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# Performance Improvement in DMV Offices using SIMIO within Lean-Six Sigma

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## Introduction

- Lean-Six Sigma
  - Business management philosophy practiced globally
- Service Systems
- Simulation
  - Optimization tool
  - Process improvement method
  - Imitating real systems
  - Not widely used in Lean-Six Sigma

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## DMV

- NCDOT Division of Motor Vehicles (DMV) operates over 175 local offices in North Carolina
- DMV contracted with NC State College of Textiles Extension services for performance improvement in their DMV offices
- Simulation was incorporated into the lean-six sigma study through a Master's Thesis (Swapnil Landge)

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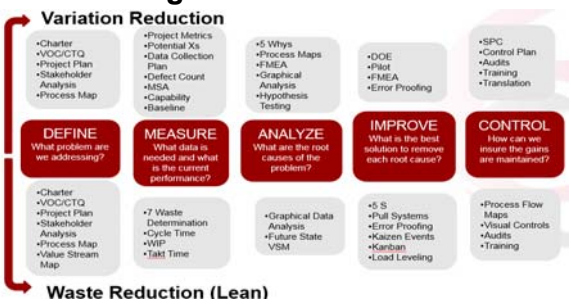
## Lean Six Sigma – DMAIC Process



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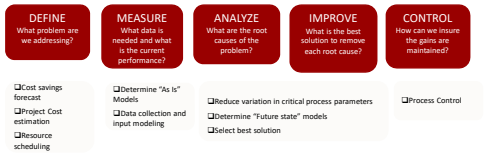
## DMAIC and Simulation

Simulation is an useful tool in the Six Sigma process improvement methodology where uncertainty and variation have the greatest impact

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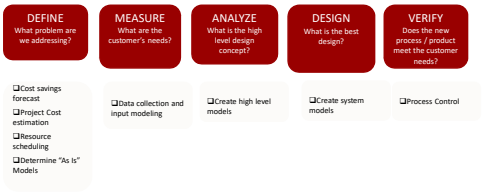
## DMADV and Simulation

Simulation is useful in any phase where the independent variables (*X*'s) are described as a distribution of values yields more realistic range of results

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## DMAIC

- Lean-Six Sigma (DMAIC) was the framework for the whole project
- Lean-Six Sigma (DMAIC) is used as a framework for the simulation model development.

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## Define Phase

- "**Problem Statement**: - The process for obtaining services at the DVM is often lengthy and requires customers to wait more than 30 minutes to initiate a transaction. Currently, there is no target for what is to be considered a reasonable wait time or total transaction; it is known, however, that presently the times are no longer than desired. The extended amount of time spent fulfilling customer needs results in lost productivity, reduced customer satisfaction and low employee morale."
- "**Mission Statement**: - The mission of this project is to reduce the average total time of customers in the driver license office by 20% by October 31, 2015. This will result in more transactions being completed by DMV, less time a customer is required to spend at the driver license office and greater execution of the organizational goal of NCDOT being a great place to work." (DMV office Lean Six Sigma Project Tollgate report 2015)

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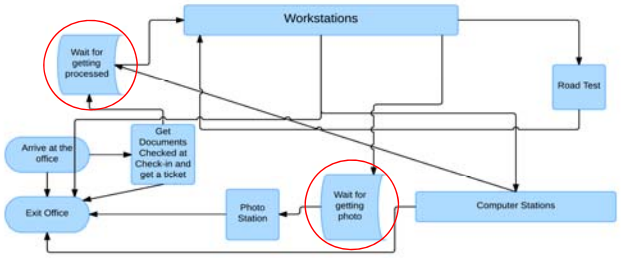
## DMV Process Map

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## Service System

- People in service systems
- Evaluators (including Photo and Greeter)
  - Absenteeism, Lateness
  - Hour lunch breaks taking in groups.

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## Measure Phase

- Gauge Important inputs based on Simulation model
- Determine Metrics that also used by simulation
- Initial Simulation can help determine Xs (i.e. help with data collection)
- Data Collected
  - Characteristics of all the Customer Types
    - Percentage and Arrival Patterns by Day
    - Processing Times of the Different Steps in the Process by Customer Type (i.e., Evaluator at Workstation, Road Test Time, Computer Written Test, etc.)
  - Lunch Schedules of the Workers
  - Number of Evaluators, Greeters for each office
  - Failure Rates on Road Test, Eye Test, and Written Test
  - Physical Layout of the DMV Offices
  - Number of Customers who Balk from System
  - Volume of customers Base on Day of Week and Month

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## Issues with the data and solutions identified using Simulation

- Problems: Incomplete or faulty wait times were main source of high wait times
- Solution: Outliers and customers forgetting documents were identified

- Problem: Double processing time the servers in case of Computer and road test was not considered
- Solution: Simulating the scenario point some missing data points which were later validated by expert opinion

- Problem: Processing time at check-in and photo server included wait and processing time
- Solution: Proper calibration of check-in time was identified which was verified by expert opinion and validated with a real sample

- Problem: Worker availability was collected at specific interval of time not involving the break duration
- Solution: Simulation model noted that the breaks were main source of delays or responsible parameters in increased time in system

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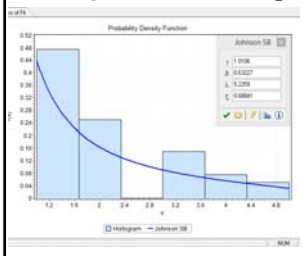
## Input Modelling



| Variable Description | SIMIO Random Expression | Determined |
|---|---|---|
| State IDs | LogLogistic(3.33, 4.16) | Fitted |
| License without any test | Lognormal(1.7425, 0.64473 | Fitted |
| License before Road Test | 3 | Expert Opinion |
| License After Road Test | Lognormal(1.786426, 0.839898) + .27 | Fitted |
| License after Road test and written Test | Lognormal(1.786426, 0.839898) + .27 | Fitted |
| License after written test before road test | Lognormal(1.786426, 0.839898) + .27 | Fitted |
| Before Written Test | Lognormal(1.786426, 0.839898) + .27 | Fitted |
| Written test/Computer Test | Lognormal(1.786426, 0.839898) + .27 | Fitted |
| Written CDL | JohnsonSB(0.18151, 0.41229, 0.68887, 13.23587) | Fitted |
| Permits | Lognormal(0.62625, 1.8545) | Fitted |
| Appointment | Lognormal(1.786426, 0.839898) + .27) | Fitted |
| Others Transactions | JohnsonSB(1.0106, 0.63227, 0.68841, 5.9143) | Fitted |
| Before Written Provisional I | Gamma(3.2009, 1.4328) | Fitted |
| After Written Provisional I | Gamma(3.2009, 1.4328) | Fitted |

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## Analyze Phase

- Simulation used mostly during Analyze and Improvement phases
  - –DOEs
  - –Understand Important Xs and Ys
  - –Build Simulation Model using Process Maps and Problem Understanding without any data
  - –Validation and Verification
  - –Root cause Analysis

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## Why SIMIO?

- Drive model from data
- Create our own objects
- Ability to modify existing objects
- For this model,
  - –Worker (Off shift nodes, lateness and absentisms,state variables)
  - –Server (States)
  - –Model Entity (Properties and States)

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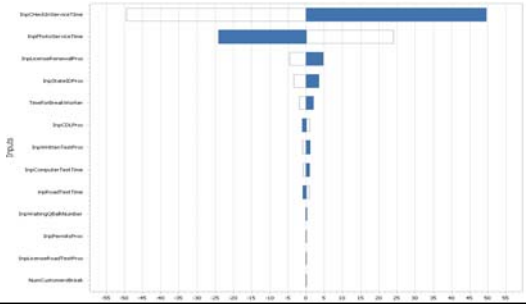
## Response Sensitivity Analysis



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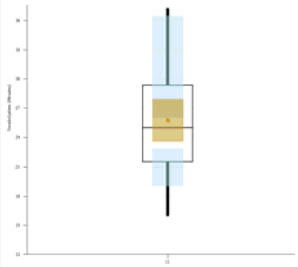
## Model Validation



- After running 30 replications, the confidence interval of the mean of the total time in system is 25.67±2.1 minutes as seen in the SMORE plot in the Adjoining Figure. Comparing this to the real data confidence interval is 26±7 which overlaps with the simulated data.
- Fully Animated Model validated by Six Sigma Team

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## Visual Validation by Experts

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## Greensboro Office

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## Durham Office

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## Data Driven Modelling

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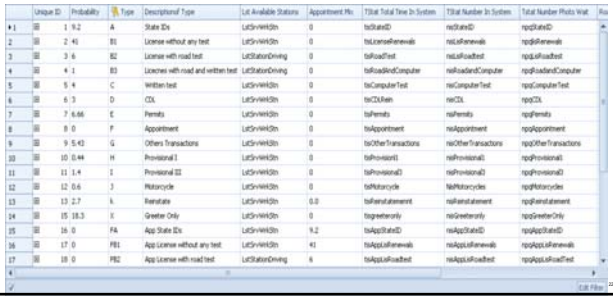
## Customer Type Tables



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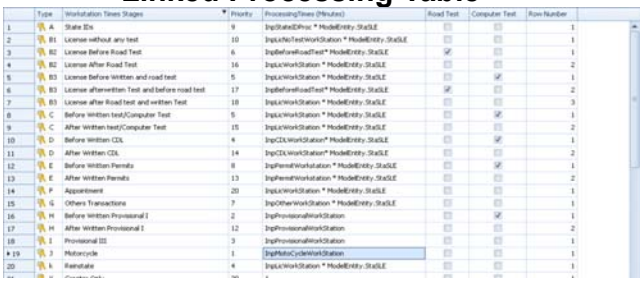
## Linked Processing Table



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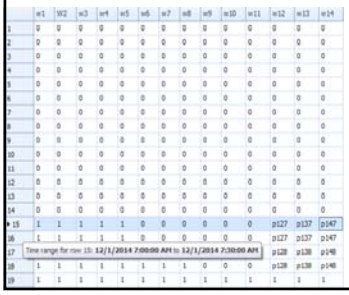
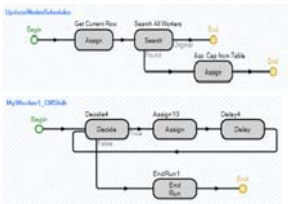
## Worker Scheduling





The value p127 means it is a property and 127 stand for 12th worker 7 am capacity.
p127 value was found using KN algorithm

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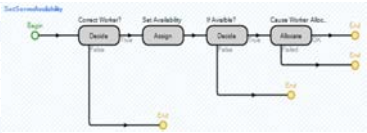
## DMV Workstation Availability – Evaluator Present

| | |
|---|---|
| Entered | SetServerAvailability |
| Input Arguments | |
| Server | srvWstn4 |
| Set Value | 1 |
| Which Worker | 6 |
| Exited | SetServerAvailability |
| Input Arguments | |
| Server | srvWstn4 |
| Set Value | 0 |
| Which Worker | 6 |



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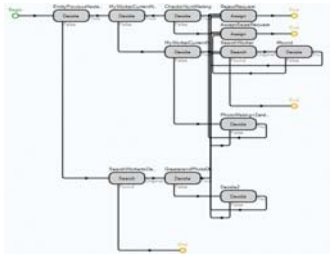
## Handling Greeter and Photo Area Evaluating the Seize Request



- Accepts and rejects requests
- Useful when greeter or photo person are off-shift

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## Improvement Phase

- Mitigating the cost of DOEs
- Proof of concepts can be validated and tested

- Improvements recommended for DMV:
  - Starting Office at 7 am
  - Adding Additional Full Time Evaluators and/or Part Time Evaluators
  - Policy changes of helping check people into the system
  - Optimizing schedule of the Evaluators

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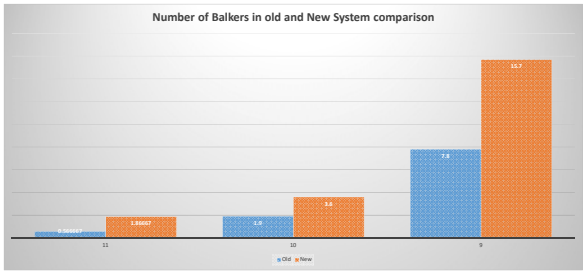

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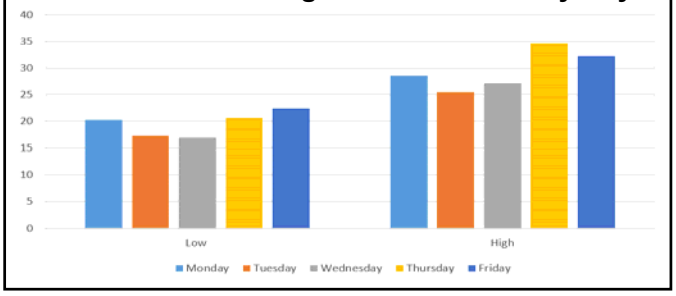
## Comparison of Average Time in System between Low-Volume and High-Volume Month by Day

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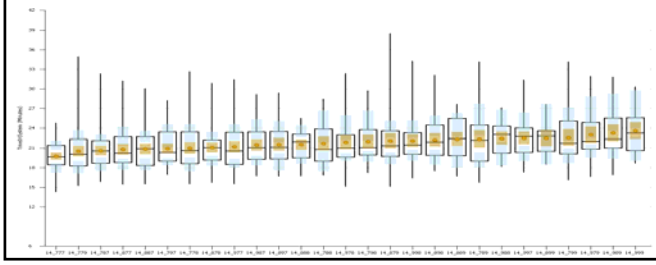
## Using KN algorithm to find the best schedule to minimize time in system in case of 11 workers and 3 additional full time workers



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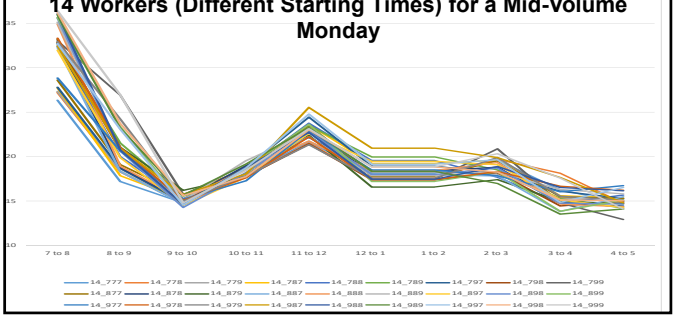
## Time in System Based on Hour with Best Scenarios Selected 14 Workers (Different Starting Times) for a Mid-Volume Monday

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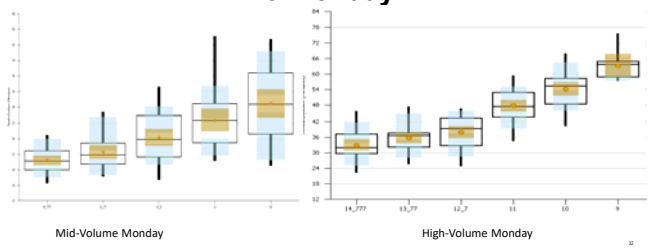
## Comparison of average time in system trend between mid-volume and high-volume months on a Monday



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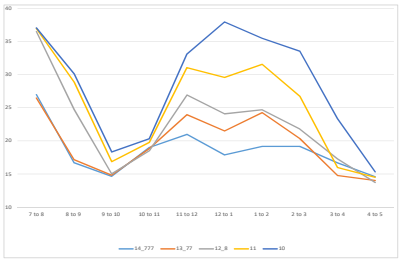
## Part Time Worker Concept



- Four hours a day (Retired Evaluators)
- 10 am -2 pm
- 7 am – 11 pm
- Optimizing/Comparing
  - Full time
  - Part Time
  - Combinations
  - Starting Schedules

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| Pattern | Description |
|---|---|
| **14_777** | 3 Full Time Workers (7 am to 4 pm) |
| **14_77_10-2** | 2 Full Time Workers (7 am to 4 pm) and 1 Part Time Worker (10am -2pm) |
| **14_7-11_10-2** | 3 Part Time Workers (2 work 7am – 11 am and 1 works 10am -2pm) |
| **14_7-11** | 3 Part Time Workers (7am – 11 pm) |
| **14_10-2_7-11** | 3 Part Time Workers (1 works 7am – 11 am and 2 work 10am -2pm) |
| **14_10-2** | 3 Part Time Workers (10am -2pm) |
| **13_77** | 2 Full Time Workers (7 am to 4 pm) |
| **13_7_10-2** | 1 Full Time Worker (7 am to 4 pm) and 1 Part Time Worker (10am - 2pm) |
| **13_7-11** | 2 Part Time Workers (7am – 11 am) |
| **13_10-2_7-11** | 1 Part Time Workers (1 works 7am – 11 am and 1 works 10am -2pm) |
| **13_10-2** | 2 Part Time Workers (10am -2pm) |
| **12_7-11** | 1 Part Time Worker (7am – 11 am) |
| **12_7** | 1 Full Time Worker (7 am to 4 pm) |
| **12_10-2** | 1 Part Time Worker (10am -2pm) |
| **11** | 0 Part Time Workers |
| **10** | 0 Part Time Workers |

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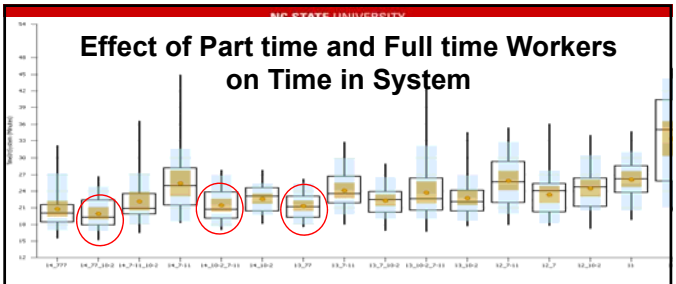
## Effect of Part time and Full time Workers on Time in System



Mid-volume Monday

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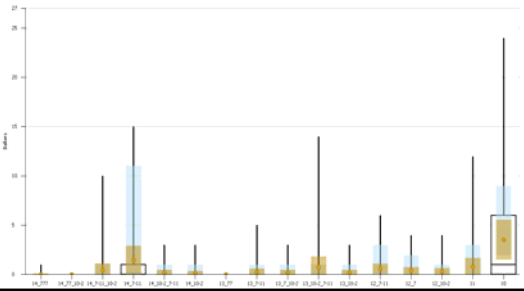
## Effect of temps, full time workers and part time workers on the balking customers



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## Control Phase

- Once improvement is implemented
  - Controls to Sustain Improvements (Control Charts, Visuals, training, documentation)
  - Virtual validation and testing of improvements for other months
- Simulation use in Control Phase
  - Collect New Data and rerun the model to make sure the recommendations are still valid (e.g., evaluator schedule, number of evaluators)
  - Use to forecast issues as new data is collected

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## Conclusion

- Identify use of Simulation at early stages of DMAIC process
  - Decreases time, money and resource utilization by identifying root cause or most important areas of focus (i.e., data to collect)
  - Six Sigma Practitioners need to Understand Simulation Capabilities
- Simulation Modelling can be used as a Lean Six Sigma tool
  - Systems where cost, time, constraints and permission barriers
- Large number of Designs (in case of DMA*D*V) or Improvements (in case of DMA*I*C) can be tested and validated faster and easier than in real life validation
  - No impact to real system

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## Recommendations for DMV

- Starting at 7 am was beneficial as 20 to 40 were waiting at 8 am
  - This has been proven and implemented at Charlotte Office
- Statistical similarity between 13 and 14 workers for the average time in system
  - Having 13 workers would be less costly
- Photo person helping the greeter can help decrease the time in system during the early hours when the photo person is mostly idle
- Policies of how many in the greeter line where the evaulators would help
- Having temporary workers during peak hours Useful

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**Thank You**
**Everyone**