An Application-Driven Modular Traffic Light Control System Using Lean Supply Chain

Sudha Rajesh (sudharajeshphd2021@gmail.com)
BS Abdul Rahman Institute of Science and Technology
Sonia R
BS Abdul Rahman Institute of Science and Technology
Amudhavalli P
BS Abdul Rahman Institute of Science and Technology
Karthikeyan S
Sathyambama Institute of Science and Technology
Beulah Jackson
Saveetha University Saveetha Engineering College
Kiran Bala B
K Ramakrishnan College of Engineering

Research Article

Keywords: Lean supply chain, Traffic congestion, simulated data, Dynamic traffic controller.

Posted Date: October 5th, 2021

DOI: https://doi.org/10.21203/rs.3.rs-935045/v1

Abstract

Lean is an endless journey to develop and excel the business. Any company would like to build and deal with the whole world pace should adopt lean. Though, in the vast majority of the companies the management philosophy or mentality of people is not so great to adopt change. Lean typically deals with superior quality, lowest cost and quicker lead time. Lean Supply chain technology in the traffic control system has supplied intelligent green interval responses to control the incapability of standard fixed traffic controllers. The researchers have implemented the technology of lean supply chain to boost up the performance of traffic light and control the traffic jam. The limitations of traditional passing vehicles have been solved by the set of rules. The two set of guidance have been monitored the traffic light system by dynamic system; the vehicle, upstream and downstream lane follows red light and the number of vehicles have passed through a green light. These kinds of vehicles have dynamically controlled the timing of red and green. The dynamic traffic controller and a fixed time controller have shown the differences in performance through the Lean supply chain theory. The researchers have compared and stimulate the data of the performance of their algorithm with the undeveloped one. The results have shown that the algorithm has much better than undeveloped one, because it increases the traffic efficiency and decreases the waiting time by 45 minutes.

1. Introduction

In today's world, the most of the cities had been suffered from an unnecessary vehicular traffic which induced many issues like, pollution, congestion, security, parking, and so on. Some infrastructure changes in the urban areas would be impossible because the researchers would have agreed that proper scheduling of traffic light could only help to decrease these kinds of issues by controlling the flow of vehicles in the cities. The number of traffic lights had been grown in the cities at the same time and the joint scheduling time had also become complex due to the large numbers of traffic lanes appeared, and the usage of automated systems for the optimum cycle scheduling of traffic light had been a required one. The blocks in the urban traffic network would bring up some serious issues like pollution, parking, and security. These issues had already seized the developments in the urban areas. The expansion of roads in the urban large cities would be seen artificial and provokes many serious issues. The Government had planned to rebuild the existing urban infrastructure but that would be very difficult to apply in practice. It had been clearly established that the planning of traffic lights would have been beneficial and economical way to fix the problems in the cities (1-3). Global optimal scheduling of traffic light would control the flow of vehicles in the cities. The efforts of traffic lights at section had achieved the goal of traffic flow, but scheduling the hundreds of traffic lights would be very difficult. Lean supply chain technology had become one of the most important area in the field of Lean supply chain because the ability of better global searching and the faster computer speed in the dynamic multi-objective (4-5). It had been applied to solve many difficult gained issues, but only few had been focused on the scheduling of urban traffic lights (6-9). At the same time, in order to increase the performance of supply chain had many attempts, like studying particle's neighbor topologies [10], applying comprehensive learning approaches [11], and retaining cooperative behaviours [12], considering time variant inertia and acceleration factors [13]. These works had suggested that lean supply management have a huge capacity to give the best in the scheduling of urban traffic lights.

In 1995, James Kennedy and Russell Eberhant had proposed the method of Lean supply chain in Lean supply chain. It could be fix the problem of nonlinear, multi-peaks optimizations. For example, it had been applied in facets of power generation, chemical industry, pharmaceutical, financial side, and many others. Many people had focused on this algorithm and became improved on it. The particle velocity had reduced to zero, when normal lean supply management and particle experienced local minimum. So, the particle had stopped moving. It made algorithm combination to extreme cities. The ability of global and local search had been balanced and it would control the slow convergence and prematurely of lean supply chain and a lean supply chain had been proposed.

In this paper, the technology of lean supply chain had been implemented to boost up the efficiency and effectiveness of traffic light and road control in a four-way, two-lane traffic. The constraints of traditional passing vehicles have been solved by the set of rules. The two set of guidance have been monitored the traffic light system by dynamic system; the vehicle, upstream and downstream lane follows red light and the number of vehicles have passed through a green light. These kinds of vehicles have dynamically controlled the timing of red and green. The dynamic traffic controller and a fixed time controller have shown the differences in performance through the Lean supply chain theory.

2. Literature Review

The best of the traffic light scheduling had been attempted by the researchers in a different method. An expert system and knowledge creation had been described as a prototype integrated data base in the novel frame work of decision support system. The improvement of decisions context had been increased the efficiency of assessment and scheduling, this had supported to the ecological planners, transport administrators or urban designer [15]. Based on the expert system a decision support system had been applied for the urban traffic scheduling. This system had been composed in the emergency situations to the approaches of traffic to control very quickly and efficiently.
Mostly they could depend on the data base of judgmental and historical traffic to provide the best scheduling demand on traffic scenario.

The consideration of demand processing and the routing had been proposed as an agent-based method. A competitive computational market had designed to check the ability of driver agents trade with the intersection manager agents. The drivers' behavior, efficiency of the urban road traffic system, less time of travel, had shown the influence of market dynamic [16].

Different methodologies were examined for the prediction of traffic information and shown the results on an algorithm of speed prediction. Their algorithm had trained with the data of historical traffic and predicted the profile of vehicle speed with the current traffic data-base [17]. Phase cycle had been altered regarding back propagation neural network method. The consideration of length of each page of motorcade had been compared with the current phase of green light, for how long it had been extended. But in the urban road networks had structured uncomplicated and those networks would be degraded when then traffic volumes change [18].

Based on the lean supply chain algorithm, a new model had tested and improved to give the best in the task. Every possible solution had been evaluated by the cellular automata-based simulator. The input of current queue length and the output of the intersection of the optimized green time had taken from the algorithm of lean supply chain [19]. During the red of each phase had been shown the over traffic by the result of lean supply chain algorithm and it has reached large size of network.

Based on the traffic junction light simulator system, fuzzy logic had been developed for the controller of smart traffic junction light. The fuzzy logic signal controller in a four-way describes a high proportion of motorcycles. They had discussed about the traffic control strategy, which had been designed for fuzzy logic controller. A fuzzy logic traffic system had been updated for two-way intersection, which also control the traffic signals based on traffic situation. Some set of traffic rules had utilized in fuzzy logic controller based on a number of inputs. But it had been quiet impossible to generate. The features of incorporate state action had implemented in high dimensional settings. The initial phase on a functional low-level controller had designed technique of multi-level architecture [20-25].

The change of signal time had been influenced and drivers were analyzed. Even more exactly, the researchers had observed the issue on the timing of determining optimum signal, when predicting the response of drivers as an example of the network design problem (NOP). The traffic imbalance had been solved by SATURN package (simulation-assignment modelling software). The flow of traffic had been viewed as a macroscopic by authors and a supply chain had to calculate in the NDP setting (offset, cycle time, and green light times for phases) [26]. It was vital to mark that the chromosome (grey-code) encoding had been done in other way. The operations had tested in the city of Chester in UK, it mentioned whole parameter and that not the exact traffic issues. Every convergence had unconventional rotations in this work. An typical encoding had used as a grey code. The calculation of believable state had been before the operation complete [27].

A supply chain has been utilized to attain better during the performance of traffic lights and pedestrians crossing in a convergence with two-lane and four-way. The vehicles and pedestrians had been controlled and solved by the limitations and two sets of parameters had monitored a dynamic control system. Some works had been related to the existed for the schedule of traffic lights in the prosecution of lean supply chain [28]. A supply chain had been tested in the two joining roads with a one-way road. Even though the diversity of the supply chain had prolonged the ability of isolated place and that was not concern the serious issue in the final research. The public and private vehicle models had been performing for the effective road of urban networks, which had made up of 16 interjections and 51 links. Every meeting had controlled by the traffic lights with regular rotation of 80’s [29-31].

3. Model Design For Traffic Light

In this design, it has awakened five sensors, every respective sensor discovered a lot of vehicles for each lane. The fifth sensor has discovered for the pedestrian. This system has evaluated the timing of red and green light for the vehicle and it has check the time taken for vehicles behind the light of red which is arrived to its destination in dynamic and static models, for instance if vehicle has come from lane X, it has gone to lane Y. This system has calculated the time travel from X to Y.

3.1 Variables

It has explained the input of variables:

1. Passing in Pedestrians, PP: Pedestrians who have passed to a green light.
2. Passing of Vehicles, VP: Vehicles that have passed to a green light.
3. Pedestrians Queue, PQ: Pedestrians behind a red light.
4. Vehicles Queue, VQ: Vehicles behind a red light.

The variables PP and VP have needed to determine the length of queue behind the red light, and the variables of PQ and VQ have needed to determine the next rotation of green light.

It has explained the output of variables:

1. Queue of Pedestrians, QRP: It has shown the static and dynamic modes of Pedestrians behind the red light for per second
2. Queue of Vehicles, QRV: It has shown the static and dynamic modes of vehicle behind the red light for every per second.
3. The Duration, D: The static and dynamic modes of vehicle which has taken the duration of travel to a destination.

The variables QRP, QRV, and D have needed to check and compare the performance of dynamic models with the static model.

3.2 Cellular Automata

Cellular automata have used to design one way and has to simplify the rules for car drivers. CA has used separate the partially connected cells which could be in an individual zone. The changes of local rules have controlled the dynamic system and every normal rule has been to confused dynamic (8). Cellular automata operation has been used in this paper cause during the blocks it has allowed us to exhibit in the significant events like, standing in the traffic, slow motion of resume, again still standing and many more. It could detect a vehicle’s basic elements that include the average speed, geographic position of vehicle, maximum speed, desired speed, current acceleration, and vehicle unique identification number.

It has identified and explained the factors of the model’s establishment, which the vehicle and lane as follows:

1. Length of lane: The basic theory of the CA was that every lane has separated into a lot of cells and every lane has a unique ID number. It explained the length of lane into number of cells and each lane has set to number 15. The volume of single cell would be 16 pixels and a single vehicle would occupy two cells i.e. 32 pixels. It has to represent the arrangements of the cell in each lane and the identifications of special ID number. This program has checked whether the cell would be empty or filled and it has discovered the original position of vehicles.
It has set the height and width of a vehicle to 16 pixels and 30 pixels. Every vehicle has the moderate size with four different colours. Every vehicle has been found by specific ID number and it has known by the destination which has fixed travel route. The layout of lane which has created with Cellular Automata has shown in Fig. 1.

2. Number of Vehicles: It has about the number of vehicles in lane.
3. Vehicles Speed: the vehicle has to travel in a respective time with lots of cell. The speed ranges have valued the difference from zero to the maximum. 5 cells per second would be the maximum speed.
Traffic Signals: This model has five traffic lights, four traffic controls and one for pedestrian crossing, which has shown in Fig. 2. Every traffic light has been categorized by specific ID number, and it has color mode for signal, i.e. red, yellow, and green. It has used to set the times for the three signal modes.

Our four-way, two-lane crossing has an entry junction and an exit junction for every lane and had an intersection junction. The meeting junction has comprised of four cells and every junction has a unique ID. The arrangements of every junction have been set and the size has to be depend on the cells. The pedestrian crossing area has been set across the lanes B1 and B.

As shown in the Fig. 2, every vehicle can move forward, stay in current position, or turn right or left. The operation of the cellular automata has been implemented in the model as follows:

1. Step1: check the decision-point
2. Whether passing on decision-point
3. Then proceed to Step3
4. Or go to Step2
5. Step2: check the cell type
6. If cell type='decision'
7. Further, evaluate the conditions of the vehicles, which direction the vehicle has taken, followed the direction and turn; decision point would be passed
8. Else proceed to Step3
9. Step3: check the cell
10. Whether the cell would be owned by a vehicle, cell type = 'empty' or cell type = 'decision'

11. Then Move
12. Else go to Step4
13. Step4: check the adjacent cells

14. If the cell has over to the left /right wouldn’t occupied by vehicles
15. Then Move to the left (right) cell
16. Or Wait.

4. Lean Supply Chain For Traffic Light Scheduling

It has explained the improvement of the rotational program of traffic lights. It elaborated the solution encoding, the fitness function, and finally the global optimization procedure. Before this, the basic concept of the PSO operation has given.

4.1. Lean supply chain

Supply chain is that deals with control time. SCM (Supply chain management) is the process that is utilized by a business in order to make sure that its supply chain is cost effective and efficient. Supply chain management is defined as the management of the flow of substances, information and financial resources throughout the whole supply chain involving the vendors, manufacturers, technicians, wholesalers, warehouses, merchants, and the ultimate customers. A supply chain is an extensive network of facilities that acquire raw materials, to convert them into semi-manufactured products and subsequently finished products and provide the products to consumers through a distributed network. The ultimate objective of SCM is to satisfy the clients’ requirement more effectively and efficiently by offering the appropriate product, in the right amount, at the correct location, on the appropriate time, and in the correct situation. Lean supply chain makes sure the precise amount of services or goods at the precise location within a time limit. It has been stated that the lean SCM is not only time-to-market for new product introductions but time-to-respond in terms of being able to meet the needs of time-sensitive customers.

A lean supply chain is the system that integrates lean philosophy into the whole supply chain for the efficient and effective use of all resources. They also state that, supply chain policy must be based upon a thorough analysis of the supply and demand characteristics of the different markets or product provided by a firm. A lean SCM is defined as a functional and tactical management philosophy that uses internet facilitating tools to impact the constant regeneration of service partner’s and supplier’s network. It is also significant for a lean SCM to make sure the overall quality of product on the market through the entire supply chain network. Therefore, the quality is characterized as a matter of how much valuable the service or product to the consumer not to the companies. Consequently, quality management system is a big problem for the manufacturing plants to maintain for a long time. Traffic light system is a particular way of decreasing the quality faults. It works in a way the traffic light works in the transportation system. In this article, lean supply chain management is utilized to control the road traffic. In this technology, each particle position x^i is modernized to each iteration g by means of

$$x_{g+1}^{i} \leftarrow x_{g}^{i} + v_{g+1}^{i}, \quad (1)$$

Where v_i^{g+1} term was the velocity of the particle, provided by the following equation:

$$v_{g+1}^{i} \leftarrow w \cdot v_{g}^{i} + \varphi_1 \cdot UN(0,1) \cdot (p_{g}^{i} - x_{g}^{i}) + \varphi_2 \cdot UN(0,1) \cdot (b_g - x_{g}^{i}). \quad (2)$$

In this formula, pig has been considered as the best solution cause the particle i has seen so far, bg was the global best particle, that the whole swarm has ever created, and w was the inertia weight of the particle (it has controlled the trade-off among exploitation and exploration). At last, Ψ1 and Ψ2 were the specific parameters which has controlled the regarding effects of the personal and global best particles, when UN (0, 1) was a common random value in [0, 1] which has typically a new for every part of the velocity vector and for each particle and repetition.

5. Models Algorithm

5.1 Initialization

The parameters setting of the algorithm has formatted, the input value of the simulations has framed, and the first generation of population has generated. The lot of genes and chromosome, generation as well as the number of individuals per population have been framed as a basic. Every common thing has considered as numbered. The additional adjustable settings were the probabilities of crossover, mutation and tournament. Some changes would be needed in the variable values when the lean supply chain performance has been improved. Some other variables were explained in every part where it has belonged. The random values of 0 and 1 to each gene and that make binary values to each chromosome were given by the array populations. A gene may have some other value, for example it may value any natural things in the cities. In this program a special Vector named input value has contained “real world sensor inputs” to discover from the junctions. Array input Values have deposited up to eight inputs for the refreshment period of future eight times. All simulations have done ten time periods, where the last two time periods were input free.

5.2 Decoding

After the initialization, the program has entered to the main loop of Standard supply chain, starting the decoding of the chromosomes. The user of decoding was definable. For instance, a chromosome could represent many different values, as shown in Fig. 3.

In this program, every chromosome has four binary genes which have represented the binary number from 0 to 15, 16 has provided separate solutions which have represented the drive orders for the intersection. The arguments of population had found certain individuals to read. A lot of genes, chromosomes, have tell that where the actual individuals to read. The first gene on the chromosome was the Least Significant Bit (LSB) and the result number was return back and deposited in variable known as parameter Value (chromosome number).

5.3 Evaluation

The intention of analysis was to control the fitness of every individual in a generation. The function of analysis has applied a mathematical function to calculate the fitness values, given in Fig. 04. The value calculated fitness would be returned from the function named Evaluate Individual. The chromosome values, input vector and the previous drive order have been contained in the argument of the function.

The fitness calculation process would be same for the all programs, and has used three states of calculation. Evaluation of present situation at the intersection were calculated regarding the inputs sensors from the site, older inputs with added priority and the previous drive order that occurred.

The new and old inputs by mathematical functions were the summary points of cnInputs in the first stage of calculation. These values have extracted from the input Value which has the input values from the intersection. The values range from 0 to 6, 0 has valued non-requesting sensor, 1 was new input and other were older remaining requests. To execute the correct input, the input has to set to zero in the main code when the output has to equal. The road vehicles have been driven in the view of simulation and left the sensor. The priority boost for non-executed requests has done by adding value until next time period.

The second calculation stage has depended on the first drive order; previousExcecution variable has some set of rules. The previous drive would give two points as excess credit or by sn. The favorable sequence of drive would be better for traffic flow. PreviousExcecution was started to the value 16 which has not valid to zero credit drive order. In certain case the same drive would have been repeated, a penalty would be proceeding as minus five points.

The last calculation stage has been summarized all chromosome points by following equation:

$$f = \sum_{n=1}^{6} (7-n)(c_{nInputs} + s_n) \qquad (3)$$

The evaluation function has been actually returned from the function of fitness calculation. In the previous two stage calculations each chromosome cn has been summarized. Example of chromosome two is c2 = 5(c2Inputs + s2). The aim of the solution has requested to execute as early as possible. Each chromosome had multiplied by number from six to down to the higher points on the early time period than last one.

5.4 Fitness function

After the evaluation of an individual the value of fitness has given. Whether this value was not equal than the present maximum value of fitness, this would become the new maximum fitness value. Including the update of maximum fitness value would variable in maxFitness, best parameter value has been deposited under six variables.

6. Methodologies

The aim of this work to achieve, the following methodologies was exploited.

6.1 Experimental Research

Experimental study method was the simple experiment, which involves the standard practice of influencing quantitative, unbiased variables to create statistic analyzed data. The scientific measurement system was based on interval or ratio. Most of the people have believed the system of “scientific measurement method” because it was all about the “pure science”. Some researchers have been accepting or refusing the null hypothesis. The results have used to analyze the hypotheses test, with statistics of clear picture [11]. This permits the researchers have to differentiate the two groups and control the impact of the intervention following processes were considered: survey, questionnaires, and interview

6.2 Agile Method

Agile Methods have broken the product into small incremental builds. These builds were provided in iterations [12]. Iteration has extended over one to three weeks. Agile software design methodology has a mixture of iterative and step-by-step procedure models with emphasis on process flexibility and customer satisfaction through the quick delivery of the software running product. Iteration has simultaneously involved to work cross functional teams on various areas like

I. Planning
II. Requirements Assessment
III. Designing
IV. Programming
V. Unit Testing and
VI. Acceptance Testing.
At the conclusion of the iteration, a functional product has exhibited to the customer and significant participants in the process.

7. Traffic Control System’s Architecture

The traffic engineers have studied and researched that the system of lean supply chain algorithm has used to control the traffic in a crossing of four-way lane. The requirement was accumulated through observation, and the process of interview has been referring to the database of real data. The requirement specifications have been added the components needed for implementing a particular software process. It also has incorporated some key points about the nature of application domain type. It might be highlighted that these constraints may change according to the application domain. The initial requirements specifications would hence include:

1. A formal definition of the primary components has required the system to implement (e.g. the use of lean supply chain algorithm).

2. A description of the data attribute structure of the functional objects/or attributes in the software system.

In the Table 1, had shown the specific data of requirement which has procured from the State ministry of transportation, Port Harcourt Nigeria. The system of lean supply chain algorithm has used for traffic light system to develop the parameters system, where context was built. Also this design has used the real time data base of the roads. It has been consisting of an input layer, optimization layer and decision layer. The Architecture of Predictive/decision making System is shown in Fig. 5.

The system has been consisting of input layer, optimization layer and decision layer. The lean supply chain algorithm has developed and found the set of parameters in low cost in the optimization layer. The low error has meant to be least cost by an objective function. A decision layer has taken decision based on the condition of input against a reference value.

The lean supply chain algorithm has developed and found the set of parameters in low cost in the optimization layer. The low error has meant to be least cost by an objective function. A decision layer has taken decision based on the condition of input against a reference value.

Optimization layer has used the technique of AI to develop and found the set of sensor setting parameters in low cost. The low error has meant to be least cost by an objective function which would be used by the decision module for optimization of road efficiency. Decision modules have produced the algorithm as based on the input data which has been against the reference value, and that would be discover on the sensor in the road traffic light control system. In these days, these direct methods had been worked for St. Pete, but growth was steady. Areas in the interstates had been expanded, and there would be impossible to expanding outwards.

Lean supply chain algorithm has used to develop the road, which has been fit the nature and it would be better on alternative roads like cycling, cars and bus to reduce the number of cars on the road. The advance sensors roads in the city have to adjust the signals automatically for the system of real fix time road nature. In the most of the cities the lean supply chain algorithm sensing technology had largely limited to induction loops embedded in asphalt. These loops could omit a single vehicle has been waiting on a small side road which has triggered a green signal across a major artery. But this couldn't differentiate a single car from the heavy traffic jam. Newer sensors couldn't omit only the density, but it could have differentiated between cars, buses, bicycles, and pedestrians, and these shows the algorithms dish out green lights with a bigger picture in mind. So, lean supply chain algorithm has used the best fit to research and review the nature of the road to choose the best path. The system is further explained using a component diagram as shown in Fig. 6.

The component of the system had been made up of three parts:

i. Input Module (Traffic Data Collection Module): This module has collected the data of the traffic on the road. This data had included the number of cars on the road.

ii. Process Module (Traffic Data Analysis Module): This module had used the Lean supply chain algorithm to analyze the data to control the pattern of traffic on the road

iii. Output Module (Traffic Control Module): This module would have used to analyze data to control the traffic on the road. The snapshots of the various modules that make up proposed Traffic Management Simulation System along with a description of their functions are shown in Fig. 7, 8, and 9.

Figure 7 was the System Login Form that has permitted the user to submit the login details to access into the system. The Simulation Setup Form of Fig. 8 has permitted the user to setup a simulation exercise. The simulation window form (see Fig. 9) has displayed the graphic simulation of traffic on the intersection of the Roads A and B.

8. Results And Discussion

Figure 10 had displayed the information on the result of the simulation exercise.

The tables had shown simulation results after the several tests on the data traffic for the cars playing the roads using the normal traffic light. The average number of cars on each side of the road per minute had given in the tables below. Simulation result on average number of the cars on the roads after the first test running had used lean supply chain algorithm Intelligent Traffic Light software was as shown in the Table 1.

Table 1
Simulation Result after test 1

Number of automobiles on Road A per minute	75
Number of automobiles on Road B per minute	125

After the second test running had used the lean supply chain algorithm Intelligent Traffic Light software had shown the simulation result on average number of the cars on the roads was as shown in Table 2 below.

Table 2
Simulation Result after test 2

Number of automobiles on Road A per minute	**50**
Number of automobiles on Road B per minute	80

Simulation result on the average number of the cars on the roads after the third test running using lean supply chain algorithm Intelligent Traffic Light software was as shown in Table 3 below. The experimental analysis of simulation results was summarized in Table 5 and Fig. 11.

Table 3
Simulation Result after test 3

Number of automobiles on Road A per minute	**50**
Number of automobiles on Road B per minute	56

Table 4
Average of the Test Results

Number of automobiles on Road A per minute	**35**
Number of automobiles on Road A per minute	40

The average numbers of the simulation traffic data had collected from the tables above were given Table 4.

It has shown the results of the number of cars had left on the road for every time of interval of the traffic light in the simulation, which has shown in the Table 5. Above the Table 1–5 has shown the test of many runs of simulation, as per the results traffic intelligent system has shown the best result on lean supply chain algorithm in the term of traffic foresee and it found the best fit in the peak period. The result had shown that the off peak period was more effective than the peak period. Cause the > 40% of the vehicle composition in the off-peak period and that of peak period was > 50%, which was not fit for the urban area. In the Fig. 7, the graphical presentation of the traffic data which has comparing the number of cars had left over on the road after the control and intelligent simulation of traffic lights. The usage of lean supply chain algorithm for the traffic light had shown the best result by the least number of cars on the road. The value of the lower number cars was test 1, the best case test scenario for reduction of traffic in the result because it has the highest traffic control time interval of 30 seconds. The worst case test scenario was the test 4 which has the highest amount of cars left on the road with a traffic light control interval of 10 seconds.

Table 5
Experimental Analysis

	Road A traffic Interval(secs)	Road A traffic Interval(secs)	No. of automobiles on	No. of automobiles on
			RoadAafter simulation	RoadBafter simulation
Test 1	35	35	30	35
Test 2	30	30	38	35
Test 3	20	20	40	40
Test 4	15	15	45	48

9. Conclusion And Further Work

In the conclusion, the Traffic Light Intelligent System which had based on lean supply chain algorithm held the best Traffic Light computerizing in the future. The data had got from the simulations would done using the proposed system, which indicated the better performance of the system. Though, modelling intelligent system had been suitable for discover the traffic lights at intersections. The stimulation of traffic would very near to reality. The work of Intelligent Traffic Light in future would be in real time hardware, as the system had not been integrated with real time hardware. Finally, the output is not symbolic i.e. cannot be interpreted as a mathematical.

Declarations

Ethical Compliance

Not applicable

Conflicts of Interest

There is no conflict of interest

Funding

There is no funding

Acknowledgments

All authors have seen the manuscript and approved to submit it to the journal.

References

1. Islam M, Rahman M (2013) Enhancing lean supply chain through traffic light quality management system. Management Science Letters 3(3):867–878
2. Jacobs F, Robert RB, Chase, Lummus RR (2011) Operations and supply chain management, vol 567. McGraw-Hill Irwin, New York
3. Packowski J (2013) LEAN supply chain planning: the new supply chain management paradigm for process industries to master today's VUCA World. CRC Press
4. Chakraborttya RK, Paul SK (2011) Study and implementation of lean manufacturing in a garment manufacturing company: Bangladesh perspective. Journal of Optimization in Industrial Engineering 4(7):11–22
5. Gordon RL, Tighe W, Siemens ITS (2005) *Traffic control systems handbook*. No. FHWA-HOP-06-006. United States. Federal Highway Administration. Office of Transportation Management
6. Rostoker MD, Daane J, and Sandeep Jaggi. "Traffic control system utilizing cellular telephone system." U.S. Patent No. 5,745,865. 28 Apr. 1998
7. Abdulmalek FA, Rajgopal J (2007) Analyzing the benefits of lean manufacturing and value stream mapping via simulation: A process sector case study. International Journal of production economics 107(1):223–236
8. Womack JP (1990) Machine that changed the world. Scribner. Womack, L., & Jones, D. (1996). Lean Thinking. Simon Schuster Ed., New York
9. Technopac (2007) A Quarterly Report on Lean Manufacturing – The way to Manufacturing Excellence. Outlook, (Website version)
10. Ferdousi F, Ahmed A (2009) An Investigation of Manufacturing Performance Improvement through Lean Production: A Study on Bangladeshi Garment Firms. International Journal of Business Management 4(9):106–116
11. Habidin NF, Yusof SM, Omar CMZC, Mohamad SIS, Janudin SE, Omar B (2012) Lean six sigma initiative: Business engineering practices and performance in Malaysian automotive industry. IOSR Journal of Engineering (IOSRJEN) 2(7):13–18
12. Ketkar M, Vaidya OS (2012) Study of emerging issues in supply risk management in India. ProcediaSocial Behavioral Sciences 37:57–66
13. Koprulu A, Albayrakoglu MM (2007) Supply chain management in the textile industry: A supplier selection model with the analytic hierarchy process. Proceedings of the Ninth International Symposium on the Analytic Hierarchy Process (ISAHP 2007). (C. Garuti (ed.)). Pittsburgh, PA: RWS Publications
14. Ohno T (1988) The Toyota Production System: Beyond Large Scale Production. Productivity Press, Portland, Productivity Press
15. Christopher M, Peck H, Towill D (2006) A taxonomy for selecting global supply chain strategies. International Journal of Logistics Management 17(2):277–287

16. Marudhamuthu R, Krishnaswamy M, MoorthyPillai D (2011) The development and implementation of lean manufacturing techniques in Indian garment industry. Jordan Journal of Mechanical Industrial Engineering 5(6):527–532
17. Mahapatra SS, Mohanty SR (2007) Lean manufacturing in continuous process industry: an empirical study. Journal Scientific Industrial Research 66(January):19–27
18. Mason-Jones R, Towil D (1999) Total cycle time compression and agile supply chain. Int J Prod Econ 62(1/2):61–73
19. Ratnayake V, Lanarolle G, Perera C, Marsh J (2009) Cellular lean model to reduce WIP fluctuation in garment manufacturing. International Journal of Six Sigma Competitive Advantage 5(4):340–358
20. Christopher M (1998) Logistics and supply chain management: strategies for Reducing Costs and Improving Service, 2nd edn. Financial Times/Pitman Publishing, London, p 168
21. Sen A (2008) The US fashion industry: A supply chain review. Int J Prod Econ 114(2):571–593
22. Mackee R, Dr. Rose D (2012) From Lean manufacturing to supply chain: a foundation for change, Lean supply chain management in the fashion industries, Lawson Whitepaper, Website version swe.lawson.com/.../lawson_whitepaper_2_a4_lowres.pdf
23. Farmakis TS, Russell D, Routsong. "Satellite based aircraft traffic control system." U.S. Patent No. 5,714,948. 3 Feb. 1998
24. Mimbela, Luz-Elena Y, Lawrence A, Klein. "Summary of vehicle detection and surveillance technologies used in intelligent transportation systems." (2007)
25. Wolff J et al ("Parking monitor system based on magnetic field senso." 2006) *IEEE Intelligent Transportation Systems Conference*. IEEE, 2006
26. Geng Y, Christos G, Cassandras (2013) "New “smart parking” system based on resource allocation and reservations". IEEE Transactions on intelligent transportation systems 14(3):1129–1139
27. Urazghildiiev I et al (2007) Vehicle classification based on the radar measurement of height profiles. IEEE Transactions on intelligent transportation systems 8(2):245–253
28. Stadtler H (2008) "Supply chain management—an overview. In: " Supply chain management and advanced planning. Springer, Berlin, pp 9–36
29. Feldmann M, Müller S. "An incentive scheme for true information providing in supply chains." *Omega* 31.2 (2003) 63–73
30. Hübner AH, Kuhn H, Sternbeck MG. "Demand and supply chain planning in grocery retail: an operations planning framework." *International Journal of Retail & Distribution Management* (2013)
31. Tracey M, Lim J-S, Mark A Vonderembse. "The impact of supply-chain management capabilities on business performance." *Supply Chain Management: An International Journal* (2005)

Figures

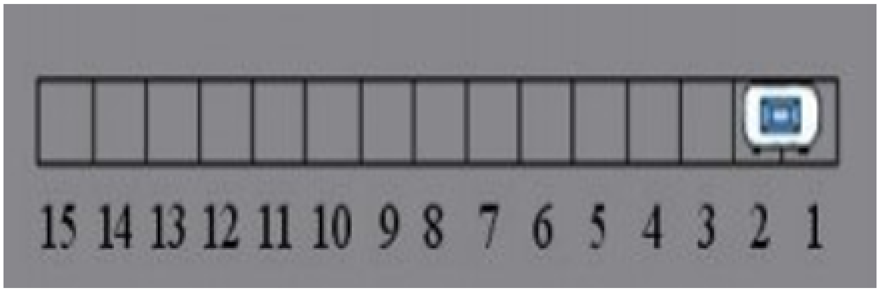

Figure 1

Standard Lane of the model

Figure 2

Traffic Model

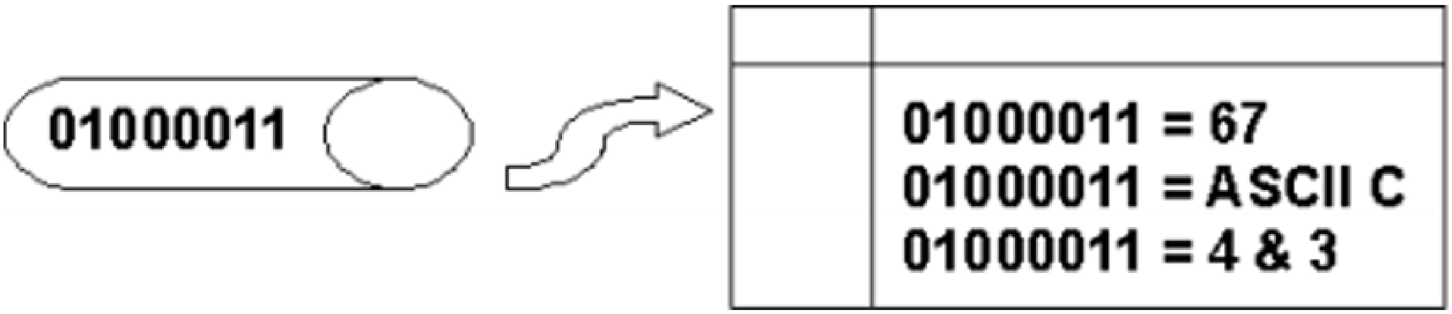

Figure 3

Three various methods to decrypt single binary chromosome

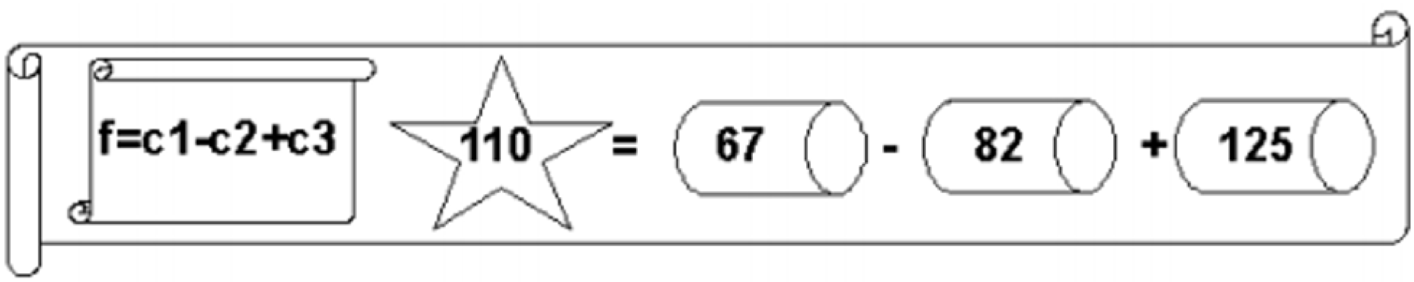

Figure 4

Fitness calculation model from an individual with three chromosomes

Image not available with this version

Figure 5

The Architecture of Predictive/decision making System is shown in Figure 5.

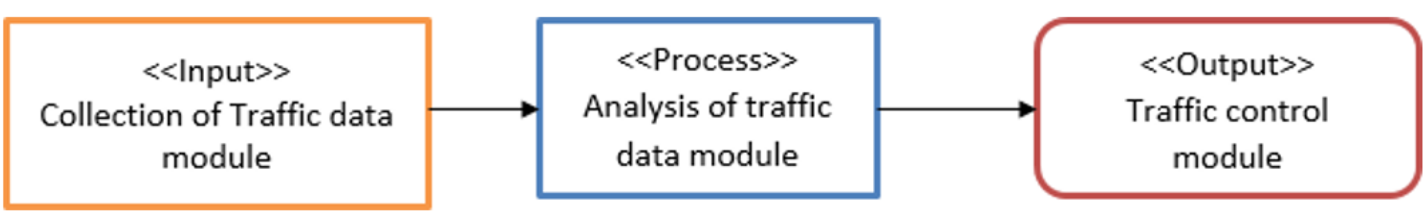

Figure 6

Projected Systems Component Architecture

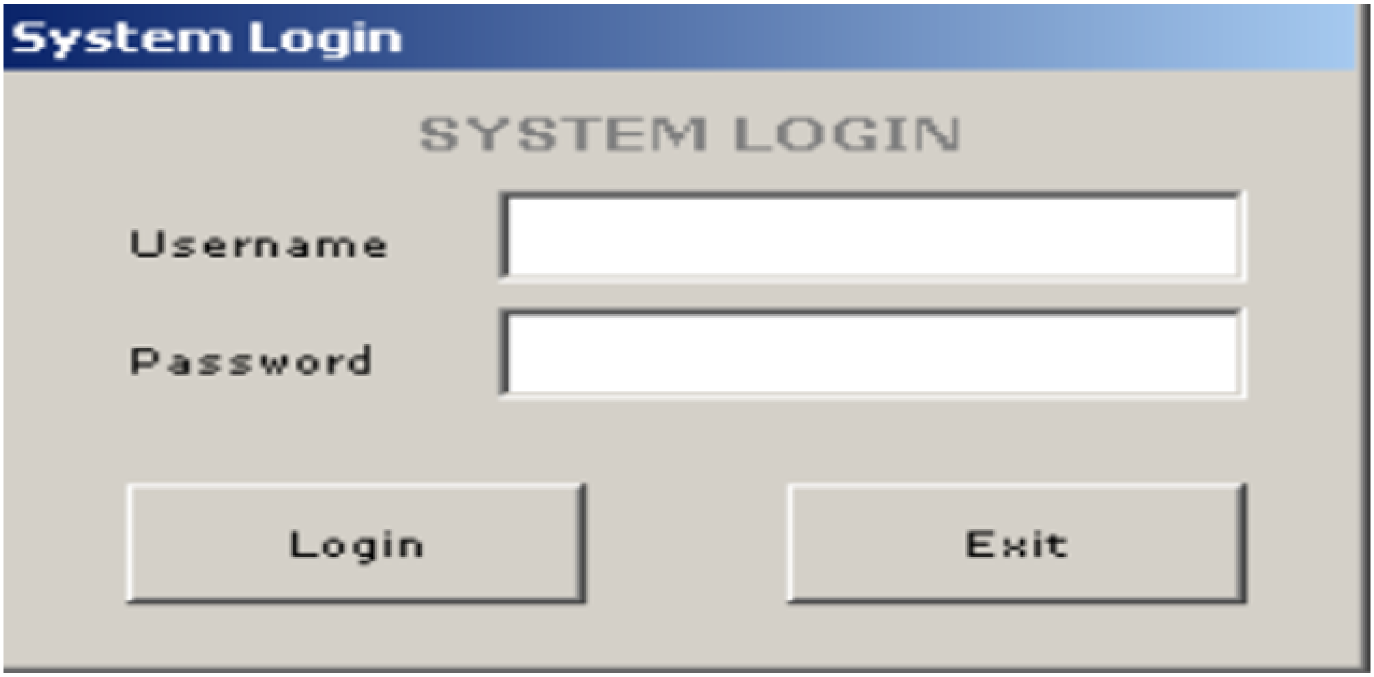

Figure 7

System Login Form

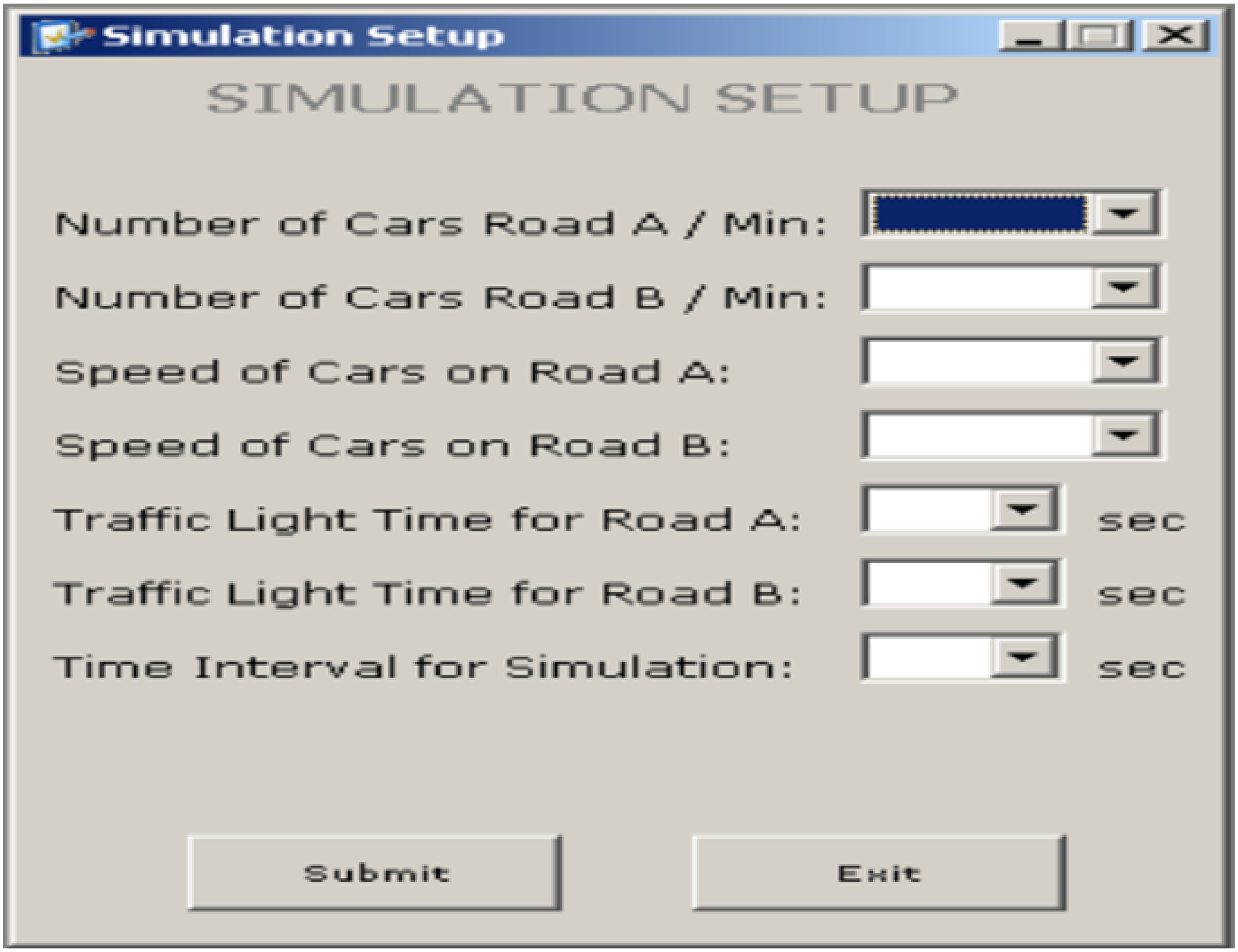

Figure 8

Simulation Setup Form

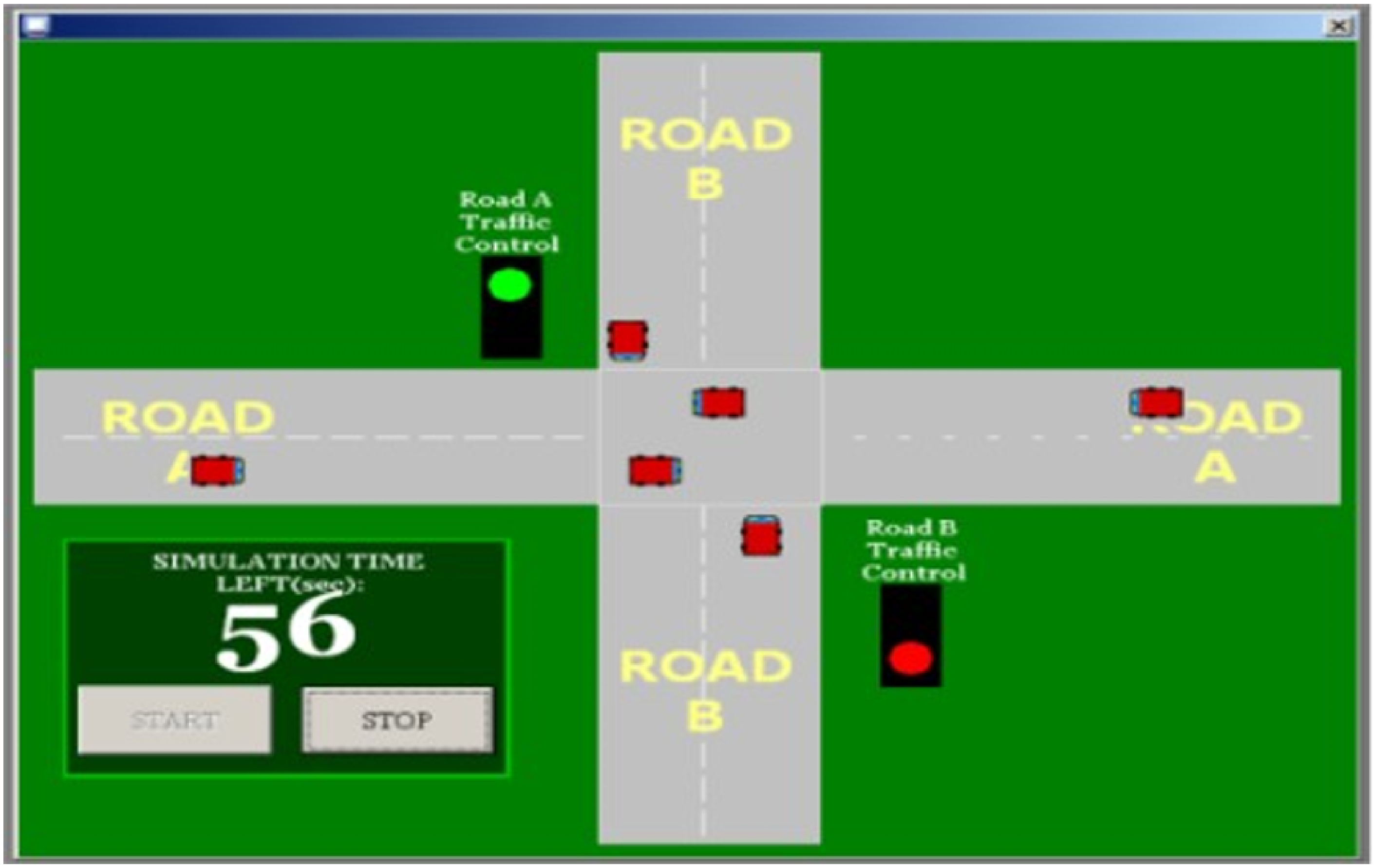

Figure 9

Snapshot of the Simulation Window

Figure 10

Snapshot of Simulation Exercise

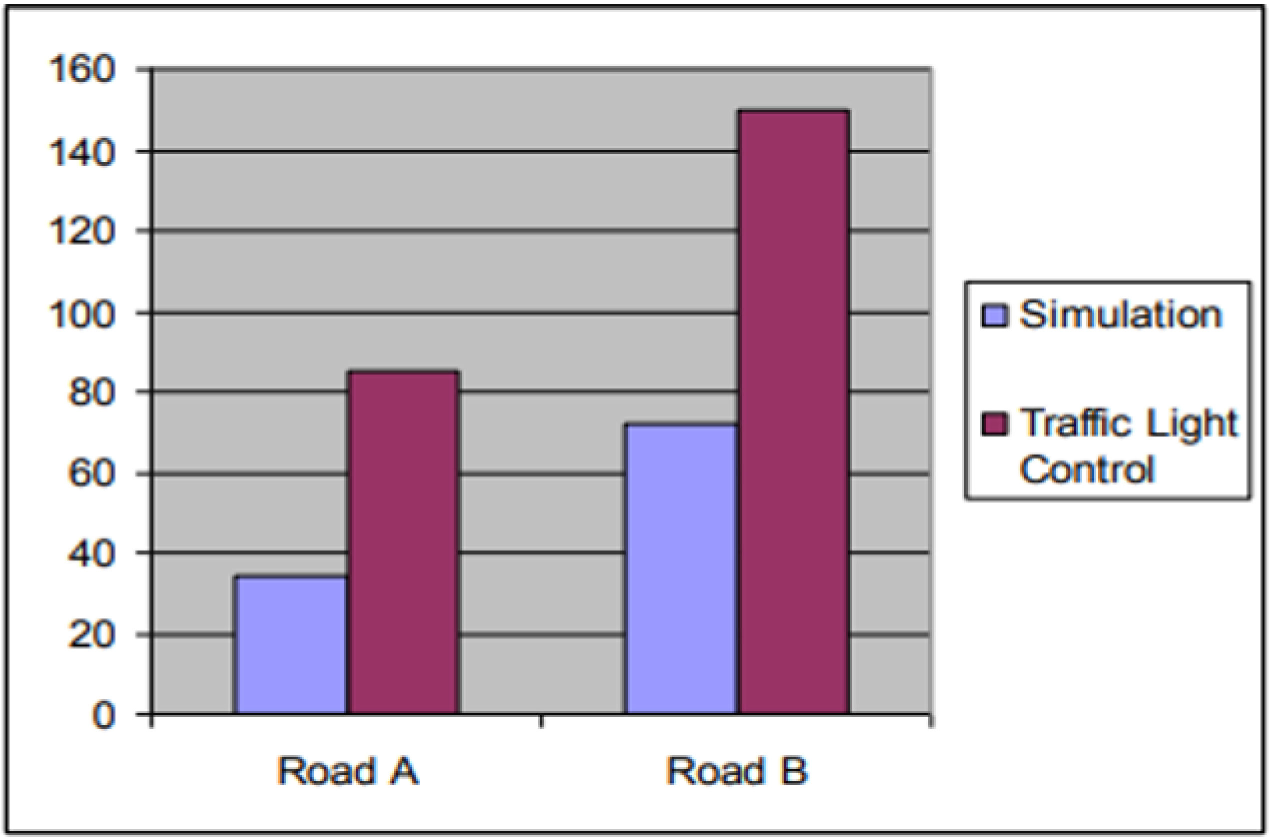

Figure 11

Graphical Representation of the Simulation Results