

Comparative Evaluation of Roundabouts with other Intersection Control Methods in the Island of Jamaica

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Abstract

Roundabouts have been in use/operation in Jamaica for many years. Some of these were inherited from the British prior to Independence in 1962. Many of these were installed along rural highways, as space constraints limited their use in urban areas. Since 1990, only two new roundabouts have been installed, and many more than this have been removed and replaced with traffic signals. Many persons have been convinced that roundabouts are outdated devices that are no longer appropriate for use in a modern society. This perception, however, has not been supported by any empirical evidence, as most of these installations are not fully evaluated to allow a true comparison of the quality/level of service provided by the various devices. This research paper compares the operational characteristics of roundabouts with other methods of intersection control used at four (4) locations in Jamaica, with similar traffic and in the same geographical area. The specific operational characteristics that are compared are: traffic volume and distribution, delay per vehicle, accident rate/conflicts, maintenance costs, land and infrastructure requirements, and driver compliance. While roundabouts generally require more land and higher initial capital outlay, the ongoing maintenance costs are significantly lower, and accident rates are generally less. However, the efficiency of roundabouts tends to decrease with increasing traffic volume, and driver compliance becomes more critical to effective operation. The findings of this study will be used to influence policy decisions and standard-setting in the selection of intersection control methods for future road improvement projects.

Background

Roundabouts have been in use/operation in Jamaica for many years. Some were inherited from the British prior to Independence in 1962. Many of these were installed along rural highways, as space constraints limited their use in urban areas.

There are about fifty (50) roundabouts in Jamaica, not including those installed fairly recently in residential schemes. Since 1990, only two new roundabouts have been installed along major public roads, and many more than this have been removed and replaced with traffic signals. Many persons have been convinced that roundabouts are outdated devices that are no longer appropriate for use in a modern society. This perception, however, has not been supported by any empirical evidence, as most of these installations are not fully evaluated to allow a true comparison of the quality/level of service provided by the various devices.

New road corridors are being constructed with priority or traffic-signal controlled junctions where roundabouts could potentially be more suitable solutions. Policy directives for the use of more grade-separated junctions further complicate the issue, as there are no clear standards or guidelines to govern intersection installations, and these are needed to establish the role and suitability of different types of intersection control to be used as the circumstances dictate.

While roundabouts generally require more land and higher initial capital outlay, the ongoing maintenance costs can be significantly lower, and accident rates are generally less. However, the efficiency of roundabouts tends to decrease with increasing traffic volume, and driver compliance becomes more critical to effective operation. Careful analysis of each potential location is therefore necessary to determine whether a roundabout would be a suitable installation for the prevailing and projected conditions.

The apparent lack of or scarcity of empirical evidence to support the view that roundabouts are inappropriate for modern day society necessitates a study that seeks to provide data that is reliable, valid and relevant, the analysis of which can/will provide a basis for an informed decision on the issue. Hence, this research will compare the *operational characteristics* of roundabouts with other methods of intersection control used at four (4) locations in Jamaica, with similar traffic and in the same geographical area.

The findings of this study will be used to influence policy decisions and standard-setting in the selection of intersection control methods for future road improvement projects.

Literature Review

Baranowski¹ states that roundabouts are being increasingly considered in the United States to improve vehicle safety, increase roadway capacity and efficiency, reduce vehicular delay and emissions and to identify community gateways. He defines a typical roundabout as an unsignalised intersection with a circular central island and a circulatory roadway around the island, at which vehicles entering the roundabout yield to vehicles already on the circulatory roadway. In relation to the future of roundabouts, he states:

“The roundabout community anticipates that roundabouts will be built in the United States annually by the hundreds in the coming years and by the thousands annually, duplicating the trends first in Britain and Australia during the 1970s and 1980s and now being repeated throughout western Europe. For example, France went from 12,000 roundabouts in 1990 to over 23,000 roundabouts today. Most have been built since the mid-1970s. In 2001, there were 23,000 roundabouts in France resulting in 1,329 injury accidents, but only 86 involving pedestrians”.

Despite this, roundabouts are still controversial in the United States. The design of the Yelm Highway project² in Thurston, Washington, included roundabouts, which have the advantage of requiring less property for a centre turn lane than some signalised locations, but citizens had concerns about pedestrian safety, driver inexperience with roundabouts and resulting backups.

Some arguments used by design engineers include: roundabouts will reduce speed, reduce the number and severity of collisions, keep traffic moving and require less maintenance than signalized intersections. The arguments given for roundabouts are relevant in the Jamaican context given the high level of accidents on our roadways, particularly fatal accidents. Also, since Jamaica is a small island nation, any intersection control mechanism that supposedly uses less property should/would likely be viewed favourably.

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One textbook on the subject states that space requirements for roundabouts have reduced over the years (see below). However, one must consider that this question of less land needed for roundabouts is relative to other factors than just the availability of land. For example, Jamaica, being a small island nation would necessarily have smaller capacity road networks and, roundabouts would have to be built to fit into that network.

Van Zuylen³ makes the following statement about roundabouts:

“If the capacity of a priority intersection is insufficient, a roundabout can be an alternative. By separating conflict areas, the performance of a roundabout is higher than the performance of most regular uncontrolled priority intersections; delays are often less and the acceptance by road users higher. The geometry and the priority rules determine the capacity of the roundabout. Due to its strong reduction of severe accidents and its high capacity in comparison with original uncontrolled intersections, roundabouts have become rather popular in the past decades. The number of roundabouts is growing fast: each year about 50 to 60 new roundabouts are built in the Netherlands.”

This certainly makes a strong argument for the use of roundabouts for intersection control. The author states that roundabouts were rarely used by Dutch road designers until the mid 1980's. Roundabouts gradually became widely accepted, as the priority rules and the design standards were changed. The distinction between traditional and modern roundabouts is primarily the fact that the circulating traffic has priority. As a consequence, traffic can leave the roundabout unhindered and buffer space on the roundabout is hardly needed. So, the size of the roundabout decreased. Another major advantage of the “new” roundabout concerns the achieved safety.

Interestingly, the crucial priority rule for the “modern” roundabout concerning its characteristic of giving the circulating traffic the priority – which is the critical element to the improved safety achieved – has been in effect in Jamaica from the very early days of the implementation and use of roundabouts in Jamaica. The operation, and resulting capacity, of most of these roundabouts are governed by the principles of gap-acceptance at low to medium speeds rather than weaving at higher speeds.

Nambisan and Parimi⁴ conducted a comparative study in Las Vegas, Nevada, with specific emphasis on the safety performance, and concluded that:

“The findings of the study reported here indicate that roundabout control is safer than STOP/signal control at the minor- and medium-level intersections evaluated. Although the findings for the major roundabout intersections are not similar, it is believed that improved road design and public awareness would increase intersection safety at such roundabouts.”

The authors noted the difficulty in choosing “comparable” intersections based on ADT, but a letter published in a subsequent *ITE Journal*⁵ presented several comments about the methodology, including the fact that the intersections being compared were in locations that did not share similar traffic, land use, or socio-economic characteristics, and that recent modifications had been made to some of the mentioned locations to improve safety.

Study Methodology

This research involved empirical data collection and field measurement of specific operational characteristics of roundabouts, to be compared with similar measurements made at intersections with other methods of intersection control. The specific characteristics that for comparison are:

- a) Traffic volume and distribution
- b) Delay per vehicle
- c) Accident rate / conflicts
- d) Maintenance costs
- e) Land / infrastructure requirements
- f) Driver compliance

Given the nature of the characteristics to be studied, various methodologies were used. These include, but are not necessarily limited to the following:

1. **Traffic counts** – using count forms/counters and/or electronic counting devices.
2. **Use of chronometers** – for determining time delays re vehicles using the intersection.
3. **Database searches** of available accident records – to ascertain the number of accidents and their cause(s) at each intersection that is being studied.
4. Appropriate economic/**costing** procedures – to determine the monetary cost of constructing and maintaining the intersections being studied.
5. Use of appropriate **distance and area measuring and imaging device(s)** - GPS / GIS, etc. – to determine the quantity of land and infrastructure required for the different types of intersections being studied.
6. **Field observation** of driver behaviour and compliance

Data Collection

- Traffic counts and queue delay studies were conducted simultaneously at the locations under comparison.
- Accident data was gathered from the accident database, validated by physical checks of records during field visits to the relevant police divisions.
- The intersection geometry was determined through a combination of on-site observation and the use of satellite imagery and aerial photography.

Data Analysis

The traffic data and queue delay results were entered and analysed using Microsoft Excel, and charts comparing the average delay per vehicle with the total intersection volume were generated. A more detailed analysis of the delay experienced on major versus minor roads was also conducted.

Projections of the economic value of potential time savings (based on measured delay at the different intersections) were made using national estimates of the value of commuter time.

Estimated construction costs (at current industry rates) for the different intersection configurations were determined for each study location, and the life cycle costs (capital and recurrent/maintenance costs) were determined for a 15-year period.

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Accident history, including the frequency, severity and nature of accidents occurring at the study locations was assessed and analysed to make comparisons between the safety record of the roundabouts and the other methods of control.

Study locations

The locations at which to execute the study were selected based on in-depth knowledge of the roundabouts throughout Jamaica. Several roundabouts could not be included in this study because of difficulty in identifying an appropriate intersection for comparison. The criteria used for selection are as follows:

1. Both intersections (roundabout and comparative intersection) should have similar traffic volume and directional distribution of traffic movements.
2. All approaches to both intersections to be two-lane roadways.
3. Intersections should be in close proximity (within one kilometre of each other) and in areas of similar land use.
4. Locations should be within one-hour travel time of the capital of Kingston.

The four (4) study locations that were ultimately selected are shown in Figure 1 below, and all are located in Kingston and St. Andrew (KSA) and St. Catherine, in urban and semi-urban areas with relatively high traffic volumes.

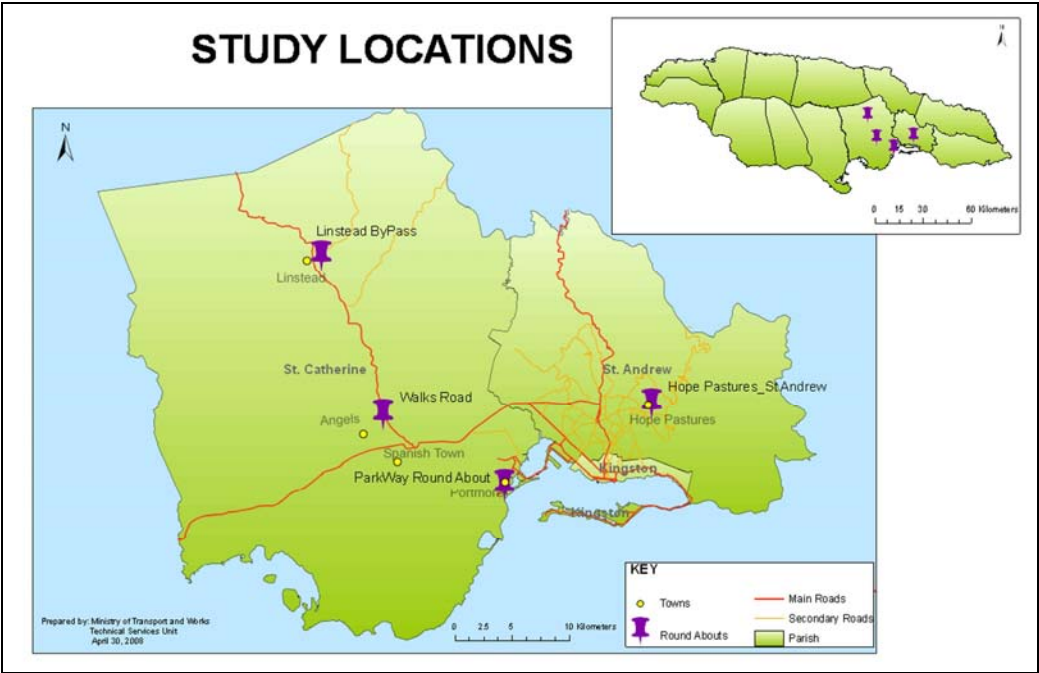


Figure 1

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Details of the study locations are set out below.

Location 1 (Hope Pastures):

Urban residential area – roundabout vs. 2-way stop control at 4-leg intersection

- a. The roundabout at the Hope Boulevard / Monterey Drive Intersection
- b. The Charlemont Drive/Monterey Drive intersection, approximately 100 metres northwest of the roundabout.

Both intersections are indicated in Figure 2.

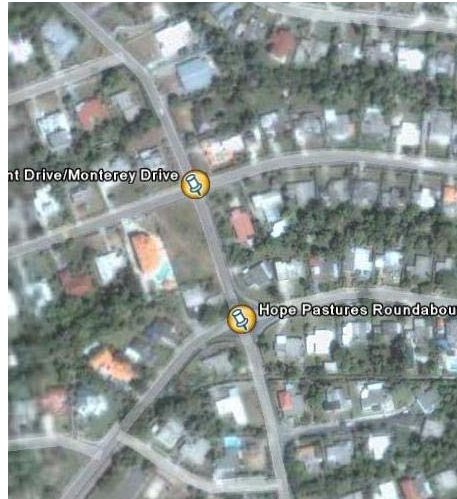


Figure 2

Location 2 (Linstead Bypass):

Rural two-lane highway – roundabout vs traffic signal at 4-leg intersection

- a. Roundabout at Rosemount intersection along Linstead Bypass
- b. The intersection of the main road to Guys Hill with Linstead Bypass at Vanity Fair

These intersections are shown in Figure 3.

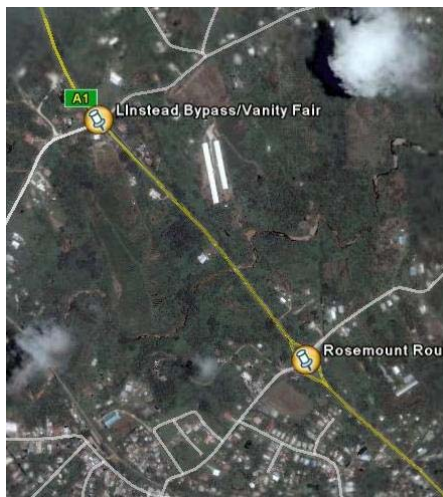


Figure 3

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Location 3 (Walks Road):

Suburban two-lane highway – roundabout vs minor street stop control at T-junction

- a. Roundabout at Walks Road/entrance to Angels Phase II
- b. Intersection at entrance to G.C. Foster College

Figure 4 shows the intersections that were studied.

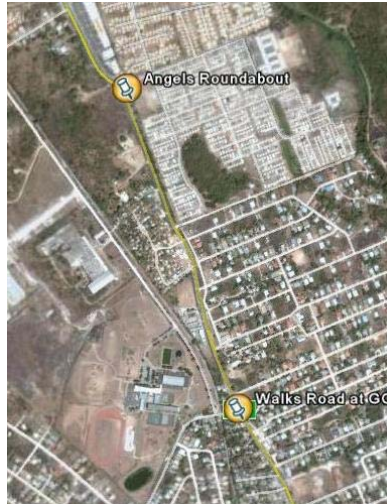


Figure 4

Location 4 (Portmore Parkway):

Urban residential area – roundabout vs 2-way stop at 4-leg intersection

- a. Roundabout at Portmore Parkway/Edgewater
- b. Intersection along Portmore Parkway at HEART Academy

These intersections are shown in Figure 5.

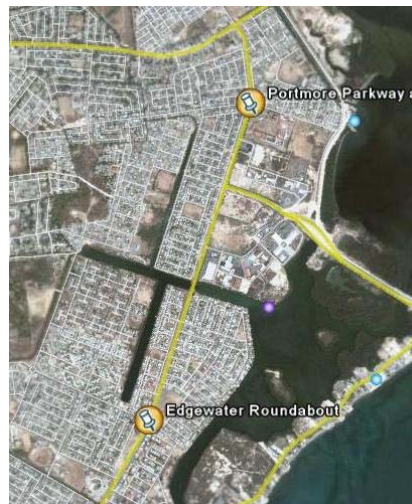


Figure 5

Research Findings

A number of setbacks were experienced that affected the results of the research exercise, and it is hoped that these can be overcome in follow-up studies, which should be conducted to assess the performance of roundabouts in more detail.

The data analysis revealed occasional observer inaccuracies and gaps in the data, some of which could be attributed to inclement weather that was experienced at the time of the study. Peak period congestion, leading to spillback into the intersections, also skewed the results somewhat, as well as overall driver and user behaviour. It should also be noted that all regulatory signs were not in place at some of the roundabouts and intersections, and this could have had an impact.

Safety

The collision history for three years (1999-2002) was used to compare the frequencies and types of collisions that took place at roundabouts and other intersections. The evaluation of the collision rates was based on the sample of intersections at which crashes occurred, because a complete inventory of all intersections was not available. The collision history for the specific study locations could not be compared because no information was available at the required level of detail.

Table 1 shows the breakdown of reported collisions at intersections by type and severity. Of the collisions occurring at roundabouts, the percentage of fatal and serious injury accidents was similar to that for unsignalised intersections, both being higher than the average for all intersections. The rates at signal-controlled junctions were lower than the overall average. For minor injuries, the frequency of occurrence was lower at roundabouts and traffic signals when compared to the overall average for all intersections, and higher at unsignalised intersections. Based on these general statistics, the installation of a roundabout or a traffic signal could be used to improve the safety record of an unsignalised intersection.

Table 1: Collisions by intersections type and severity (1999-2002)

Intersection type	# of collisions	Fatal	Serious injury	Minor injury	Property damage only
Roundabout	227	3/227 = 1.32%	15/227 = 6.61%	21/227 = 9.25%	188/227 = 82.82%
Traffic signal	2156	12/2156 = 0.55%	106/2156 = 4.92%	194/2156 = 9.00%	1844/2156 = 85.53%
Other	5845	73/5845 = 1.25%	394/5845 = 6.74%	662/5845 = 11.33%	4716/5845 = 80.68%
Total all intersections	8228	88/8228 = 1.07%	515/8228 = 6.26%	877/8228 = 10.66%	6748/8228 = 82.01%

Table 2 compares the collision rate for roundabouts and traffic signals in relation to the number of intersections of each type. As there are far fewer roundabouts than traffic signals, the number of collisions per intersections and the injury/fatality rate is higher at traffic signals than at roundabouts. This would indicate that roundabouts have better safety characteristics than traffic signals. However, average daily traffic information for each intersection type was not available, so no analysis in relation to the exposure of motorists could be carried out. This is an important factor which should be evaluated to provide a complete assessment of the safety record at the different types of intersections.

Table 2: Comparison of collisions at roundabouts and traffic signals (1999-2002)

Intersection type	# of intersections	# of collisions	Collisions per intersection	Injury and fatal collisions	Injury/fatality per intersection
Roundabout	~ 50	227	4.54	39	0.78
Traffic signal	~ 200	2156	10.78	312	1.56

At roundabouts, rear-end collisions were predominant (41%), followed by other accidents (34%, including switching lanes, failing to keep in lane, and improper swerving), and crossing collisions (15%). In contrast, at other intersections (signalised and unsignalised), crossing crashes accounted for 31% of the occurrences, with 22% being rear-end collisions, 16% other accidents, and 14% turning crashes. For this comparison, traffic signals are included in the category of “other intersections”.

Table 3 shows the comparison of traffic crashes by accident type.

Table 3: Traffic crashes by accident type (1999-2002)

Accident type	ROUNDBABOUTS		OTHER INTERSECTIONS	
	Number	% of total	Number	% of total
Bicycle accident	6	2.64	190	2.37
Crossing accident	34	14.98	2494	31.17
Head-on accident	1	6.60	319	3.99
Overtaking accident	4	1.76	550	6.87
Pedestrian accident	3	1.32	233	2.91
Rear-end accident	93	40.97	1750	21.87
Single accident	8	3.52	131	1.64
Turning accident	0	0	1078	13.47
Other accident	78	34.36	1256	15.70
Total	227	100	8001	100

While general conclusions may be drawn from the information presented in the tables above, more detail is required for these results to be conclusive, and more research is needed in this area.

Driver compliance

During the data collection, the behaviour of drivers was observed to have a large influence on the performance of especially the roundabouts. The factors that had a major effect on the performance are:

- the (pseudo) conflict at entrances of the roundabout
- vehicles stopping along the kerb on the roundabout
- obscurity of traffic rules regarding right-of-way

The latter was also observed in The Netherlands, and regulation was adapted which significantly improved the performance of roundabouts. The traffic rules in Jamaica are well established, but many roundabouts are poorly signed and marked, and addressing this through improved maintenance could be a way to improve the level of compliance.

Another part of drivers' behaviour in Jamaica was the tendency to stop along the side of the road on the roundabout unloading goods and/or people. This caused passing vehicles to reduce their speed or caused unsafe situations when passing vehicles did not reduce their speed.

Especially on large roundabouts in rural areas, drivers approaching the roundabout hardly reduced speed. As a result, traffic on the minor flows approached the roundabout more carefully.

Traffic Volume

The selected intersections experienced 12-hour traffic volumes ranging from about 7,800 vehicles to just under 20,000 vehicles. As shown in Table 4, the roundabouts experienced slightly lower traffic than the comparative intersections, but with sufficient similarity in the hourly traffic to allow reasonable comparisons of the average delay per vehicle.

Table 4: Range of observed hourly traffic

Location	Intersection Type	Lowest traffic/hr	Highest traffic/hr	12-hour volume
Hope Pastures	Rdbt.	446	981	7814
	2-way	519	963	8083
Walks Road	Rdbt.	1079	1686	16960
	T-junc	1300	2269	19723
Linstead	Rdbt.	680	1116	8960
	Signal	817	1204	10882
Portmore	Rdbt.	954	1622	13713
	2-way	1181	1596	14875

Average delay

The estimated delay at roundabouts varied from 0.32 seconds/vehicle to 4.0 seconds/vehicle. In contrast, the delay at intersections ranged from 1.79 seconds/vehicle to 15.22 seconds/vehicle, and was higher than that at roundabouts for all traffic volume situations observed. Table 5 shows the ranges for the specific intersections.

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Table 5: Range of observed average delay

Location	Int. Type	Lowest delay	Highest delay
Hope Pastures	Rdbt.	0.32	2.76
	2-way	4.94	12.53
Walks Road	Rdbt.	0.36	4.00
	T-junc	1.79	11.92
Linstead	Rdbt.	0.85	3.72
	Signal	12.08	15.22
Portmore	Rdbt.	0.53	3.32
	2-way	2.33	5.89

Figure 6 shows the average delay for each hourly volume observed at intersections and roundabouts, and the larger delay at intersections is readily apparent. The large delays indicated by the dashed ellipse were experienced at the signalised intersection.

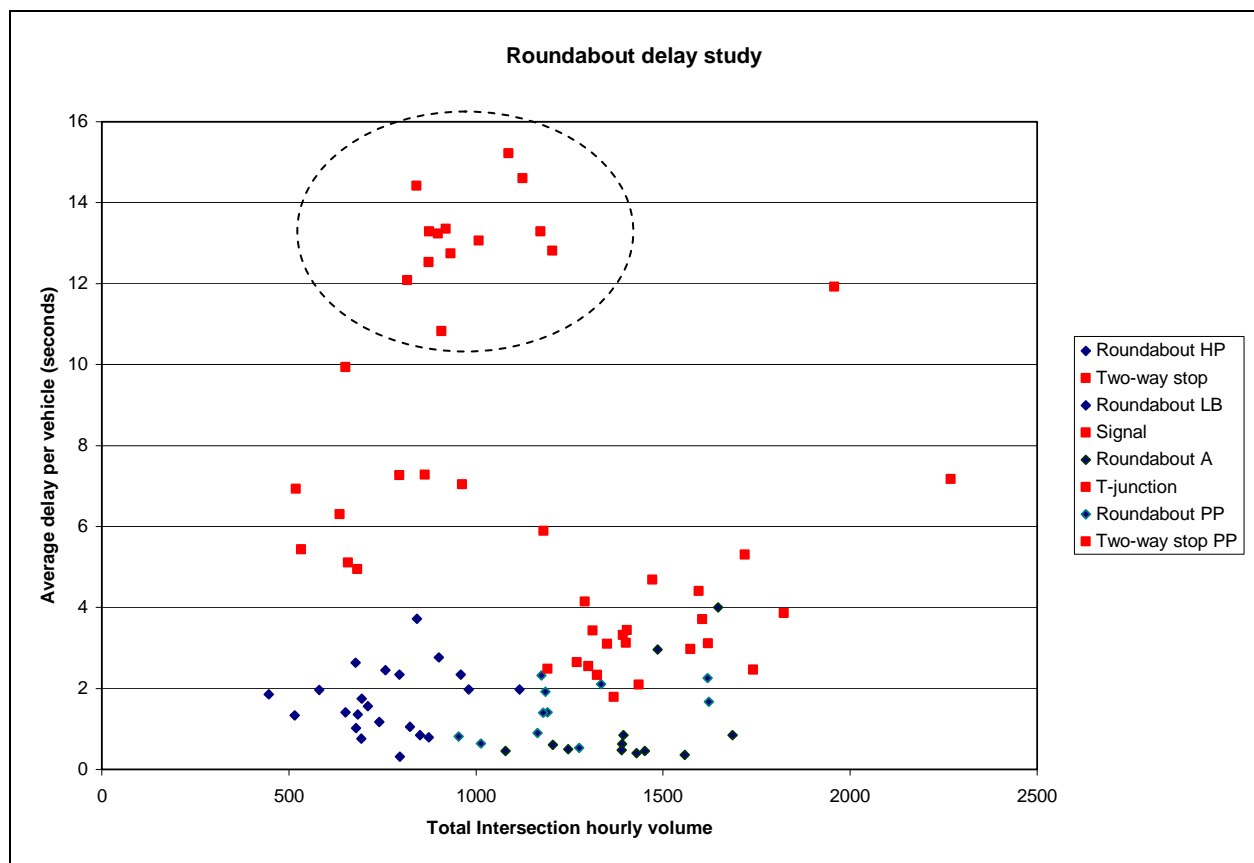


Figure 6

The data also indicates the reduced difference between intersection and roundabout delays with increasing intersection volume. From a total volume of around 1,400 vehicles per hour, the difference in performance becomes less clear.

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At higher traffic volumes, downstream congestion affected the study intersections in some locations, reducing the throughput and increasing the measured delay for reasons not related to the intersection geometry or operation.

It must be noted that in all cases except one (Portmore) the volume of the side flows is relatively small compared to the main flows (ca. 10-25%). With small side flows, the performance of roundabouts is significantly better than that of priority intersections.

There seems to be no statistical relation between the intersection/roundabout volume and average delay since correlation coefficients vary between -0.10 and 0.55.

For Portmore, at least three of the four legs are used more intensively which will estimate the performance more accurately. Ignoring extreme values, the performance of the roundabout on average is higher, as can be seen in Figure 7. Roundabout delay values are concentrated around 1.5 seconds per vehicle whereas intersections delay values are concentrated more around 3.0 seconds per vehicle.

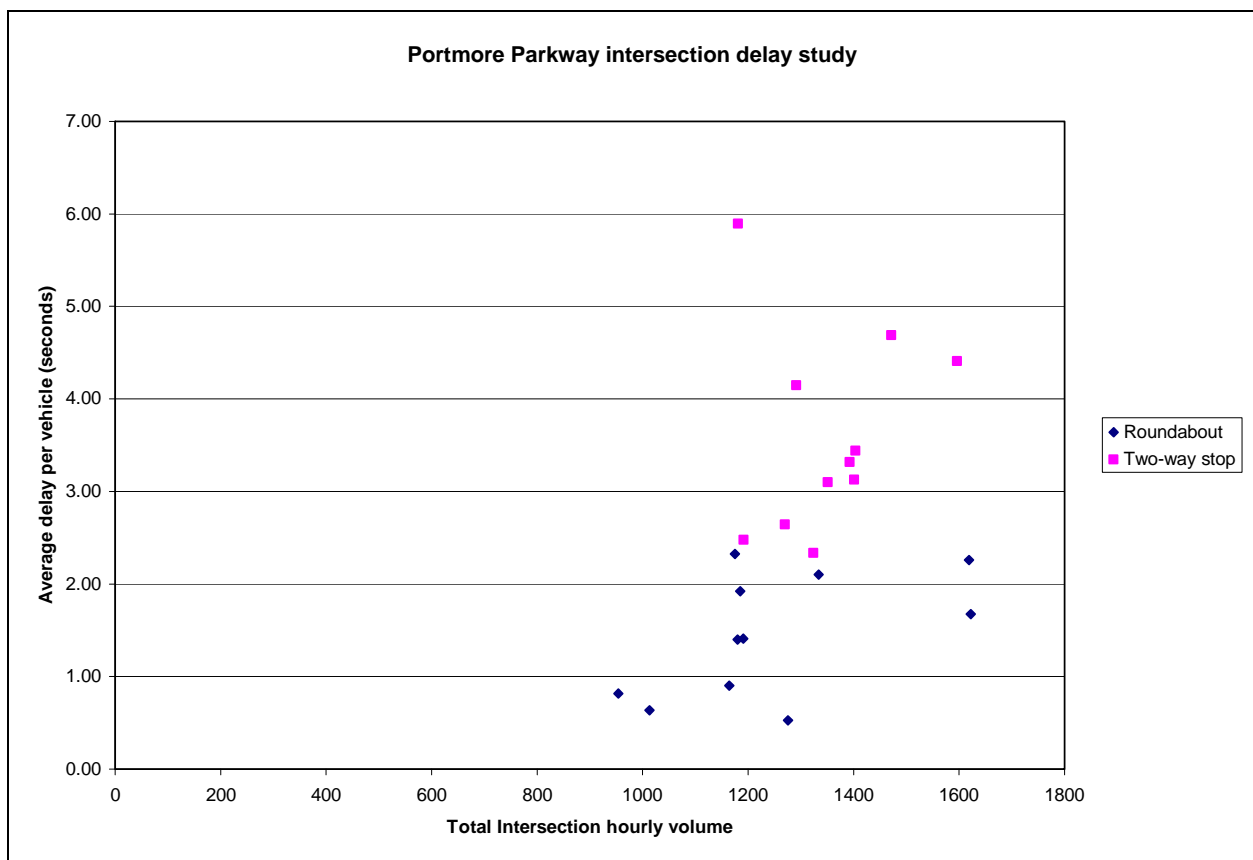


Figure 7

Roundabout delays at 1,200 vehicles per hour volume vary strongly from ca. 1.0 to 2.2 seconds per vehicle. From this, one may assume that performance is dependent on other factors besides traffic volumes that have not been considered in this study. The impact of directional

distribution of traffic, external influences (downstream constraints), and weather may be some of the factors that cause the observed variation at 1,200 vehicles per hour.

A closer look at the traffic flow shows that the minor flows experience most delays on both crossing lay-outs. Again, the roundabout delays are (slightly) lower than the intersection delays as well as the variance in delays. This is illustrated by the example in Figure 8. The delay for minor flows at the two-way stop ranges from 5 to 20 seconds/vehicle in contrast to delays ranging from 0 to 5 seconds for the roundabout minor approach. The difference in major flow delay is not as significant.

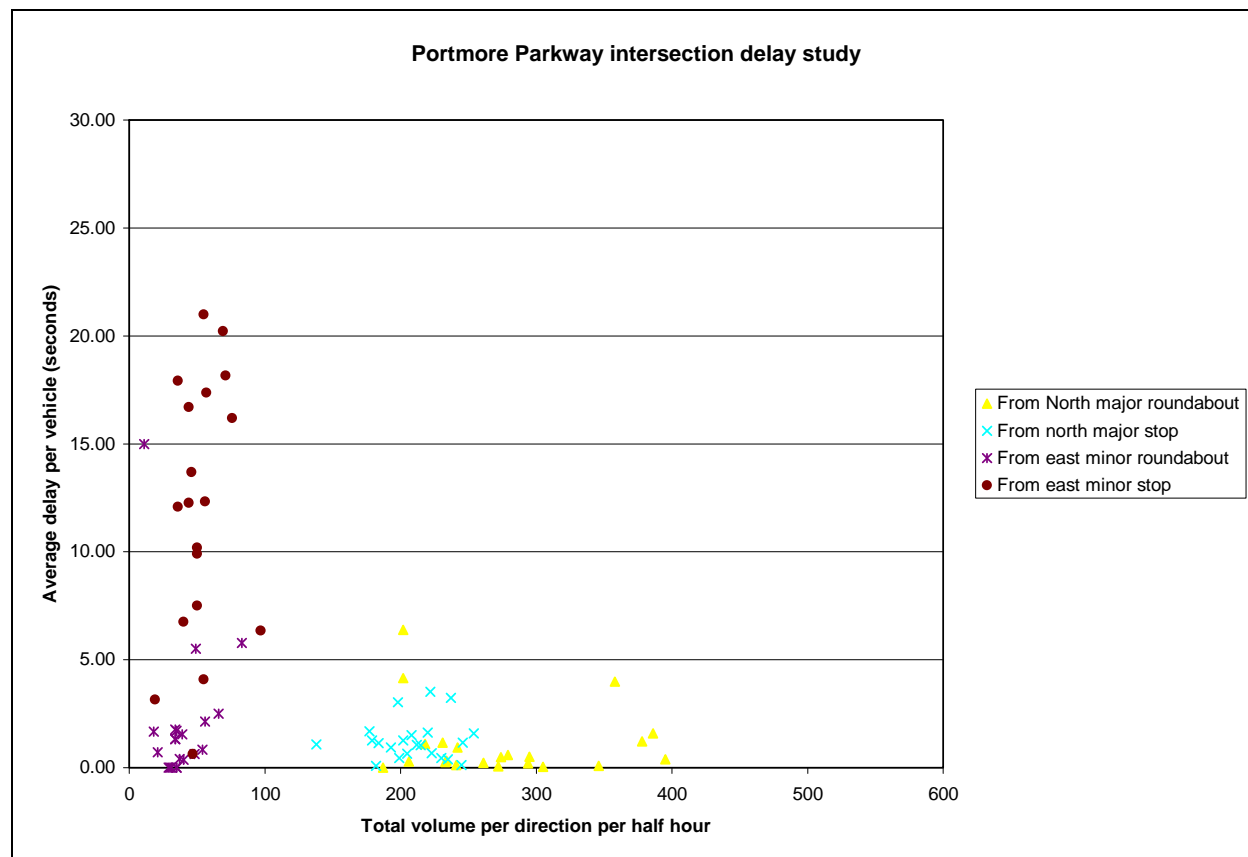


Figure 8

Overall time savings

The daily average delay per vehicle was used to project the potential time saving that is achieved as a result of the existing roundabout, and the results are shown in Table 6. The approach used presumes that delay similar to that observed at the comparative junction would also be experienced at the roundabout for the observed traffic volume. The daily savings per vehicle was translated to a total time savings for the roundabout. This is a benefit to users that has an economic value.

Table 6: Time savings at roundabouts

Location	Intersection Type	Total Daily Volume	Total Delay (sec)	Daily Average (sec/veh)	Saving per vehicle per day (sec)	Total daily saving (hr)
Hope Pastures	Rdbt. 2-way	7814	12465	1.60	6.23	13.52
		8083	63315	7.83		
Walks Road	Rdbt. T-junc	16960	18750	1.11	3.40	16.02
		19723	88995	4.51		
Linstead	Rdbt. Signal	8960	16500	1.84	11.65	29.00
		10882	146835	13.49		
Portmore	Rdbt. 2-way	13713	20670	1.51	2.10	8.00
		14875	53670	3.61		

Construction and Maintenance Costs

Tables 7 and 8 show the surface area, construction costs and estimated annual maintenance costs for the investigated roundabouts and priority intersections respectively. For the roundabout, the total surface, including middle section and safety isles, is given between brackets.

The costs for laying asphalt is estimated at J\$2,500 per m² (inclusive ground preparatory works). The estimated costs for land acquisition varies between J\$2,000 and J\$3,000, depending on location. In addition to this infrastructure the intersection at Linstead requires a traffic signal installation (approximately J\$2.8 million¹). Additional costs include supporting infrastructure and signs.

Maintenance is limited to patching of the road surface. It is assumed that after 7 years the total surface of the road has been patched. For the signalised intersection, energy consumption of traffic lights is included.

Table 7: Construction and maintenance costs for roundabouts

Costs Roundabouts	Hope Pastures	Portmore	Angels	Linstead
Surface area (m ²)	604 (831)	2,112 (5,497)	1,794 (3,231)	1,458 (4,505)
Land acquisition (J\$)	2,077,500	8,742,500	6,843,125	8,357,523
Asphalt surface (J\$)	1,812,000	5,280,000	4,485,625	2,916,018
Additional (25%)	972,375	3,505,625	2,832,188	2,818,385
Total construction (MJ\$)	4.86	17.53	14.16	14.09
Annual O&M costs (MJ\$)	0.1208	0.4224	0.3589	0.2916

¹ The currency exchange rate at the time of the study was J\$70:US\$1.

Table 8: Construction costs for intersections

Costs Intersections (J\$)	Hope Pastures	Portmore	Angels	Linstead
Surface area	49	993	178	1,680*
Land acquisition	147,000	2,482,500	443,750	3,360,000
Road surface	122,500	2,482,500	443,750	4,200,000
Additional (25%)	67,375	1,241,250	221,875	1,890,000
Traffic signals	0	0	0	2,800,000
Total (MJ\$)	0.34	6.21	1.11	12.25
Annual O&M costs (MJ\$)	0.0098	0.1986	0.0355	0.4560

* This intersection has two right-turn lanes located on the main road, increasing the asphalt surface.

For small, not signalized intersections (Hope Pastures, Angels) the maintenance is only about 10% of that for the investigated roundabout. For large intersections and large roundabouts the difference is much smaller (about 50% for Portmore) and with increasing size of the intersection requiring extra lanes, a roundabout may even become more attractive regarding maintenance costs.

Life cycle cost comparison

A fifteen (15) year life was used to determine the life cycle costs of the intersection, including initial construction and annual maintenance as set out above. Roundabouts, with larger surface areas, have higher costs as shown in Table 9.

Table 9: 15-year construction and maintenance

Location	Type	Construction (J\$'000)	Maintenance (J\$'000/year)	15-year C&M (J\$'000)
Hope Pastures	Rdbt.	4,860	120.8	6,672.0
	2-way	340	9.8	487.0
Walks Road	Rdbt.	14,160	358.9	19,543.5
	T-junc	1,110	35.5	1,642.5
Linstead	Rdbt.	14,090	291.6	18,464.0
	Signal	12,250	456.0	19,090.0
Portmore	Rdbt.	17,530	422.4	23,866.0
	2-way	6,210	198.6	9,189.0

The savings in time for users of roundabouts was taken into consideration in the life cycle analysis. An hourly value of J\$120 was used to place a value on the savings to be achieved, but only applied for weekdays with no savings attributed to weekend traffic. As there was no specific collision data for these intersections, the economic impact from a safety perspective could not be included.

Table 10 summarises the results, showing that the roundabouts at two of the locations had a lower net cost than the comparative intersection. At the higher traffic locations with smaller intersections, the savings achieved at roundabouts did not offset the higher costs of maintaining the infrastructure.

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Table 10: Net Cost of Intersections for 15-year period

Location	Type	15-year C&M cost (J\$'000)	15-year time savings (hrs)	Value of savings (J\$'000)	Net Cost (J\$'000)
Hope Pastures	Rdbt.	6,672.0	52,728	6,327	345.0
	2-way	487.0			487.0
Walks Road	Rdbt.	19,543.5	62,478	7,497	12,046.5
	T-junc	1,642.5			1,642.5
Linstead	Rdbt.	18,464.0	113,100	13,572	4,892.0
	Signal	19,090.0			19,090.0
Portmore	Rdbt.	23,866.0	31,200	3,744	20,122.0
	2-way	9,189.0			9,189.0

Conclusions

Although not a statistically representative sample, the collected data on estimated delays at intersections and roundabouts indicates that at lower intersection volumes the performance of roundabouts is higher than that of priority intersections.

With increasing intersection capacity, the performance of roundabouts reduces and similar delays are found at total intersection volumes of about 1,400 vehicles per hour. It must be noted that in three out of the four cases studied, the minor flows represent only 10 to 25% of the total volume.

Delays are primarily experienced on the minor flows with high major flows; probably a result of small gaps on congested major flows.

Roundabouts are more expensive to construct and maintain than priority intersections, but can result in significant savings for users through reductions in delay for traffic flows up to 1500 vehicles/hour and where minor flows are less than 25% of the total volume.

In the long term, large intersections controlled by traffic signals can be more costly than well-designed roundabouts, especially if they are not programmed and maintained with optimal signal timing.

Recommendations

Further research should be conducted to look more closely at the safety elements of roundabouts in comparison with other types of intersection control. This could be achieved through conflict studies where specific collision information is not available.

A further study of factors affecting delay at roundabouts should be carried out, given the variation observed at volumes of about 1200 vehicles per hour.

In order to determine whether the observed operational characteristics are consistent for this type of control in different locations and situations, a follow-up study looking at roundabouts only should be conducted. This would allow for extrapolation of these results to be applied in various scenarios.

Using this comparative evaluation, roundabouts could be implemented in Jamaica up to intersection volumes of about 1,400 vehicles per hour in the peak period. With relatively small minor flows, roundabouts could significantly reduce delays on both the major flow as the minor flows, especially when compared to signalised intersections. Locations that meet these characteristics are likely to be along major corridors in rural areas, in the vicinity of major towns and communities.

Operational thresholds and guidelines should be developed that will inform decisions about the selection of intersection control measures. This would allow roundabouts to be assessed alongside other types of control in a professional and replicable manner.

In designs for sub-urban and rural corridors, at locations where priority control is insufficient for safety or capacity reasons, roundabouts should be given due consideration as a viable and realistic alternative to traffic signals.

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