Understanding Variation with Process Behavior Charts (Control Charts)

There are several different kinds of control charts. The chart that is probably the best for use in local government is known as the Individual Moving Range chart or I-MR or sometimes X-MR. It is actually two separate charts that should be prepared and used together. The charts are meant to examine the process behavior of some data over time to determine if it is predictable process and what amount variation is part of the process. While the chart starts off with the assumption the data is "in control" one of the key purposes of the chart is to determine if that is the case.

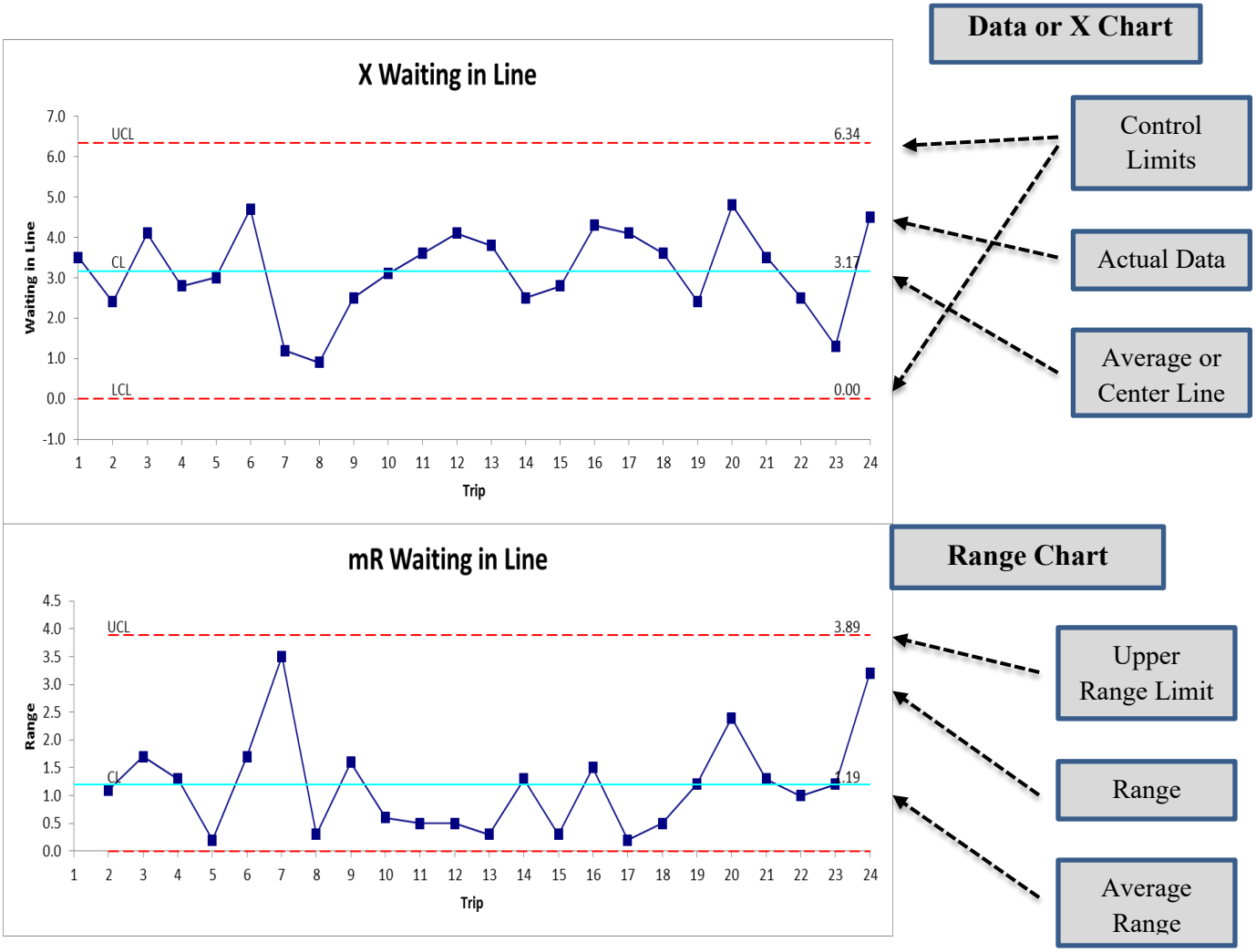
Imagine an operation where we are concerned with actual waiting time. The goal is for waiting times to be under five minutes. Twenty-four consecutive data points were collected and are show at the right. The I-MR chart is constructed with the following steps.

1. Calculate the range which is the absolute value of the difference between the current point and the previous point.
2. Find the average of the ranges.
3. Create an upper limit for the ranges by multiplying the average range by 3.268 and add to the average range.
4. Plot the range chart.
5. Find the average for the actual data.
6. Calculate upper and lower control limits for the actual data with the formula DataAverage ± 2.66*AverageRange
7. Plot the data chart with the data line and the upper and lower control limits.

Trip	Waiting in Line	Range
1	3.5	
2	2.4	1.1
3	4.1	1.7
4	2.8	1.3
5	3	0.2
6	4.7	1.7
7	1.2	3.5
8	0.9	0.3
9	2.5	1.6
10	3.1	0.6
11	3.6	0.5
12	4.1	0.5
13	3.8	0.3
14	2.5	1.3
15	2.8	0.3
16	4.3	1.5
17	4.1	0.2
18	3.6	0.5
19	2.4	1.2
20	4.8	2.4
21	3.5	1.3
22	2.5	1
23	1.3	1.2
24	4.5	3.2
Average	3.17	1.19

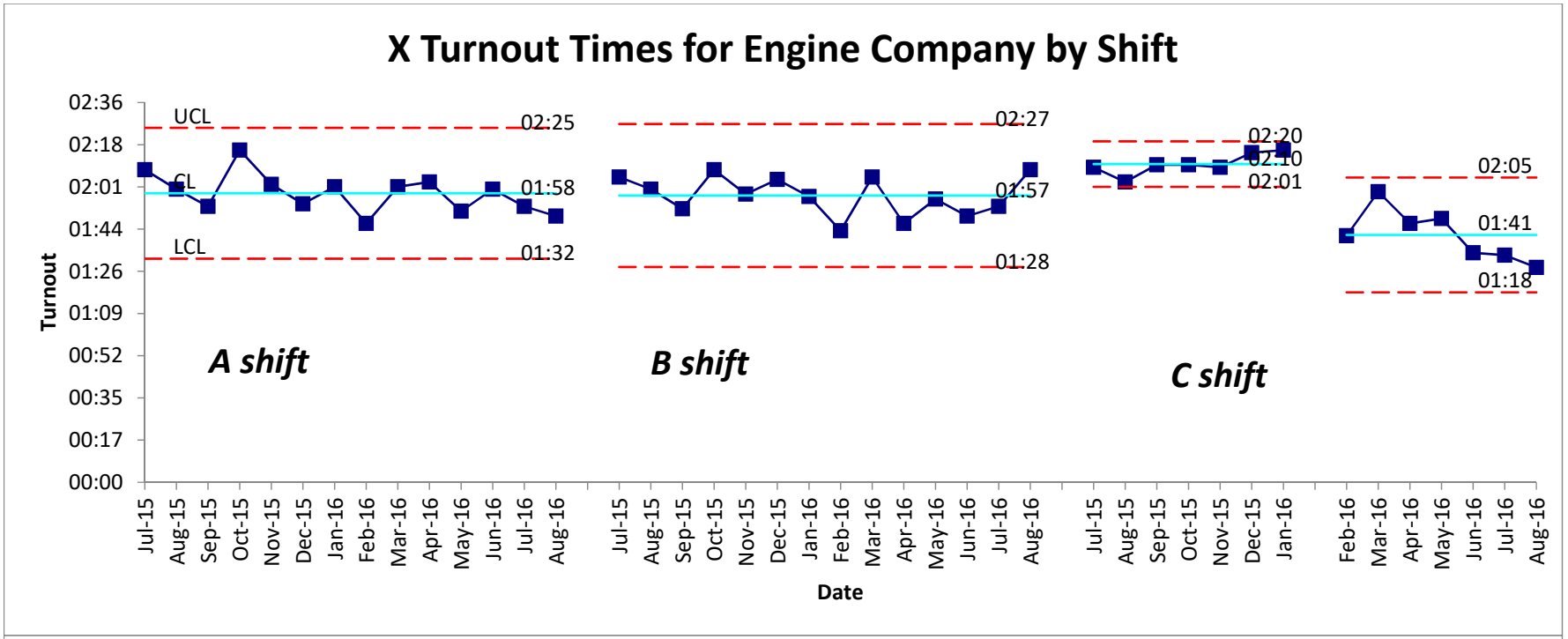
The resulting Range and Data chart are shown on the next page. Interpreting the charts.

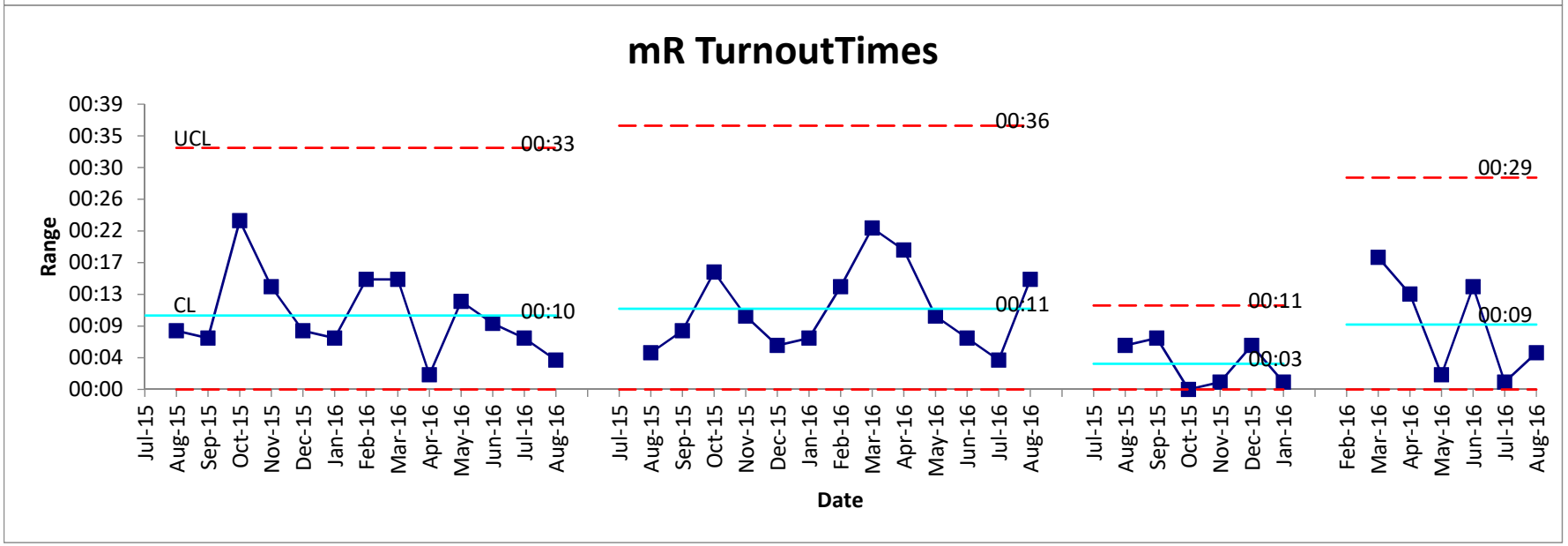
1. The range chart tells us the average movement from period to period is 1.19 minutes and the maximum change in waiting time from one period to the next we should see, assuming a predictable process, is 3.89 minutes.
2. No points on the range chart are past the 3.89 control limit so there are no points of concern on that range chart. The changes from one period to the next are predicable.
3. On the waiting time data chart, we see that the times while varying all lie within the control limits. We would conclude this is a stable and predictable process.
4. The average waiting time is 3.17 minutes and the maximum that would be expected is 6.34 minutes and we might see instances of zero waiting time.
5. Unless changes take place, we can use this for making predictions going forward and checking when we have problems.



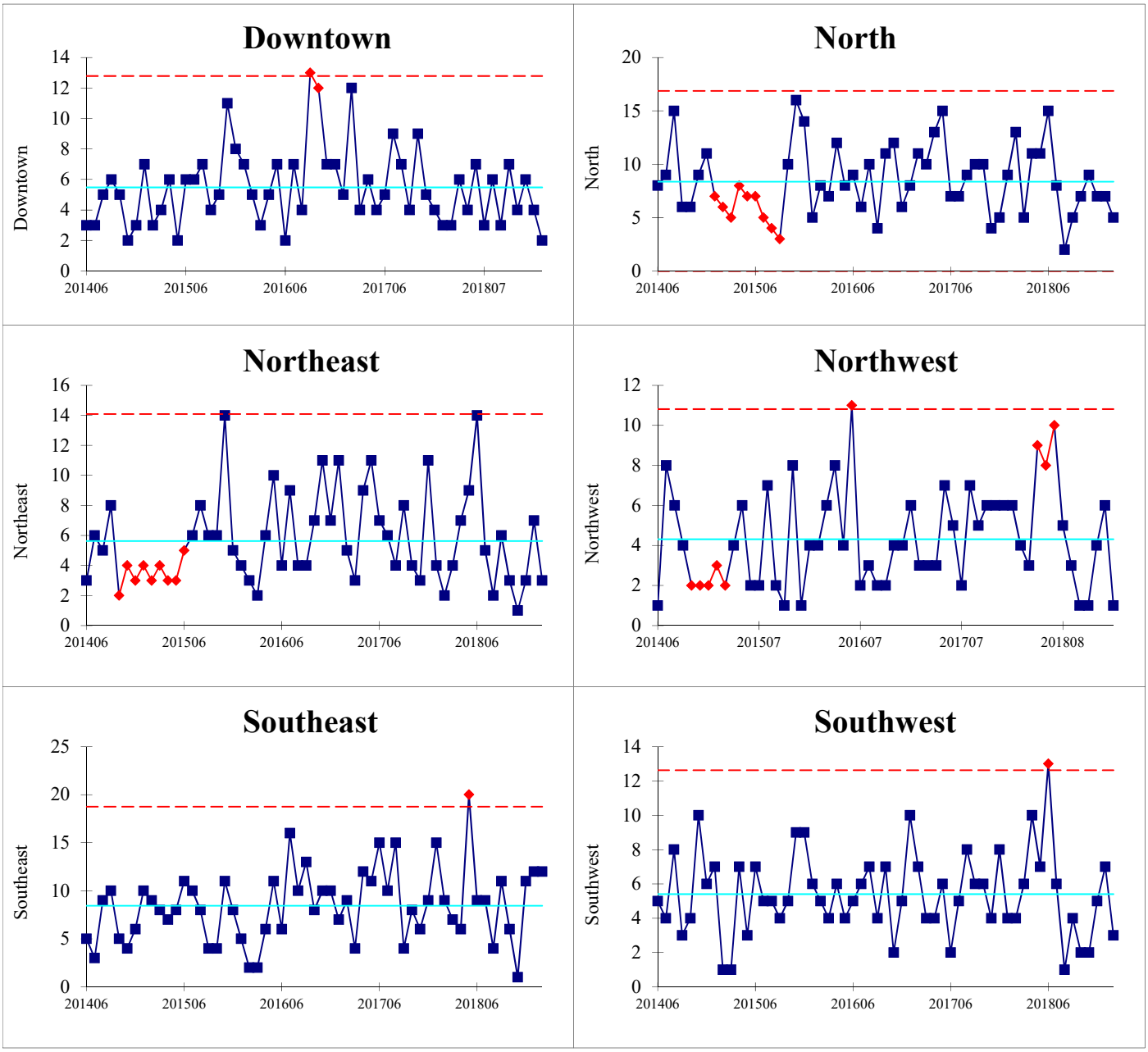
Control charts can be calculated with a little work in Excel. The template included with class will do a basic first cut I-MR chart. Several companies sell add-ins for Excel which help you make the process of creating controls very easy. Possible vendors include:

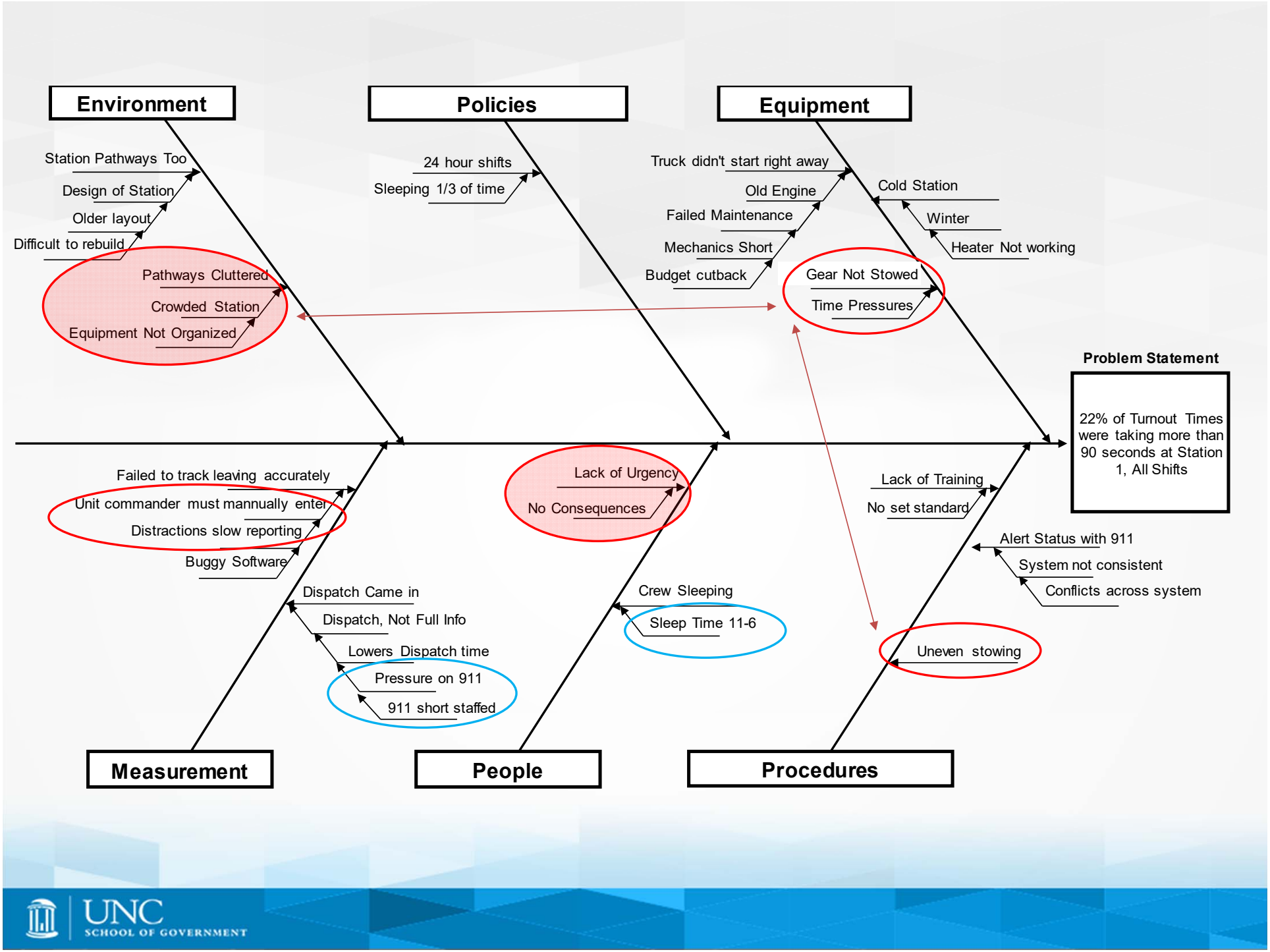
1. www.Qimacros.com
2. www.spcforexcel.com
3. www.sigmaxl.com/
4. www.sigmazone.com
5. http://www.pipproducts.com/qi_charts.html


X Turnout Times for Engine Company by Shift
Turnout
02:36
02:18
02:01
01:44
01:26
01:09
00:52
00:35
00:17
00:00
UCL
CL
LCL
02:25
01:58
01:32
02:27
01:57
01:28
02:20
02:10
02:01
02:05
01:41
01:18
A shift
B shift
C shift
Jul-15
Aug-15
Sep-15
Oct-15
Nov-15
Dec-15
Jan-16
Feb-16
Mar-16
Apr-16
May-16
Jun-16
Jul-16
Aug-16
Date


mR TurnoutTimes
Range
00:39
00:35
00:30
00:26
00:22
00:17
00:13
00:09
00:04
00:00
UCL
CL
00:33
00:10
00:36
00:11
00:11
00:03
00:29
00:09
Jul-15
Aug-15
Sep-15
Oct-15
Nov-15
Dec-15
Jan-16
Feb-16
Mar-16
Apr-16
May-16
Jun-16
Jul-16
Aug-16
Date

Burglary/Commercial Based on Raleigh Open NBIRS Data Reported by Month for June 2014 to February 20, 2019




Environment
Station Pathways Too
Design of Station
Older layout
Difficult to rebuild
Pathways Cluttered
Crowded Station
Equipment Not Organized
Policies
24 hour shifts
Sleeping 1/3 of time
Equipment
Truck didn't start right away
Old Engine
Failed Maintenance
Mechanics Short
Budget cutback
Cold Station
Winter
Heater Not working
Gear Not Stowed
Time Pressures
Problem Statement
22% of Turnout Times were taking more than 90 seconds at Station 1, All Shifts
Failed to track leaving accurately
Unit commander must mannually enter
Distractions slow reporting
Buggy Software
Dispatch Came in
Dispatch, Not Full Info
Lowers Dispatch time
Pressure on 911
911 short staffed
Lack of Urgency
No Consequences
Crew Sleeping
Sleep Time 11-6
Lack of Training
No set standard
Alert Status with 911
System not consistent
Conflicts across system
Uneven stowing
Measurement
People
Procedures

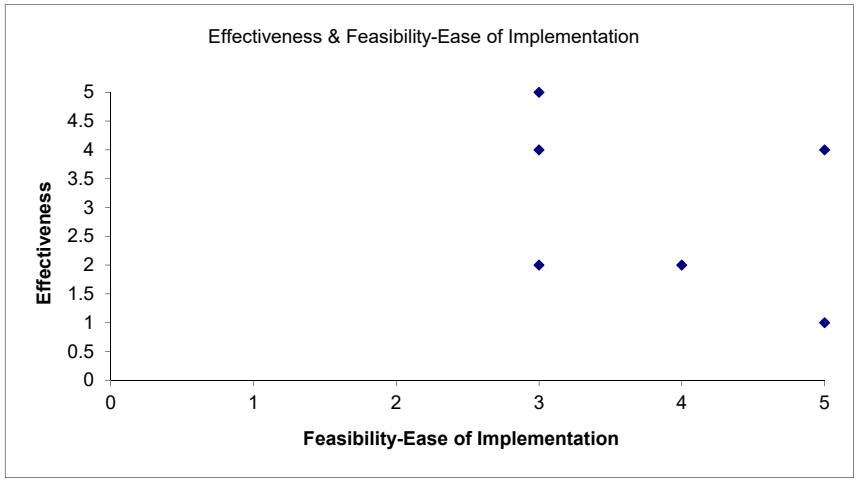
Problem Statement: 22% of Turnout Times were Taking more than 90 seconds at Station 1, All Shifts

Root Cause	Countermeasure/Proposed Solutions	Feasibility	Specific Actions	Effectiveness	Overall	Action (Who?)	Value ($/period)
Lack of Urgency	Lecture	5		1	5		
	Performance Reviews	3		2	6		
	Ice Cream Bet	5		4	20		
Pathways Cluttered	Clean Up Station	4	One time or monthly	2	8		
	Organize Equipment	3	Racks, labels	4	12		
	System for Putting Away Gear	3	Standard Procedure	5	15		

http://www.qimacros.com/quality-tools/solution

Feasibility: 1-low, 5-high
1-Expensive & Difficult to implement
5-Inexpensive and easy to implement

Effectiveness: 1-low, 5-high
1-Not very effective
5-Very Effective



A CHECKLIST FOR CHECKLISTS

DEVELOPMENT

- ☐ Do you have clear, concise objectives for your checklist?

IS EACH ITEM:

- ☐ A critical safety step and in great danger of being missed?
- ☐ Not adequately checked by other mechanisms?
- ☐ Actionable, with a specific response required for each item?
- ☐ Designed to be read aloud as a verbal check?
- ☐ One that can be affected by the use of a checklist?

HAVE YOU CONSIDERED:

- ☐ Adding items that will improve communication among team members?
- ☐ Involving all members of the team in the checklist creation process?

DRAFTING

DOES THE CHECKLIST:

- ☐ Utilize natural breaks in workflow (pause points)?
- ☐ Use simple sentence structure and basic language?
- ☐ Have a title that reflects its objectives?
- ☐ Have a simple, uncluttered, and logical format?
- ☐ Fit on one page?
- ☐ Minimize the use of color?

IS THE FONT:

- ☐ Sans serif?
- ☐ Upper and lowercase text?
- ☐ Large enough to be read easily?
- ☐ Dark on a light background?

- ☐ Are there fewer than 10 items per pause point?

- ☐ Is the date of creation (or revision) clearly marked?

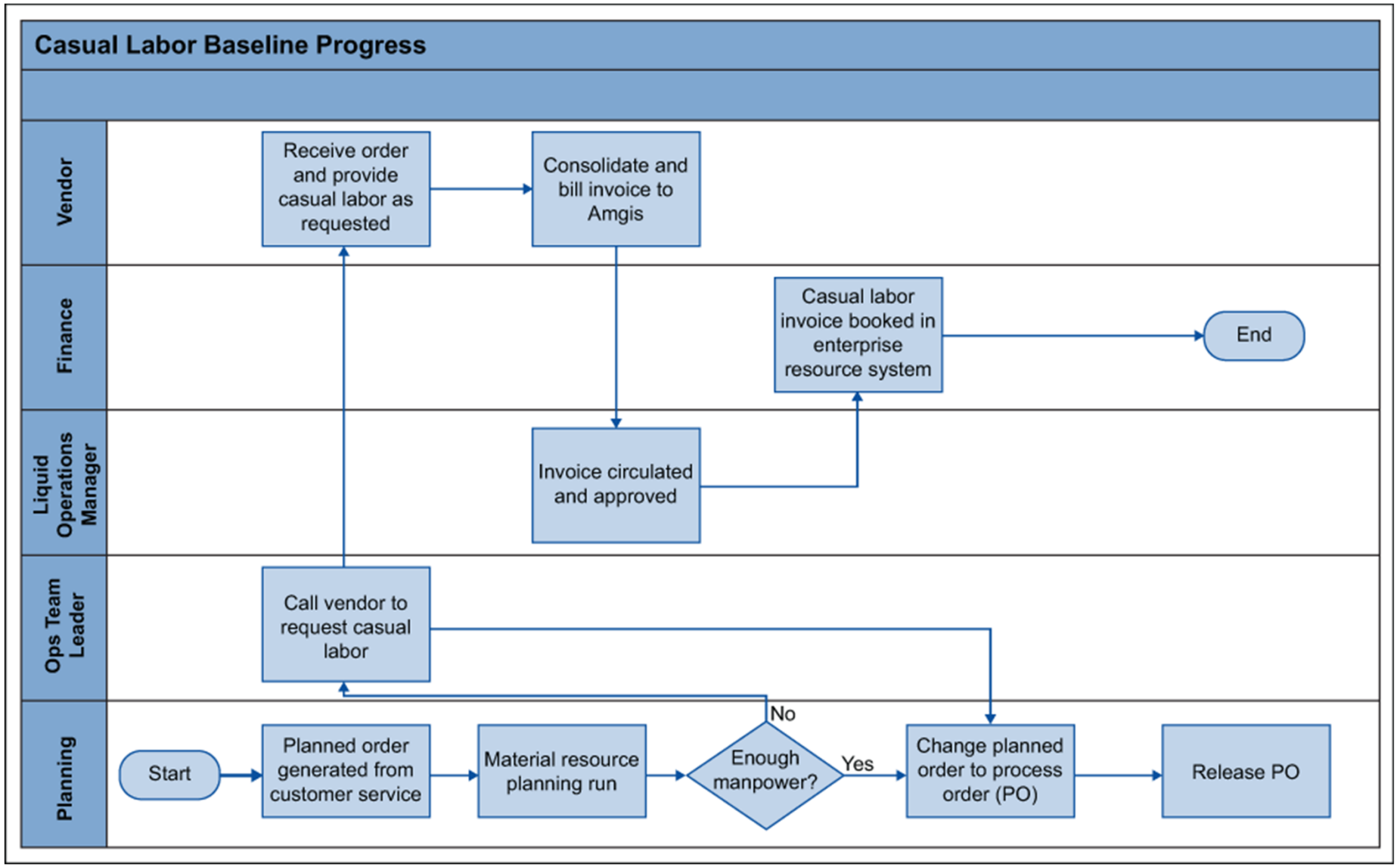
VALIDATION

HAVE YOU:

- ☐ Trialed the checklist with front-line users (either in a real or simulated situation)?
- ☐ Modified the checklist in response to repeated trials?

DOES THE CHECKLIST:

- ☐ Fit the flow of work?
- ☐ Detect errors at a time when they can still be corrected?
- ☐ Work easily enough that it can be completed in a reasonably brief period of time?
- ☐ Have a timetable for future review and revision of the checklist?


Casual Labor Baseline Progress
Vendor
Finance
Liquid Operations Manager
Ops Team Leader
Planning
Receive order and provide casual labor as requested
Consolidate and bill invoice to Amgis
Casual labor invoice booked in enterprise resource system
End
Invoice circulated and approved
Call vendor to request casual labor
Start
Planned order generated from customer service
Material resource planning run
Enough manpower?
No
Yes
Change planned order to process order (PO)
Release PO

Identifying Waste

Lean is a continuous process improvement methodology that focuses on identifying and eliminating non-value added or wasteful activities. Value is defined from the perspective of the community/populations we serve. By knowing what your community/population values helps one to identify the value-added or those activities which are truly needed. Lean focuses on 8 types of wastes. The acronym **DOWNTOWN** is used to help remember the 8 types of waste.

Defects
Overproduction
Waiting
Non value-added processing
Transportation
Inventory
Motion
Employee (Underutilizing)

Examples of the 8 Wastes

Defects-Is the work accurate and complete?

- Charts or reports with incorrect or incomplete information
- Inaccurate data entered into computer, on reports, etc.
- Mislabeled containers, forms, reports, etc.
- Clients on hold and their phone call lost

Overproduction- Are there forms, services, activities that are being done that aren't really needed?

- Overstaffing of flu clinic when it isn't flu season
- Printing all forms instead of capturing the information in a computer
- Multiple forms with same information
- Staff meetings held when it could have been shared in an email

Waiting

- Clients waiting for services
- Nurses waiting to use scales to weigh children OR staff waiting to use the copier/fax machine
- Waiting for a response back via email, etc.

Non-value added processing-Does the activity/task add value for clients?

- Reports reviewed by multiple people or multiple sign-offs
- Passing customer calls around (phone musical chairs)
- Multiple chairs/stations during clinic visit

Transportation-Is there excess movement of supplies, patients, and/or materials?

- Moving a client from room to room
- Too many mouse clicks on your website before getting to the information
- Having to walk between buildings, floors, etc. to get services

Inventory-Are there too many materials/supplies on hand?

- Files in a cabinet that are no longer used
- Overstocked supplies or outdated supplies, files, etc.

Motion –Is there excessive motion of staff?

- Staff searching for information, supplies, etc.
- Walking from the front of the office to back of office to get something

Employee (underutilization)—Is your agency tapping into skills, talents, and abilities of your staff?

- Is there a way to cross train people to do other jobs?

WASTE WALK

Area: _____

Date: _____

Use the Waste Walk worksheet to identify wastes that you see.

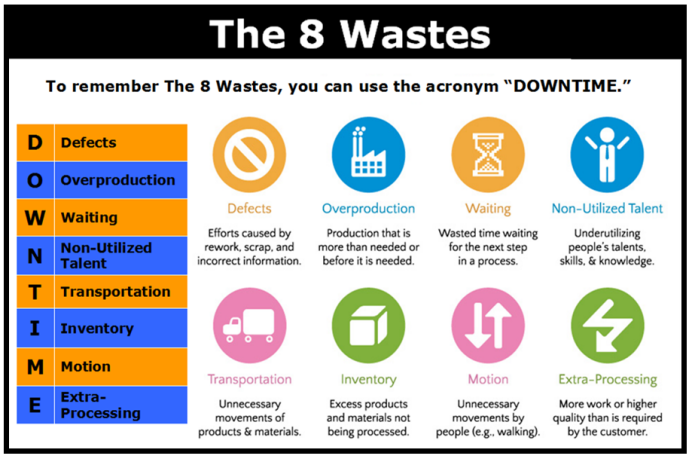
	8 WASTES								
OBSERVED WASTE	Defect	Overproduction	Waiting	Non-value added Processing	Transportation	Inventory	Motion	Employee Skill/Knowledge	IMPROVEMENT IDEA

THE 8 WASTES

DEFECT	Product or service that does not meet customer demand due to quality issue (include rework)
OVERPRODUCTION	Make more than, earlier than, or faster than required
WAITING	Wait for equipment, supplies, people, test results, etc.
NON-VALUE ADDED PROCESSING	Effort adds no value to product or service from customer's viewpoint
TRANSPORTATION	Excess material movement
INVENTORY	Supply in excess of single-piece flow
MOTION	Any movement of people or machines that does not add value to product or service
EMPLOYEE AS A RESOURCE	Not using people's knowledge, skills, and abilities

What is DOWNTIME?

DOWNTIME is a tool to identify the 8 types of waste that can exist in a process. Different approaches to Lean may include 7, 8, or 9 types of waste, but no matter how you break things down, the overall goal is to ensure we are observing a process, identifying waste, and identifying how to eliminate the waste.



Remember that in Lean, we want to eliminate waste because it is **disrespectful** to:

- **HUMANITY** - because it wastes scarce resources.
- **CITIZENS** - because it asks them to endure and pay for processes with no value.
- **INDIVIDUALS** - because it asks them to do work with no value.

The 8 Wastes	Related Examples & Questions
1. Defects	• Is there re-work because of errors, poor quality control, or lack of standards?
2. Overproduction	• Pushing work downstream before the next person is ready • Producing reports no one needs • Entering repetitive information
3. Waiting	• Waiting for info , resources, or approvals • Dependency on others to complete tasks • System response or down time
4. Non-utilized/underutilized human talent & things	• Underuse of people's talents or skills • Printers, computers, & scanners not being used
5. Transportation	• Email distribution lists not up-to-date • Unorganized work space • Multiple handoffs
6. Inventory	• Extra office supplies or other inventory than is needed • Files awaiting task completion • Filled in-boxes (paper and electronic)
7. Motion	• Unnecessary data entry or motion between areas • Searching for work documents or other supplies • Hand carrying paperwork to other departments
8. Excessive Processing	• Can some tasks be combined or eliminated? • Is too much time spent on unnecessary tasks?

Notes:

DOWNTIME Worksheet

Use the table below to "***ID waste in your current process"*** and make notes about how to eliminate it:

Types of Waste	Waste Identified in Your Process
Defects Something that causes rework, like an unintended over issuance	
Overproduction Many extra copies of applications that have now become obsolete	
Waiting time Waiting for clients to submit verifications	
Non-Utilized Human Talent Workers walking clients to child support enforcement – 40 hours were spent and 33 miles were walked/month	
Transportation Needlessly going to another location for a meeting that could happen over the phone	
Inventory Volume of applications to process	
Motion Unnecessary human movement	
Excessive Processing Extra steps in a process simply because we have always done it that way	

Notes: