Simulation Project

Team B

Improve Throughput of the Main Road

Hannoversche Str. / Diesdorfer / Ummendorfer Str.

Milestone 8

Presented by

Karthikeyan Muthukumar

Overview

1. Milestone Results
2. Recommendations
3. Cost Summary
4. Why should you hire us?
5. Lessons Learned
6. Final Remarks

Project Organization

- Project Goal: Improve Throughput of the Main Road - Hannoversche Str.
- Team: Team B with six members
- Duration: 13 weeks
- Assigned Budget: 60000 €
- 8 Milestones

Milestone 1 - Team Formation

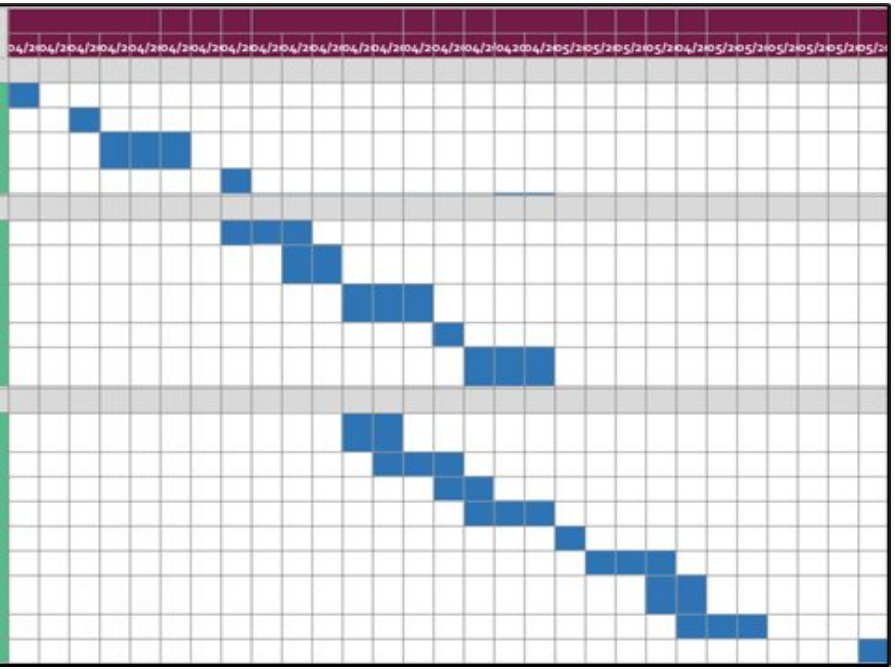
- To assign roles
- To agree on a team goal
- To agree on assessment and quality criteria

Team Members

1.	Karthikeyan Muthukumar	*Team Leader*
2.	Rahul Pothanchery	*Conceptual Model*
3.	Juwana Jose	*Input Data Analyst*
4.	Ijaaz Muhammed Mullamangalam	*Chief Software Architect*
5.	Gregor Göpfert	*Experiment Designer*
6.	Oleeviya Babu Poikarayil	*Validation and Quality Control*

Milestone 2 - Project Plan

WBS NUMBER	TASK TITLE	LEAD	START DATE	DUE DATE	DURATION (IN HOURS)	PROGRESS
1	TEAM					
1.1	Role assignment	Everyone	13/04/23	13/04/23	3	100%
1.2	Project site visiting	Everyone	15/04/23	15/04/23	12	100%
1.3	Slide preperation	Karthik/ Everyone	16/04/23	18/04/23	6	100%
1.4	Presentation	Karthik	20/04/23	20/04/23	_	100%
2	PROJECT PLAN					
2.1	Project scheduling	Juwana	20/04/2023	22/04/2023	5	100%
2.2	Cost estimation	Juwana/ Oleeviya	22/04/2023	23/04/2023	3	100%
2.3	Slide preperation	Juwana/ Karthik	24/04/2023	26/04/2023	7	100%
2.4	Presentation	Juwana	27/04/2023	27/04/2023	_	100%
2.5	Rework	Juwana/Every one	28/04/2023	30/04/2023	5	100%
3	CONCEPTUAL MODEL					
3.1	Analysis of current traffic situation and road plan	Everyone	24/04/2023	25/04/2023	3	100%
3.2	Identifying events	Rahul/Ijaaz	25/04/2023	27/04/2023	4	100%
3.3	Assumptions and simplifications	Rahul	27/04/2023	28/04/2023	2	100%
3.4	Designing petrinets	Rahul	28/04/2023	30/04/2023	13	100%
3.5	Identifying required data	Rahul/Juwana	01/05/2023	01/05/2023	6	100%
3.6	Identifying quantitites for simulation results	Rahul/Gregor	02/05/2023	04/05/2023	4	100%
3.7	Validation of conceptual model	Rahul/ Oleeviya	04/05/2023	05/05/2023	5	100%
3.8	Slide preperation	Rahul	05/05/2023	07/05/2023	8	100%
3.9	Presentation	Rahul	11/05/2023	11/05/2023	_	100%

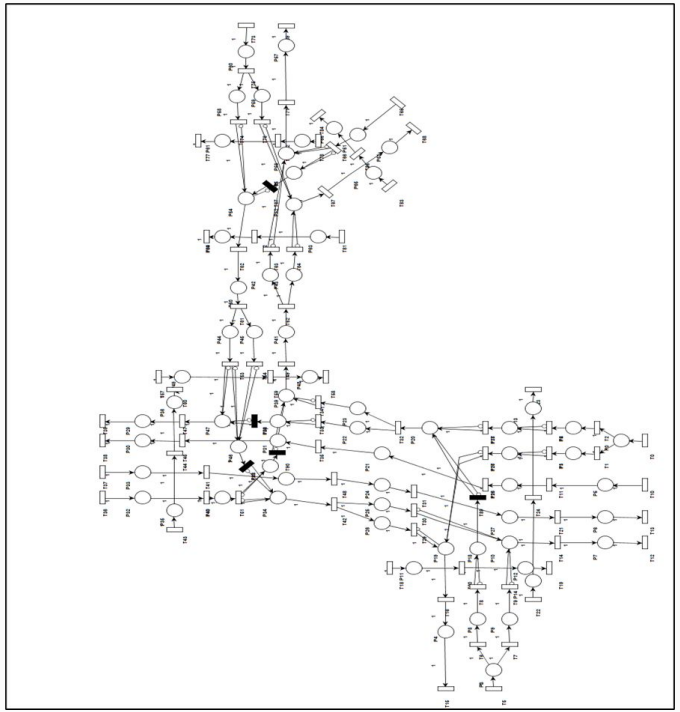


Project Budget → Estimated Budget : 55800 €

Milestone #	Milestone	Estimated Budget
1	Team formation	2,100 €
2	Project plan	2,000 €
3	Conceptual model	5,000 €
4	Data analysis	16,700 €
5	Simulation program	11,300 €
6	Validation	8,600 €
7	Experiments	2,100 €
8	Final report	8,000 €

Milestone 3 - Conceptual Model

- To make a Stochastic Petri Net model of the real world system
- To identify quantities that would be required as input to the model and the ones that were intended to use as simulation results



Assumptions

- Neglected the Hermsdorfer straße
- Traffic lights functioning based on fixed timings
- Cars having same length and uniform speed
- Tram as a custom agent
- Modelled to mimic the evening rush hour
- Everyone follows the rules

Experiments Planned

- Removing a traffic signal
- Combining tram lanes into one
- Subway for pedestrians
- Optimizing the traffic signals

Input Variables

- Inter-arrival time of vehicles/trams/pedestrians on all nodes
- Average length of vehicles
- Probability of vehicles turning to different lanes
- Average speed and acceleration of vehicles
- Traffic light phase timings

Output Variables

- Average queue length
- No. of vehicles exiting the nodes
- Average time spent by vehicles in the system

Milestone 4 - Data Analysis

- To collect and analyse the data necessary for the parameterization of the program
- Preparing data for validation

Input Data

- Probability of taking a direction
- Average length of vehicles
- Traffic light timings
- Inter-arrival times

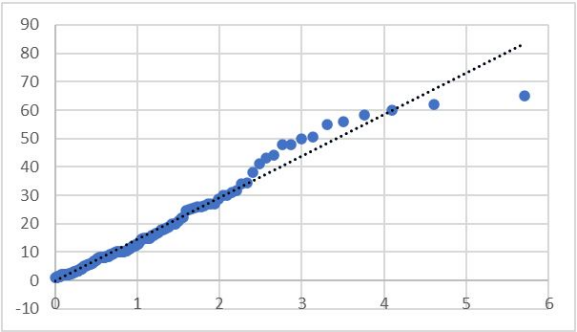
Output Data

- Average queue length
- Average time spent by vehicles in the system
- Number of vehicles exiting the node

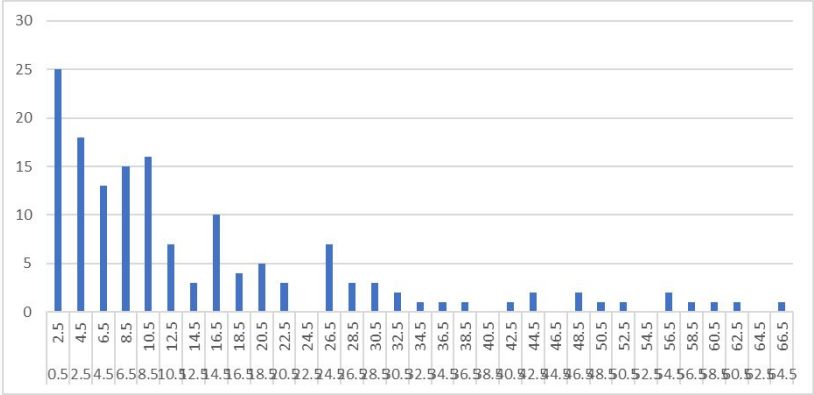
Analysis of the Data

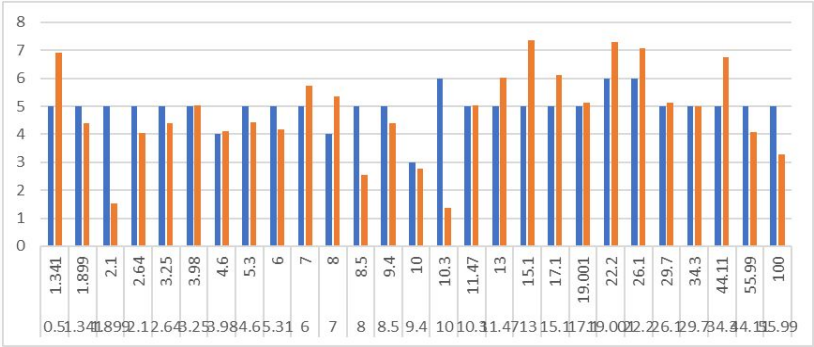
Mentioned below are the steps we adopted to analyze the data associated:

1. Creating histogram
2. Creating quantile-quantile plots
3. Goodness of fit Chi-squared test



Histogram, QQ Plot, Chi Squared Test - Hannoversche Str.





Street	Distribution	n	f	α	Parameters	Chi_0	Chi_stat
Hannoversche	Exponential	134	25	0.9	Mean = 15.3422, λ = 0.06518	34.38159	30.89538
Ummendorfer	Exponential	67	11	0.9	Mean = 35.82433, λ = 0.027914	17.27501	11.1751
Diesdorfer Grasseweg	Gamma	159	7	0.05	α= 3.75, β= 0.8	14.07	8.26
Kummelsberg	Lognormal	120	12	0.05	Mean = 0.931317, stdev = 0.607715	21.03	13.751
Große Diesdorfer	Custom distribution	-	-	-	-	-	-

Milestone 5 - Simulation Program

- To model and program the real world system in AnyLogic
- Preparation for the experiments

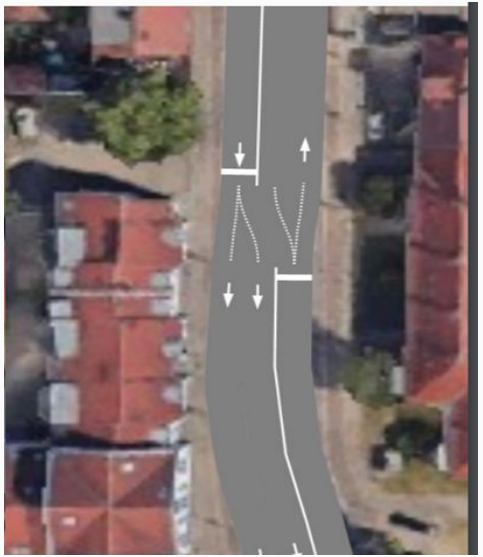
Design

We divided the design into different parts,

- Modeling Vehicles
- Modeling Trams
- Modeling Traffic lights

Difference between Simulation Program and Real World System

- Creation of two intersections in Hannoversche Str
- Tram signals were not included in the simulation
- Trams sharing the same roads as vehicles
- Buses were not included in our model



Milestone 6 - Validation

We validated our model by,

- running 100 simulation replications
- across an hour of simulation time and
- calculating confidence intervals with a 99 percent confidence level (alpha=0.01).

➔ When the measured output parameters are included, the validation process indicates that the model is mathematically correct and a major amount of our real-world mean data falls inside the confidence ranges produced from the replications.

➔ As a result, we can conclude that our simulation model is correct and mimics the real-world system.

Validation Results

STREET	LOWER	UPPER	REAL WORLD THROUGHPUT
Hannoversche str.	400.362	428.898	420
Kummelsberg	534.987	574.533	542
Diesdorfer Graseweg	377.768	407.892	404
Große Diesdorfer Str.	255.081	272.739	266
Ummendorfer Str.	43.233	47.567	51

STREET	LOWER	UPPER	REAL WORLD AVERAGE QUEUE LENGTH
Hannoversche South	3.564	4.022	3.714
Hannoversche North West	1.761	1.954	1.857
Kummelsberg	17.237	17.31	17.294
Diesdorfer Graseweg	27.445	27.8	27.525
Große Diesdorfer Str.	6.839	7.381	7.138
Ummendorfer Str.	0.314	0.5	1.4166

STREET	LOWER	UPPER	REAL WORLD AVERAGE TIME (in seconds)
Time Spent North	26.19	26.99	26.78
Time Spent South	27.72	29.04	28.12

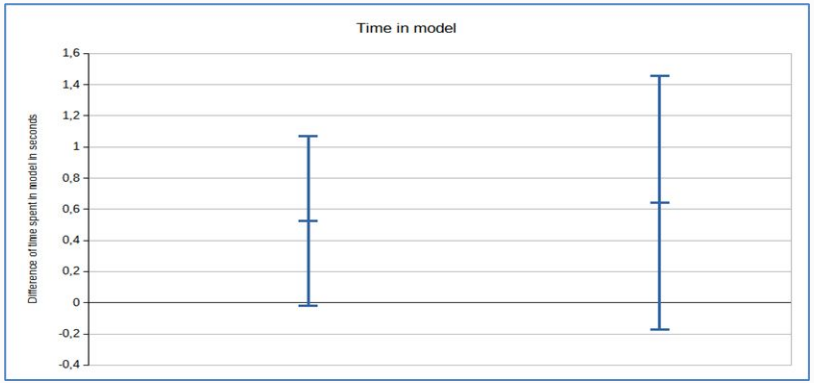
Milestone 7 - Experiments

Experiment 1

- Moving the tramlines to the south→ taking up less of the intersection

Result:

- Normal Traffic → No difference to the normal Model

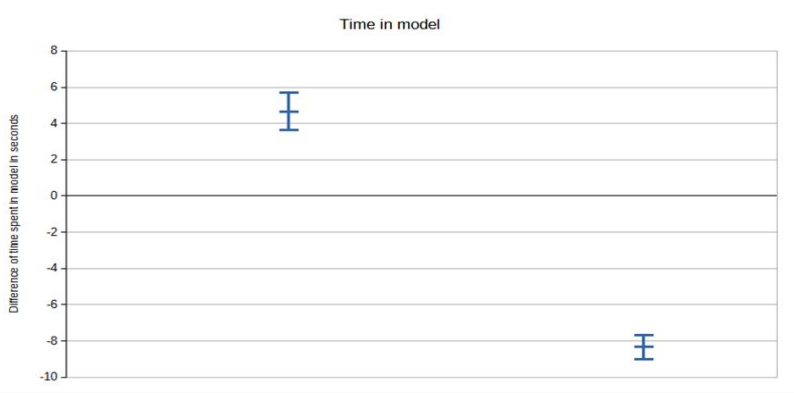


Experiment 2

- Joining up the Hannoversche Straße with Kümmelsberg

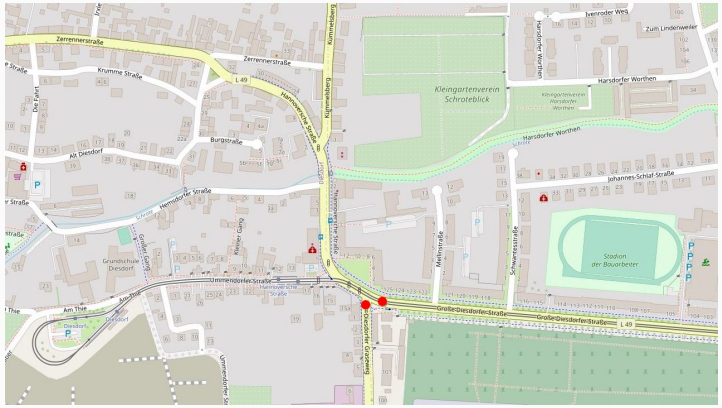
Result:

- A decrease for the time needed to go north
- A great increase for the time needed to go south (that's because the time in model is measured between the intersections)



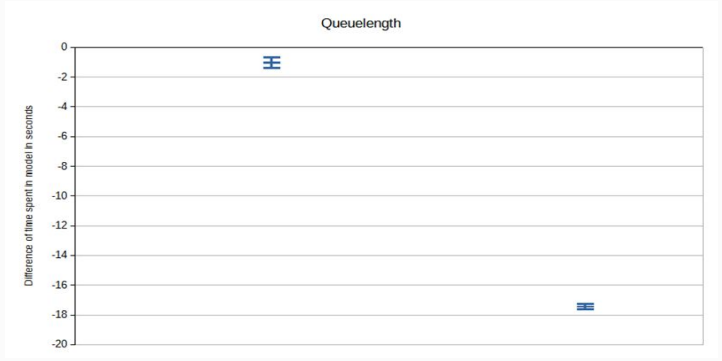
Experiment 3

- Changing up the traffic lights at the lower intersection



Result:

- A decrease in queue lengths of both Diesdorfer and Graseweg

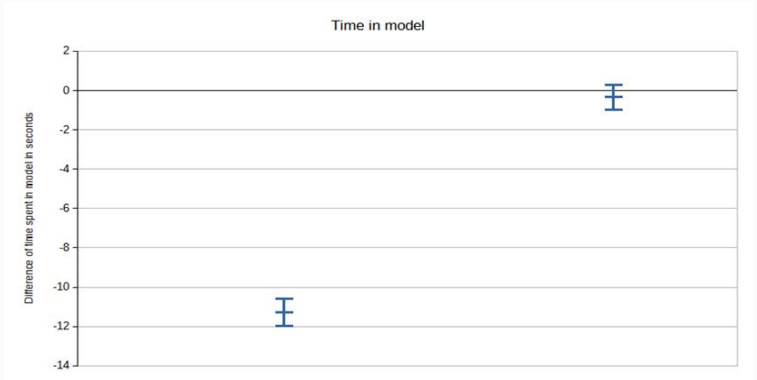


Experiment 4

- Building an underpass for cars coming from Graseweg and Große Diesdorfer Straße

Result:

- Normal Traffic → No difference to the normal Model



Recommendations

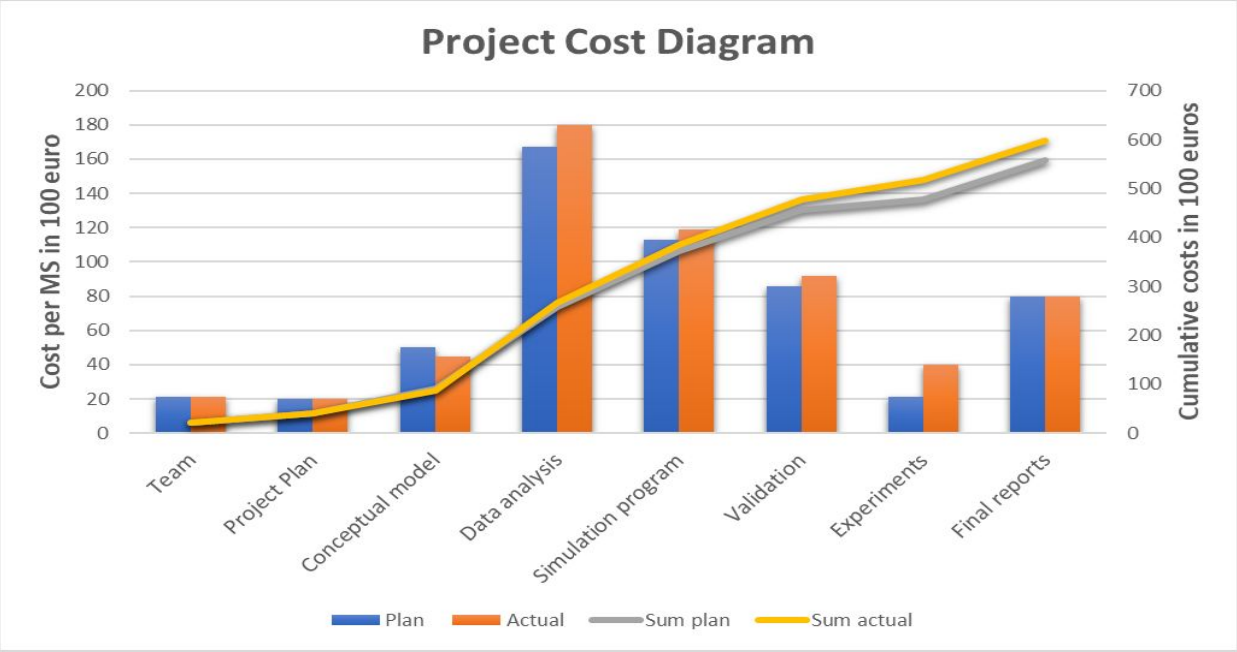
- All experiments except the first one improve the throughput
- Change of traffic lights yield the best result

  → it is also the cheapest one
- Changed Kümmelsberg intersection has little effect on the throughput

  → improves the time spent in model

  → recommended together with a change of traffic lights

Project Cost



Why should you hire us again?

Lessons Learned

- Effective Communication
- Planning and Flexibility
- Value of Data Analysis
- Teamwork and Collaboration
- Continuous Learning and Adaptation
- Importance of Milestone Evaluation
- Real-world Application of Skills
- Effective Time and Resource Management

Final Remarks

Thank You

Questions?