Chapter 3 – Experimental Design

This study was undertaken to determine how a roundabout functioned compared to traditional intersection traffic control. This chapter describes the process used to determine which intersections were included in this study, and how they were examined.

Section 3.1 – Video Data Collection

The City of Manhattan, Kansas obtained and installed a specially designed video camera and recording equipment for data collection (see Figure 6). The camera, supplied by Intelligent Highway Systems, Inc., (White Plains, NY), was designed to provide full 360^{o} view when mounted above the intersection.

Figure 6 - Omnidirectional Video Camera Mounted to Street Light Pole

At the roundabout, the camera was installed on an existing street light pole in the southeast corner of the intersection. The camera was attached to the end of a street light arm that was then attached to the wood street light pole. The camera was mounted perpendicular to the ground, which allowed the video image to be relatively distortion free to the horizon in all directions. The camera was mounted similarly for data collection at the two non-roundabout locations.

Mounting heights for the camera were approximately 6 meters (20 feet) above the street surface. According to the manufacturer specifications, this mounting height provides a focal plane of approximately 40.5 meters by 54.0 meters (133 feet by 177 feet) (List). The camera

allows the focal plane to be changed (made larger or smaller) based on the height above the intersection. The camera was generally mounted directly above the curbline; however, this was strictly a function of field conditions (pole location).

At all intersections the camera feed went into a VCR/ TV unit housed in a recycled traffic signal controller cabinet (see Figure 7). This allowed all equipment to be mounted on a single pole. The signal cabinet provided a secure weather tight location for the recording equipment.

The video image was recorded on standard VHS videotapes. This required site visits each time a new tape was needed. In all, over 200 hours of videotape was collected from the three intersections.

Figure 7 - Video Recording Assembly

The reason for video data collection was used was two-fold. First, it allowed data to be collected for examination at a later time. Second, the videotape could be viewed and re-viewed during the data analysis phase of the project. This method was used on a study in New York *(6)*.

> "Information on volumes, lane usage, and delays were extracted from the resulting video tapes to learn more about how automated data extraction schemes might be devised and to perform capacity analysis…. Second, it seemed that the use of an omnidirectional camera at roundabouts might be a very cost-effective instrumentation option. Instead of either an array of pavement-based sensors, or a collection of conventional camera, a single omnidirectional camera, strategically placed, could provide information about all movements at the facility simultaneously" *(6).*

Similar to these findings, the ability to have the videotapes of the intersection in operation was invaluable through this research.

Section 3.2 – Manual Data Collection

Manual data collection refers to the manual extraction of data from the videotapes. Once the videotapes were collected, they were evaluated through observation. The two objectives of the manual data collection were to obtain traffic flows and traffic conflicts.

Traffic flows were observed on the tape and the information (turning movement counts) recorded on pre-prepared data sheets. The traffic counts were recorded in 15-minute intervals, which became the input information for analysis by the computer program SIDRA.

The second type of data collected by videotape observation was traffic conflicts.

> "A traffic conflict is a traffic event involving two or more road users, in which one user performs some atypical or unusual action, such as a change in direction or speed, that places another user in jeopardy of a collision unless an evasive maneuver is undertaken" *(7)*.

Traffic conflicts are discussed in detail in a later chapter on safety. Each tape reviewer was trained on the types of traffic conflicts and how to identify them. The tape reviewers watched for traffic conflicts as they collected the traffic flow data.

Section 3.3 – Comparable Intersections

The Manhattan roundabout was constructed prior to the initiation of this study. Therefore, the before/ after method of evaluating its operation was not available to the research team. Instead, evaluation was performed by comparing the operation of the roundabout to two comparable intersections.

A comparable intersection was determined to be one that had the same general physical layout, and operated under similar traffic loadings as the roundabout. Comparable locations were geographically limited to the City of Manhattan, Kansas. This was due to the field support provided by the City and the desire to have all intersections located within the City. Having all intersections located within the City allowed the creation of public awareness information where all information and conclusions stem from a single jurisdiction. It also avoids the possible differences that could be present if drivers from different locals were examined.

The general physical and operational features of the roundabout, and those desired of the comparable intersections, were determined to be as shown in Table 5. These traits were used to select a set of possible comparable intersections from all possible locations within the corporate limits of the city of Manhattan, Kansas. The criteria were established to guide selection toward locations that would operate similarly to the Candlewood/ Gary intersection had the roundabout not been constructed. In this way, inferences could be made following experimentation as to weather the operation of the roundabout was better, worse, or similar to more traditional intersection traffic controls.

The study team and advisory committee members reviewed the possible comparable intersections. Based on personal knowledge of the intersections and study focus, two comparable intersections were chosen.

One comparable intersection was located at Dickens Avenue and Wreath Avenue (DW). This 4-leg intersection is located on the west side of Manhattan. Both roads were 2-lane collector roads carrying traffic levels at those specified in the selection criteria. Posted speed limits on both streets were within the range specified. This intersection operated under two-way STOP control.

Table 5 - Comparable Intersection Selection Criteria

Physical Traits:	**General Description/ Range:**
Approach legs	Four
Number of approach lanes	One*
Type of approach roads	Local and/or collector
Total intersection traffic volume	5,000 – 10,000 vpd
Approach speeds	40 – 56 kph (25 – 35 mph)

*Had the Candlewood Drive/ Gary Avenue roundabout not been built, turn lanes would most likely have been striped to accommodate turning movements. Therefore, the number of approach lane criteria relates to thru lanes only.

The second comparable intersection chosen for study was located at Juliette Avenue and Pierre Street (JP). This was the intersection of a 2-lane collector and a 2-lane local road. Traffic levels and speeds on both streets fell within the trait range specified. This intersection operated under two-way STOP control.

Section 3.4 – Data Analysis

This phase of the project began with a statistical evaluation of raw traffic data to assure that the three intersections were being observed under 'similar' traffic conditions. Then the data was used as input into the computer evaluation program SIDRA. This software was used to evaluate all three intersections operating under their existing traffic control (roundabout, two-way STOP). SIDRA provided output values for the six measures of effectiveness (MOEs) (described in Table 6). This data was then statistically evaluated to determine which, if any, of the three intersections could be considered to be operating better then the others.

Table 6 - Intersection Measures of Effectiveness

Measure of Effectiveness:	**Description:**
95% Queue	Length of the queue for all approaches at the 95% confidence level
Average Delay	Average vehicle delay for all entering vehicles
Maximum Approach Delay	Average vehicle delay for the approach with the highest average vehicle delay
Proportion Stopped	Proportion of entering vehicles that are required to stop due to vehicles already in the intersection
Maximum Proportion Stopped	Proportion of entering vehicles that are required to stop due to vehicles already in the intersection on the approach with the highest proportion stopped value
Degree of Saturation	Amount of capacity that is consumed by the current traffic loading (commonly referred to as the v/c ratio)

The study MOEs initially included Level of Service (LOS). This MOE was dropped as it was found that the three intersections operated at LOS A/B *(8)*. The narrow range of LOS values

did not allow meaningful analysis based on level of service values to be completed. Since LOS is based on average vehicle delay, the LOS analysis was not lost, simply replaced by the more precise measure of average vehicle delay.

The intersection MOEs were compared with one another using standard statistical methods. Testing for normality and equal variances was performed first. This was followed by one of three statistical tests, depending on the results of the normality and equal variance testing. Conclusions were drawn for each MOE with regard to the operation of the intersections and intersection control types.

This study was designed to evaluate the operation of the roundabout in Manhattan, Kansas. The conclusions from this study will apply to other locals only if the overall conditions are similar to that found in this study. If the conditions in other places differ significantly from those found here, detailed local study is warranted. Such detailed study could use the same procedures developed here with the use of local data. In all cases, the results of this study provide additional information for use throughout the United States with regard to increasing the roundabout knowledge database.