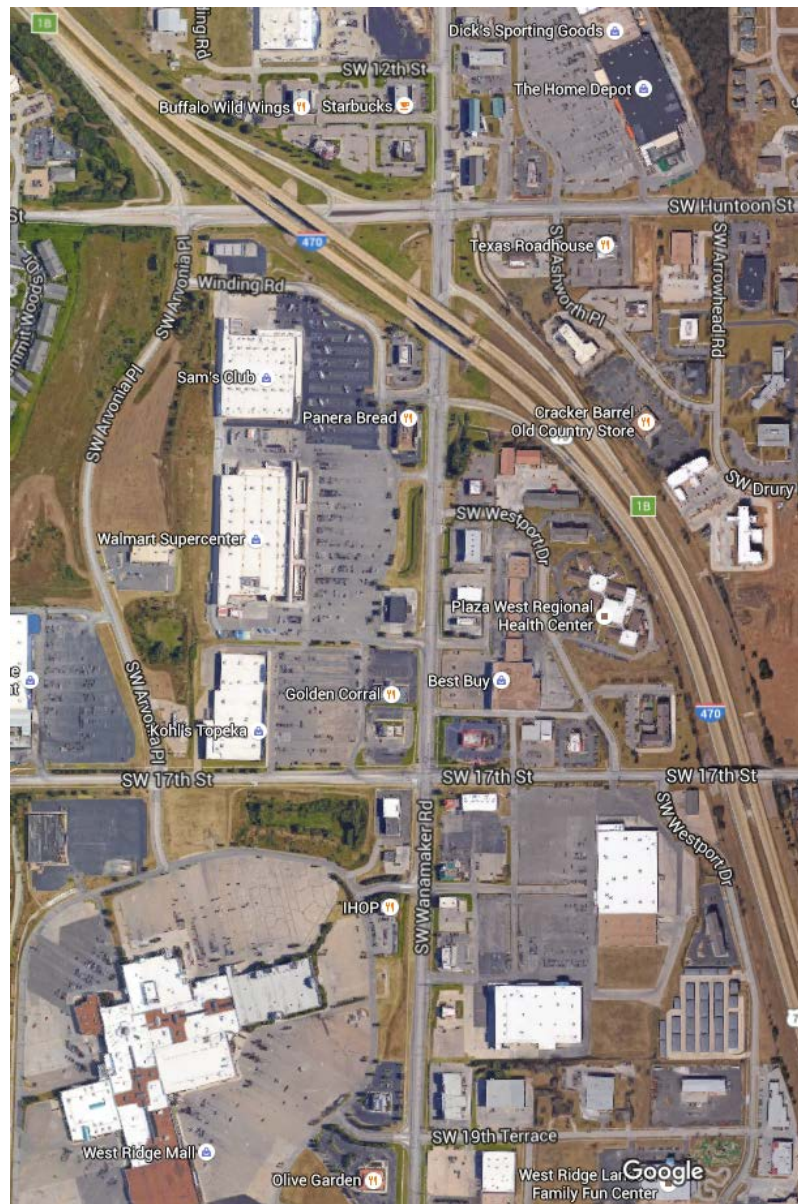


Figure 2. Wannamaker corridor in Topeka, Ks. (source: Google maps).

Wanamaker corridor is a highly developed commercial corridor in the western part of Topeka, KS. Although the actual Wannamaker corridor is much longer, only a portion of the corridor from a business entrance north of 12th Street (refer [Figure 2](#)) till the intersection of 19th Street and Wanamaker Road (refer [Figure 2](#)) is used in this study. There are many number of business entrances along the Wannamaker corridor that are controlled by stop signs. The intersections on Wannamaker Road at Huntoon Street, the on-ramp to I-470, 17th Street, a business entrance at the northeast corner of the West Ridge Mall, and 19th Street are controlled by traffic-actuated signals. Each of the signalized intersections were replaced with roundabout treatment for “after” condition in this study. Businesses entrances that are controlled by stop signs were assumed to be right turn only; in other words, when left turn at a stop sign is prohibited, the vehicle will have to proceed to the next roundabout and take a U-turn to travel in its intended direction. Traffic counts for two one-hour periods at the selected signalized intersections were obtained from the city traffic engineer.

3.1. SIDRA Analysis

SIDRA is an intersection analysis software that is used worldwide for calculating intersection capacity, level of service, and performance analysis for various intersection treatments. SIDRA 5.1 version software was used to compare the performance metrics of the current signalized intersections to what would happen if the current signalized intersections were converted to roundabouts and only right turns were allowed at all other intersections. SIDRA intersection software was specifically used to compare traffic operations at the intersections of Wanamaker Road and Huntoon Street (refer [Figure 3](#)) and Wannamaker Road and off-ramp of I-470 (refer [Figure 3](#)).



Figure 3. Wannamaker Road, Huntoon Street to I-470 Off-Ramp. (Source: Google Maps).

Vehicles that are exiting from I-470 via I-470 off-ramp and turning right (going North) onto Wannamaker Road experience many conflicts with north bound vehicles on Wannamaker Road. Similarly, left turning vehicles from the I-470 off-ramp face conflicts with south bound vehicles of Wannamaker Road. If we assume a roundabout replacing the existing signalized intersection at Wannamaker Road and Huntoon Street, then the left turns from I-470 off-ramp would make a right turn, travel north, make a U-turn at Wannamaker Road and Huntoon Street intersection and then proceed south on Wannamaker Road without facing severe conflicts.

Figures 4(a)-(d) indicates the hourly traffic volume of the intersections of Huntoon Street and I-470 ramp with Wannamaker Road before and after the assumed roundabout. The intersection of Wannamaker Road with Huntoon Street was initially signalized controlled; a roundabout control was assumed at this location. The Intersection of Wannamaker Road with I-470 off-ramp is T-intersection having stop control for I-470 off-ramp; for the after condition at this T-intersection, only right turns are allowed for vehicles from I-470 off-ramp and left turning vehicles should take a right turn, proceed to hypothetical roundabout at Wannamaker Road and Huntoon Street, take a U-turn and then proceed to their intended direction. At the Wannamaker Road and Huntoon Street intersection, traffic counts of approaching traffic and turning movements are same for the before and after situation (part A and part B of Figure 4), except for the south approach of Wannamaker Road in the after condition (refer part B of Figure 4) which has an additional 174 vehicles making U-turns; these 174 U-turns are vehicles that were making left turn from I-470 off-ramp onto Wannamaker Road at the T-intersection in the before situation (part C of Figure 4).

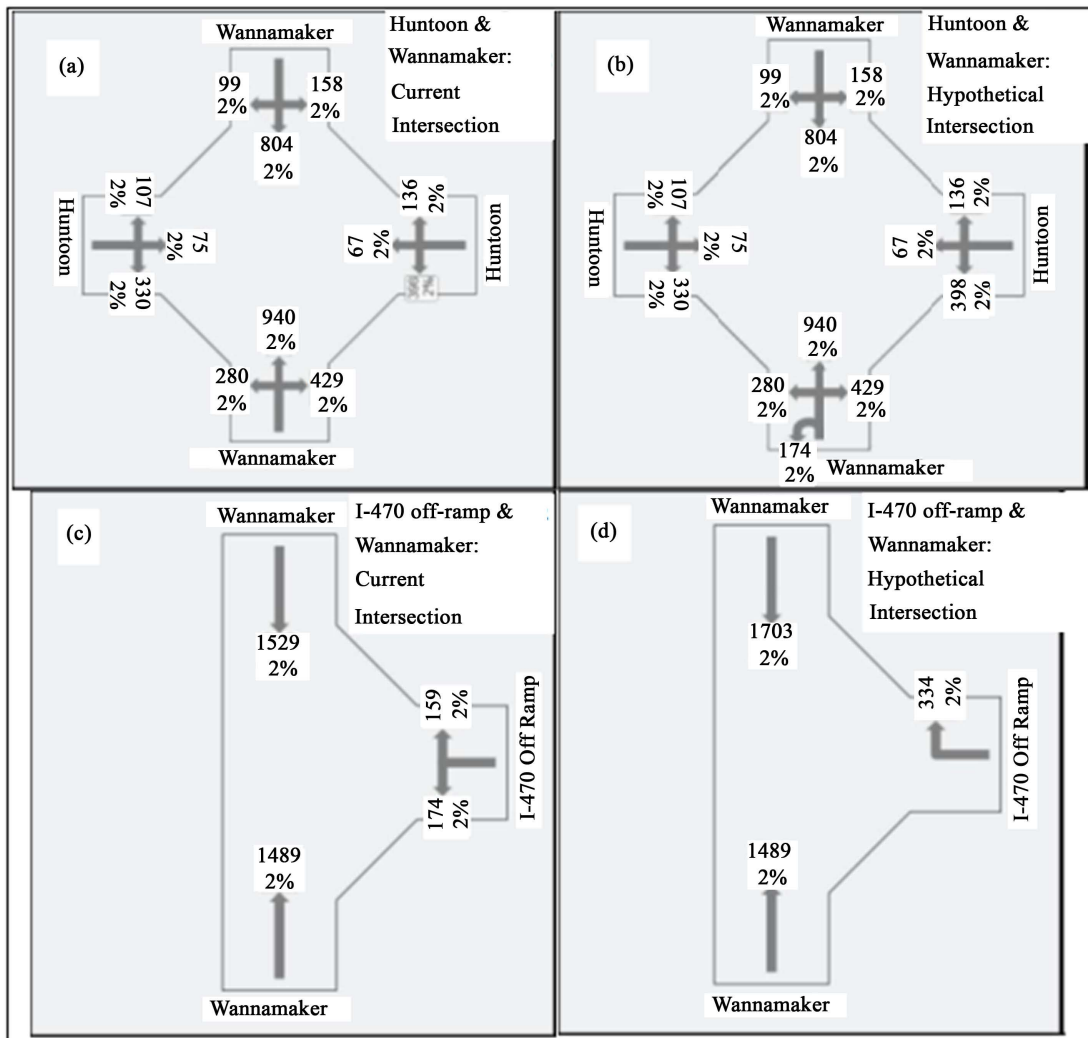


Figure 4. Hourly traffic counts of the intersections of Huntoon street and I-470 Off-Ramp with wannamaker road.

Based on SIDRA analysis, average delay per vehicle and level of service for each possible vehicle movement is calculated for all approaches of Wannamaker Road intersecting with Huntoon Street and I-470 off-ramp and is shown in **Figure 5**. It can be observed from Part B of **Figure 5** that the delay on each movement is comparatively less for roundabout when compared to before treatment. The delay for left turns especially is observed significantly less; this trend is also observed for south leg of the Wannamaker Road and Huntoon Street roundabout even though the approach volume is 174 vehicles more. At signalized intersection, although vehicles travel faster while using the intersection when compared to roundabout, the wait time for a green light at signalized intersection reduces the overall average speed. An optimal cycle length of 108 seconds was used for the signalized intersection at Wannamaker Road and Huntoon Street intersection, and the SIDRA analysis showed that 20% of the left turning vehicles for the two approaches of Wannamaker Road cannot clear the intersection. Therefore, the left turn arrows (part A of **Figure 5**) for both approaches of Wannamaker Road are red indicating a level of service of “F”. Russell *et al.* have analyzed multiple roundabouts in Kansas and found that for any given level of traffic, various vehicle movements at roundabout generally operated at a minimum one level of service higher than comparable movements at signals [12].

Total vehicle operating and time costs were analyzed for the current treatment of Huntoon Street and I-470 off-ramp with Wannamaker Road and compared to hypothetical roundabout treatment at Wannamaker Road and Huntoon Street. Classification of traffic vehicles was not available for intersections of Wannamaker Road with Huntoon Street and I-470 off-ramp, therefore SIDRA default values were used for a mix of different kinds of vehicles and percentage of trucks. The costs for all vehicle movements, except the left turn vehicle movements, are found substantially the same; for many instances, the costs for signalized options are slightly higher. The

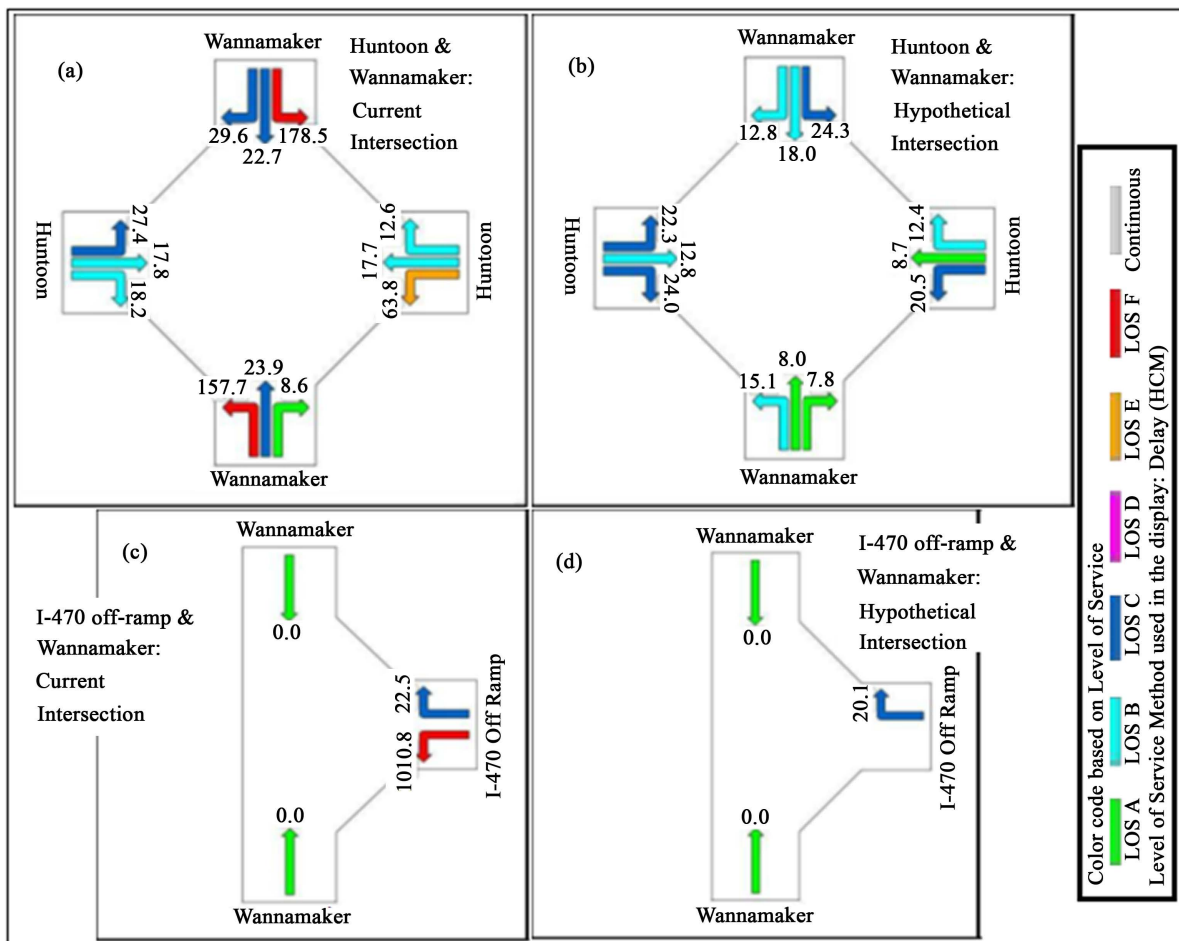


Figure 5. Level of service and average delay for before and after roundabout treatment at Huntoon street and Wannamaker Road.

operating costs and time cost for left turning vehicles are found substantially higher for a signalized option mainly because of the delay experienced by left turning vehicles. Carbon-dioxide (CO₂) emissions were found to be same whether the intersection is signalized treatment or a roundabout treatment. As far as emissions are concerned, through movements are slightly better with the signalized intersection and turning movements are slightly better with roundabout treatment. The additional right turn and the U-turn movements resulting by making Wannamaker Road and I-470 off-ramp intersection right turns only have generated additional CO₂ emissions, however, they are considerably less when compared to emissions that are eliminated when the left turning vehicles at Wannamaker Road and I-470 off-ramp intersection are diverted toward the hypothetical Wannamaker Road and Huntoon Street Roundabout.

3.2. Business Entrance near the Bed Bath & Beyond Store

As a part of this study, one business entrance on Wannamaker corridor is also analyzed which is a T-intersection that provides access to a large parking lot that served several stores, including Bed Bath & Beyond and Hobby Lobby. This business entrance is shown in [Figure 6](#).

Access onto Wannamaker Road from the business entrance is controlled by a stop sign. A signalized intersection is present immediately to the north of the T-intersection business entrance which serves IHOP and West Ridge Shopping Center on the west and K-Mart on the east. South of the T-intersection business entrance is another signalized intersection at 19th Terrace Road. For the purpose of after condition for this study, the two signalized intersections were replaced with hypothetical roundabouts and the left turns at the T-intersection were restricted. By restricting left turn movements at the business entrances, the left turn movements off of Wannamaker from the center lane are also eliminated. In this case, left turning vehicles onto the entrance off of Wannamaker and left turning vehicles onto the Wannamaker off of the entrance proceed to the roundabout just to the



Figure 6. Bed bath & beyond and hobby lobby access onto Wanamaker. (Source: Google Maps).

south and north roundabouts respectively and make a U-turn to continue their trip. A 16.4 second delay of left turning vehicles onto the entrance, a 474.8 second delay of left turning vehicles onto the Wanamaker off of the entrance has been eliminated after considering roundabouts. Moreover, the delay of right turning vehicles off of the entrance onto the Wanamaker has diminished from 42.4 seconds to 15 seconds.

3.3. VISSIM Analysis

Apart from the SIDRA analysis, a secondary analysis was conducted for the traffic in the vicinity of Wannamaker Road and Huntoon Street intersection using a different model—VISSIM. The objective is similar to that involved in the SIDRA analysis that was conducted at the selected intersection. Similar to SIDRA, VISSIM software is also used to analyze specific intersections, but can also be used to analyze a series of intersections or a limited network.

A VISSIM simulation was run for the current signalized configuration and the hypothetical roundabout configuration at Wannamaker Road and Huntoon Street and also for T-intersection (Wannamaker Road and I-470 off-ramp) south of the intersection which clearly showed that the queue length is much shorter on the I-470 off-ramp when all vehicles turn right and the southbound vehicles make a U-turn at the Wannamaker Road and Huntoon Street roundabout. The average delay and level of service results from the VISSIM analysis for the before after conditions at the two intersections of Wannamaker Road with Huntoon Street and I-470 off-ramp are summarized in **Table 2**. Average delay for all approaches at Wanamaker Road and Huntoon Street intersection is reduced from 32.8 seconds (signalized treatment) to 9.5 seconds (hypothetical roundabout treatment). The greatest reduction in the average delay for all the approaches is at T-intersection of Wannamaker Road and I-470 off-ramp from 92.9 seconds to 11.3 seconds. It has to be noted that some of the vehicles (174 vehicles) having a 11.3 second delay at the I-470 off-ramp terminal will also experiencing a 9.5 second delay while making a U-turn at Wannamaker Road and Huntoon Street roundabout. However, the total deal is still considerably less than what they are experiencing with the current configuration.

4. Conclusions and Recommendations

This study analyzed the impact of roundabouts at businesses to their business performance and overall traffic flow. This task is achieved by two major study objectives: 1) conducting survey of businesses around the roundabout corridors in different places in the US and 2) conducting a before-after study of a business corridor in Topeka, KS by simulating the after situation of the business corridor with a hypothetical roundabout treatment using SIDRA and VISSIM software.

An analysis of survey responses from business owners from Kansas and Indiana regarding the roundabout near their business has showed that business owners' perception of roundabout differs with location of roundabout. Since roundabouts are relatively new in the United States, in some areas, their implementation tend to be a polarizing topic when they are initially introduced, *i.e.* strong supporters on one side and strong opponents on the other side. Similar results were also observed from the business owner surveys conducted in various cities in the state of Kansas and in Caramel, IN; business owner's views vary from wide acceptance to non-acceptance. In Caramel, IN, 35.7% of the business owners felt roundabout was an "excellent" addition to their street or neighborhood, 35.7% felt "very good", and 14.3% felt "good" *i.e.* a total of 85.7% of the respondents though that roundabouts have a positive impact on their business performance. Caramel, IN is relatively small to medium sized city with over 60 roundabouts and is called as "roundabout city". In Topeka, KS 23.1% of the business owners felt roundabout was a "very good" addition to their street or neighborhood, and 38.4% felt "good" *i.e.* a total of 61.5% of the respondents though that roundabouts have a positive impact on their business performance. Roundabout acceptance seems to increase as the number of roundabout installations in an area increase and the

Table 2. Performance measures by VISSIM analysis.

Criterion Location	Current Intersection With Signals		Theoretical Roundabout	
	Level of Service	Average Delay (sec)	Level of Service	Average Delay (sec)
Wanamaker Road and Huntoon Street	C	32.8	A	9.5
I-470 Off Ramp onto Wanamaker Road	F	92.9	B	11.3

length of time residents have been exposed to them. More public education about the safety effectiveness, performance metrics, and other advantages of roundabouts can probably increase their acceptance in the future. However, at present, as can be seen in the survey, views vary from wide acceptance to non-acceptance. The simulation of a hypothetical roundabout corridor on Wanamaker Road in Topeka, KS using SIDRA and VISSIM showed significant reductions in delay and queueing for most all significant traffic movements. The conclusion from the software simulations is that roundabouts installation would provide better traffic flow and improved access to businesses.

Acknowledgements

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