



World Journal of Mathematics

<https://www.scirea.org/journal/WJM>

December 26, 2023

Volume 1, Issue 1, 2023

<https://doi.org/10.54647/wjm5071003>

## NAVIGATING THE INTERSECTION: A COMPARISON OF ROUNDABOUTS AND TRAFFIC LIGHTS

**Gabriel Obed Fosu**

Department of Mathematics, Kwame Nkrumah University of Science and Technology, Ghana

Email: [gabriel.of@knust.edu.gh](mailto:gabriel.of@knust.edu.gh)

### **Abstract**

This paper compares two intersection traffic management mechanism —roundabouts and traffic lights. It focuses on the distinctive qualities to consider while picking the best possible choice. The paper emphasizes how choosing an acceptable traffic control measure necessitates considering the particular intersection setting and the distinctive qualities of competing alternatives. It concludes that selecting the best traffic control measure is essential for guaranteeing the efficient and safe flow of traffic through intersections and that traffic control measures will continue to advance alongside new technology and urban planning methods.

**Keywords:** Roundabouts, Traffic lights, Traffic control, Safety, Urban Planning, Congestion

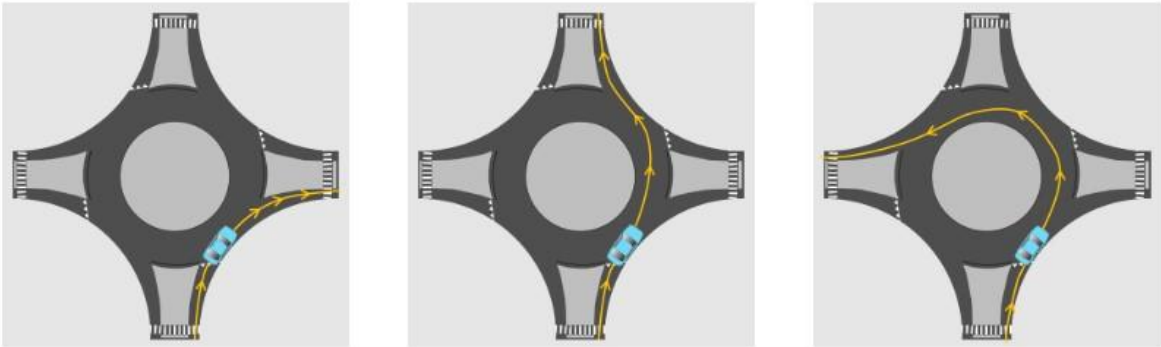
### **1. Introduction**

Tools for managing and regulating traffic flow at intersections incorporate traffic control measures. They are essential in promoting secure and effective mobility in cities and suburbs.

Although they function differently, traffic lights and roundabouts are two frequently used traffic control devices that govern traffic flow. This essay compares and contrasts these two traffic control strategies, examining their benefits, drawbacks, and applicability in various scenarios.

To control traffic at junctions, traffic lights use a system of traffic signals. They are extremely organized in guaranteeing a safe and effective flow of traffic since they clearly indicate when to stop and when to move forward. Prioritizing diverse forms of transportation, such as pedestrian crossings, bicycle lanes, and public transit lanes, is one of traffic lights' main benefits. Additionally, they control traffic during peak hours, easing congestion and enhancing motorists' trip times. However, it is also well recognized that traffic lights contribute to environmental pollution, create backups, and delays.

On the other hand, roundabouts are circular crossroads where traffic circles a center island in a clockwise pattern. Due to their capacity to decrease accidents, particularly major ones involving pedestrians and cyclists, they are growing in popularity in many areas. They encourage slower speeds, lowering the chance of collisions at high speeds, and they take away the possibility of head-on or side-impact incidents. Additionally, roundabouts are more ecologically friendly than conventional intersections and have better traffic flow and congestion reduction. They can, however, be difficult for new drivers to maneuver, especially those who are not conversant with the traffic laws.



**Figure 1:** Maneuvering a roundabout

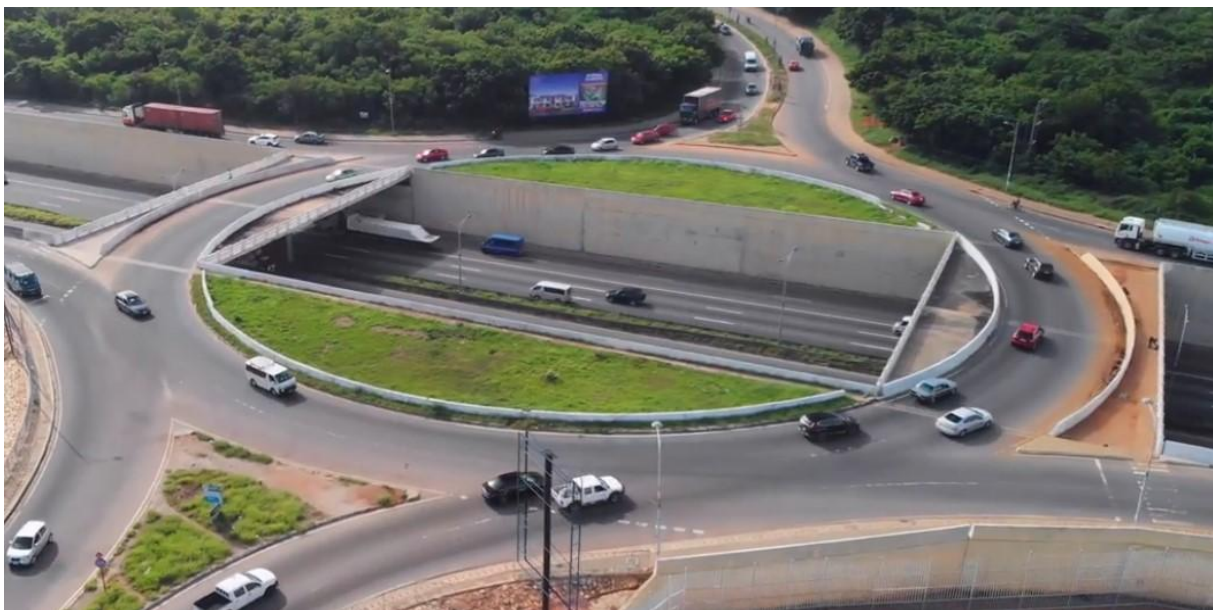
The current paper will examine the benefits, drawbacks, and probable effects of traffic signals and roundabouts on safety, environment, aesthetics, and traffic flow. The elements to take into account while choosing the best traffic control measure and their applicability in various scenarios will also be covered. It will also examine how new technology may affect traffic control strategies as well as their potential role in urban planning. In conclusion, urban

planners and policymakers can choose the most appropriate option by recognizing the distinctive features of each traffic control measure, thereby increasing traffic flow, enhancing safety, and encouraging sustainable mobility.

## 2. Roundabouts

Roundabouts are circular crossroads intended to control traffic flow by requiring entering vehicles to yield to existing traffic. Roundabouts are frequently utilized in locations with heavy traffic or congestion because they can decrease traffic delays, increase safety, and improve the area's overall attractiveness. It improves the area's overall beauty in addition to improving safety. In order to provide a warm and inviting entry to a community, roundabouts are embellished with sculptures and other aesthetic elements.

The potential of roundabouts to lessen traffic congestion is one of their most important benefits. Roundabouts have been demonstrated to reduce vehicle delay by up to 62 percent when compared to typical intersections [10]. Roundabouts allow vehicles to enter without stopping at a red signal, thereby aiding in reducing travel times, fuel use, and pollution. It is an effective method of traffic regulation that are gaining popularity around the globe. Roundabouts are less harmful to the environment than traffic lights because they don't use power. Additionally, roundabouts are made to be self-regulating, so they don't need any outside control devices like traffic lights. Since it is



**Figure 2:** Achimota roundabout in Ghana

designed to reduce the speed of traffic, it makes the use of such an intersection safer for motorists, pedestrians, and cyclists.

Roundabouts are safer than typical intersections, with fatal crashes and injury crashes each being reduced by up to 90%. This could be attributed to slower moving traffic, a ban on left turns into oncoming traffic, and the usage of yield signs in place of stop signs or traffic signals. In comparison to typical intersections, roundabouts cut fatal incidents by 90% and injury crashes by 76% [9]. This is due to the fact that roundabouts lessen the amount of conflict points at an intersection. Conflict points occur when two or more vehicles come into contact with one another. Roundabouts lessen conflict sites by requiring traffic to circle an island in a circular way. Vehicle collisions are less likely as a result of this.

Roundabouts have significant drawbacks. One common concern is their ability to confound drivers, especially those unfamiliar with roundabouts. For some drivers, particularly those who are unfamiliar with them, roundabouts might be bewildering. This may prompt motorists to act carelessly, which may result in accidents. Roundabouts could cause traffic jams and safety hazards. It can be challenging for big vehicles like trucks and buses to maneuver. This is due to the higher turning radius of large vehicles compared to smaller ones. Finally, although roundabouts usually use less energy and resources than traffic signals, they still need energy and resources to build and maintain them.

In spite of these issues, transportation authorities continue to favor roundabouts as a way to control traffic and raise safety. Roundabout design and execution will probably become increasingly more effective and efficient as transportation technology develops.

### **3. Traffic Lights**

One of the most widely utilized traffic management devices worldwide is the traffic light. They are a quick and efficient way to control traffic at crossings. Red signals stop, green signals go, and yellow signals warn. Traffic lights employ a succession of red, yellow, and green lights to manage traffic. Every single color represents a certain action that vehicles and pedestrians must do, and the system is intended to guarantee that traffic moves smoothly and safely.



**Figure 3:** Traffic Lights

The simplicity of usage of traffic signals is one of its most important benefits. Traffic lights are a common choice for transportation organizations since motorists are accustomed to them and understand how they work. Both drivers and pedestrians are aware of when to stop and when to get off the road. This predictability lowers the probability of accidents by enabling cars and pedestrians to safely cross junctions. In locations where there is a lot of foot activity, traffic lights are also quite useful. Drivers are required to stop at red lights to give pedestrians the right of way. Pedestrians can cross the street safely by adhering to the approved pedestrian signals. This guarantees that even in regions with heavy traffic, people may cross the road safely.

However, traffic lights have a number of drawbacks. One of the most serious issues is that they may cause traffic congestion. At a red light, vehicles must come to a complete stop, causing delays and extended travel times. This delay can be especially troublesome during peak travel hours when traffic loads are high. Furthermore, traffic lights can increase fuel consumption and emissions because they compel vehicles to be idle while waiting for the light to turn green.

Another downside of traffic lights is the effect they have on safety. According to [4,11], traffic signals can increase the probability of accidents, particularly rear-end collisions. When drivers approach a red light, they may not have enough time to stop, resulting in a collision. Furthermore, drivers may attempt to run a red light, increasing the likelihood of an intersection accident.

Traffic lights remain a common traffic control method, particularly in densely populated urban areas. Transportation organizations can increase the efficiency and effectiveness of traffic lights by utilizing modern technology such as adaptive traffic signal systems. Sensors in adaptive traffic signal systems assess traffic volumes and modify the timing of traffic signals to reduce delays and improve safety. These systems can also be used to prioritize emergency vehicles, ensuring that they get to their destination swiftly and securely.

#### **4. Comparison between Roundabouts and Traffic Lights**

Safety, effectiveness, environmental impact, and aesthetics should all be taken into account while choosing the best traffic control measure for a given intersection. Both traffic signals and roundabouts have special benefits and drawbacks, so which one to employ should depend on the particulars of the intersection in issue.

Roundabouts are often better suited for crossroads with heavy traffic volumes, high-speed limits, and safety concerns. They are also appropriate for high-traffic crossings with a high volume of pedestrians and motorcycles. On the other hand, traffic lights are better suited for junctions with low to medium traffic volumes, where the need to prioritize different forms of transportation is less crucial and high-speed collisions are unlikely.

Roundabouts often improve transportation networks by lowering congestion, travel times, and accidents. They also advocate more environmentally friendly modes of transportation, such as walking, cycling, and taking public transportation. Traffic lights can also help transportation networks by increasing traffic flow and minimizing congestion. They are highly organized, allowing different modes of transit to be prioritized, and they may be changed to respond to changing traffic patterns. However, traffic lights can cause delays and congestion, especially during rush hour, and they require constant maintenance, which can be expensive. Roundabouts, on the other hand, have high initial construction costs and require continuing maintenance to function properly [6-8].

Moreover, roundabouts are often safer than traffic lights in terms of safety, lowering the chance of serious accidents, particularly those involving pedestrians and bicycles. Traffic lights, on the other hand, can be useful in reducing the number of accidents caused by distracted driving.

Aesthetically, roundabouts are often more visually pleasing than traffic lights [5]. They are frequently landscaped with trees and other vegetation to provide a visually appealing focal point in the surrounding region. Contrarily, traffic lights can diminish the general aesthetic appeal of the vicinity because they are so apparent.

The specific characteristics of the intersection in question should be taken into consideration while deciding the traffic management measure to employ. Both traffic control methods have particular benefits and drawbacks; therefore, selecting one should be carefully thought out in light of the aforementioned discourse.

## **5. Future Implications**

Effective traffic control techniques will become more and more necessary as cities expand and change. Traffic management techniques must be incorporated into more significant urban planning initiatives to support sustainable transportation methods and advance livable cities. To ensure that traffic management measures are created and put into action in an efficient and contextually acceptable way, it will be necessary for transportation planners, urban designers, and local officials to work together.

As new technologies continue to alter transportation systems, urban planners will also need to take into account the long-term effects of traffic management strategies. For instance, traffic management procedures may need to change if self-driving cars become more commonplace. This can entail the usage of designated lanes or intersection layouts that are suitable for self-driving cars. Urban planners may develop and put into action efficient traffic management strategies that meet the demands of their communities by remaining abreast of new technological developments and taking the long term effects of traffic control measures into account.

Emerging technologies like artificial intelligence (AI) and the Internet of Things (IoT) are likely to influence how traffic control measures are implemented in the future. By using realtime data to adjust traffic signal timings and react to shifting traffic patterns, AI-powered traffic management systems have the potential to increase traffic flow, decrease congestion, and increase safety. IoT-enabled infrastructure and connected vehicles can communicate with one another to enhance efficiency and safety in traffic control [1-3,12].

## 6. Conclusion

To ensure efficient and safe traffic flow across intersections, it is essential to choose the right traffic control methods. The decision between traffic lights and roundabouts should be made after considering the intersection's special features, such as traffic volume, pedestrian activity, and the surrounding area. Both traffic signals and roundabouts have advantages and disadvantages, and the best choice will depend on the circumstances around the intersection. When choosing a traffic control method, it is vital to consider costs, maintenance requirements, and any potential effects on transportation systems. Additionally, new technologies like AI and IoT are anticipated to become more significant in traffic control strategies in the future, thus urban planners should take these into account when planning and making decisions.

## References

- [1] Abdullah, H. N., Hashim, I. A., and Abd, B. H. (2010). Design and implementation of an intelligent traffic light system. *Engineering and Technology Journal*, 28(15):5079–5087.
- [2] Ariffin, W. N. S. F. W., Keat, C. S., Prasath, T., Suriyan, L., Nore, N. A. M., Hashim, N. B. M., Zain, A. S. M., et al. (2021). Real-time dynamic traffic light control system with emergency vehicle priority. In *Journal of Physics: Conference Series*, volume 1878, page 012063. IOP Publishing.
- [3] Deshpande, S. and Hsieh, S.-J. (2023). Cyber-physical system for smart traffic light control. *Sensors*, 23(11):5028.
- [4] Dong, S., Zhang, M., and Li, Z. (2020). Risk analysis of vehicle rear-end collisions at intersections. *Journal of advanced transportation*, 2020:1–11.
- [5] Ingale, P. P. and Tigga, A. (2022). Analyzing efficiency and applications of providing a roundabout: A literature review. *International Journal Of Multidisciplinary Research In Science, Engineering and Technology*, pages 1262–1265.
- [6] Jensen, S. U. (2017). Safe roundabouts for cyclists. *Accident Analysis & Prevention*, 105:30–37.



- [7] Meuleners, L. B., Stevenson, M., Fraser, M., Oxley, J., Rose, G., and Johnson, M. (2019). Safer cycling and the urban road environment: A case control study. *Accident Analysis & Prevention*, 129:342–349.
- [8] Poudel, N. and Singleton, P. A. (2021). Bicycle safety at roundabouts: a systematic literature review. *Transport reviews*, 41(5):617–642.
- [9] Retting, R. A., Persaud, B. N., Garder, P. E., and Lord, D. (2001). Crash and injury reduction following installation of roundabouts in the united states. *American journal of public health*, 91(4):628.
- [10] Rodegerdts, L. A. (2010). *Roundabouts: An informational guide*, volume 672. Transportation Research Board.
- [11] Wang, W., Li, Y., Lu, J., Li, Y., Wan, Q., et al. (2019). Estimating rear-end accident probabilities with different driving tendencies at signalized intersections in china. *Journal of Advanced Transportation*, 2019.
- [12] Wang, Y., Yang, X., Liang, H., Liu, Y., et al. (2018). A review of the self-adaptive traffic signal control system based on future traffic environment. *Journal of Advanced Transportation*, 2018.