Six Sigma Project-Story-Book

for the project: **Littering in Almaden Park & Guadalupe River Trail**

Green-Belt Candidate: Julieta Duarte Ramirez
Julidu09@hotmail.com

INTRODUCTION

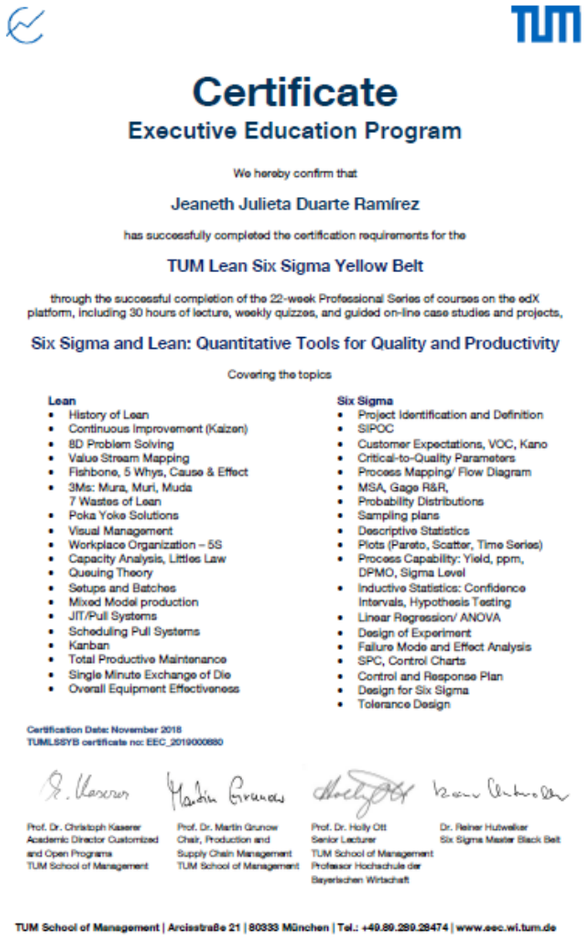
My introduction as a Green-Belt candidate

My name is Julieta Duarte, and I am an Industrial Engineer from Colombia, bilingual with 11 years of experience leading continuous improvement projects (products, processes and services); designing, effectively implementing, and maintaining management quality systems; developing and conducting quality audits in regulated environments.

Throughout my professional life I have lived and experienced quality: I have seen how the mind opens and have turned sceptics into my greatest allies; I have led small, medium and large improvement projects; I have failed, started from scratch then designed a better plan and succeeded; I have worked with everyone in the supply chain: customers, CEOs, coordinators, operational staff, suppliers, etc. and I have seen exceptional ideas for improvement flourish and become real through this valuable participation.

Great!

TUM Lean Six Sigma Yellow Belt Certificate



Certificate

Executive Education Program

We hereby confirm that

Jeaneth Julieta Duarte Ramírez

has successfully completed the certification requirements for the

TUM Lean Six Sigma Yellow Belt

through the successful completion of the 22-week Professional Series of courses on the edX platform, including 30 hours of lecture, weekly quizzes, and guided on-line case studies and projects,

Six Sigma and Lean: Quantitative Tools for Quality and Productivity

Covering the topics

Lean

- History of Lean
- Continuous Improvement (Kaizen)
- 8D Problem Solving
- Value Stream Mapping
- Fishbone, 5 Whys, Cause & Effect
- 3Ms: Mura, Muri, Muda
  7 Wastes of Lean
- Poka Yoke Solutions
- Visual Management
- Workplace Organization – 5S
- Capacity Analysis, Littles Law
- Queuing Theory
- Setups and Batches
- Mixed Model production
- JIT/Pull Systems
- Scheduling Pull Systems
- Kanban
- Total Productive Maintenance
- Single Minute Exchange of Die
- Overall Equipment Effectiveness

Six Sigma

- Project Identification and Definition
- SIPOC
- Customer Expectations, VOC, Kano
- Critical-to-Quality Parameters
- Process Mapping/ Flow Diagram
- MSA, Gage R&R,
- Probability Distributions
- Sampling plans
- Descriptive Statistics
- Plots (Pareto, Scatter, Time Series)
- Process Capability: Yield, ppm, DPMO, Sigma Level
- Inductive Statistics: Confidence Intervals, Hypothesis Testing
- Linear Regression/ ANOVA
- Design of Experiment
- Failure Mode and Effect Analysis
- SPC, Control Charts
- Control and Response Plan
- Design for Six Sigma
- Tolerance Design

Certification Date: November 2018
TUMLSSYB certificate no: EEC_2019000880

Prof. Dr. Christoph Kaserer, Academic Director Customized and Open Programs, TUM School of Management
Prof. Dr. Martin Grunow, Chair, Production and Supply Chain Management, TUM School of Management
Prof. Dr. Holly Ott, Senior Lecturer, TUM School of Management, Professor Hochschule der Bayerischen Wirtschaft
Dr. Reiner Hutwelker, Six Sigma Master Black Belt

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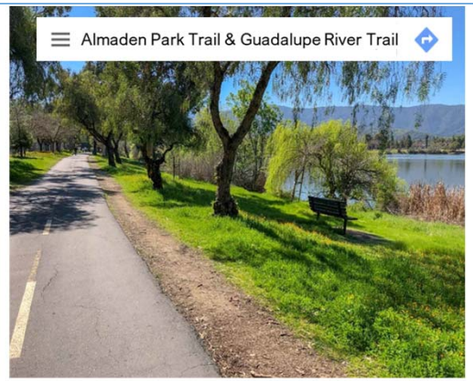
DEFINE

Identification and Definition of a Six Sigma Project

Wonderful place, great focus for your project!

Project Overview:



Project:
Littering in Almaden Park & Guadalupe River Trail
★★☆☆ 4 Reviews

Overview Reviews Data Photos

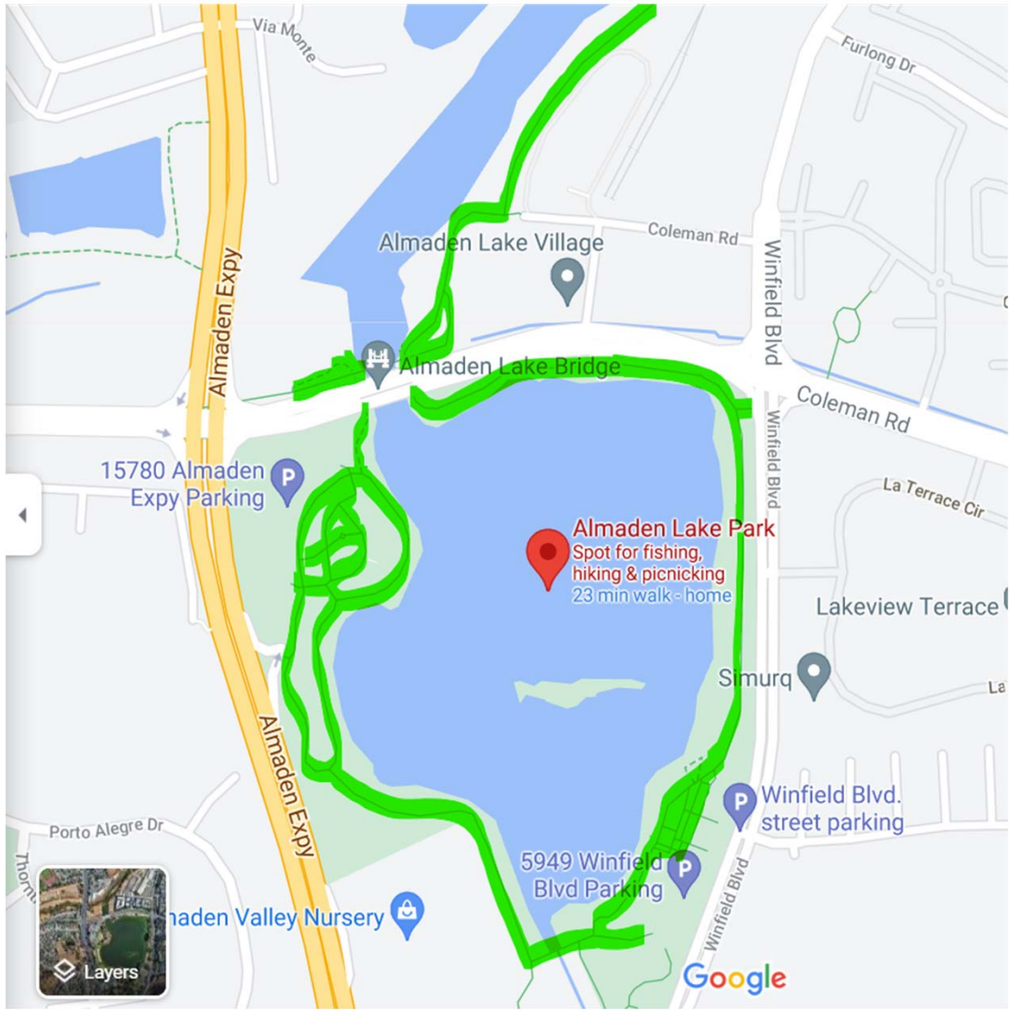
The Lake Almaden Trail follows the banks of Lake Almaden. 0.6 miles.

The trail system is directly linked to extensive mileage along the Los Alamitos Creek and Guadalupe River Trails.

Address:
6099 Winfield Blvd, San Jose, CA 95120
United States of America

Phone: (408) 277-5130

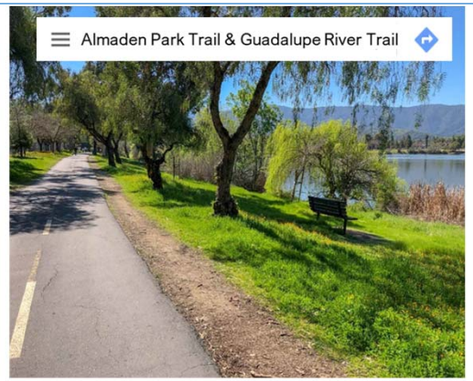
Link to Website



Part of the trail in which I will focus my project.

Wonderful idea, no-one did this before!

Almadem Lake Park Reviews:



Project:
Littering in Almaden Park & Guadalupe River Trail
★★☆☆☆ 4 Reviews

Overview Reviews Data Photos

These reviews were taken from the park's Google website.

Link to source

The weakness:
The trail is being affected by littering! Despite of the many trash cans provided along the way and signs that try to educate people, I always find trash during my hikes, trash that sadly will end up in the waterways or affecting the wildlife in the area.

Melissa Jimenez Chien
1 review

★★☆☆☆ 3 days ago NEW

I've brought my kids here several times to ride their bikes and scooters around the lake. Before the pandemic it was usually pretty well maintained but lately I have noticed more **trash** and discarded masks throughout the trail. The loop is good for strolling but I think the lake has seen better days. Hopefully they will have more time to maintain this park post pandemic because it needs some TLC.

E M
Local Guide · 39 reviews

★★★★★ a month ago

It's nice and quiet early in the morning but after that .....Well people ruin it with **trash** and ignorance.

Tyler Greene
4 reviews

★★★★★ 7 months ago

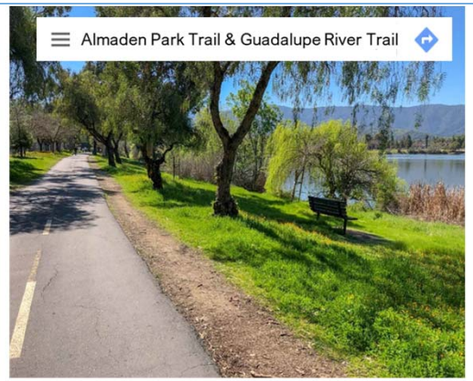
Very beautiful lake and sanctuary for the animals and ourselves providing a good place to teach kids about wildlife, fishing, history, conservation, ect. and please remember to pack your **trash**! Thanks!

Verena Fuchs
Local Guide · 16 reviews

★☆☆☆☆ 2 years ago

... a 'disco' with bright lights and loud music. It is not a peaceful place, ignorant humans have not only ruined the lake by contaminating it but on top harass wildlife and pollute the environment with **trash** and sound. It's a sad place.
More

Data:



Project:
Littering in Almaden Park & Guadalupe River Trail
★★☆☆ 4 Reviews

Overview Reviews Data Photos

Source: Keep America Beautiful
2020 NATIONAL LITTER STUDY
Summary Report: May 2021
https://kab.org/litter-study/

The study comprises four major components: a survey examining public attitudes about litter, a visible litter survey that provides an estimate of the litter on the ground across the USA, behavioral observations that shed light on littering behavior in public and a survey that estimates the public costs of litter in the United States.

Aggregate Count of Litter per Capita, Roadway and Waterway

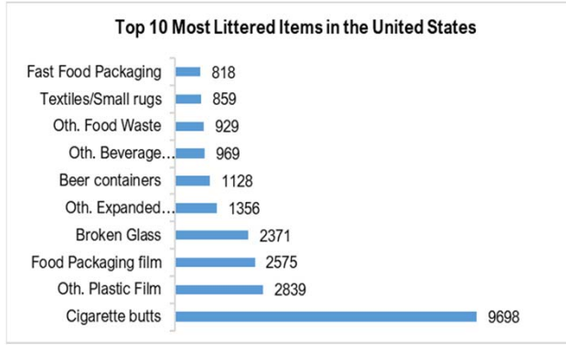
Total Litter Items	23,678,026,500	25,895,018,900	49,573,045,400
Population1	325,386,357	325,386,357	325,386,357
Litter Items Per Capita	73	80	152

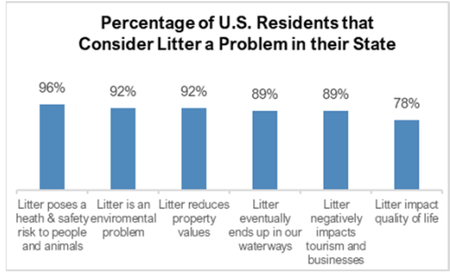
About roadway and waterways…

The Study estimates nearly 50 billion pieces of litter along U.S. roadways and waterways at the time of the Study. For many, that is an unfathomable number. However, when accounting for the U.S. population, 50 billion pieces of litter equate to 152 pieces of litter for every U.S. resident. This is a large number but is something to which individuals can relate. People can visualize 152 pieces of litter where they live, and they can begin to see that the litter problem can be solved.

About the items littered…

- Litter made from plastic comprises 38.6 percent of all litter across waterways and roadways combined.4 Nine out of ten pieces of litter on the ground in the U.S. were under four inches in size. Though smaller litter may be less visible, it remains the dominant type of litter in the United States.
- Cigarette butts continue to be the single most littered item in the United States, even though cigarette butt litter has declined dramatically since 2009.
- Plastic films, both general use films and food-packaging films, such as candy wrappers or snack bags, represent the second and third most littered items in America.
- Nearly 350 million plastic bags were littered on United States roadways and waterways. The vast majority (94.6 percent) of plastic bags littered were not trash bags, but other types of bags (i.e., retail store plastic bags).

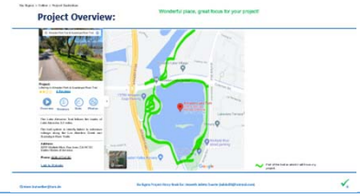




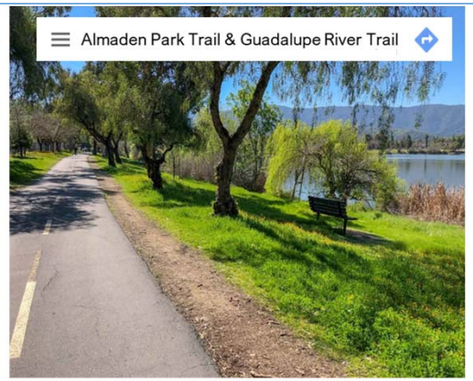
About the people…

- Across the nation, U.S. residents agree that litter is a problem where they live. Ninety percent (90%) of U.S. residents reported that litter is a problem in their state.
- Americans understand that litter has a strong negative impact on their communities. Large majorities of U.S. residents (75 to 97 percent) recognize that litter negatively affects the environment, waterways, property taxes, home values, tourism and businesses, quality of life, and health and safety in their communities.

Thats overall a wonderful start!



Photos:



Project:
Littering in Almaden Park & Guadalupe River Trail
★★☆☆ 4 Reviews

Overview Reviews Data Photos

Items typically littered:

1) Plastic bottles, some of them found in proximity to trash cans.
2) Big bags full of trash typically broken by animals trying to find food.
3) PPE Masks.
4) Paper: packaging and office supplies
5) Little pieces of litter: plastic remains, beverage packaging.

DEFINE

Identification and Definition of a Six Sigma Project

Six Sigma Challenge

Project-Definition

The trail is being affected by littering! Despite of the many trash cans provided along the way and signs that try to educate people, I always find trash during my hikes, this trash will sadly end up in the waterways or affecting the wildlife in the area. For us as a garbage disposal service it requires a lot of effort to clean the ground in addition to emptying the trash-cans.

Activities we perform (disposal of waste), reduce the quality of products / services (trail-cleaning). This quality defect occurs very often and has a very strong impact on the internal/ external customer. The problem can be solved halfway by the own department.

Relevance of the topic:	50%
Suitability for method:	Six Sigma
Solvable by own department up to:	50%

Section 1: Process and Output

Summary:

The Service TRAIL-CLEANING is an intangible final Output for external Customers and is in the Creation Process CLEAN TRAILS within a year 53 - 365 times generated. Important Input of the Process to generate the Product TRAIL-CLEANING is: PLASTIC BOTTLES, PPE MASKS, PAPER, PACKAGING, ETC..

Section 2: Problem

Summary:

1. Problem: TRAIL-CLEANING DIRTY. TRAIL-CLEANING fulfills the requirement on Quality (is error-free) in 40%.

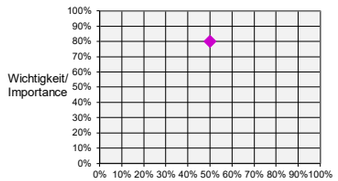
2. Problem: TRAIL-CLEANING INSUFFICIENT TRASH CANS ON GUADARUPE TRAIL CONECTION. TRAIL-CLEANING fulfills the requirement on Availability (right quantity) in 80%.

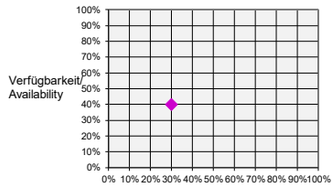
3. Problem: TRAIL-CLEANING INCORRECT RECYCLING PRACTICES. TRAIL-CLEANING fulfills the requirement on efficient utilisation of means (no waste of Input, Resources) in 80%.

Section 3: Effect

Summary: Voice of Business

The satisfaction of the process-owners with the Consumption in the Creation Process of the TRAIL-CLEANING is: 60%.
The total costs of the specified 3 problems are estimated by 11.5 billions$ / year.
They are primarily the result of quality costs due to scrap and additional expenditure.
The solution of the problems is rated as:
- medium URGENT (50%-Level)
- major IMPORTANT (80%-Level)





Summary: Voice of Customer

The satisfaction of the external customers with the:
- Quality of TRAIL-CLEANING is: 30%.
- Availability of TRAIL-CLEANING is: 40%.

Section 4: Solution

Solution Idea to 1. Problem

Maintain trash cans clean; evaluate signs, are they effective? People understand instructions?; Create campain: Clean up litter in your free time, get your neighbors involved; Set up litter cleaning groups.

Solution Idea to 2. Problem

Identify peak times.

Solution Idea to 3. Problem

Community effort

additional Information

Your additional comments, advices, feedback … are very appreciated.

Personal Data

First Name	Julieta	Surname	Duarte R.
Unit	Management services.	Location	San Jose, CA
Telephone	1234567890	eMail	julidu09@gmail.com

Results:

- The voice of the internal customer was heard, finding this project suitable for six sigma.
- The problems and effects were identified, described and estimated.
- Possible solutions to the problems were listed.

Interpretation and implication:

Problem number 1 is the one that unfulfilled the requirement the most, 60%.

DEFINE

SIPOC, Voice to Criticals, Project-Charter, Stakeholder Communication

Also here new ideas in arranging information!

SIPOC: Core steps Almaden Lake project

Process-Step	Supplier	Input (xl)	Process (xMR)	Output (Y)	Customer
A					
1	Citizen	Object	Use object / Generate trash	Trash	
2		Trash	Decide on how to discard trash: analize materials, harmfulness, etc.	Decision 1: disposal requirements	
3		Decision 1: disposal requirements	Identify disposal options	Decision 2: disposal options	
4		Decision 2: disposal options	Select disposal location	Decision 3: disposal location	
5		Decision 3: disposal location	Dispose trash	Trash-can (full)	Garbage Collector
B					
6	Almaden Lake Park Maintenance Services	Trash removal guidelines	Develop trash management plan	Trash Management plan	
7		Trash Management plan	Implement plan	Plan implemented	Garbage Collector
C					
8	Garbage Collector	Trash-can (full)	Empty trash-can	Trash-can (empty)	Citizen
9	Garbage Collector / Citizen	Ground (littered)	Clean the ground	Ground (trash-free)	Citizen

Results

Three type of process steps were identify:

Type A: Activities that represent where the decision of littering is made.

Type B: activities performed by the Almadem Lake Park Managment in order to implement their removal plan.

Type C: the excecution of the removal plan.

Interpretation and implication:

Since process steps type A are defined by decisions made by citizens, the result can vary. Based on those, the result of the process can be, waste correctly disposed in a trashcan or littered.

Very elaborated

Detailed Summary: Voice of costumer and Business

Y	Voice	of …	Critical Business Requirement (CBR) or Critical Customer Requirement (CCR)	Problem	Kano-Category	Severity	Critical to Quality (CtQ) Rank
Y_03	Decision 3: disposal location Trash overflowing	Customer	CCR: Decision 3: disposal location Capacity Not exceed	Decision 3: disposal location Capacity Exceed	Must-Be	55%	6
Y_04	Trash-can (full) Trash thrown on other than trash can	Management	CBR: Trash-can (full) Location Correct	Trash-can (full) Location Wrong	Must-Be	71%	4
Y_02	Trash-can (full) Trash cans and surroundings overcrowded or in bad condition	Customer	CCR: Trash-can (full) Disposal areas Good	Trash-can (full) Disposal areas Bad	More/Less-Is-Better	30%	7
Y_01	Decision 2: disposal options Not available in location	Customer	CCR: Decision 2: disposal options Availability >3 in location	Decision 2: disposal options Availability <3 in location	Must-Be	64%	5
Y_05	Decision 1: disposal requirements Not enough recycling options	Customer	CCR: Decision 1: disposal requirements Recycling-bins >60%	Decision 1: disposal requirements Recycling-bins <60%	More/Less-Is-Better	90%	1
Y_06	Ground (trash-free) Trash on the ground and waterways	Customer	CCR: Ground (trash-free) Litter non-existent	Ground (trash-free) Litter >5	Must-Be	83%	2
Y_07	Ground (trash-free) picking up litter from the ground	Management	CBR: Ground (trash-free) Cleaning-effort < 8 working hours per week	Ground (trash-free) Cleaning-effort > 8 working hours per week	More/Less-Is-Better	10%	8
Y_08	Trash-can (full) Organic and reciclyng materials mixed	Management	CBR: Trash-can (full) Recycling-practices Correct	Trash-can (full) Recycling-practices Incorrect	More/Less-Is-Better	80%	3

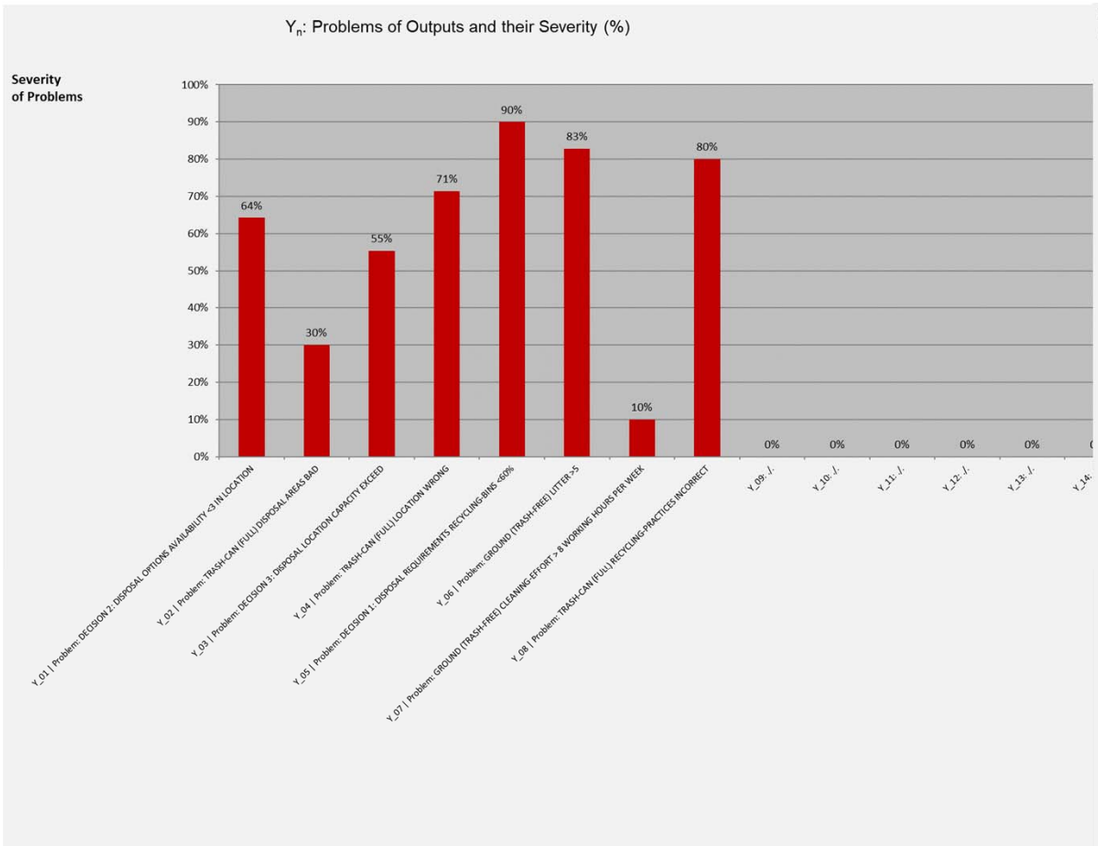
Results:

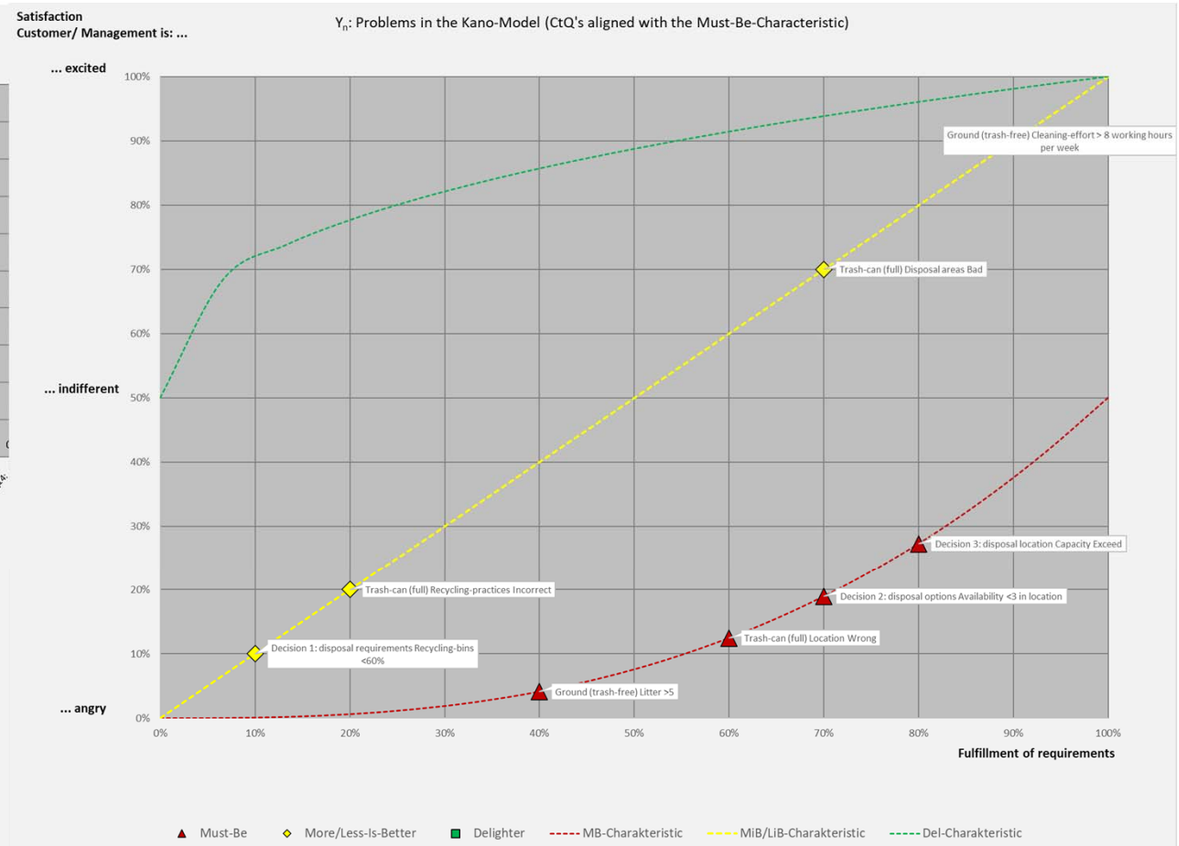
1. Business and customers were interview, as a result 8 problems were identified and evaluated.
2. Sigma Guide helped us to identify the Critical problems – The CTQ‘s. The ranking, based on the severity and the ranking of each problem in comparison to all defined problems is presented on the last column.

Interpretation and implication:

The bullets on the chart represent the 5 problems that based on the severity need to be address first in order to improve quality and availability.

The CTQ Bar Chart & the Kano Model Evaluation





Interpretation and implication

My project will be focused on the 5 Must Be and More / Less-is-Better problems with the highest level of severity.

Project Charter: The agreement

Project-Charter	Project-Name
	Improve cleanliness of the Almaden Lake Park trails

Business-Case	Process & Output
The Service TRAIL-CLEANING is an intangible final Output for external Customers and is in the Creation Process CLEAN TRAILS within a year 53 - 365 times generated. Important Input of the Process to generate the Product TRAIL-CLEANING is: PLASTIC BOTTLES, PPE MASKS, PAPER, PACKAGING, ETC..	Product/ Service: trail-cleaning Process: clean trails
Voice of Customer (VoC)	**Problems**
The satisfaction of the external customers with the: - Quality of TRAIL-CLEANING is: 30%. - Availability of TRAIL-CLEANING is: 40%.	Y_05 | Decision 1: disposal requirements Recycling-bins <60% Y_06 | Ground (trash-free) Litter >5 Y_08 | Trash-can (full) Recycling-practices Incorrect
Voice of Business (VoB)	**Solution-Ideas**
The satisfaction of the process-owners with the Consumption in the Creation Process of the TRAIL-CLEANING is: 60%. The total costs of the specified 3 problems are estimated by 11.5 billions$ / year. They are primarily the result of quality costs due to scrap and additional expenditure. The solution of the problems is rated as: - medium URGENT (50%-Level) / - major IMPORTANT (80%-Level)	Maintain trash cans clean; evaluate signs, are they effective? People understand instructions?; Create campain: Clean up litter in your free time, get your neighbors involved; Set up litter cleaning groups. Identify peak times. Community effort
Comment	**Comment**

In Scope		Out of Scope	
in:	Littering within the selected trail	out:	Illegal dumping
in:		out:	Waste generated by wild animals in the area: geese, ducks, etc.
in:		out:	Littering out of the thail of focus
in:		out:	

Management			
Sponsor		Supplier	
A_ccountable		Customer	Mabel Rada (Neighbor)
A_ccountable		...?	
Controlling	Justin Ruble (Neighborhood representative)	...?	

Targets		Timeline
Y_05	Clean trails (< 10 observation in a day)	10 April 2022
Y_06	Trash cans are available in the guadalupe river trail connection (>2)	10 April 2022
Y_08	Recycling instructions are clear (graded 4 ot of 5 in customer satisfaction)	10 April 2022

Experts			
Black-Belt		Master-Black-Belt	Reiner Hutwelker
Green-Belt	Eng. Julieta Duarte	...?	
Green-Belt		...?	
Expert	Mr. Expert	...?	

Timeline	Define	Measure	Analyse	Improve	Control*	Control	End
Target-Date:	31 January 2022	28 May 2022	28 June 2022	28 July 2022	28 August 2022	28 August 2022	31 August 2022
Completion-Date:							
Evaluation:	days expired: 113	days remaining : 4	days remaining : 35	days remaining : 65	days remaining : 96	days remaining : 96	days remaining : 99

Results:

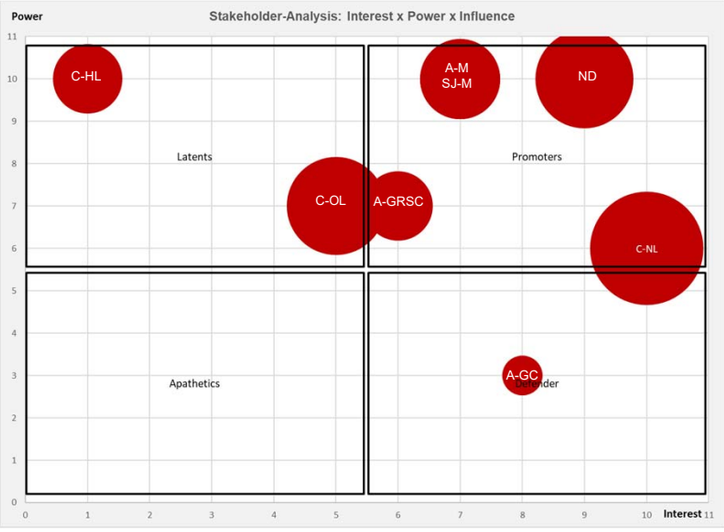
1. The project-charter tool helped us to summarized the project bringing information from previews fases.
2. The CTQ's with the highest severity (Voice-to-Criticals) were evaluated and prioritized, which leaded us to define the 3 main problems.
3. The scope of the project, the team and targets were defined.
4. The timeline of the project was established.

Interpretation and implication

1. Wild animals waste, especially due to geese, is a big problem. Nevertheless it was classified as “out of scope” since in this moment we can’t control the geese population in the area.

Finding the Right Communication plan: Knowing my Stakeholders

Select one of your targets	Who in the company is positively/ negatively affected by the achievement of this target? (Name)	Pseudonym	... target-achievement		Type of communication	Frequency
Y_05 | Clean trails (< 10 observation in a day)	Citizen (Non-Litterer)	C-NL	10	6	personal talk	as needed
Y_05 | Clean trails (< 10 observation in a day)	Citizen (Occasional-Litterer)	C-OL	5	7	newsletter	as needed
Y_05 | Clean trails (< 10 observation in a day)	Citizen (Heavy-Litterer)	C-HL	1	10	newsletter	as needed
Y_07 | Trash cans are available in the guadalupe river trail connection (>2)	Garbage Removal Service	A-GRS	6	7	eMail	as needed
Y_05 | Clean trails (< 10 observation in a day)	Garbage Collector	X	8	3	newsletter	as needed
Y_04 | Recycling instructions are clear (graded 4 ot of 5 in customer satisfaction)	Management (Almaden Lake Park)	A-M	7	10	eMail	as needed
Y_04 | Recycling instructions are clear (graded 4 ot of 5 in customer satisfaction)	Management (City of San Jose)	SJ-M	7	10	eMail	as needed
Y_05 | Clean trails (< 10 observation in a day)	Neighborhood group (Nextdoor App)	ND	9	10	team discussion	as needed



Results

What an interesting tool! ☺

1. The ranking of the stakeholders based on power X Interest X My influence was generated.
2. The stakeholders were located in their especific quadrant, finding the latents for my project.

Interpretation and implication

1. Citizens who are heavy and occasional litterer are very important to my project since they ate located in the **Latents quadrant**: low interest and high power.
2. Most of the stakeholders are in the **Promoters quadrant**, which means they have high interest and high power for my project.
3. Almaden lake garbage collectors are classified as **Defenders**: high interest but low power.
4. No **Apathetic** Stakeholders were found.

Results of the DEFINE-Steering

Define-Steering				
Tool	**Application**	**Documentation**	**Comment**	**Decision**
Introduction, Presentation of Critical Product/ Service	ok	ok		**Master-Black-Belt**
Project-Topic	ok	ok		Dr. Reiner Hutwelker reiner.hutwelker@tum.de
Project-Definition	ok	ok		17-Jan-2022
SIPOC	ok	ok		**passed**
VoC/ VoB/ CtQ (Voice to Criticals)	ok	ok		**Sponsor**
Project-Charter	ok	ok		name/ email
Stakeholder Communication	ok	ok		1-Jan-2021
Additonal Notes			Dear Julieta, it happens very rarely that a student applies all the tools correctly at the first go, documents them in an understandable way and adds his own methodological ideas to it. If you now manage to secure official support - Removal Service/ City Hall - you are already a candidate for our Environmental Green Belt Award this year. - In any case - please keep up the good work - it's excellent! - Go to MEASURE - Reiner	**passed/ failed**

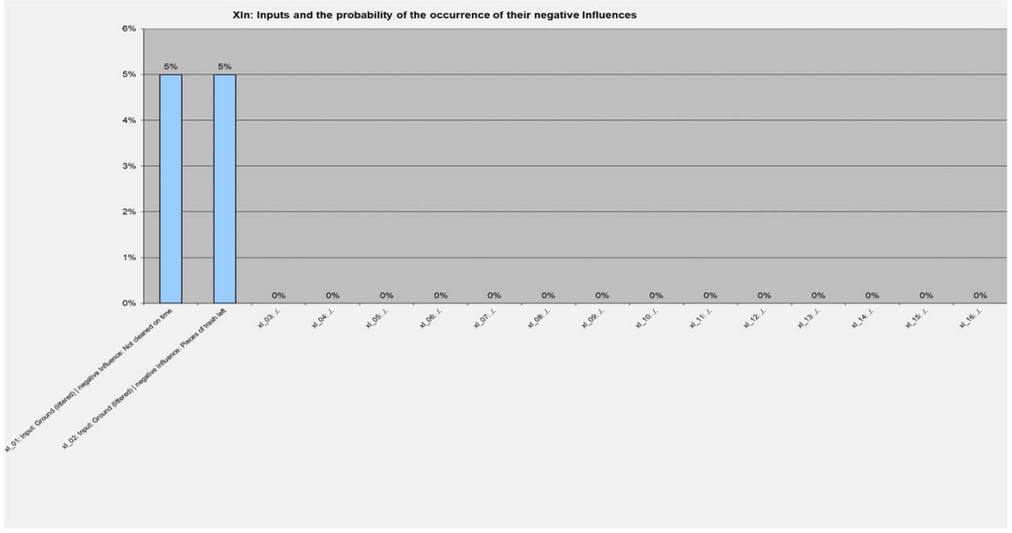
Only proceed to the next phase after a positive decision of MBB and Sponsor

MEASURE

Input-Analysis, Process-Mapping/ -Analysis, C&E-Matrix, Data-Collection-Plan, Hypothesis

Input Analysis: negative influences of the inputs

xI_01		
Which Input is necessary for the Process CLEAN TRAILS?	Ground (littered)	Input
	Please select an answer.	
What do you require from GROUND (LITTERED)?	Be cleaned on time	Requirement
	Please enter your answer.	
To which category does the Requirement BE CLEANED ON TIME belong?	Availability (right Quantity just in Time)	Requirement-Category
	Please select an answer.	
Which deviation of GROUND (LITTERED) from the Requirement is problematic for the Process?	Not cleaned on time	negative Influence
	Please enter your answer.	
How often does the negative Influence GROUND (LITTERED) NOT CLEANED ON TIME occur?	5%	Probability of Occurrence
	Please enter a value between: 0% - 100%.	



Results

Two external imputs were analized focussing on the externals imputs of the SIPOC. We specified the requirements and evaluated the frequency of how often these deviations occur.

Interpretation and implication

The probability of occurrence for both of them in 5%.

Adjusted

Sophisticated adaption ☺

Please be careful with negations (no/ not/ lack of/ …) as you cannot observe „things“ that are not existent.

Negations used to describe negative influences/ causes typically indicate solutions that are not (yet) implemented.

itching to solutions too early

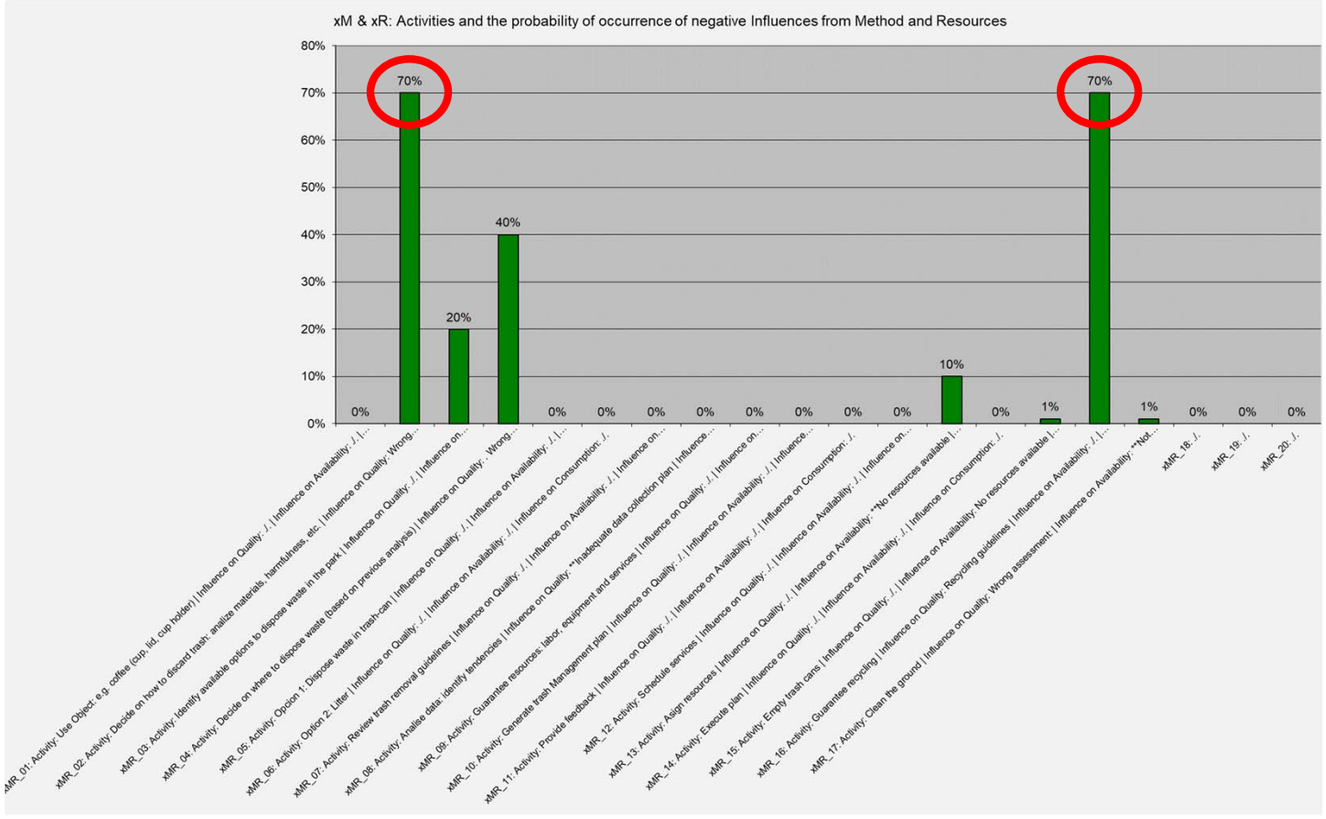
xistent/ do not happen.

Who …	… does what?	Please specify the Process-Steps in detailed Activities the format: Verb + Noun (e.g.: weigh Ingredients)																
		1. Activity	2. Activity	3. Activity	4. Activity	5. Activity	6. Activity	7. Activity	8. Activity	9. Activity	10. Activity	11. Activity	12. Activity	13. Activity	14. Activity	15. Activity	16. Activity	17. Activity
1. Process-Step	Citizen NON-LITTERER	Use Object: e.g., coffee (cup, lid, cup holder)	Decide on how to discard trash: analyze materials, [illegible]	Identify available options to dispose waste in the park	Decide on where to dispose waste (based on previous [illegible]	Opcion 1: Dispose waste in trash-can												
2. Process-Step	Citizen HEAVY LITTERER						Option 2: Litter											
3. Process-Step	Almaden Lake Park Maintenance Services							Review trash removal guidelines	Analise data: identify tendencies	Guarantee resources: labor, equipment and services	Generate trash Management plan	Provide feedback	Schedule services	Asign resources	Execute plan			
4. Process-Step	Garbage Collector															Empty trash cans	Guarantee recycling	
5. Process-Step	Garbage Collector / Citizen																	Clean the ground
Input:	Which Inputs are necessary to start the Activity?	Object	Trash	Decision 1: disposal requirements	Decision 2: disposal options	Decision 3: disposal location	Decision 3: disposal location	Trash removal guidelines	...?	...?	Trash Management plan	...?	...?	...?	...?	Trash-can (full)	...?	Ground (littered)
Methods:	Which Instructions/ Rules direct how to perform the Activity?		. Information about recycling written on the package. . Personal habits. . Personal Knowledge.	Overview of the area	. Personal habits		. Personal habits		. Results from previous timeframe .Statistics .Complaints, requirements and suggestions							.Work place instructions	Recycling instructions	.Work place instructions
Resources:	Which Equipment/ Machines/ Tools operate or support the Activity?			Park signs Trash cans visible	. Trash Cans . Recycling bins	. Trash Cans . Recycling bins				Workforce, machinery, trash cans, bins, plastic bags, etc.				Workforce, machinery, trash cans, bins, plastic bags, etc.		. Machinery .Trashcans and bins . Bags, etc	. Machinery .Trashcans and bins . Bags, etc	. Machinery .Trashcans and bins . Bags, etc
Output:	Which Output results from the Activity?	Trash	Decision 1: disposal requirements	Decision 2: disposal options	Decision 3: disposal location	Trash-can (full)	Trash-can (full)	...?	...?	Trash Management plan	...?	...?	...?	...?	Plan Implemented	...?	Trash-can (empty)	Ground (trash-free)
Which Influences of the: - Methods and - Resources negatively affect:	... the Quality (Faultlessness/ Fulfilment of Purpose) of the Output?		Wrong assessment: recycling instructions are confusing, tendency to litter; lack of knowledge		. Wrong assessment: - Pressure of time. - Trash cans and surroundings overcrowded or in bad condition. - Recycling instructions on bins are confusing				Inadequate data collection plan								Recycling guidelines are confusing	Wrong assessment
	... the Availability (right Quantity just in Time) of the Output?			Trash cans / recycling bins or signs not visible or available in location														
	... the Consumption and Waste of Input and/ or Resources?													Resources incorrectly assigned			**Trash incorrectly managed	
How often are the Activities affected by these negative Influences?			70%	20%	40%	0%	0%		0%	0%				10%		0%	70%	1%

littering depend on a sequence of individual decisions and habits two scenarios for 2 type were created:

- **Citizen 1 Non-Litterer:** will follow the activities from 1 to 5.
- **Citizen 2 Heavy-Litterer:** will trigger negative influencers related to their personal habits.

Activities and the probability of occurrence of negative Influences from Method and Resources



Results

Top 2 ranking – activities:

- 70% Decide on how to discard trash: analyze materials, harmfulness, etc.
- 70% Guarantee recycling.

Interpretation and implication

1. **Decide on how to discard trash.**
   Negative influence: Wrong assessment (recycling instructions are confusing, tendency to litter; lack of knowledge).
2. **Guarantee recycling.**
   Negative influence: Recycling guidelines are confusing.

C&E Matrix: the strength of the relationships of each influence on each problem.

C&E Matrix	Output (Y)	Severity	64%	30%	55%	71%	90%	83%	10%	80%	Results for: Impact of Influences (xI & xP) on the Outputs (Y)		
		Kano-Category	Must-Be	More/Less-Is-Better	Must-Be	Must-Be	More/Less-Is-Better	Must-Be	More/Less-Is-Better	More/Less-Is-Better			
		Problems (= Effects)	Y_01 | Problem: DECISION 2: DISPOSAL OPTIONS AVAILABILITY <3 IN LOCATION A	Y_02 | Problem: TRASH-CAN (FULL) DISPOSAL AREAS BAD Q	Y_03 | Problem: DECISION 3: DISPOSAL LOCATION CAPACITY EXCEED A	Y_04 | Problem: TRASH-CAN (FULL) LOCATION WRONG Q	Y_05 | Problem: DECISION 1: DISPOSAL REQUIREMENTS RECYCLING-BINS <60% A	Y_06 | Problem: GROUND (TRASH-FREE) LITTER >5 Q	Y_07 | Problem: GROUND (TRASH-FREE) CLEANING-EFFORT > 8 WORKING HOURS PER WEEK C	Y_08 | Problem: TRASH-CAN (FULL) RECYCLING-PRACTICES INCORRECT Q	Product Sum of the Impact of each Influence (xI & xP) on all Outputs (Y)	Percentual Impact of each Influence (xI & xP) on all Outputs (Y)	Ranking of the Impact of each Influence (xI & xP) on all Outputs (Y)
Influences from Input (xI) (= Causes)	**Probability**	**Rank**											
xI_01: Input: Ground (littered) | Requirement: Be cleaned on time | Requirement-Category: Availability (right Quantity just in Time) | negative Influence: Not cleaned on time A	5%	1			100%						0.03	1%	6
xI_02: Input: Ground (littered) | Requirement: Be 100% cleaned | Requirement-Category: Quality (Faultlessness/ Fulfilment of Purpose) | negative Influence: Pieces of trash left Q	5%	1		100%							0.02	0%	7
Influences from Process-Step (xMR) (= Causes)	**Probability**	**Rank**											
xMR_02: Activity: Decide on how to discard trash: analyze materials, harmfulness, etc. | Input: Trash | Methods: . Inform Q about recycling written on the package. . Personal habits. . Personal Knowledge. | Resources: ./. | Output: Decision 1: disposal requirements | Influence on Quality: Wrong assessment: recycling instructions are confusing, tendency to litter; lack of knowledge | Influence on Availability: ./. | Influence on Consumption: ./.	70%	1				100%		70%		100%	1.47	38%	1
xMR_03: Activity: Identify available options to dispose waste in the park | Input: Decision 1: disposal requirements | Meth A Overview of the area | Resources: Park signs Trash cans visible | Output: Decision 2: disposal options | Influence on Quality: ./. | Influence on Availability: Trash cans / recycling bins or signs not visible or available in location | Influence on Consumption: ./.	20%	4	100%								0.13	3%	4
xMR_04: Activity: Decide on where to dispose waste (based on previous analysis) | Input: Decision 2: disposal options | Q Methods: . Personal habits | Resources: . Trash Cans . Recycling bins | Output: Decision 3: disposal location | Influence on Quality: . Wrong assessment: - Pressure of time. - Trash cans and surroundings overcrowded or in bad condition. - Recycling instructions on bins are confusing | Influence on Availability: ./. | Influence on Consumption: ./.	40%	3		100%		100%		100%		100%	1.06	28%	3
xMR_13: Activity: Asign resources | Input: ./. | Methods: ./. | Resources: Workforce, machinery, trash cans, bins, plastic b A etc. | Output: ./. | Influence on Quality: ./. | Influence on Availability: **No resources available | Influence on Consumption: Resources incorrectly assigned	10%	5	50%				50%				0.08	2%	5
xMR_15: Activity: Empty trash cans | Input: Trash-can (full) | Methods: .Work place instructions | Resources: . Machinery A ,Trashcans and bins . Bags, etc | Output: ./. | Influence on Quality: ./. | Influence on Availability: No resources available | Influence on Consumption: ./.	1%	6			50%						0.00	0%	9
xMR_16: Activity: Guarantee recycling | Input: ./. | Methods: Recycling instructions | Resources: . Machinery Q ,Trashcans and bins . Bags, etc | Output: Trash-can (empty) | Influence on Quality: Recycling guidelines are confusing | Influence on Availability: ./. | Influence on Consumption: ***Trash incorrectly managed	70%	1				100%				100%	1.06	28%	2
xMR_17: Activity: Clean the ground | Input: Ground (littered) | Methods: .Work place instructions | Resources: . Machine Q ,Trashcans and bins . Bags, etc | Output: Ground (trash-free) | Influence on Quality: Wrong assessment | Influence on Availability: **Not resources available | Influence on Consumption: ./.	1%	6						100%			0.01	0%	8
Results for: Determination of Outputs (Y) by Influences (xI)	**Product Sum of the Determination of each Output (Y) by the Influences (xI & xP)**		0.1605	0.1350	0.0304	1.2849	0.0450	0.7458	0.0000	1.4400			
	Percentual Determination of each Output (Y) by the Influences (xI & xP)		4%	4%	1%	33%	1%	19%		37%			
	Ranking of the Determination of each Output (Y) by the Influences (xI & xP)		4	5	7	2	6	3		1			

Results

This was a very interesting tool to use! The strength of the relationships were evaluated and here you can see the most important results.

Interpretation and implication

Problems that are well determined by influences:

- Y_08 | Problem: TRASH-CAN (FULL) RECYCLING-PRACTICES INCORRECT
- Y_04 | Problem: TRASH-CAN (FULL) LOCATION WRONG
- Y_06 | Problem: GROUND (TRASH-FREE) LITTER >5

Chart C&E Heatmap: The risk of each influence-problem pair.

Chart: C&E Heatmap The cells indicate the strength of each relationship between influences (xI and xP) and the related Outputs (Y) as Risks (Probability x Severity). The Risks are the basis for prioritizing of the corresponding Hypothesis between x and Y. (Nothing needs to be entered here)		Severity	64%	30%	55%	71%	90%	83%	10%	80%	Results for: Impact of Influences (xI & xP) on the Outputs (Y)		
		Output (Y) Problems (= Effects)	Y_01 | Problem: DECISION 2: DISPOSAL OPTIONS AVAILABILITY <3 IN LOCATION	Y_02 | Problem: TRASH-CAN (FULL) DISPOSAL AREAS BAD	Y_03 | Problem: DECISION 3: DISPOSAL LOCATION CAPACITY EXCEED	Y_04 | Problem: TRASH-CAN (FULL) LOCATION WRONG	Y_05 | Problem: DECISION 1: DISPOSAL REQUIREMENTS RECYCLING-BINS <60%	Y_06 | Problem: GROUND (TRASH-FREE) LITTER >5	Y_07 | Problem: GROUND (TRASH-FREE) CLEANING-EFFORT > 8 WORKING HOURS PER WEEK	Y_08 | Problem: TRASH-CAN (FULL) RECYCLING-PRACTICES INCORRECT	risk-weighted Product Sum of the Impact of each Influence (xI & xP) on all Outputs (Y)	risk-weighted Percentual Impact of each Influence (xI & xP) on all Outputs (Y)	Ranking of the risk-weighted Impact of each Influence (xI & xP) on all Outputs (Y)
Influences from Input (xI) (= Causes)		**Probability**	**D**	**E**	**F**	**G**	**H**	**I**	**J**	**K**			
xI_01: Input: Ground (littered) | Requirement: Be cleaned on time | Requirement-Category: Availability (right Quantity just in Time) | negative Influence: Not cleaned on time		5%			7%						0.0664	2%	7
xI_02: Input: Ground (littered) | Requirement: Be 100% cleaned | Requirement-Category: Quality (Faultlessness/ Fulfilment of Purpose) | negative Influence: Pieces of trash left		5%		1%							0.0126	0%	9
Influences from Process-Step (xMR) (= Causes)		**Probability**											
xMR_02: Activity: Decide on how to discard trash: analyze materials, harmfulness, etc. | Input: Trash | Methods: . Information about recycling written on the package. . Personal habits. . Personal Knowledge. | Resources: ./. | Output: Decision 1: disposal requirements | Influence on Quality: Wrong assessment: recycling instructions are confusing, tendency to litter; lack of knowledge | Influence on Availability: ./. | Influence on Consumption: ./.		70%				35%		37%		48%	1.1973	32%	1
xMR_03: Activity: Identify available options to dispose waste in the park | Input: Decision 1: disposal requirements | Methods: Overview of the area | Resources: Park signs Trash cans visible | Output: Decision 2: disposal options | Influence on Quality: ./. | Influence on Availability: Trash cans / recycling bins or signs not visible or available in location | Influence on Consumption: ./.		20%	17%								0.1660	4%	5
xMR_04: Activity: Decide on where to dispose waste (based on previous analysis) | Input: Decision 2: disposal options | Methods: . Personal habits | Resources: . Trash Cans . Recycling bins | Output: Decision 3: disposal location | Influence on Quality: . Wrong assessment: - Pressure of time. - Trash cans and surroundings overcrowded or in bad condition. - Recycling instructions on bins are confusing | Influence on Availability: ./. | Influence on Consumption: ./.		40%		3%		29%		43%		39%	1.1301	30%	2
xMR_13: Activity: Asign resources | Input: ./. | Methods: ./. | Resources: Workforce, machinery, trash cans, bins, plastic bags, etc. | Output: ./. | Influence on Quality: ./. | Influence on Availability: **No resources available | Influence on Consumption: Resources incorrectly assigned		10%	6%				16%				0.2253	6%	4
xMR_15: Activity: Empty trash cans | Input: Trash-can (full) | Methods: .Work place instructions | Resources: . Machinery .Trashcans and bins . Bags, etc | Output: ./. | Influence on Quality: ./. | Influence on Availability: No resources available | Influence on Consumption: ./.		1%			2%						0.0184	0%	8
xMR_16: Activity: Guarantee recycling | Input: ./. | Methods: Recycling instructions | Resources: . Machinery .Trashcans and bins . Bags, etc | Output: Trash-can (empty) | Influence on Quality: Recycling guidelines are confusing | Influence on Availability: ./. | Influence on Consumption: ***Trash incorrectly managed		70%				35%				48%	0.8290	22%	3
xMR_17: Activity: Clean the ground | Input: Ground (littered) | Methods: .Work place instructions | Resources: . Machinery .Trashcans and bins . Bags, etc | Output: Ground (trash-free) | Influence on Quality: Wrong assessment | Influence on Availability: **Not resources available | Influence on Consumption: ./.		1%						11%			0.1103	3%	6
Results for: Determination of Outputs (Y) by Influences (x)	risk-weighted Product Sum of the Determination of each Output (Y) by the Influences (xI & xP)		0.2303	0.0396	0.0848	0.9872	0.1610	0.9069	0.0000	1.3456			
	risk-weighted Percentual Determination of each Output (Y) by the Influences (xI & xP)		6%	1%	2%	26%	4%	24%	0%	36%			
	Ranking of the risk-weighted Determination of each Output (Y) by the Influences (xI & xP)		4	7	6	2	5	3		1			

Results

Relative risk level for the influence – problem pair x – Y:

- High risk (>10%)
- Medium risk (1-10%)
- Low risk: low risk <1%

Interpretation and implication

The results will be used to prioritize the corresponding hypothesis between x and Y.

The most important result!

Summary of important influence (x) problem (Y) relationships

Legend

	(nearly) no risk
	low risk
	moderate risk
	high risk
	very high risk

Results

The chart shows present clearly the risk level for the influence – problem pair x – Y.

Interpretation and implication

Pairs that present the higher risk:

- Y_08, xMR_16: 48%
- Y_08, xMR_02: 48%
- Y_06, xMR_04: 43%

The results will be used to prioritize the corresponding hypothesis between x and Y.

Data Collection Plan: The outputs (Y)

Ranking of Influences (xI & xMR) and Outputs (Y)	Influences (xI & xMR) and Outputs (Y)	What should be measured?	Please specify the measurand (e.g. Time)	Please specify the units of the measurand (e.g. days)	Please specify the Target and its Specification Limits - if known - in the format: Target: USL: LSL:	Which different values can the Measurand take? (Scale of Data)	How should the Data be collected?	Is a Measurement-System-Analysis (MSA) necessary?	Which Data about the circumstances should additionally be collected? (Blocking-/ Condition-Variables)	How large should the Sample Size be?	Where should the Data be collected? (Location/ Source)	For which Time Interval should the Data be collected? (Start/ End)	Which Variable-Name will you assign to the Measurand?	In which File will the Data be stored?
Output (Y)														
5	Y_01 | Problem: DECISION 2: DISPOSAL OPTIONS AVAILABILITY <3 IN LOCATION	Number of trash cans found at the park in specific zone	Amount	Trash cans available	Target: 3 LSL: 1	**Data discrete or continuous (Cardinal-Scale)**	**collect new data**	**no**	Location, trash can type (standar, recycling)	50	Almaden Lake Park	1 week	Y01	Data Y.xlsx
7	Y_02 | Problem: TRASH-CAN (FULL) DISPOSAL AREAS BAD	Condition of trash cans and surrondings	Degree	4 Very Good, 3 Good, 2 Not Good, 1 Very Bad	Target: 4 LSL: 3	**Data Rank Ordered (Ordinal-Scale)**	**collect new data**	**no**	Trash-can ID, Location, description, date, time	20	Almaden Lake Park	3 Weeks	Y02	Data Y.xlsx
6	Y_03 | Problem: DECISION 3: DISPOSAL LOCATION CAPACITY EXCEED	Filling level of the trash can at specific location	Degree	4 Empty, 3 Half filled, 2 Full, 1 Overfilled	USL: 2 Full	**Data Rank Ordered (Ordinal-Scale)**	**collect new data**	**no**	Trash-can ID, Location, description, date, time	20	Almaden Lake Park	3 Weeks	Y03	Data Y.xlsx
4	Y_04 | Problem: TRASH-CAN (FULL) LOCATION WRONG	Observation: opportunities when people litter or disposed trash in the wrong location	Number	Opportunities when people litter or disposed trash in the wrong location	Target 0 USL: 3	**Data in > 2 Levels (Nominal-Scale)**	**collect new data**	**no**	Gender, Age, Socioeconomic Status	40	Almaden Lake Park	3 Weeks	Y04	Google Forms: Examining public attitudes about litter
1	Y_05 | Problem: DECISION 1: DISPOSAL REQUIREMENTS RECYCLING-BINS <60%	Number of recycling bins available at specific zone	Amount	Recycling bins available	LSN: 60%	**Data discrete or continuous (Cardinal-Scale)**	**collect new data**	**no**	Trash-can ID	50	Almaden Lake Park	1 week	Y05	Data Y.xlsx
2	Y_06 | Problem: GROUND (TRASH-FREE) LITTER >5	Number of garbage pieces surrounding trash cans	Amount	Pieces of trash within a radius of 5 meters around a trash-can	Target: 0 USL: 5	**Data discrete or continuous (Cardinal-Scale)**	**collect new data**	**no**	Location, day, time, Trash: group and category	50	Almaden Lake Park	3 Weeks	Y06	Data Y.xlsx
8	Y_07 | Problem: GROUND (TRASH-FREE) CLEANING-EFFORT > 8 WORKING HOURS PER WEEK	Effort to clean the ground around trash-can	Time	Working hours	Target: 8 USL: 8,5	**Data discrete or continuous (Cardinal-Scale)**	**collect new data**	**no**	Date, shift.	20	Almaden Lake Park	20 days	Y07	Data Y.xlsx
3	Y_08 | Problem: TRASH-CAN (FULL) RECYCLING-PRACTICES INCORRECT	Recycling effectiveness	Amount	Items incorreclty disposed in recycling bin	Target: 0 USL: 3	**Data discrete or continuous (Cardinal-Scale)**	**collect new data**	**no**	Trash-can ID, Location, Material type, date, time.	20	Almaden Lake Park	3 Weeks	Y08	Data Y.xlsx

This is the how we will measure the outputs

Data from Almaden Lake Park operation will be needed to measure this output.

Data Collection Plan: Influences from the input (xI) & Process-Step (xMR)

Ranking of Influences (xI & xMR) and Outputs (Y)	Influences (xI & xMR) and Outputs (Y)	What should be measured?	Please specify the measurand (e.g. Time)	Please specify the units of the measurand (e.g. days)	Please specify the Target and its Specification Limits - if known - in the format: Target: USL: LSL:	Which different values can the Measurand take? (Scale of Data)	How should the Data be collected?	Is a Measurement-System-Analysis (MSA) necessary?	Which Data about the circumstances should additionally be collected? (Blocking-/ Condition-Variables)	How large should the Sample Size be?	Where should the Data be collected? (Location/ Source)	For which Time Interval should the Data be collected? (Start/ End)	Which Variable-Name will you assign to the Measurand?	In which File will the Data be stored?
Influences from Input (xI) (= Causes)														
7	xI_01: Input: Ground (littered) | negative Influence: Not cleaned on time	Delayed in the cleaning up schedule	Amount	Schedule was delayed	Target: 0 USL: 2	**Data discrete or continuous (Cardinal-Scale)**	**collect new data**	**no**	Shift, delayed explanation, day, time, location	20	Almaden Lake Park	3 Weeks	xL01	Data Y..xlsx
9	xI_02: Input: Ground (littered) | negative Influence: Pieces of trash left	Number of garbage pieces surrounding trash cans after cleaning procedures.	Amount	Pieces of trash within the zone	Target: 0 USL: 5	**Data discrete or continuous (Cardinal-Scale)**	**collect new data**	**no**	Date, time, location	20	Almaden Lake Park	3 Weeks	xL02	Data Y..xlsx
Influences from Process-Step (xMR) (= Causes)														
1	xMR_02: Activity: Decide on how to discard trash: analyze materials, harmfulness, etc. | Input: Trash | Methods: . Information about recycling written on the package. . Personal habits. . Personal Knowledge. | Resources: ./. | Output: Decision 1: disposal requirements | Influence on Quality: Wrong assessment: recycling instructions are confusing, tendency to litter; lack of knowledge | Influence on Availability: ./. | Influence on Consumption: ./.	People attitudes/knowledge about recycling, harmfulness assessment, etc.	Level of knowledge about recycling, harmfulness of materials, etc	5 Strongly agree, 4 Somewhat agree, 3 Neither agree nor disagree, 2 Somewhat disagree, 1 Strongly disagree	Target 1 USL: 2	**Data Rank Ordered (Ordinal-Scale)**	**collect new data**	**no**	Gender, Age, Socioeconomic Status	50	Almaden Lake Park	3 Weeks	Xmr02	Google Forms: Examining public attitudes about litter
5	xMR_03: Activity: Identify available options to dispose waste in the park | Input: Decision 1: disposal requirements | Methods: Overview of the area | Resources: Park signs Trash cans visible | Output: Decision 2: disposal options | Influence on Quality: ./. | Influence on Availability: Trash cans / recycling bins or signs not visible or available in location | Influence on Consumption: ./.	Satisfaccion with the number of trash cans found in location	Level of satisfaction	1 to 5	Target 4 LSL: 3	**Data Rank Ordered (Ordinal-Scale)**	**collect new data**	**no**	Gender, Age, Socioeconomic Status, location.	50	Almaden Lake Park	3 Weeks	xMR03	Google Forms: Examining public attitudes about litter
2	xMR_04: Activity: Decide on where to dispose waste (based on previous analysis) | Input: Decision 2: disposal options | Methods: . Personal habits | Resources: . Trash Cans . Recycling bins | Output: Decision 3: disposal location | Influence on Quality: . Wrong assessment: - Pressure of time. - Trash cans and surroundings overcrowded or in bad condition. - Recycling instructions on bins are confusing | Influence on Availability: ./. | Influence on Consumption: ./.	Scenarios in which people consider littering acceptable	Littering awarness	5 Strongly agree, 4 Somewhat agree, 3 Neither agree nor disagree, 2 Somewhat disagree, 1 Strongly disagree	Target 1 USL: 2	**Data Rank Ordered (Ordinal-Scale)**	**collect new data**	**no**	Location, Description, Gender, Age, Socioeconomic Status	50	Almaden Lake Park	3 Weeks	Xmr04	Google Forms: Examining public attitudes about litter
3	xMR_16: Activity: Guarantee recycling | Input: ./. | Methods: Recycling instructions | Resources: . Machinery .Trashcans and bins . Bags, etc | Output: Trash-can (empty) | Influence on Quality: Recycling guidelines are confusing | Influence on Availability: ./. | Influence on Consumption: ***Trash incorrectly managed	Understanding of instructions (recycling bins): What should you discard in here? Picture with diferent types of recycling bins	Understanding of guidelines related to recycling bins	1 Clear, 2 Confusing, 3 Very confusing	Target: clear	**Data in > 2 Levels (Nominal-Scale)**	**collect new data**	**no**	Description, Gender, Age, Socioeconomic Status	50	Almaden Lake Park	3 Weeks	Xmr16	Almaden_lake_park.xlsx

Data from Almaden Lake Park operation will be needed to measure this output.

Great, that you also tried the „manual“ formulation

Hypothesis for Y and xi, xm and xr, their risk to cause a problem and recommended statistical tests

	Risk	Y_06: Output: Ground (trash-free) [Degree of: Amount (Pieces of trash within a radius of 5 meters around a trash-can)]
1	43%	There is a/ no Relationship betw een: xMR_04: Activity: Decide on w here to dispose w aste (based on previous analysis) [Ranking Position of: Littering aw arness (Points: 1 to 5)] and: Y_06: Output: Ground (trash-free) [Degree of: Amount (Pieces of trash w ithin a radius of 5 meters around a trash-can)] according to the Principle: The larger the value of x, the larger (resp. smaller) is the value of Y.
	Relationship Hypothesis	**Type of test:** Rank Correlation (Spearman)/ General Regression

	Risk	Y_08: Output: Trash-can (full) [Degree of: Amount (Items incorreclty disposed in recycling bin)]
2	48%	There is a/ no Relationship betw een: xMR_02: Activity: Decide on how to discard trash: analyze materials, harmfulness, etc. [Ranking Position of: Level of know ledge about recycling (System of points betw een: Question D + Question E)] and: Y_08: Output: Trash-can (full) [Degree of: Amount (Items incorreclty disposed in recycling bin)] according to the Principle: The larger the value of x, the larger (resp. smaller) is the value of Y.
	Relationship Hypothesis	**Type of test:** Rank Correlation (Spearman)/ General Regression

	Risk	Y_08: Output: Trash-can (full) [Degree of: Amount (Items incorreclty disposed in recycling bin)]
3	48%	There is a/ no Relationship betw een: xMR_16: Activity: Guarantee recycling [Ranking Position of: Understanding of guidelines related to recycling bins (1 Understandable, 2 Confusing, 3 Very confusing)] and: Y_08: Output: Trash-can (full) [Degree of: Amount (Items incorreclty disposed in recycling bin)] according to the Principle: The larger the value of x, the larger (resp. smaller) is the value of Y.
	Relationship Hypothesis	**Type of test:** Rank Correlation (Spearman)/ General Regression

Results

The hypotesis were authomaticly generated by SigmaGuide based on the xY-pairings of the C&E Matrix, the information from the Data Collection Plan and the prioritization by the related Risks from the C&E Heatmap.

Interpretation and implication:

1	*There is a relationship between*	Xmr04: Littering awarness	*and*	Y_06: Number of garbage pieces surrounding trash cans
2	*There is a relationship between*	xMR02: Level of knowledge about recycling, harmfulness of materials, etc	*and*	Y_08: Recycling effectiveness
3	*There is a relationship between*	Xmr16: Understanding of instructions (recycling bins)	*and*	Y_08: Recycling effectiveness

I will focus on these three hypothesis in the ANALYSIS phase.

☺

Aditional Hypothesis

Relationship-Hypothesis: Y= f(x)

Y= f(x)	Variable/ Measurand x		Variable/ Measurand Y	Scale Level x	Scale Level Y	Graphical Representation	Statistic test
There is a relationship between	Degree of crowdedness in the zone (x)	*and*	Number of trash cans available (Y)	Ordinal	Cardinal	Scatterplot	Rank correlation (Spearman)
There is a relationship between	Degree of crowdedness in the zone (x)	*and*	Filling level of the trash can at specific location (Y)	Ordinal	Ordinal	Scatterplot	Rank correlation (Spearman) Ordinal - Logistic - Regression
There is a relationship between	Number of trash cans available (x)	*and*	Filling level of the trash can at specific location (Y)	Cardinal	Ordinal	Scatterplot	Rank correlation (Spearman) Ordinal - Logistic - Regression
There is a relationship between	Gender (x)	*and*	Tendency to litter (Y)	Nominal	Nominal	Bar Chart	Chi-Square
There is a relationship between	Age (x)	*and*	Tendency to litter (Y)	Nominal	Nominal	Bar Chart	Chi-Square
There is a relationship between	Level of education (x)	*and*	Tendency to litter (Y)	Nominal	Nominal	Bar Chart	Chi-Square
There is a relationship between	Degree of crowdedness in the zone (x)	*and*	Number of recycling bins available (Y)	Ordinal	Cardinal	Scatterplot	Rank correlation (Spearman)
There is a relationship between	Number of recycling bins available (x)	*and*	Rating of trash can Availability (Y)	Cardinal	Ordinal	Scatterplot	Rank correlation (Spearman) Ordinal - Logistic - Regression
There is a relationship between	Degree of crowdedness in the zone (x)	*and*	Number of garbage pieces surrounding trash cans (Y)	Ordinal	Cardinal	Scatterplot	Rank correlation (Spearman)
There is a relationship between	Number of trash cans available (x)	*and*	Number of garbage pieces surrounding trash cans (Y)	Cardinal	Cardinal	Scatterplot	Product-Moment-Correlation (Pearson) / General Regression
There is a relationship between	Condition of recycling bin and surroundings (x)	*and*	Number of items incorrectly disposed in recycling bin (Y)	Ordinal	Cardinal	Bar Chart	Rank correlation (Spearman)

Difference-Hypothesis Y1= Y2

Y1= Y2	Variable/ Measurand Y		Variable/ Measurand x	Scale Level Y	Scale Level x	Graphical Representation	Statistic test
There is a diference	Number of trash cans available (Y)	*Between levels of*	Trail Zones 1 to 9 (x)	Cardinal	Nominal	Box-Plot	ANOVA
There is a diference	Condition of trash cans and surroundings (Y)	*Between levels of*	Trail Zones 1 to 9 (x)	Ordinal	Nominal	Box-Plot	Kruskal-Wallis-Test
There is a diference	Filling level of the trash can at specific location (Y)	*Between levels of*	Day of the week (x)	Ordinal	Nominal	Box-Plot	Kruskal-Wallis-Test
There is a diference	Filling level of the trash can at specific location (Y)	*Between levels of*	Time of the day (x)	Ordinal	Nominal	Line-Chart	Kruskal-Wallis-Test
There is a diference	Number of recycling bins available (Y)	*Between levels of*	Trail Zones 1 to 9 (x)	Cardinal	Nominal	Box-Plot	ANOVA
There is a diference	Number of garbage pieces surrounding trash cans (Y)	*Between levels of*	Trail Zones 1 to 9 (x)	Cardinal	Nominal	Box-Plot	ANOVA
There is a diference	Number of garbage pieces surrounding trash cans (Y)	*Between levels of*	Day of the week (x)	Cardinal	Nominal	Box-Plot	ANOVA
There is a diference	Number of garbage pieces surrounding trash cans (Y)	*Between levels of*	Time of the day (x)	Cardinal	Nominal	Line-Chart	ANOVA
There is a diference	Number of recycling bins available (Y)	*Between levels of*	Type of trash littered (x)	Cardinal	Nominal	Box-Plot	ANOVA

Results

Aditional hypothesis (not mentioned in SigmaGuide) were formulated as follow:

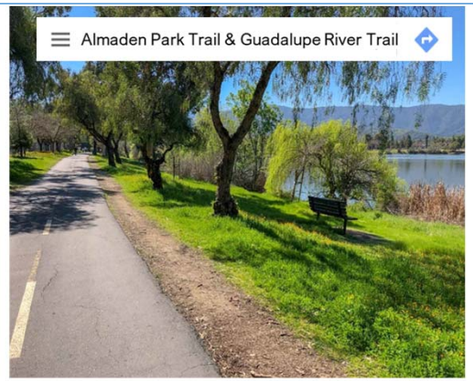
Relationship Hypothesis: 11

Difference Hypothesis: 9

Notes:

For this exercise and in order to execute the data collection plan, the system of trails was divided in 9 zones and categorized based on their level of crowdedness. In the next slide I will get to it in more detail.

Zones:



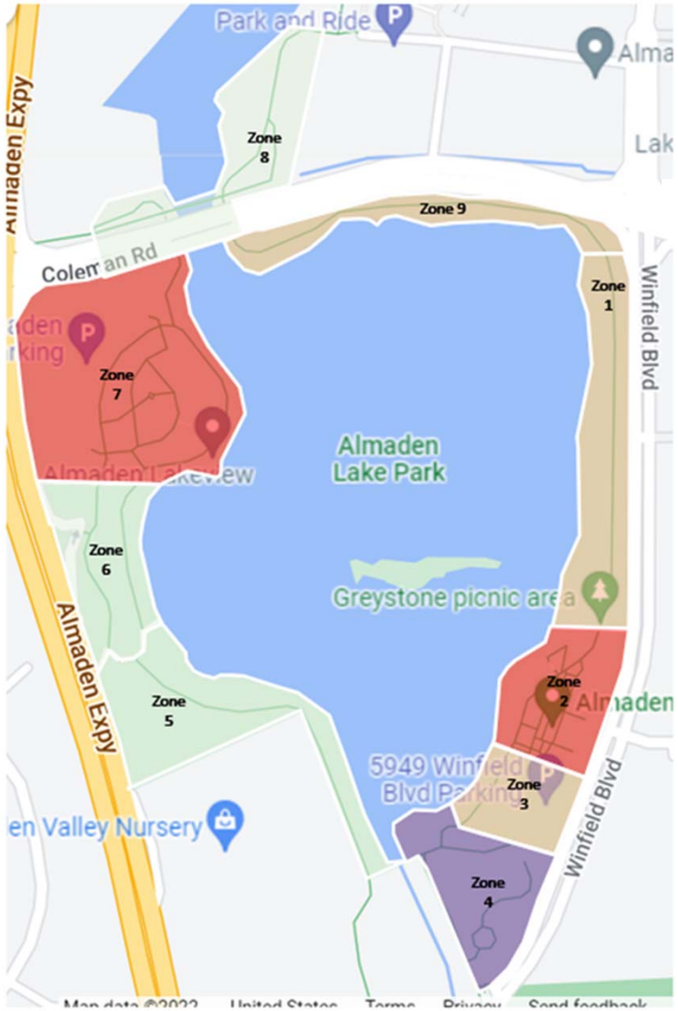
Project:
Littering in Almaden Park & Guadalupe River Trail
★★☆☆ 4 Reviews

Overview Zones Data Photos

Link to survey: Examining public attitudes about litter in Almaden Lake Park

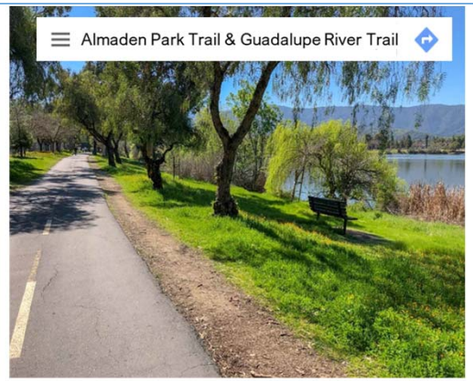
General Classification:

Location	Crowdedness	Link to Map
Zone 1	2	Click
Zone 2	4	Click
Zone 3	2	Click
Zone 4	3	Click
Zone 5	1	Click
Zone 6	1	Click
Zone 7	4	Click
Zone 8	1	Click
Zone 9	2	Click



Level of crowdedness:

Zone 1:



Project:
Littering in Almaden Park & Guadalupe River Trail
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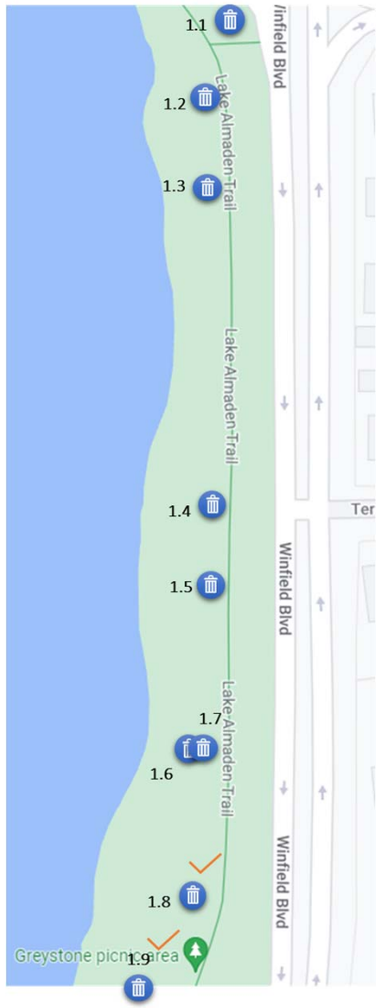
Overview Zones Data Photos

Zone:

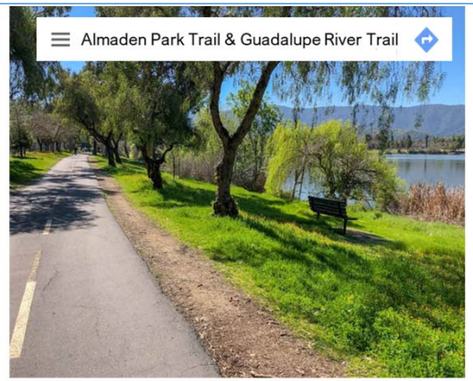
Crowdedness	2 - Moderate
Picnic area:	Greystone
Main activities:	Walking

Trash Cans found in zone:

Regular	Recycling
9	0



Zone 2:



Project:
Littering in Almaden Park & Guadalupe River Trail
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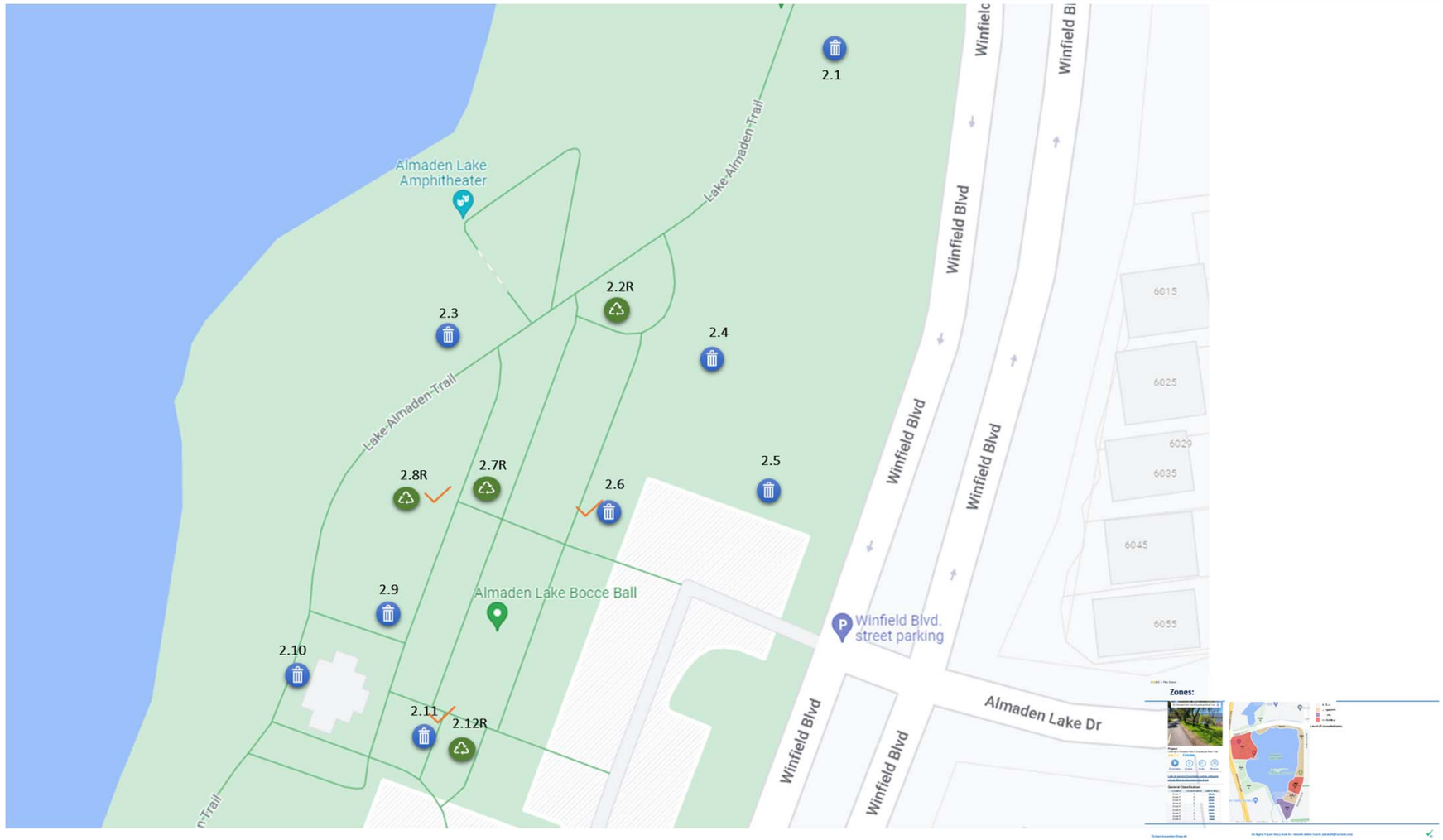
Overview Zones Data Photos

Zone:

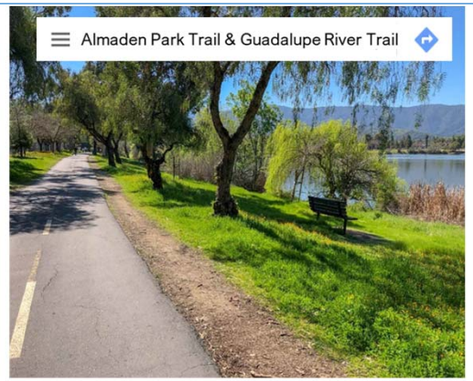
Crowdedness:	4 - Very Busy
Picnic area:	No
Main activities:	Playground 1 Bocce Ball Court 4 Basketball Court 1

Trash Cans found in zone:

Regular	Recycling
12	4



Zone 3:



Project:
Littering in Almaden Park & Guadalupe River Trail
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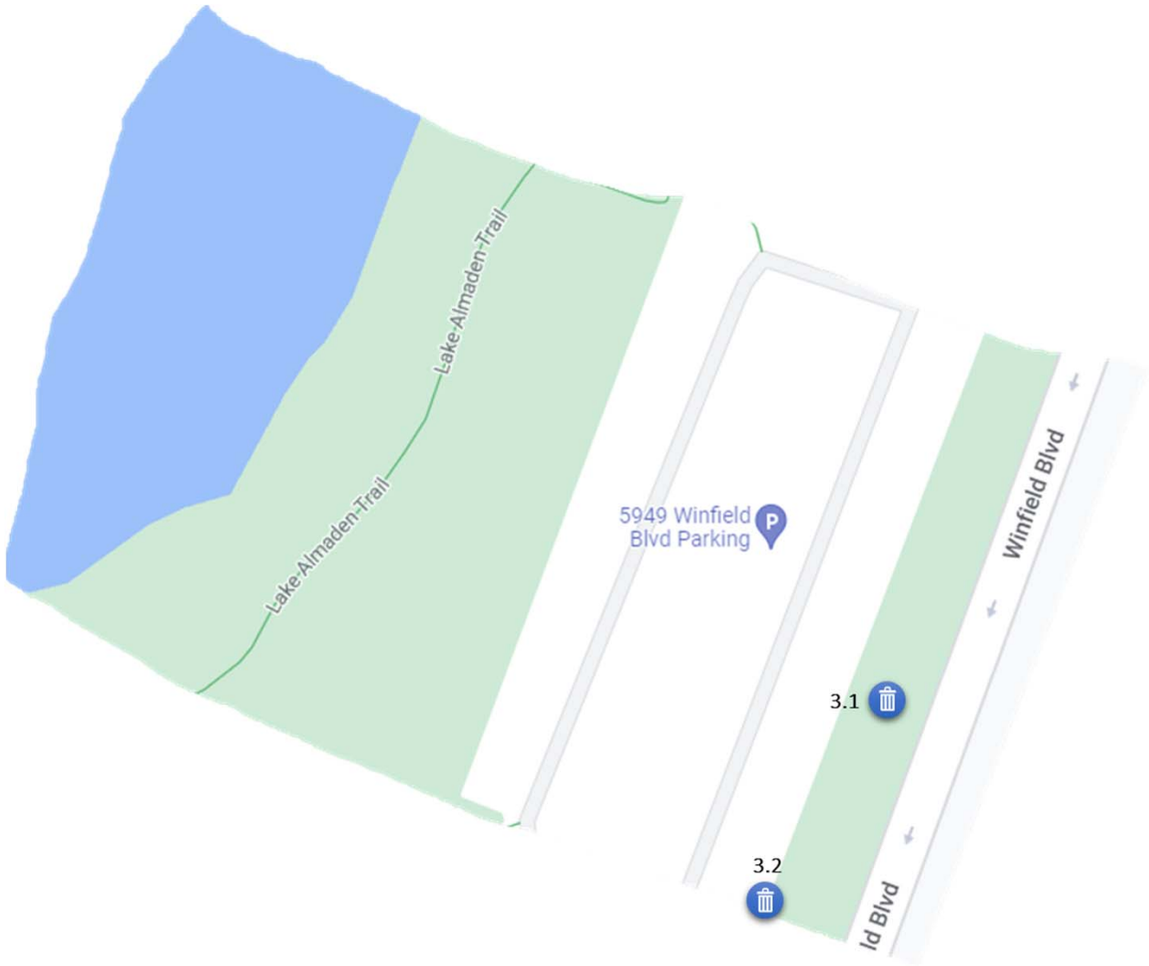
Overview Zones Data Photos

Zone:

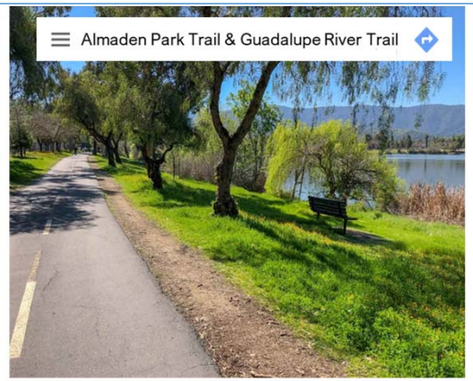
Crowdedness:	2 - Moderate
Picnic area:	No
Main activities:	Walking Wildlife (Ducks, Geese)

Trash Cans found in zone:

Regular	Recycling
2	0



Zone 4:



Project:
Littering in Almaden Park & Guadalupe River Trail
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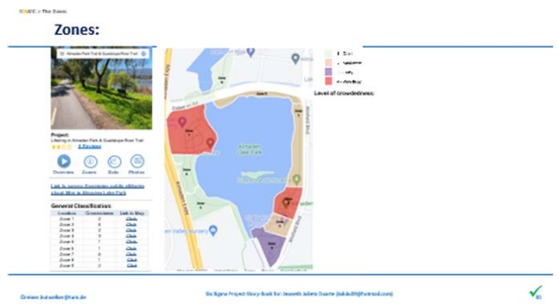
Overview | Zones | Data | Photos

Zone:

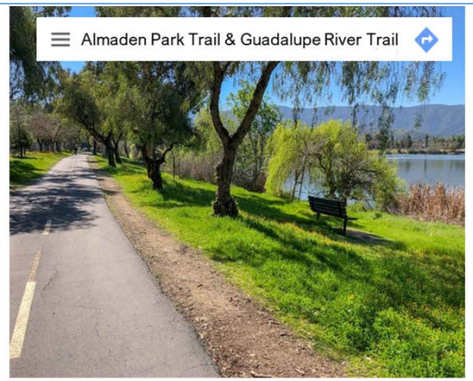
Crowdedness:	3 - Busy
Picnic area:	South point Quicksilver Arrollo
Main activities:	Picnic

Trash Cans found in zone:

Regular	Recycling
20	6



Zone 5:



Project:
Littering in Almaden Park & Guadalupe River Trail
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Overview Zones Data Photos

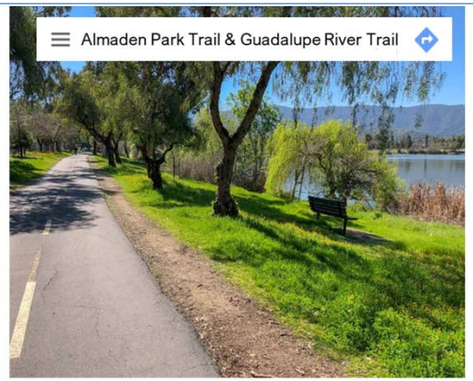
Zone:

Crowdedness:	1
Picnic area:	Ohlone Peppertree
Main activities:	Walking Observing Wildlife

Trash Cans found in zone:

Regular	Recycling
20	0

Zone 6:



Project:
Littering in Almaden Park & Guadalupe River Trail
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Overview Zones Data Photos

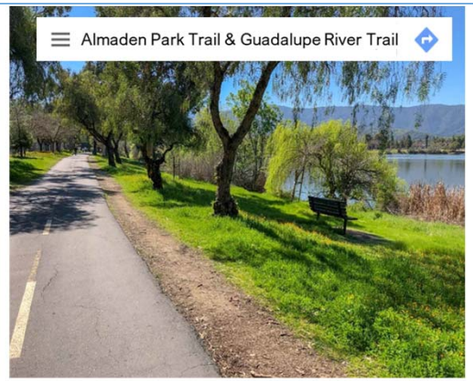
Zone:

Crowdedness:	1
Picnic area:	No
Main activities:	Walking

Trash Cans found in zone:

Regular	Recycling
5	0

Zone 7:



Project:
Littering in Almaden Park & Guadalupe River Trail
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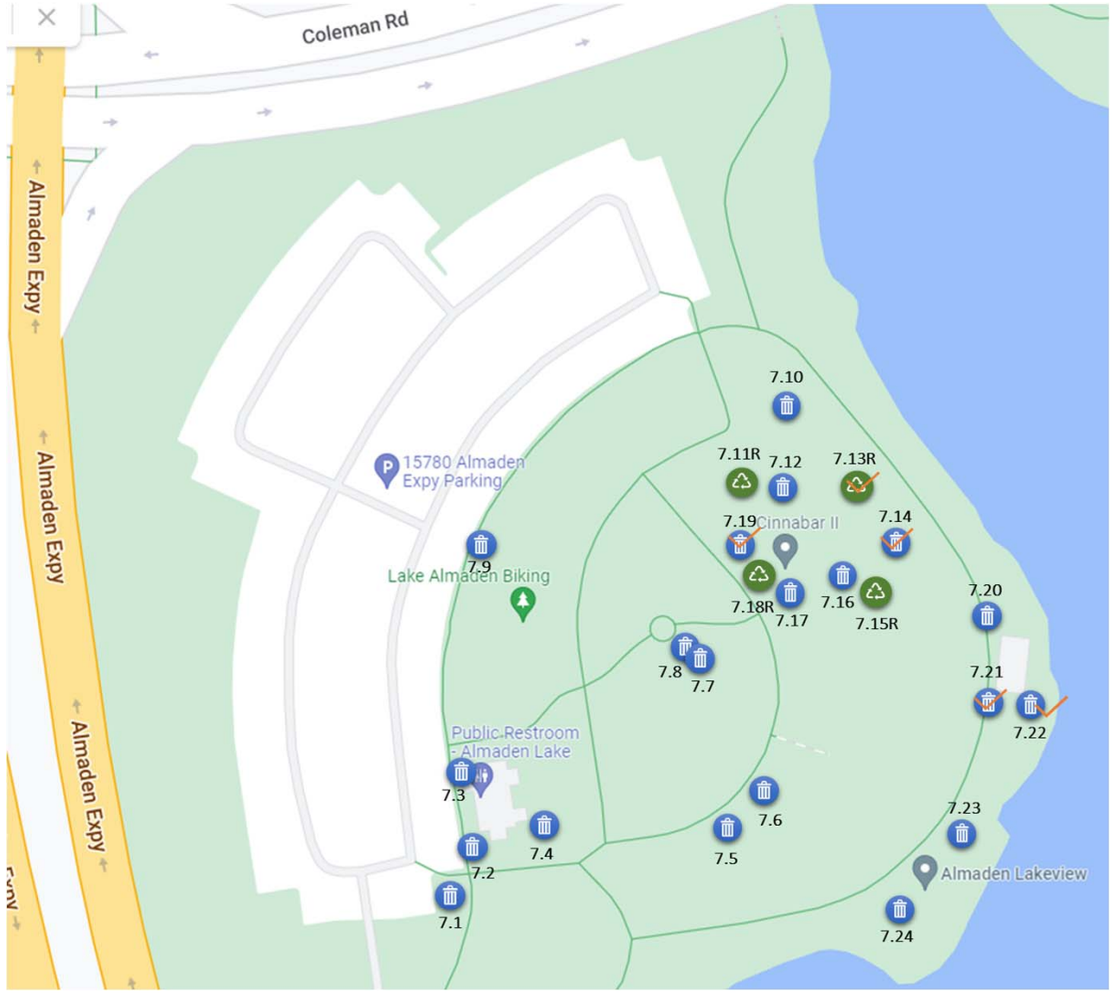
Overview | Zones | Data | Photos

Zone:

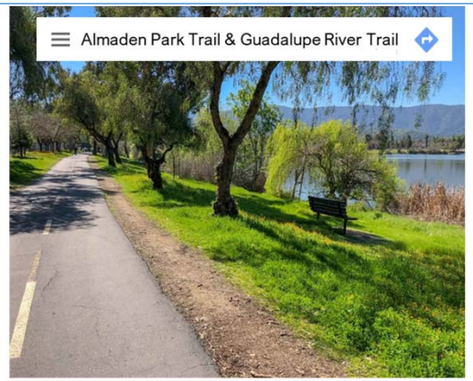
Crowdedness:	4 - Very Busy
Picnic area:	Lakeview Cinnabar I Cinnabar II
Main activities:	Picnic Playground

Trash Cans found in zone:

Regular	Recycling
24	4



Zone 8:



Project:
Littering in Almaden Park & Guadalupe River Trail
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Overview Zones Data Photos

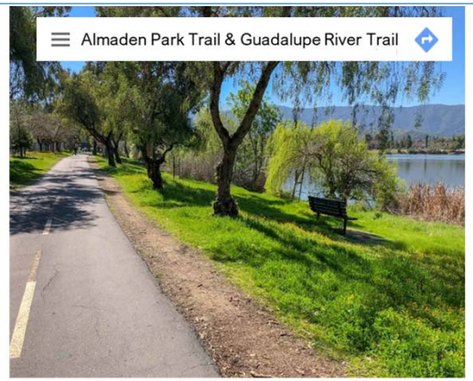
Zone:

Crowdedness:	1
Picnic area:	No
Main activities:	Walking Fishing

Trash Cans found in zone:

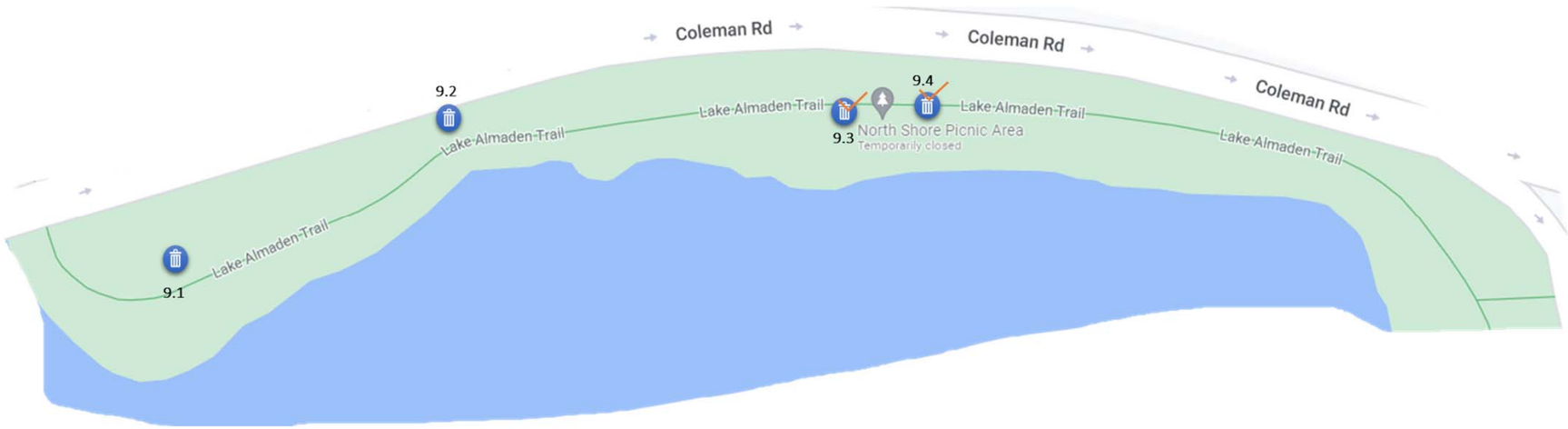
Regular	Recycling
0	0

Zone 9:



Project:
Littering in Almaden Park & Guadalupe River Trail
★★☆☆☆ 4 Reviews

Overview Zones Data Photos



Zone:

Crowdedness:	2 Moderate
Picnic area:	North Shoreline
Main activities:	Walking

Trash Cans found in zone:

Regular	Recycling
4	0

ADJUSTED

Location? – In this case I would prefer an alphanumeric/ text variable in Minitabn

You will get this, pasting these data in Minitab due to the „8R“

In other cases this nominally scaled variable might be falsely used in a parametric test (correlation, …)

	C1	C2	C3-D	C4-D	C5	C6	C7-T	C8-T	C9	C10-T	C11	C12	C13-T	C14	C15	C16	C17	C18	C1
	x_Crowdedness	Y01_Amount	x_Date	x_Day	x_Zone	x_Bin_ID	x_Bin_Type	Y02_Condition	Y02_Rank	Y02_Status	Y02_Bin_Dirty	Y02_Surroundigs_Dirty	Y03_Filling_Level	Y03_Degree	Y06_Pieces_of_Trash	Y_Glass	Y_Metal	Y_Organics	Y_Pa
1	2	9	12-Apr-22	Wednesday	1	1.80	Regular	Good	3	Pass	0	0	Empty	1	1	0	0	1	
2	2	9	12-Apr-22	Wednesday	1	1.90	Regular	Good	3	Pass	0	0	Empty	1	8	3	5	0	
3	2	9	29-Apr-22	Saturday	1	1.80	Regular	Not Good	2	Fail	1	0	Half filled	2	8	0	0	0	
4	2	9	29-Apr-22	Saturday	1	1.90	Regular	Good	3	Pass	0	0	Half filled	2	4	2	0	0	
5	2	9	30-Apr-22	Sunday	1	1.80	Regular	Good	3	Pass	0	0	Half filled	2	2	0	1	0	
6	2	9	30-Apr-22	Sunday	1	1.90	Regular	Good	3	Pass	0	0	Half filled	2	3	0	0	0	
7	4	16	12-Apr-22	Wednesday	2	2.60	Regular	Good	3	Pass	0	0	Half filled	2	2	0	0	1	
8	4	16	12-Apr-22	Wednesday	2	2.80	Recycling	Good	3	Pass	0	0	Half filled	2	2	0	0	0	
9	4	16	29-Apr-22	Saturday	2	2.60	Regular	Good	3	Pass	0	0	Half filled	2	0	0	0	0	
10	4	16	29-Apr-22	Saturday	2	2.80	Recycling	Not Good	2	Fail	1	0	Full	3	4	0	1	0	
11	4	16	30-Apr-22	Sunday	2	2.60	Regular	Not Good	2	Fail	1	0	Full	3	0	0	0	0	
12	4	16	30-Apr-22	Sunday	2	2.80	Recycling	Not Good	2	Fail	1	0	Full	3	3	0	0	0	
13	2	2	12-Apr-22	Wednesday	3	3.10	Regular	Good	3	Pass	0	0	Empty	1	3	0	2	1	
14	2	2	12-Apr-22	Wednesday	3	3.20	Regular	Good	3	Pass	0	0	Empty	1	1	0	0	0	
15	2	2	29-Apr-22	Saturday	3	3.10	Regular	Good	3	Pass	0	0	Empty	1	7	0	0	5	
16	2	2	29-Apr-22	Saturday	3	3.20	Regular	Good	3	Pass	0	0	Half filled	2	3	0	0	0	
17	2	2	30-Apr-22	Sunday	3	3.10	Regular	Good	3	Pass	0	0	Half filled	2	3	0	0	0	
18	2	2	30-Apr-22	Sunday	3	3.20	Regular	Not Good	2	Fail	1	0	Half filled	2	4	0	2	0	
19	3	26	12-Apr-22	Wednesday	4	4.70	Regular	Good	3	Pass	0	0	Half filled	2	3	1	0	0	
20	3	26	12-Apr-22	Wednesday	4	4.40	Recycling	Good	3	Pass	0	0	Half filled	2	2	0	0	0	
21	3	26	29-Apr-22	Saturday	4	4.70	Regular	Good	3	Pass	0	0	Half filled	2	3	0	3	0	
22	3	26	29-Apr-22	Saturday	4	4.40	Recycling	Good	3	Pass	0	0	Full	3	2	0	0	0	
23	3	26	30-Apr-22	Sunday	4	4.70	Regular	Not Good	2	Fail	1	0	Full	3	2	0	0	0	

Results

Data was collected in two different ways:

- Survey Examining public attitudes about litter in Almaden Lake Park - People's behavior related to littering.
- Field study: Collecting data about the actual littering situation at the 9 different zones.

ADJUSTED

Let me addionally recommend to use leading x´s or Y´s to indicate the variable as an influence or problem e.g.

x_01_Trash-Can-Location

Y_01_Trash-Pieces

This might be very helpful for larger datasets as a transparent reminder on the character of your variables.

Results of the MEASURE-Steering

Measure-Steering				
Tool	**Application**	**Documentation**	**Comment**	**Decision**
Input-Analysis	ok	ok		**Master-Black-Belt**
Process-Mapping/ -Analysis	ok	ok	See my notes	Dr. Reiner Hutwelker reiner.hutwelker@tum.de
C&E-Matrix & -Heatmap / Summary for Sponsor	ok	ok		30-May-2022
Data-Collection-Plan	ok	ok		**passed**
MSA (optional)	ok	ok		**Sponsor**
Hypotheses	ok	ok	See my notes	name/ email
Data-Worksheet	ok	ok	See my notes	1-Jan-2021
Additonal Notes			Dear Julieta, this is again a great phase of your project. You applied all tools correctly, documented them reasonably and put a lot of effort and YOUR OWN IDEAS! – I really appreciate this, as it additionally indicates your motivation and your competence! – Excellent work! Please got to ANALYSE and continue with this graded version of your story-book - Reiner	**passed/ failed**

Only proceed to the next phase after a positive decision of MBB and Sponsor

Analyse

Data Evaluation, Process Performance, Test of Hypotheses, Root Cause Analysis

How available are trash bins at Almaden Lake Park? How are they distributed?

Output (Y) – Source: FIELD STUDY

- Y_01 | Trash bins available
- Y_02 | Condition of trash cans and surroundings
- Y_03 | Filling level of trash bins at specific location
- Y_04 | Opportunities when people littered
- Y_05 | Recycling bins available
- Y_06 | Garbage pieces on the ground
- Y_08 | Recycling practices

Influences from Process Step – Source: SURVEY

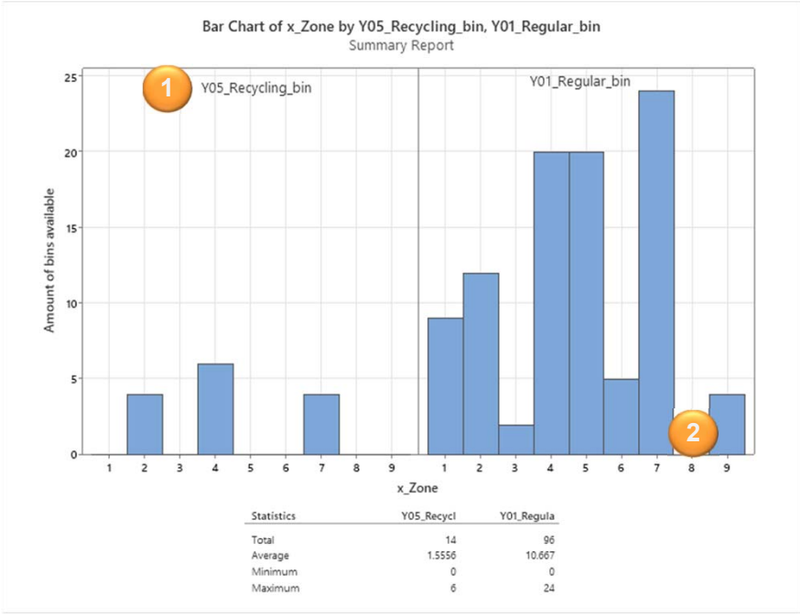
- xMR_02 | Level of knowledge about recycling
- xMR_03 | Satisfaction number of trash bins
- xMR_04 | Littering awareness
- xMR_16 | Understanding of guidelines (recycling bins)

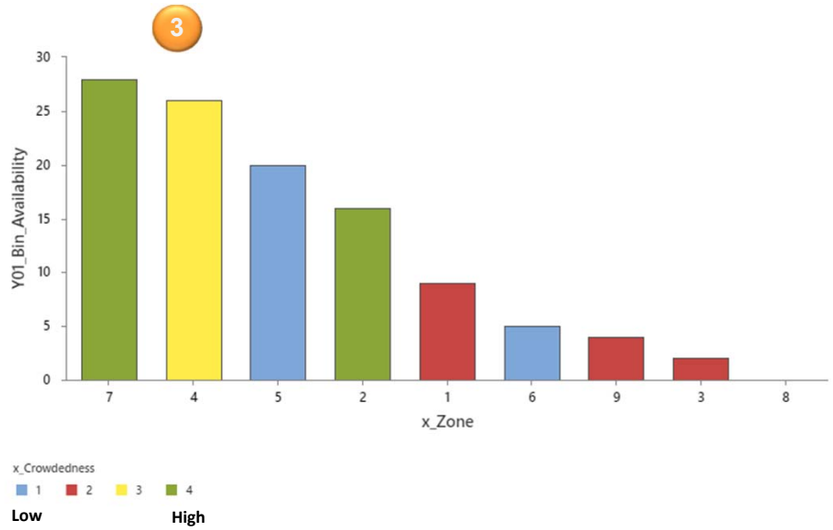
Considerations:

- Scale of Data: Cardinal Scale.
- The data repesents the population. 100% of the trash bins currentrly available at the park.
- Crowdedness levels were estimated in a scale 1 to 4 where 4 represents a very crowded zone.

You might want to see:

- Zones Map Slide 30





Plausability check: pass.

Important Results:

1. Recycling bins are available in just 3 of the 9 zones of the park. They represent the 13% of the total.
2. There are no bins available in zone 8.
3. In most of the cases, for zones with a high level of crowdedness, the number of bins available is above the avarage. Recycling bins are available just in crowded zones.

How clean are trash bins and surroundings in Almaden Lake Park?

Output (Y) – Source: FIELD STUDY

- Y_01 | Trash bins available
- Y_02 | Condition of trash cans and surroundings
- Y_03 | Filling level of trash bins at specific location
- Y_04 | Opportunities when people littered
- Y_05 | Recycling bins available
- Y_06 | Garbage pieces on the ground
- Y_08 | Recycling practices

Influences from Process Step – Source: SURVEY

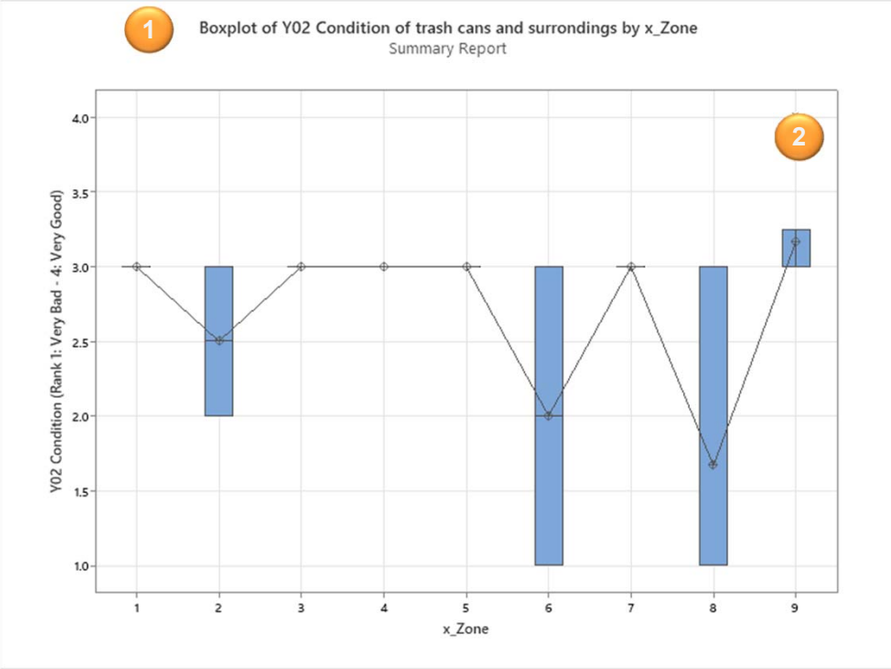
- xMR_02 | Level of knowledge about recycling
- xMR_03 | Satisfaction number of trash bins
- xMR_04 | Littering awareness
- xMR_16 | Understanding of guidelines (recycling bins)

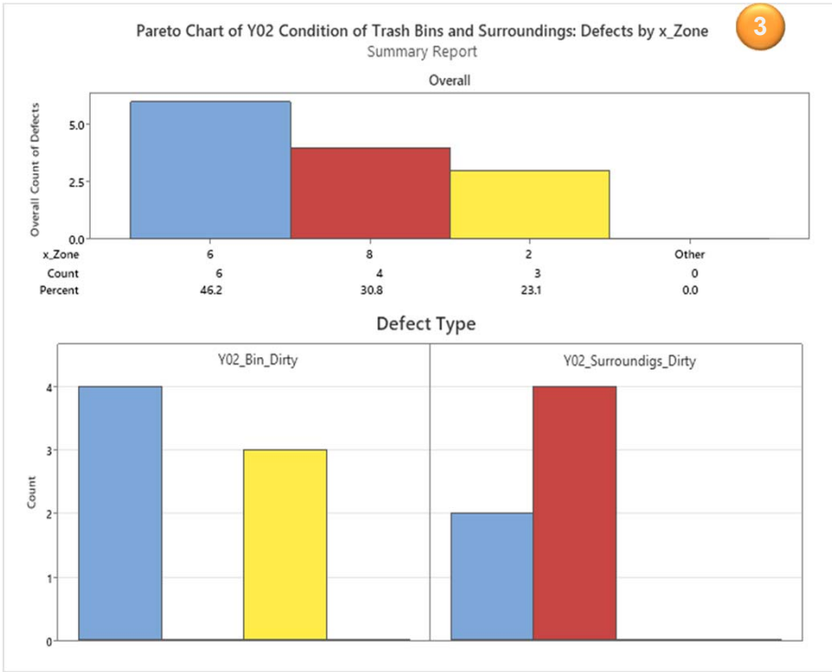
Considerations:

- Scale of Data: Ordinal Scale.
- Ranking: 4 Very Good - 1 Very Bad
- n = 54; Subgroup size (by zone) = 6.
- There are no trash bins in zone 8. Two points in the zone were selected to evaluate the condition of its surroundings.

You might want to see:

- Zone 8 Map Slide 30





Plausability check: some inputs were corrected**.**

Important Results:

1. There is an apparent difference between the medians of the zones 2, 6, 8 and the others. Zones 1, 3, 4, 5, 7 show no variability.
2. One outlier was idetify in zone 9. It corresponds to an evaluation of 4 due to the fact that the bin is brand new.
3. Zone 6, 8 and 2 evidenced defects which are represented in the pareto chart.

Do people litter? Who litter?

Output (Y) – Source: FIELD STUDY

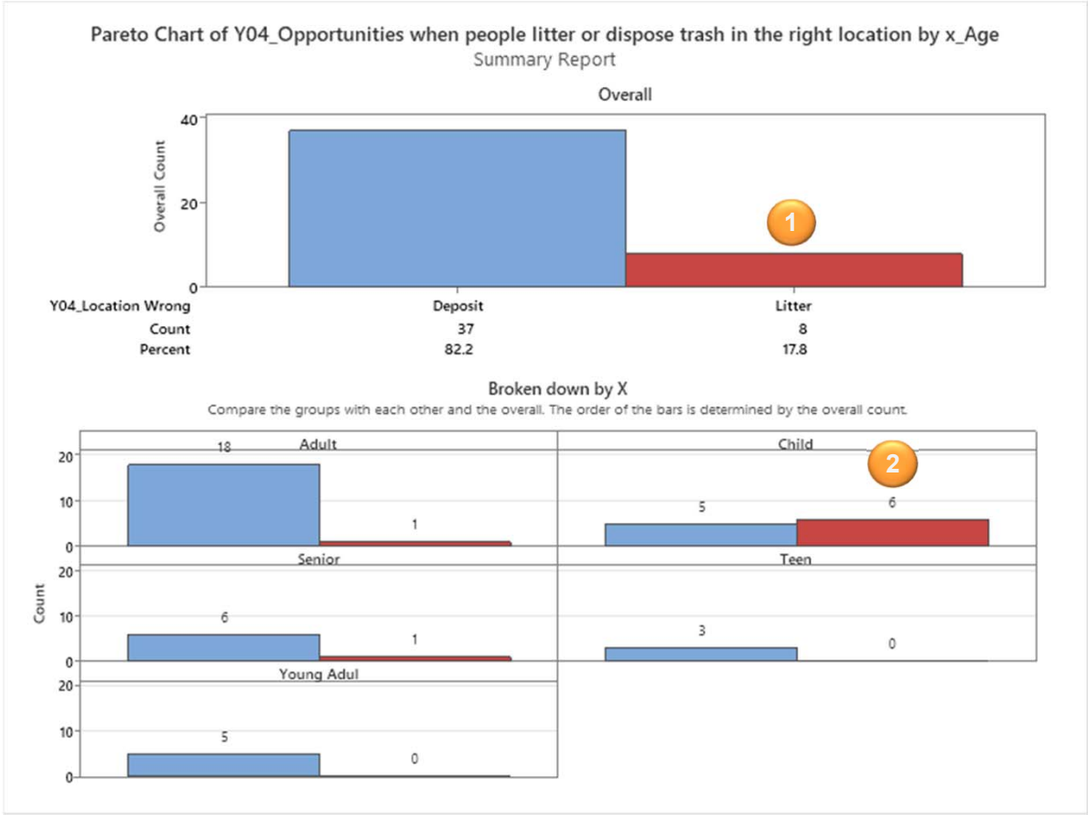
- Y_01 | Trash bins available
- Y_02 | Condition of trash cans and surroundings
- Y_03 | Filling level of trash bins at specific location
- Y_04 | Opportunities when people littered
- Y_05 | Recycling bins available
- Y_06 | Garbage pieces on the ground
- Y_08 | Recycling practices

Influences from Process Step – Source: SURVEY

- xMR_02 | Level of knowledge about recycling
- xMR_03 | Satisfaction number of trash bins
- xMR_04 | Littering awareness
- xMR_16 | Understanding of guidelines (recycling bins)

Considerations:

- Scale of Data: Nominal scale - Data in > 2 Levels.
- Categories: Deposit or Litter.
- n = 39; Subgroup size (by zone) = 6.



Y04_Locati	Adult Count	Adult Percent	Child Count	Child Percent	Senior Count	Senior Percent	Teen Count	Teen Percent	Young Adul Count	Young Adul Percent	Overall Count	Overall Percent
Deposit	18	94.74	5	45.45	6	85.71	3	100.00	5	100.00	37	82.22
Litter	1	5.26	6	54.55	1	14.29	0	0.00	0	0.00	8	17.78
Total	19	100.00	11	100.00	7	100.00	3	100.00	5	100.00	45	100.00

Plausability check: pass.

Important Results:

1. 17.8% of the people observed, decided to litter.
2. In 54% of the cases the littering was made by children while playing.

How bad is the littering situation in Almaden Lake Park?

Output (Y) – Source: FIELD STUDY

- Y_01 | Trash bins available
- Y_02 | Condition of trash cans and surroundings
- Y_03 | Filling level of trash bins at specific location
- Y_04 | Opportunities when people littered
- Y_05 | Recycling bins available
- Y_06 | Garbage pieces on the ground
- Y_08 | Recycling practices

Influences from Process Step – Source: SURVEY

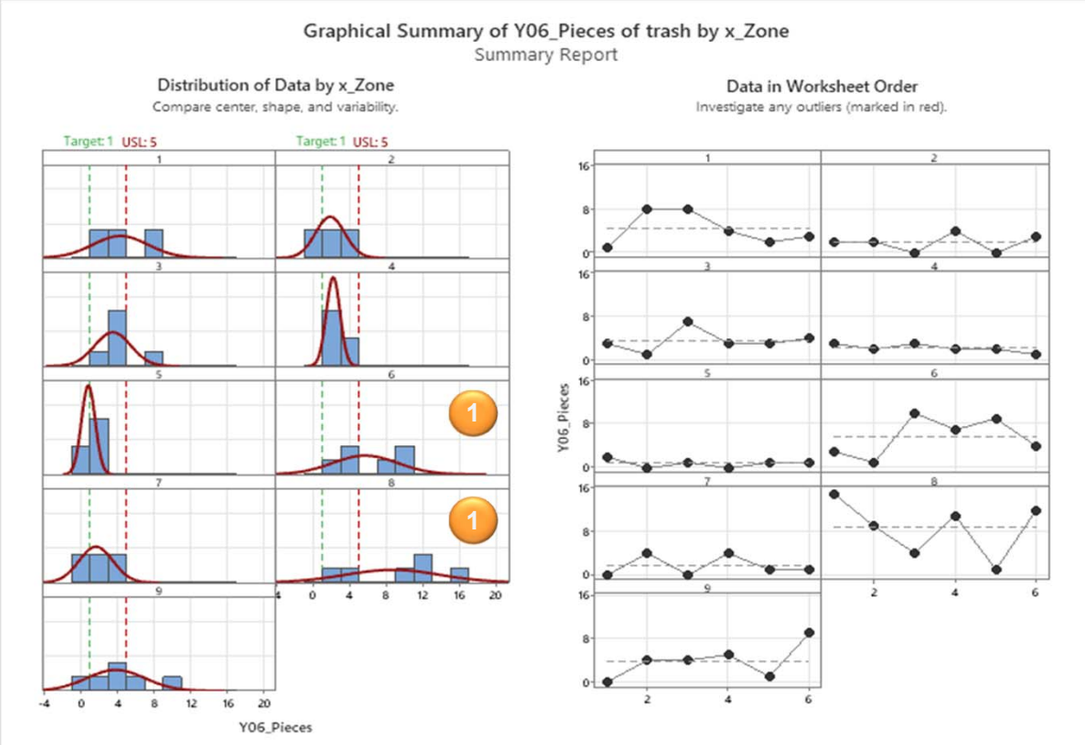
- xMR_02 | Level of knowledge about recycling
- xMR_03 | Satisfaction number of trash bins
- xMR_04 | Littering awareness
- xMR_16 | Understanding of guidelines (recycling bins)

Considerations:

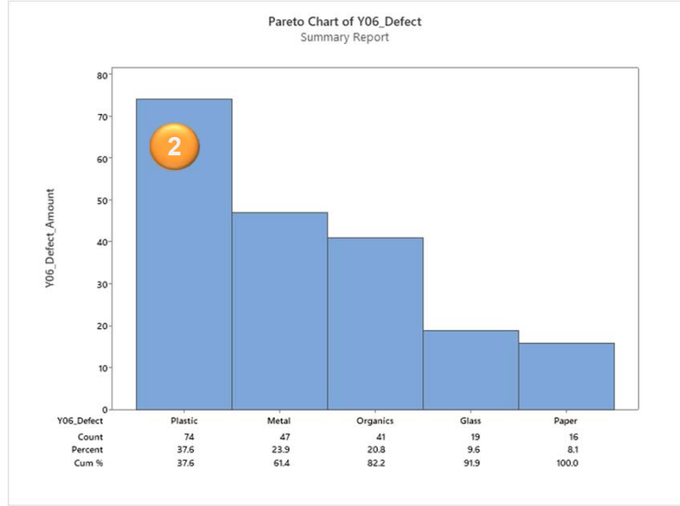
- Scale of Data: Cardinal Scale
- n= 54; Subgroup size (by zone) = 6.
- Normality test (By Zone): shows a significant result (p>0.05), meaning data are normally distributed.

You might want to see:

- Zones Map Slide 30



Group	N	Mean	95% CI	StDev	95% CI	Min	Median	Max	Normality Test P	Normality Test Decision
1	6	4.3333	(1.1734, 7.4933)	3.0111	(1.8795, 7.3850)	1	3.5	8	0.239	Pass
2	6	1.8333	(0.1521, 3.5146)	1.6021	(1.0000, 3.9293)	0	2	4	0.414	Pass
3	6	3.5	(1.4275, 5.5725)	1.9748	(1.2327, 4.8435)	1	3	7	0.124	Pass
4	6	2.1667	(1.3767, 2.9567)	0.75277	(0.4699, 1.8463)	1	2	3	0.143	Pass
5	6	0.83333	(0.0433, 1.6233)	0.75277	(0.4699, 1.8463)	0	1	2	0.143	Pass
6	6	5.6667	(1.9317, 9.4016)	3.5590	(2.2216, 8.7289)	1	5.5	10	0.704	Pass
7	6	1.6667	(-3E-01, 3.6206)	1.8619	(1.1622, 4.5665)	0	1	4	0.057	Pass
8	6	8.6667	(3.1667, 14.167)	5.2409	(3.2714, 12.854)	1	10	15	0.659	Pass
9	6	3.8333	(0.4872, 7.1795)	3.1885	(1.9903, 7.8202)	0	4	9	0.517	Pass



Plausability check of the data: pass.

Important Results:

1. Zones 6, 8 and 9 are the ones that show the more variability.
2. Histograms show data outside of the specification limits in zones 1, 3, 6, 8 y 9.
3. 37.6% of the littered pieces correspond to plastic objects.

Are recycling practices at Almaden Lake Park effective?

Output (Y) – Source: FIELD STUDY

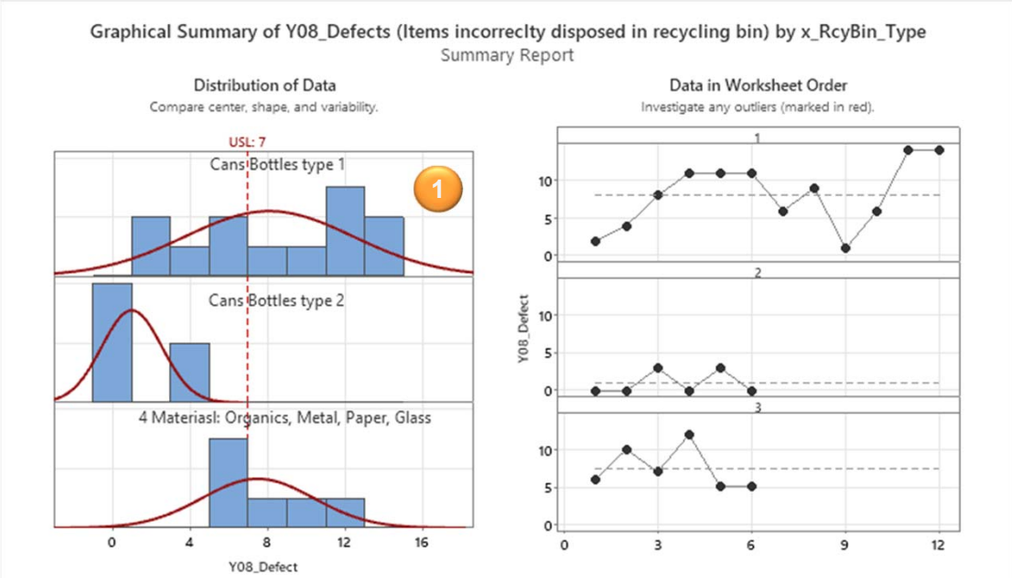
- Y_01 | Trash bins available
- Y_02 | Condition of trash cans and surroundings
- Y_03 | Filling level of trash bins at specific location
- Y_04 | Opportunities when people littered
- Y_05 | Recycling bins available
- Y_06 | Garbage pieces on the ground
- Y_08 | Recycling practices

Influences from Process Step – Source: SURVEY

- xMR_02 | Level of knowledge about recycling
- xMR_03 | Satisfaction number of trash bins
- xMR_04 | Littering awareness
- xMR_16 | Understanding of guidelines (recycling bins)

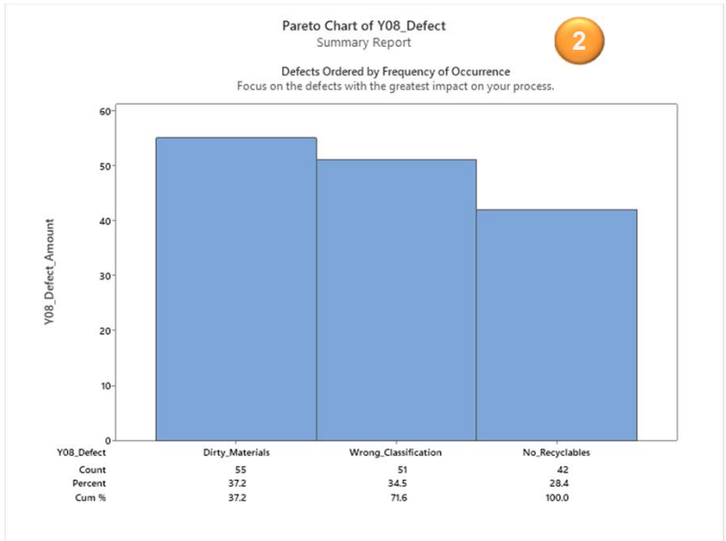
Considerations:

- Scale of Data: Cardinal Scale.
- n= 24.
- Normality test (By type of recycling bin): shows the following:
  - Type 2: significant result (p<0.005), meaning data are not normally distributed. Interpret results under reservation.
  - Type 1 and 4 Materials: significant result (p>0.05), meaning data are normally distributed.



Normality Test

Group	N	Mean	95% CI	StDev	95% CI	Min	Median	Max	P	Decision
1	12	8.0833	(5.3144, 10.852)	4.3580	(3.0872, 7.3994)	1	8.5	14	0.613	Pass
2	6	1	(-6E-01, 2.6258)	1.5492	(0.9670, 3.7996)	0	0	3	<0.005	Fail
3	6	7.5	(4.4766, 10.523)	2.8810	(1.7983, 7.0659)	5	6.5	12	0.227	Pass



Plausability check of the data: pass.

Important Results:

1. There is an apparent difference between recycling bins. The type 1 shows the more variability followed by 4 materials.
2. The frecuency of the defects: Dirty Materials and Wrong Classification is almost the same.

How much do we know about recycling?

Output (Y) – Source: FIELD STUDY

- Y_01 | Trash bins available
- Y_02 | Condition of trash cans and surroundings
- Y_03 | Filling level of trash bins at specific location
- Y_04 | Opportunities when people littered
- Y_05 | Recycling bins available
- Y_06 | Garbage pieces on the ground
- Y_08 | Recycling practices

Influences from Process Step – Source: SURVEY

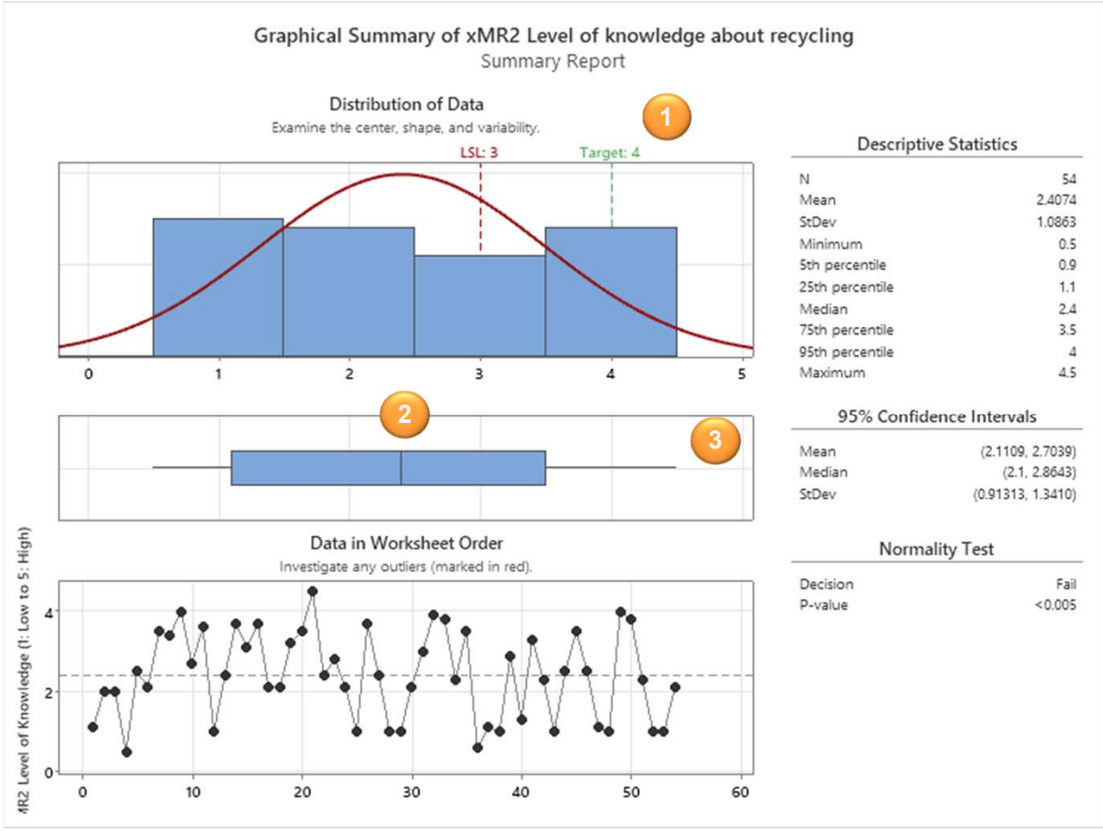
- xMR_02 | Level of knowledge about recycling
- xMR_03 | Satisfaction number of trash bins
- xMR_04 | Littering awareness
- xMR_16 | Understanding of guidelines (recycling bins)

Considerations:

- Scale of Data: Ordinal Scale.
- n= 54; Subgroup size (by zone) = 6.
- Normality test (By Zone): shows a significant result (p<0.005), meaning data are not normally distributed. Interpret results under reservation.
- Evaluation |points between question E and D (survey):
  - Max points 5: High Knowledge
  - Min points 1: Low Knowledge

You might want to see:

Link to survey: Examining public attitudes about litter in Almaden Lake Park



Plausability check: some inputs were corrected**.**

Important Results:

1. Distrubution of the: level of knowledge about recycling in an histogram.
2. Based on the evaluations, a low level of knowledge about recycling is observed, more than 50% of the evaluations are below the lower specification limit (3); half the scores are below 2.4.
3. No outliers were identified.

The data shows that not much!

How much do we know about recycling?

Output (Y) – Source: FIELD STUDY

- Y_01 | Trash bins available
- Y_02 | Condition of trash cans and surroundings
- Y_03 | Filling level of trash bins at specific location
- Y_04 | Opportunities when people littered
- Y_05 | Recycling bins available
- Y_06 | Garbage pieces on the ground
- Y_08 | Recycling practices

Influences from Process Step – Source: SURVEY

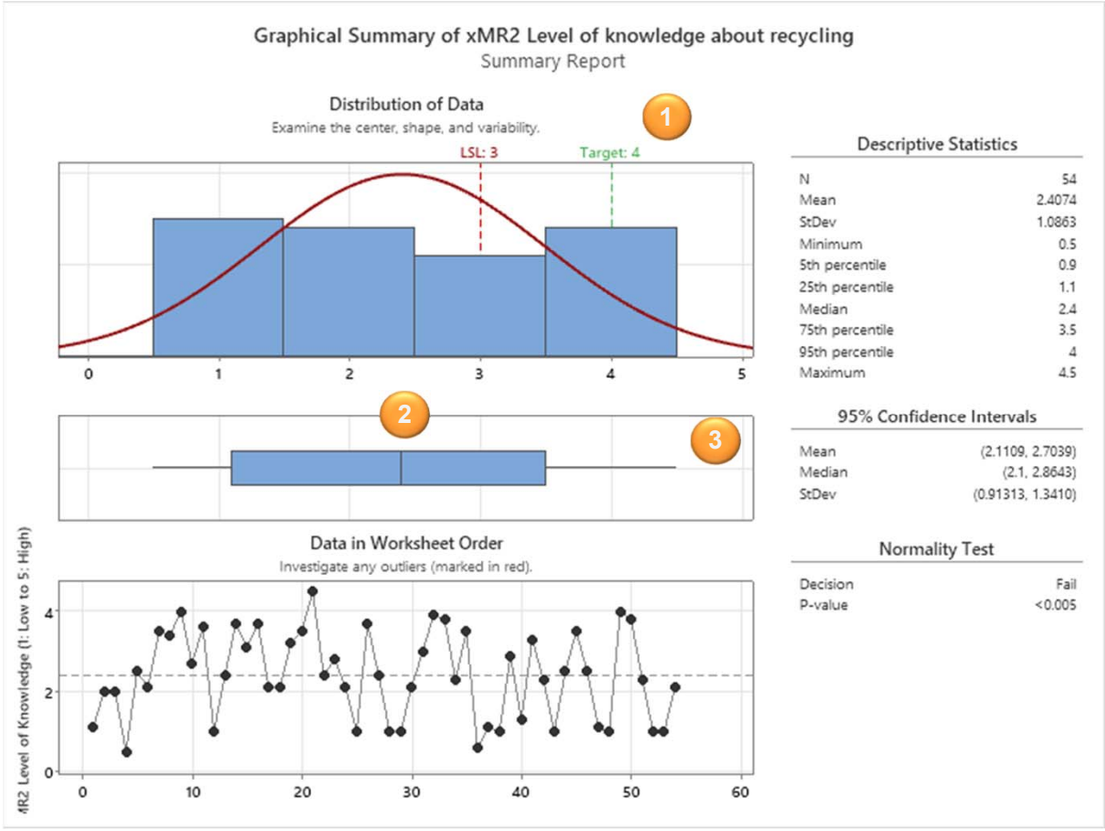
- xMR_02 | Level of knowledge about recycling
- xMR_03 | Satisfaction number of trash bins
- xMR_04 | Littering awareness
- xMR_16 | Understanding of guidelines (recycling bins)

Considerations:

- Scale of Data: Ordinal Scale.
- n= 54; Subgroup size (by zone) = 6.
- Normality test (By Zone): shows a significant result (p<0.005), meaning data are not normally distributed. Interpret results under reservation.
- Evaluation |points between question E and D (survey):
  - Max points 5: High Knowledge
  - Min points 1: Low Knowledge

You might want to see:

Link to survey: Examining public attitudes about litter in Almaden Lake Park



Plausability check: some inputs were corrected**.**

Important Results:

1. Distrubution of the: level of knowledge about recycling in an histogram.
2. Based on the evaluations, a low level of knowledge about recycling is observed, more than 50% of the evaluations are below the lower specification limit (3); half the scores are below 2.4.
3. No outliers were identified.

The data shows that not much!

How well aware are we about littering as a problem?

Output (Y) – Source: FIELD STUDY

- Y_01 | Trash bins available
- Y_02 | Condition of trash cans and surroundings
- Y_03 | Filling level of trash bins at specific location
- Y_04 | Opportunities when people littered
- Y_05 | Recycling bins available
- Y_06 | Garbage pieces on the ground
- Y_08 | Recycling practices

Influences from Process Step – Source: SURVEY

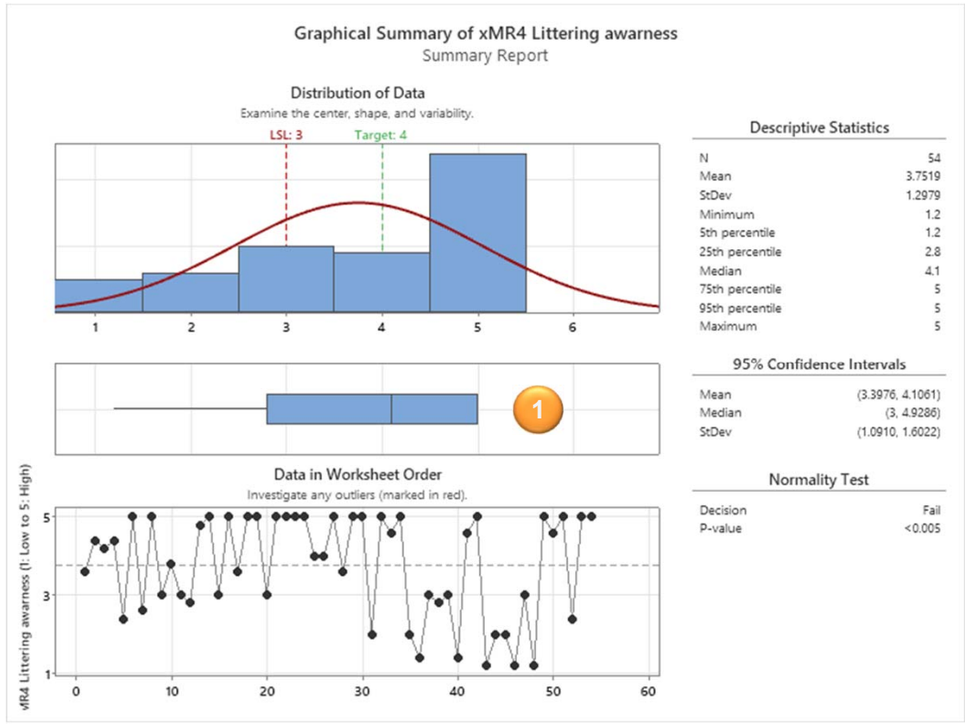
- xMR_02 | Level of knowledge about recycling
- xMR_03 | Satisfaction number of trash bins
- xMR_04 | Littering awareness
- xMR_16 | Understanding of guidelines (recycling bins)

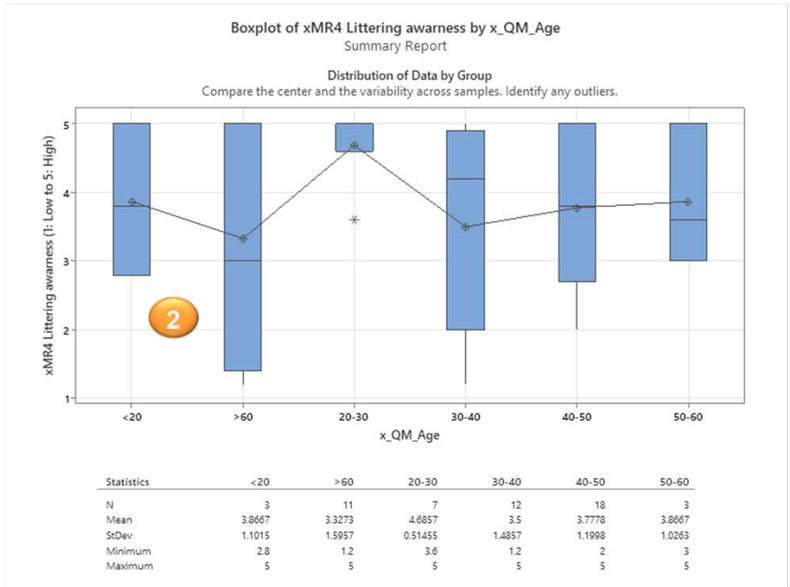
Considerations:

- Scale of Data: Ordinal Scale.
- n= 54; Subgroup size (by zone) = 6.
- Normality test shows a significant result ($p<0.005$), meaning data are not normally distributed. Interpret results under reservation.
- Evaluation |points question A (survey):
  - Max points 5: High awareness
  - Min points 1: Low awareness

You might want to see:

Link to survey: Examining public attitudes about litter in Almaden Lake Park





Plausability check: pass.

Important Results:

1. Based on the evaluations, a high level of littering awareness is observed, more than 70% of the observations are above the lower specification limit; half the scores are above 4.1.
2. A difference between the medians of the groups is observed. The groups >60 and 30-40 are the ones with mote variability and scores below the LSL.

Do we really understand the instructions on bins about recycling?

Output (Y) – Source: FIELD STUDY

- Y_01 | Trash bins available
- Y_02 | Condition of trash cans and surroundings
- Y_03 | Filling level of trash bins at specific location
- Y_04 | Opportunities when people littered
- Y_05 | Recycling bins available
- Y_06 | Garbage pieces on the ground
- Y_08 | Recycling practices

Influences from Process Step – Source: SURVEY

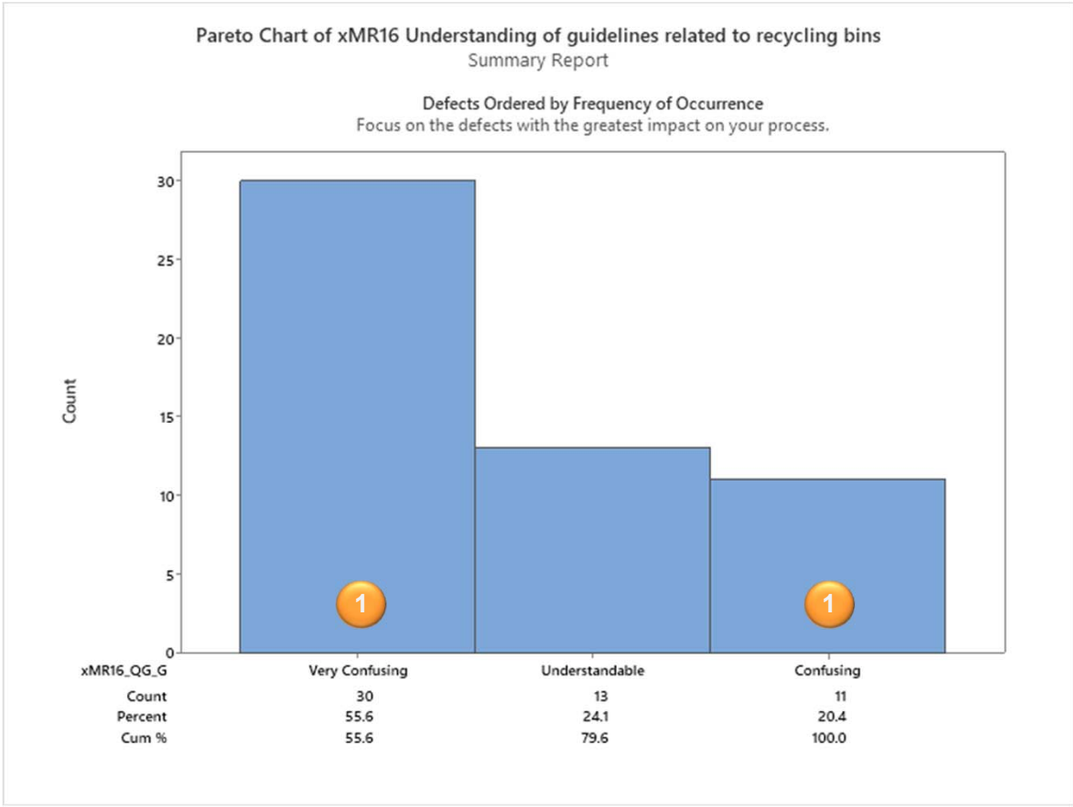
- xMR_02 | Level of knowledge about recycling
- xMR_03 | Satisfaction number of trash bins
- xMR_04 | Littering awareness
- xMR_16 | Understanding of guidelines (recycling bins)

Considerations:

- Scale of Data: Ordinal scale.
- Ranking | Question G (survey): 1 Understandable, 2 Confusing, 3 Very confusing
- n= 54; Subgroup size (by zone) = 6.

You might want to see:

Link to survey: Examining public attitudes about litter in Almaden Lake Park



Plausability check: pass.

Important Results:

1. 55.6% the opportunities people consider the guidelines related to recycling bins to be VERY confusing, 20.4% to be confusing.

A wonderful idea for subgrouping the control-chart!

Control Chart: Y06 Pieces of trash

Output (Y) – Source: FIELD STUDY

- Y_01 | Trash bins available
- Y_02 | Condition of trash cans and surroundings
- Y_03 | Filling level of trash bins at specific location
- Y_04 | Opportunities when people littered
- Y_05 | Recycling bins available
- Y_06 | Garbage pieces on the ground
- Y_08 | Recycling practices

Influences from Process Step – Source: SURVEY

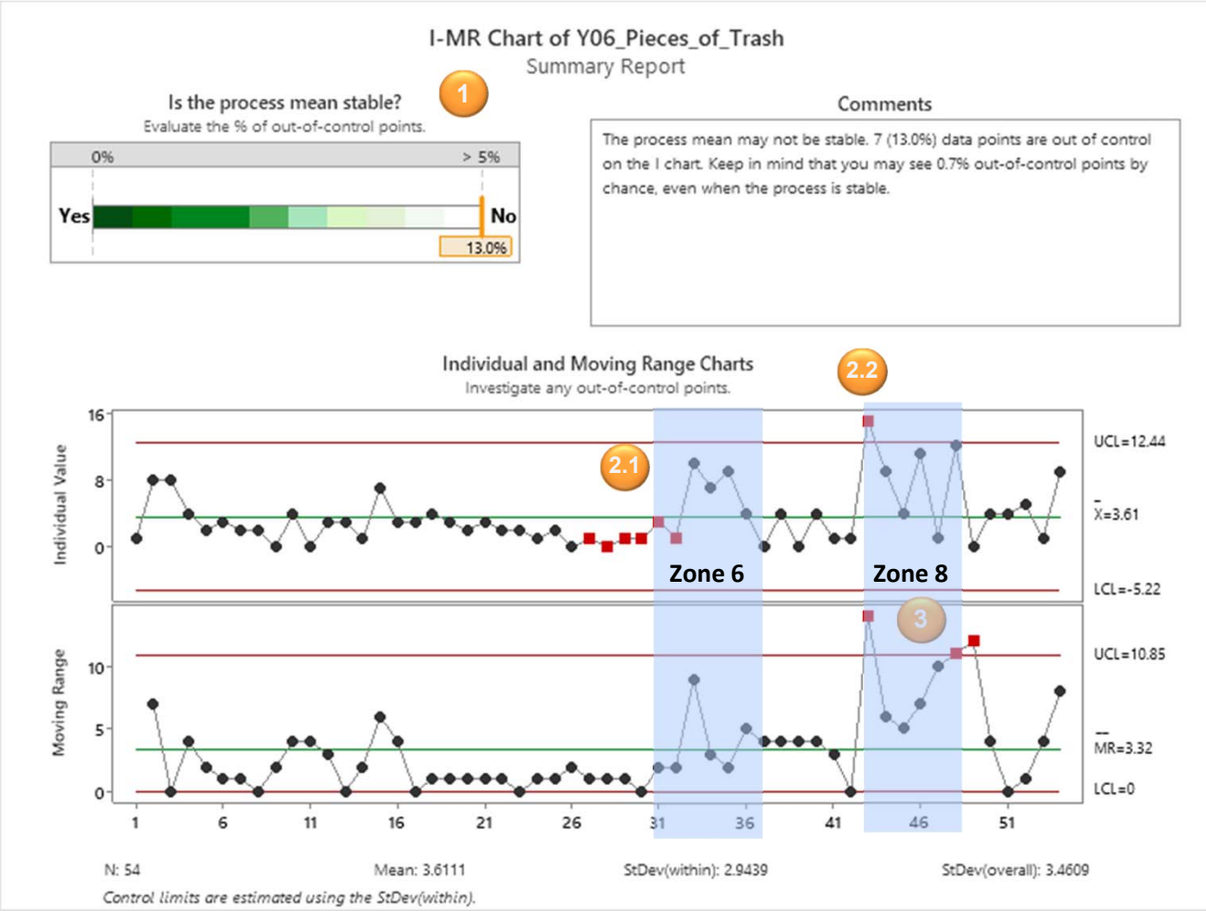
- xMR_02 | Level of knowledge about recycling
- xMR_03 | Satisfaction number of trash bins
- xMR_04 | Littering awareness
- xMR_16 | Understanding of guidelines (recycling bins)

Considerations:

- Scale of Data: Cardinal Scale
- n= 54; Subgroup size (by zone) = 6.

You might want to see:

- Trash bins availability Slide 43
- Pieces of trash by Zone



Important Results:

1. The proces mean is not stable.
2. The **Individual values** chart shows 7 outliers (red):
   2.1. shift in mean: six consecutive points above the mean.
   2.2. data point outside control limits.
3. The **Moving Range** chart shows 3 points outside control limits. Is important to notice that this data point correspond to zones 6 and 8.

Control Chart: Y08 Items incorrectly disposed in recycling bin

Output (Y) – Source: FIELD STUDY

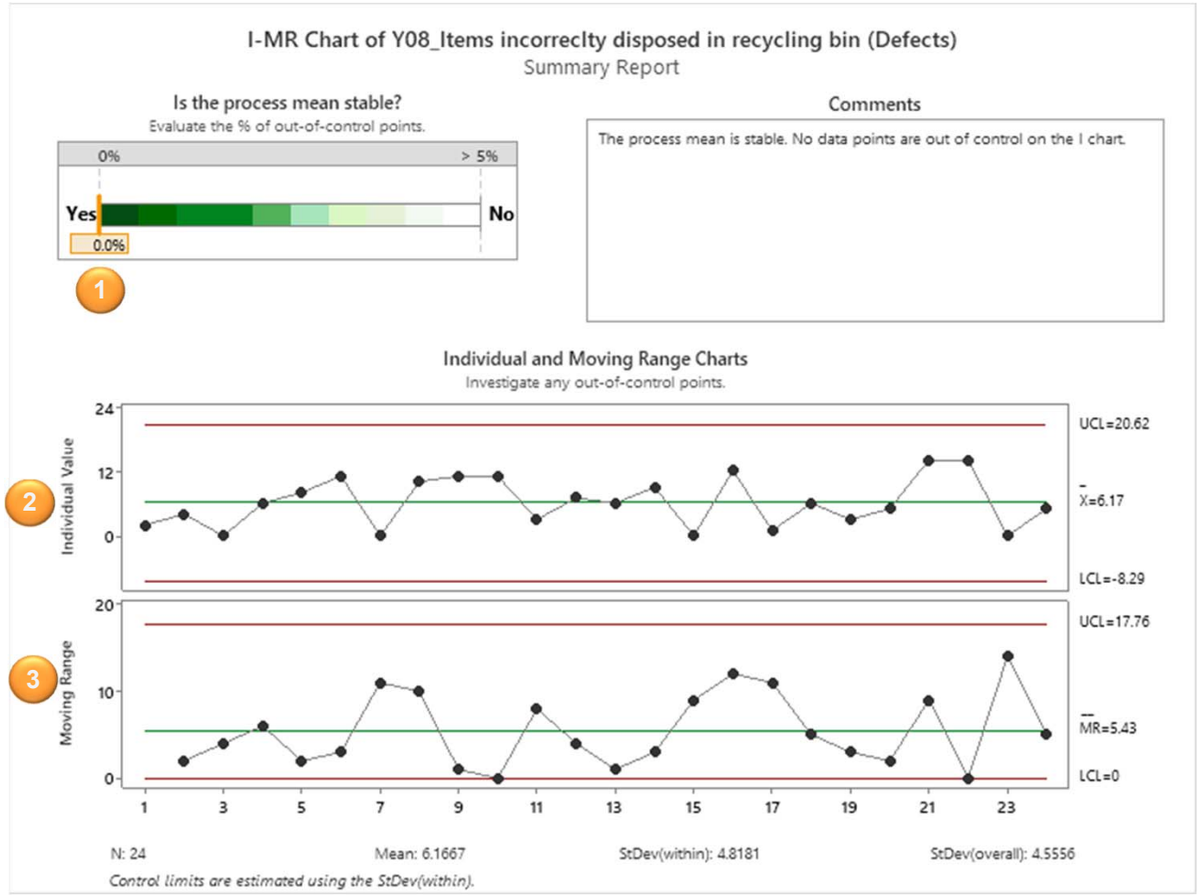
- Y_01 | Trash bins available
- Y_02 | Condition of trash cans and surroundings
- Y_03 | Filling level of trash bins at specific location
- Y_04 | Opportunities when people littered
- Y_05 | Recycling bins available
- Y_06 | Garbage pieces on the ground
- Y_08 | Recycling practices

Influences from Process Step – Source: SURVEY

- xMR_02 | Level of knowledge about recycling
- xMR_03 | Satisfaction number of trash bins
- xMR_04 | Littering awareness
- xMR_16 | Understanding of guidelines (recycling bins)

Considerations:

- Scale of Data: Cardinal Scale.
- n= 24.



Important Results:

1. The proces mean is stable.
2. The **Individual values** chart shows no outliers.
3. The **Moving Range** chart shows no points outside control limits.

How capable is our process: Number of garbage pieces surrounding trash cans – Zone 6?

Output (Y) – Source: FIELD STUDY

- Y_01 | Trash bins available
- Y_02 | Condition of trash cans and surroundings
- Y_03 | Filling level of trash bins at specific location
- Y_04 | Opportunities when people littered
- Y_05 | Recycling bins available
- Y_06 | Garbage pieces on the ground
- Y_08 | Recycling practices

Influences from Process Step – Source: SURVEY

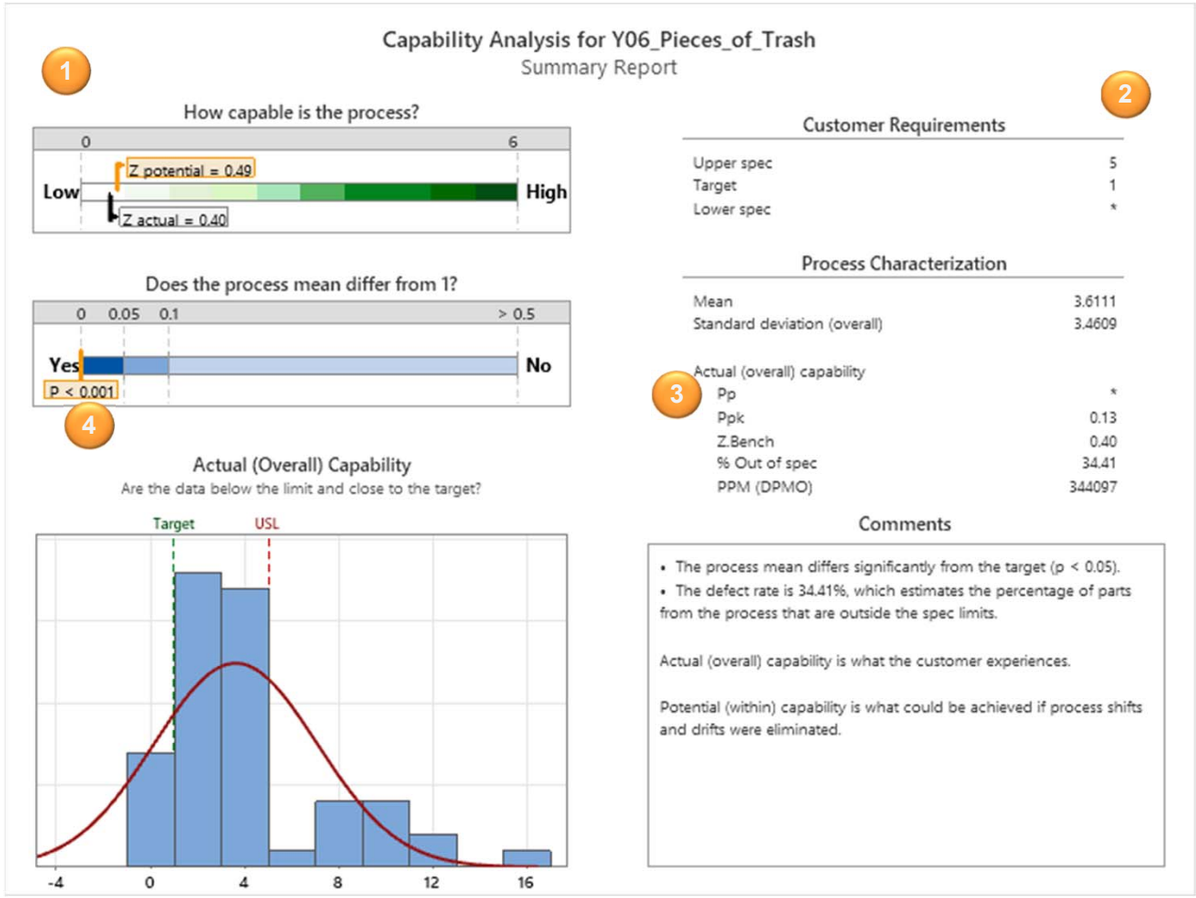
- xMR_02 | Level of knowledge about recycling
- xMR_03 | Satisfaction number of trash bins
- xMR_04 | Littering awareness
- xMR_16 | Understanding of guidelines (recycling bins)

Considerations:

- Scale of Data: Cardinal Scale
- n= 54; Subgroup size (by zone) = 6.
- Normality test: shows a significant result (p<0.005), meaning data are not normally distributed. Interpret results under reservation.

You might want to see:

- Distribution of the Y_06 | Garbage pieces on the ground by Zone. Slide 46



Important Results:

1. The results show low process capability. The Z-Values indicate an actual sigma level of 0.4, and the potential sigma level of 0.49, we are far away from 6 sigma.
2. The customer requirements are defined as specification limits on the number of pieces of trash within a radius of 5 meters around a trash-can.
3. Different parameters of process capability.
4. The process mean (=3.61) significantly differs from the target (=1) (p<0.001).
5. The Histogram shows the distribution of our data. The green line indicates the target value and the red one the USL, (LSL is not necessary as we do not fear values below the target).

How capable is our process: Recycling effectiveness?

Output (Y) – Source: FIELD STUDY

- Y_01 | Trash bins available
- Y_02 | Condition of trash cans and surroundings
- Y_03 | Filling level of trash bins at specific location
- Y_04 | Opportunities when people littered
- Y_05 | Recycling bins available
- Y_06 | Garbage pieces on the ground
- Y_08 | Recycling practices

Influences from Process Step – Source: SURVEY

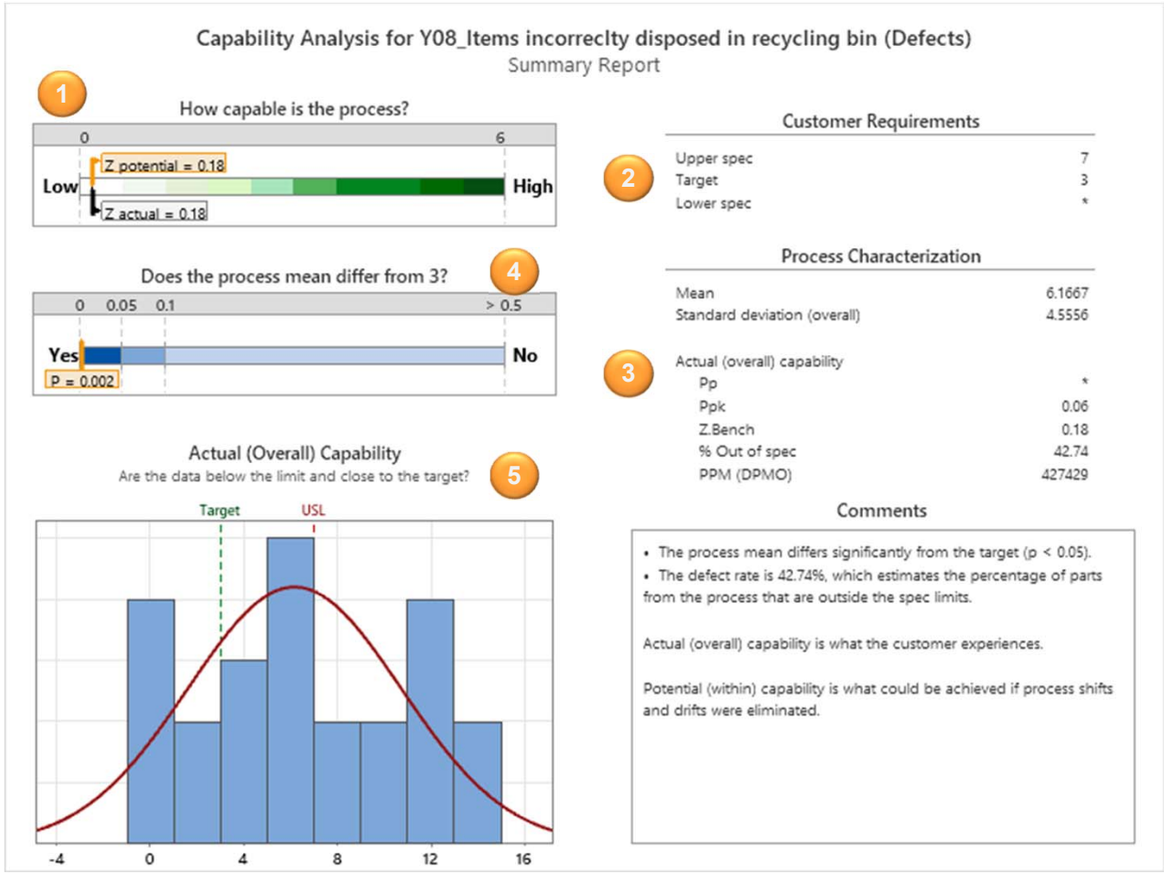
- xMR_02 | Level of knowledge about recycling
- xMR_03 | Satisfaction number of trash bins
- xMR_04 | Littering awareness
- xMR_16 | Understanding of guidelines (recycling bins)

Considerations:

- Scale of Data: Cardinal Scale
- n= 24; Subgroup size (by zone) = 4.
- Normality test: shows a significant result (p>0.05), meaning data are normally distributed.

You might want to see:

Recycling bins availabile Slide 43



Important Results:

1. The results show low process capability. The Z-Values indicate an actual and potential sigma level of 0.18. We are far away from 6 sigma.
2. The customer requirements are defined as specification limits on the number of items incorrectly disposed in recycling bin.
3. Different parameters of process capability.
4. The process mean (=6.16) significantly differs from the target (=3) (p<0.002).
5. The Histogram shows the distribution of our data. The green line indicates the target value and the red one the USL, (LSL is not necessary as we do not fear values below the target).

Is there is a relationship between **Xmr04: Littering awareness** and **Y_06: Number of garbage pieces surrounding trash cans?**

IMPORTANT CONSIDERATIONS

Output (Y) – Source: FIELD STUDY:

Y_01 | Trash bins available

Y_02 | Condition of trash cans and surroundings

Y_03 | Filling level of trash bins at specific location

Y_04 | Opportunities when people littered

Y_05 | Recycling bins available

Y_06 | Garbage pieces on the ground
Cardinal Scale.
n= 54; Subgroup size (by zone) = 6.
Normality test: fail (p<0.005).

Y_08 | Recycling practices

Influences from Process Step (xMR) – Source SURVEY:

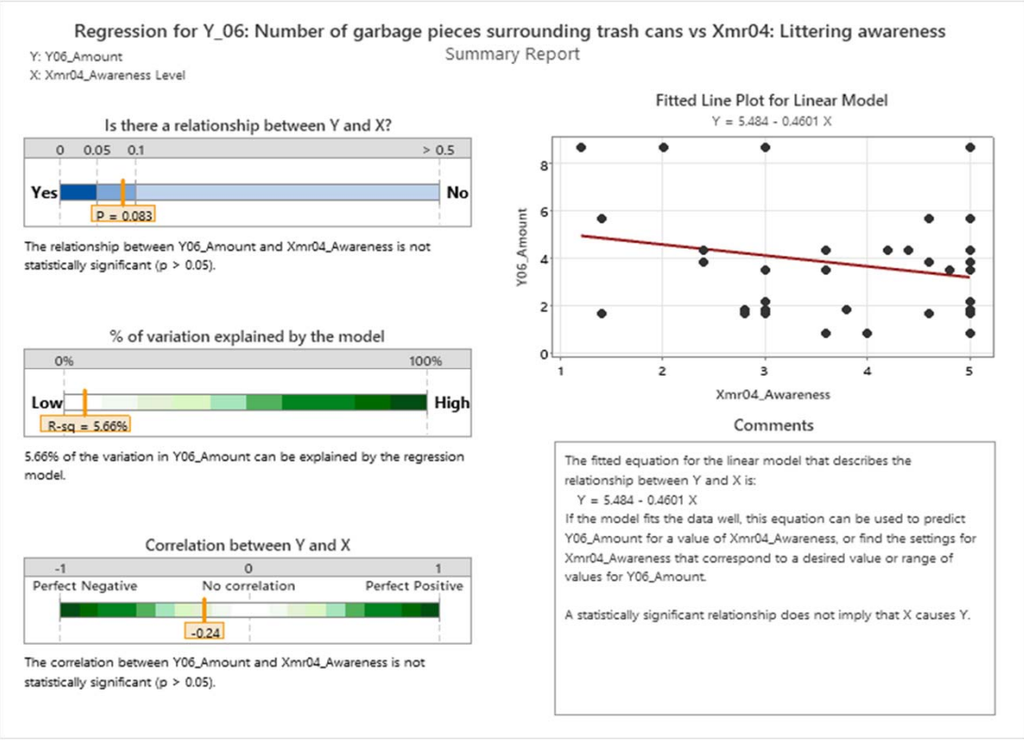
xMR_02 | Level of knowledge about recycling

xMR_03 | Satisfaction number of trash bins

xMR_04 | Littering awareness
Ordinal Scale.
n= 54; Subgroup size (by zone) = 6.
Normality test: fail (p<0.005).

xMR_16 | Understanding of guidelines (recycling bins)

Risk	**Y_06: Output: Ground (trash-free) [Degree of: Amount (Pieces of trash within a radius of 5 meters around a trash-can)]**
43%	There is a/ no Relationship betw een: xMR_04: Activity: Decide on w here to dispose w aste (based on previous analysis) [Ranking Position of: Littering aw arness (Points: 1 to 5)] and: Y_06: Output: Ground (trash-free) [Degree of: Amount (Pieces of trash w ithin a radius of 5 meters around a trash-can)] according to the Principle: The larger the value of x, the larger (resp. smaller) is the value of Y.
Relationship Hypothesis	**Type of test:** Rank Correlation (Spearman)/ General Regression



Important Results:

With a p-value=0.083, the relationship between Xmr04 and Y06 is not statistically significant and with a low R-sq=5.66 also not practically relevant.

In future please keep in mind, that results like these arr based on a small sample size, and that your scales have a small range, only allowing a restricted variability.

But of course – I follow your documentation

Is there is a relationship between **xMR02: Level of knowledge about recycling** and **Y_08: Recycling effectiveness?**

IMPORTANT CONSIDERATIONS

Output (Y) – Source: FIELD STUDY:

Y_01 | Trash bins available

Y_02 | Condition of trash cans and surroundings

Y_03 | Filling level of trash bins at specific location

Y_04 | Opportunities when people littered

Y_05 | Recycling bins available

Y_06 | Garbage pieces on the ground

Y_08 | Recycling practices
Cardinal Scale
n= 24; Subgroup size (by zone) = 4.
Normality test: pass (p>0.05)

Influences from Process Step (xMR) – Source SURVEY:

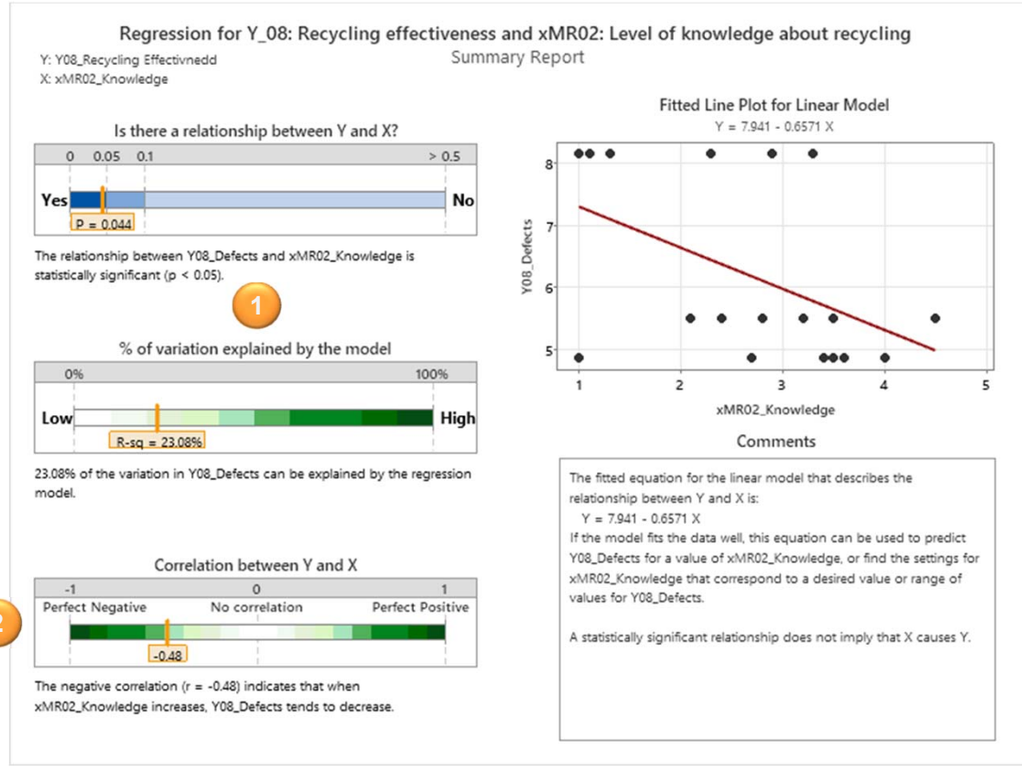
xMR_02 | Level of knowledge about recycling
Ordinal Scale.
n= 54; Subgroup size (by zone) = 6.
Normality test: fail (p<0.005). *Interpret results under reservation.*

xMR_03 | Satisfaction number of trash bins

xMR_04 | Littering awareness

xMR_16 | Understanding of guidelines (recycling bins)

Risk	Y_08: Output: Trash-can (full) [Degree of: Amount (Items incorreclty disposed in recycling bin)]
48%	There is a/ no Relationship betw een: xMR_02: Activity: Decide on how to discard trash: analyze materials, harmfulness, etc. [Ranking Position of: Level of know ledge about recycling (System of points betw een: Question D + Question E)] and: Y_08: Output: Trash-can (full) [Degree of: Amount (Items incorreclty disposed in recycling bin)] according to the Principle: The larger the value of x, the larger (resp. smaller) is the value of Y.
Relationship Hypothesis	**Type of test:** Rank Correlation (Spearman)/ General Regression



Important Results:

1. With a p-value=0.044, the relationship between Xmr02 and Y08 is statistically significant. However, with a R-sq=23.08%, it is considered not practically relevant.
   Here I´d like to suggest a different view. The measurement error in our (interview) data on this topic is probably larger than with hard measurements. And you can explain 28% of the vraiability of defects. In my opinion this is highly practically relevant and a lever for IMPROVE.
2. The negative correlation (r=-0.48) would indicate the negative relationship: when the level of knowledge increases, the number of pieces incorrectly recycled tends to decrease.

Is there a relationship between **Y_08: Recycling effectiveness** and **Xmr16: Understanding of instructions (recycling bins)?**

IMPORTANT CONSIDERATIONS

Output (Y) – Source: FIELD STUDY:

Y_01 | Trash bins available

Y_02 | Condition of trash cans and surroundings

Y_03 | Filling level of trash bins at specific location

Y_04 | Opportunities when people littered

Y_05 | Recycling bins available

Y_06 | Garbage pieces on the ground

Y_08 | Recycling practices

Cardinal Scale

n= 24; Subgroup size (by zone) = 4.

Normality test: pass (p>0.05)

Influences from Process Step (xMR) – Source SURVEY:

xMR_02 | Level of knowledge about recycling

xMR_03 | Satisfaction number of trash bins

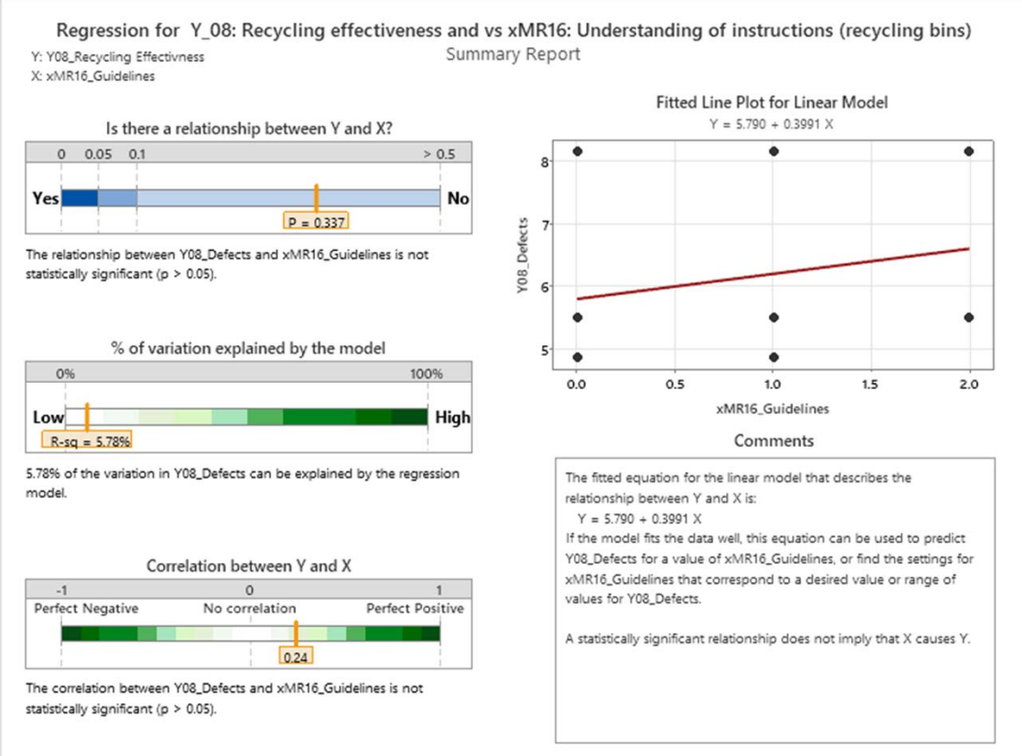
xMR_04 | Littering awareness

xMR_16 | Understanding of guidelines (recycling bins)

Ordinal scale.

n= 54; Subgroup size (by zone) = 6.

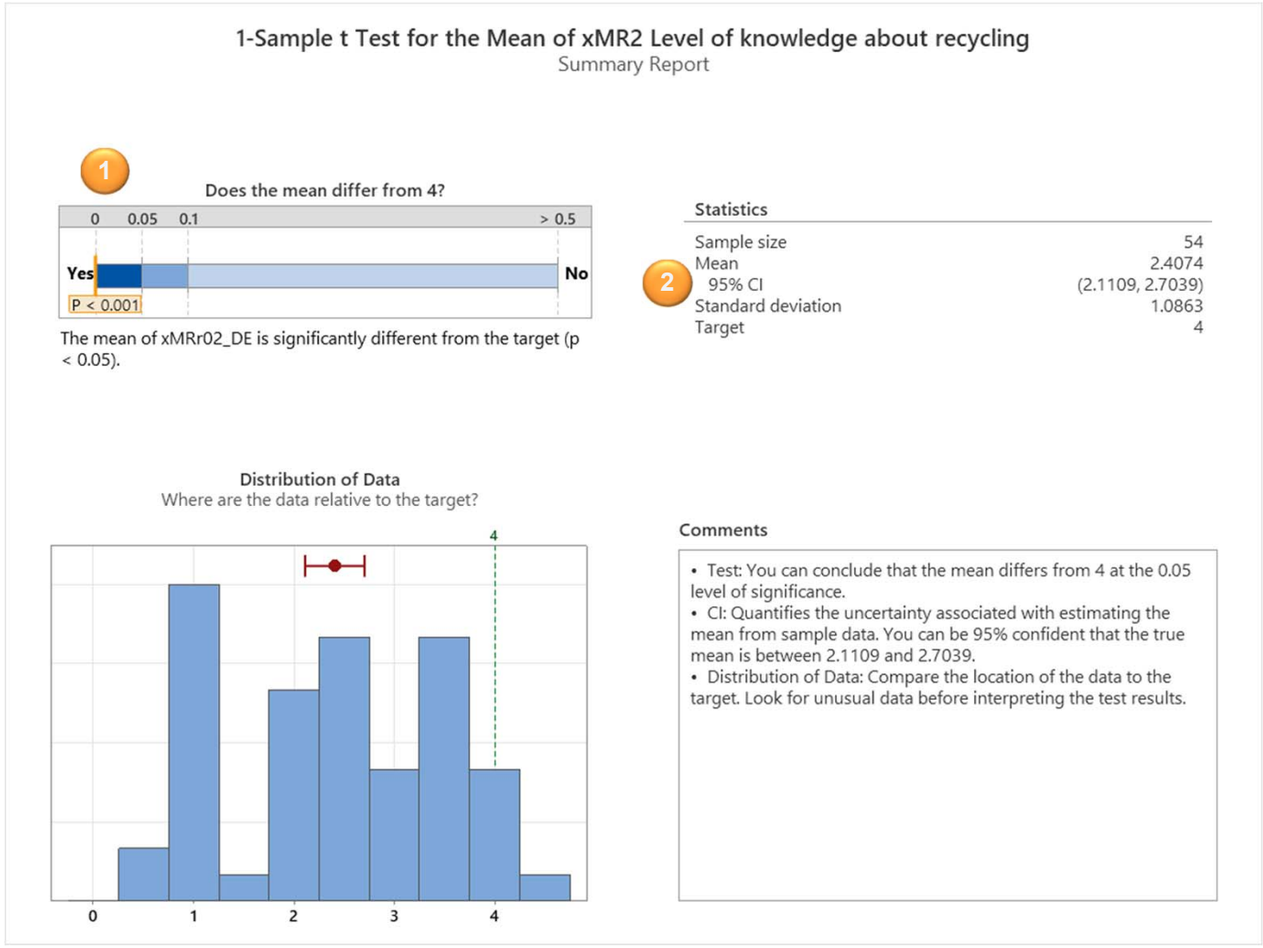
Risk	Y_08: Output: Trash-can (full) [Degree of: Amount (Items incorreclty disposed in recycling bin)]
48%	There is a/ no Relationship between: xMR_16: Activity: Guarantee recycling [Ranking Position of: Understanding of guidelines related to recycling bins (1 Understandable, 2 Confusing, 3 Very confusing)] and: Y_08: Output: Trash-can (full) [Degree of: Amount (Items incorreclty disposed in recycling bin)] according to the Principle: The larger the value of x, the larger (resp. smaller) is the value of Y.
Relationship Hypothesis	**Type of test:** Rank Correlation (Spearman)/ General Regression



Important Results:

With a p-value=0.337, the relationship between Xmr16 and Y08 is not statistically significant and also with a low R-sq=5.78% not practically relevant.

Is there is a difference in **xMR02 level of knowledge about recycling** between **sample data and target?**



Important Results:

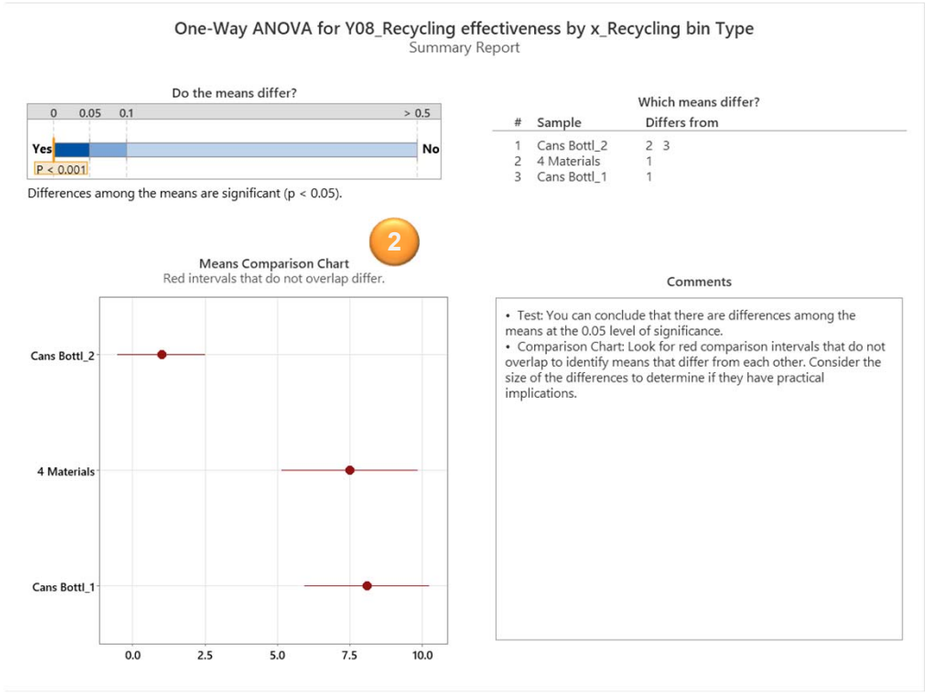
1. With a p-value < 0.001, the mean of Xmr02 differs significantly from the target of 4
2. With a confidence of 95% we could expect the true mean to lie between 2.1109 and 2.7039.

Interpretation and implication

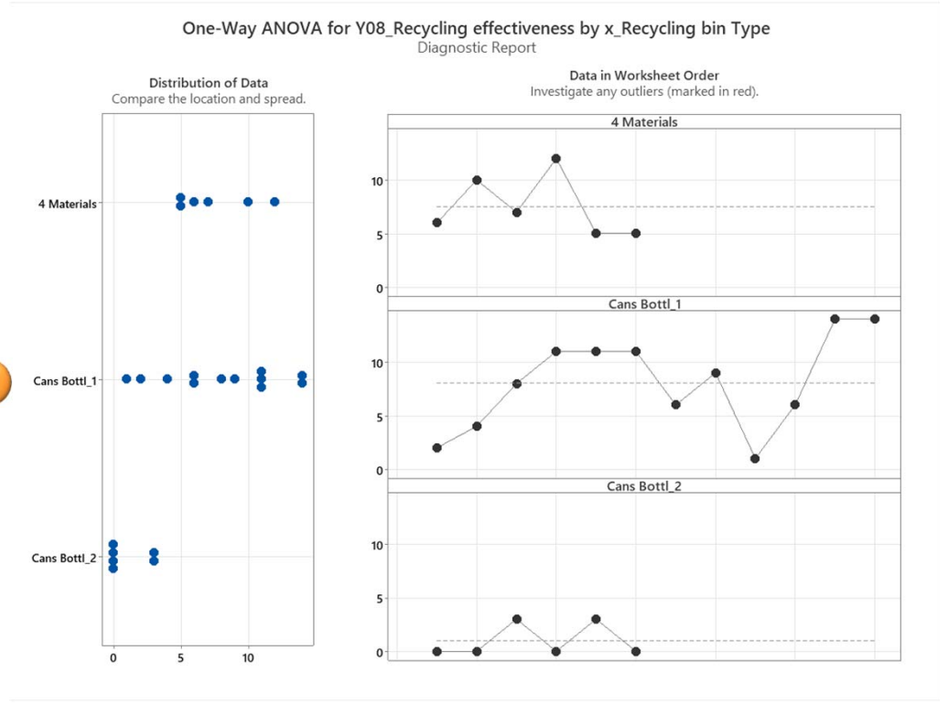
1. Based on the results, improving the level of knowledge about recycling is necessary in order to get closer to the target of 4.

Is there is a difference in **Y_08: Recycling effectiveness** between **Types of Recycling Bins?**

1



3



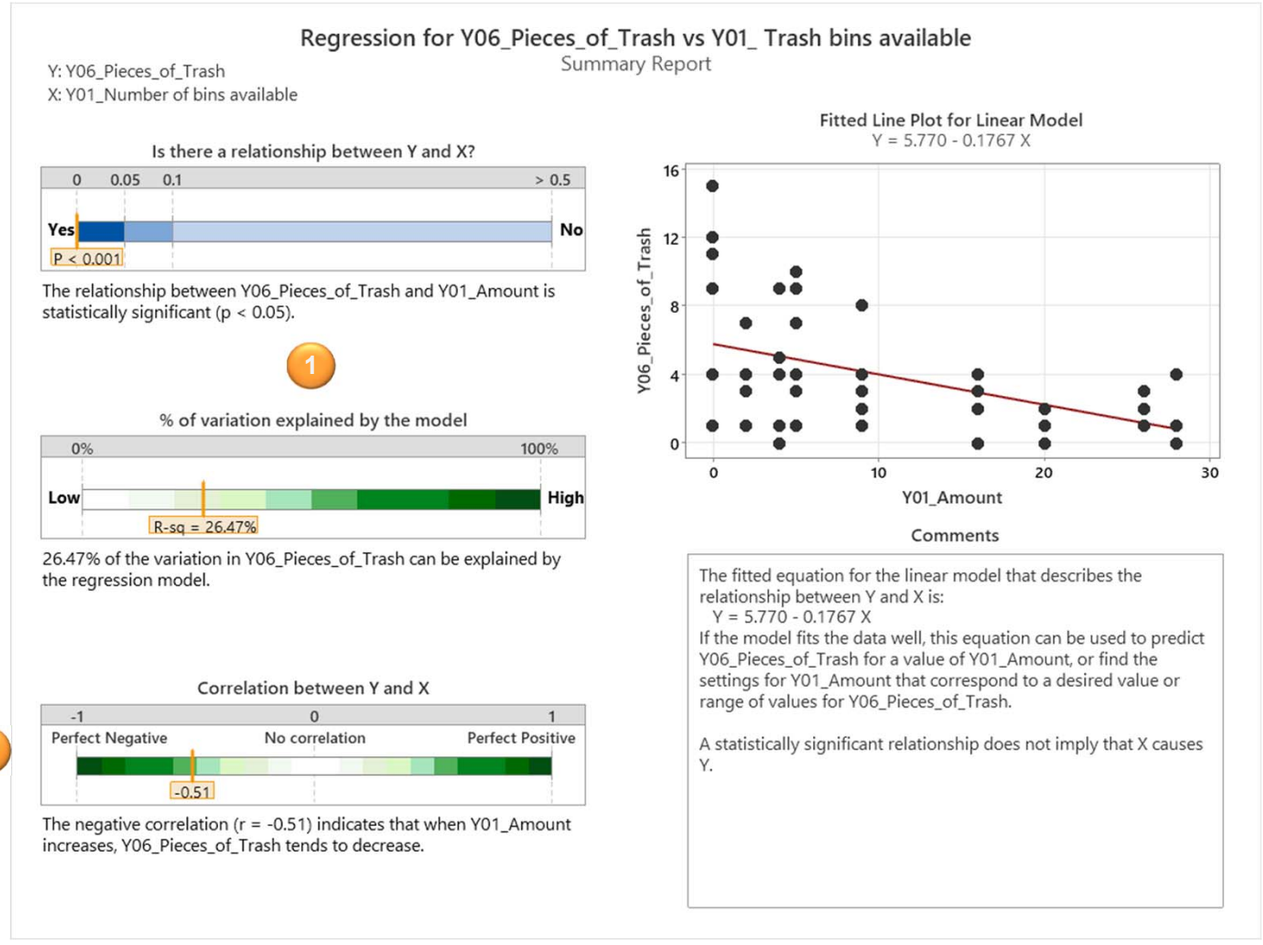
Important Results:

1. With a p-value <0.001 the differences between some of the means are statistically significant.
2. The mean for #1: type 2 bins (for cans and bottles) is significantly different from the other two.

Interpretation and implication

1. Based on the results and the spread of the data, type 2-like bins are more likely to increase recycling effectiveness.

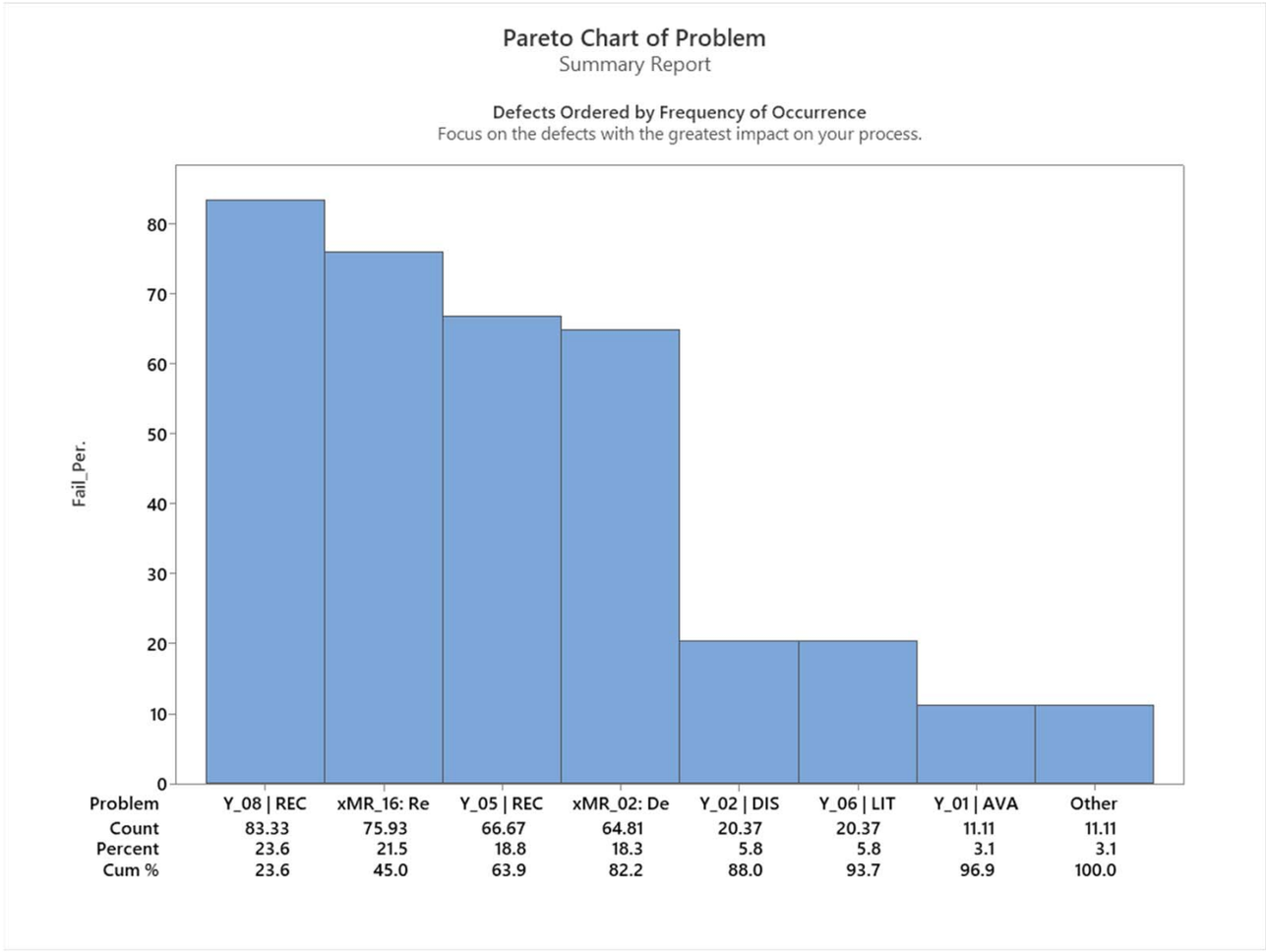
Is there is a relationship between **Y01 Number of trash bins available** and **Y06: Number of garbage pieces surrounding trash cans?**



Important Results:

1. With a p-value < 0.001, the relationship between Y01 and Y06 is statistically significant. For the purpose of this project, with a R-sq=26.47% it is considered practically relevant.
2. The negative correlation (r=-0.51) indicate the negative relationship: when the number of trash bisn increases, the number of garbage pieces surrounding trash cans tends to decrease.

Problem prioritization



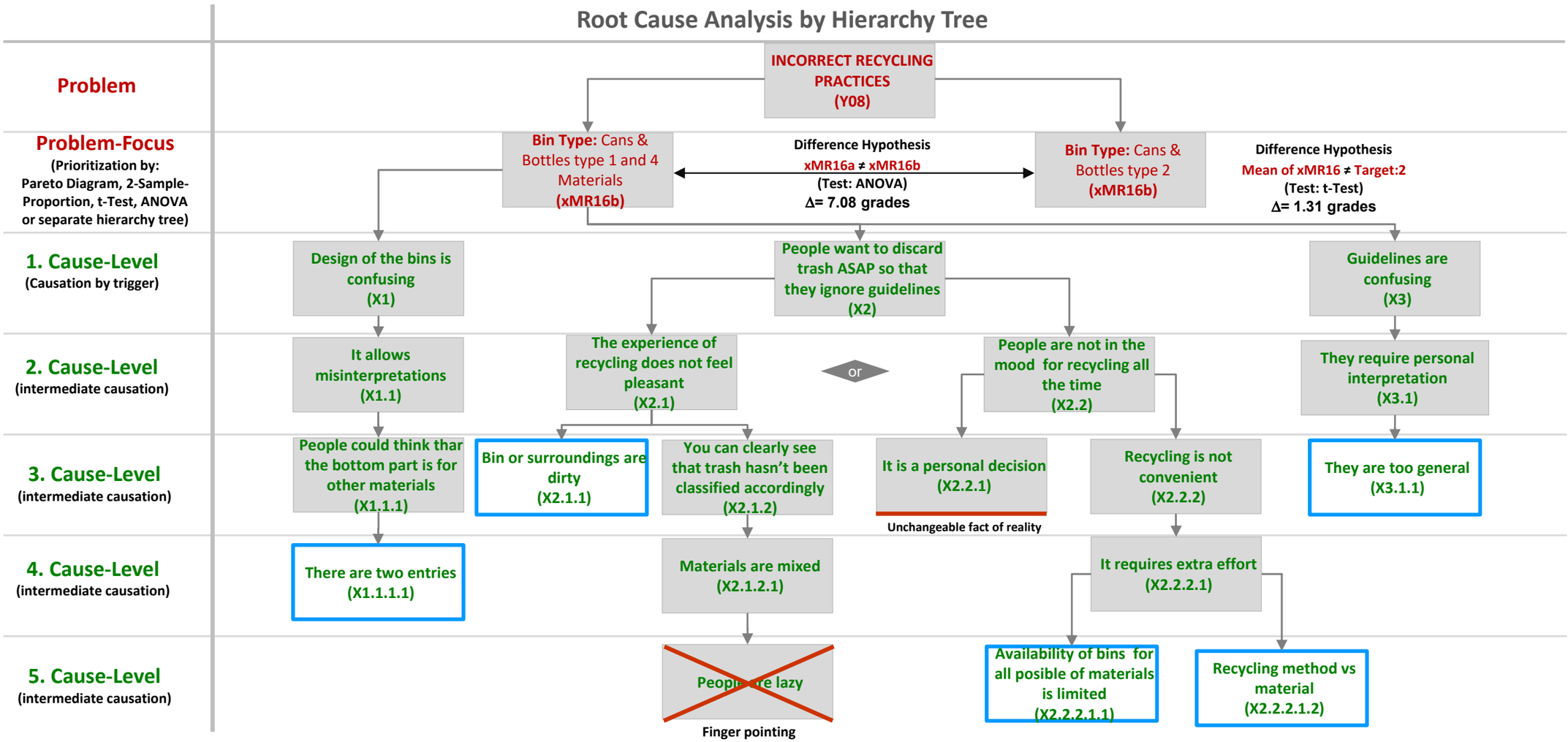
Results | The defects were prioritized according to their frequency; each problem was classified based on their categories and analyzed to find dependencies.

Ranking	Quality	Availability
1	Y_08 | Problem: TRASH-CAN (FULL) RECYCLING-PRACTICES INCORRECT	
2	xMR_16: Activity: Guarantee recycling | Influence on Quality: Recycling guidelines are confusing (1)	
3		Y_05 | Problem: DECISION 1: DISPOSAL REQUIREMENTS RECYCLING-BINS <60% (4)
4	xMR_02: Activity: Decide on how to discard trash: analyze materials, harmfulness, etc. | Influence on Quality: Wrong assessment: recycling instructions are confusing, tendency to litter; lack of knowledge (2)	
5	Y_02 | Problem: TRASH-CAN (FULL) DISPOSAL AREAS BAD	
6	Y_06 | Problem: GROUND (TRASH-FREE) LITTER >5 (3)	
7		Y_01 | Problem: DECISION 2: DISPOSAL OPTIONS AVAILABILITY <3 IN LOCATION (5)
8		Y_03 | Problem: DECISION 3: DISPOSAL LOCATION CAPACITY EXCEED (6)

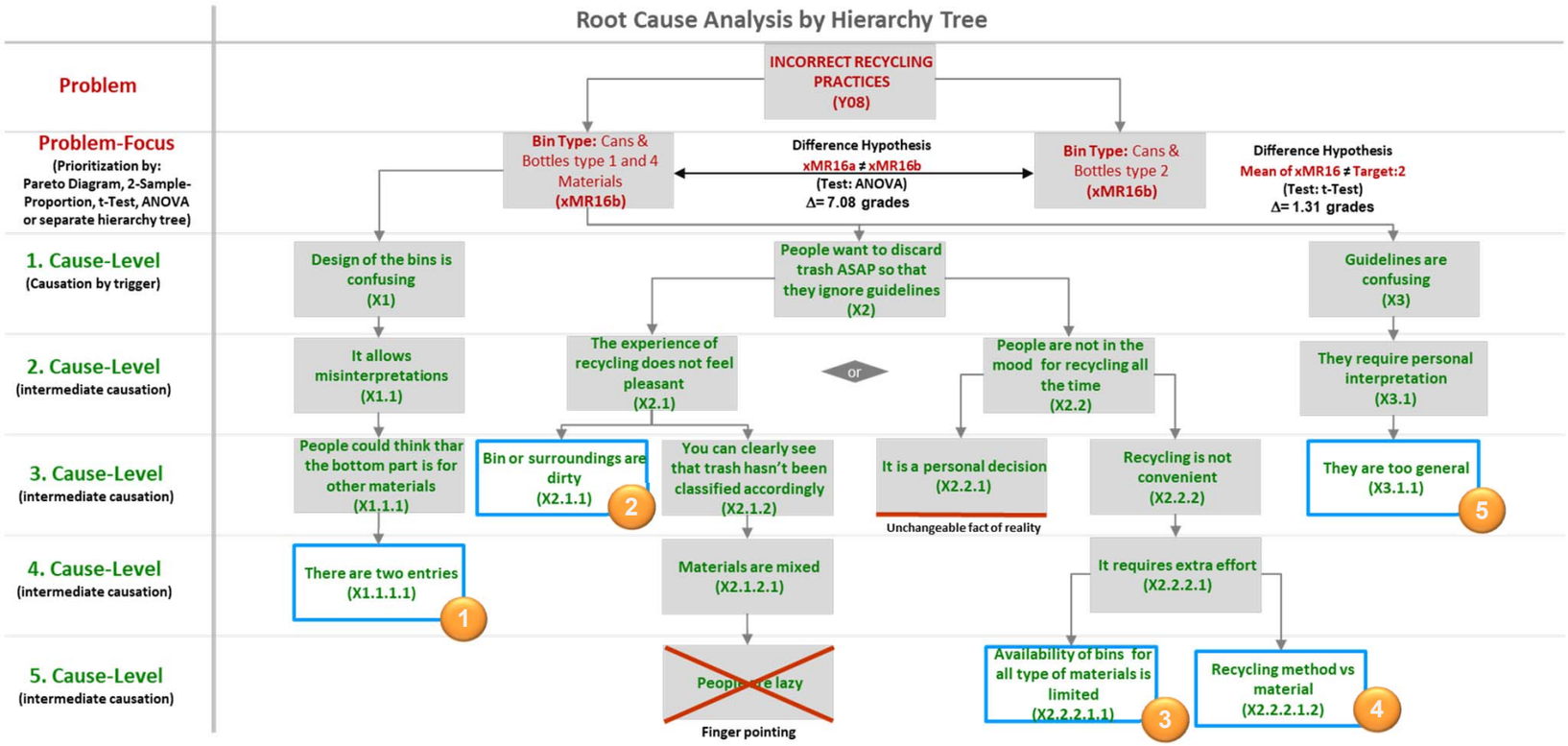
Interpretation and implication| Based on the results; the prioritized problems will be:

- Y_08 | Problem: TRASH-CAN (FULL) RECYCLING-PRACTICES INCORRECT
  - xMR_16: Recycling guidelines are confusing
  - xMR_02: Influence on Quality: Wrong assessment: tendency to litter; lack of knowledge
- Y_06 | Problem: GROUND (TRASH-FREE) LITTER >5

Analysis strategy: why are recycling practices incorrect?



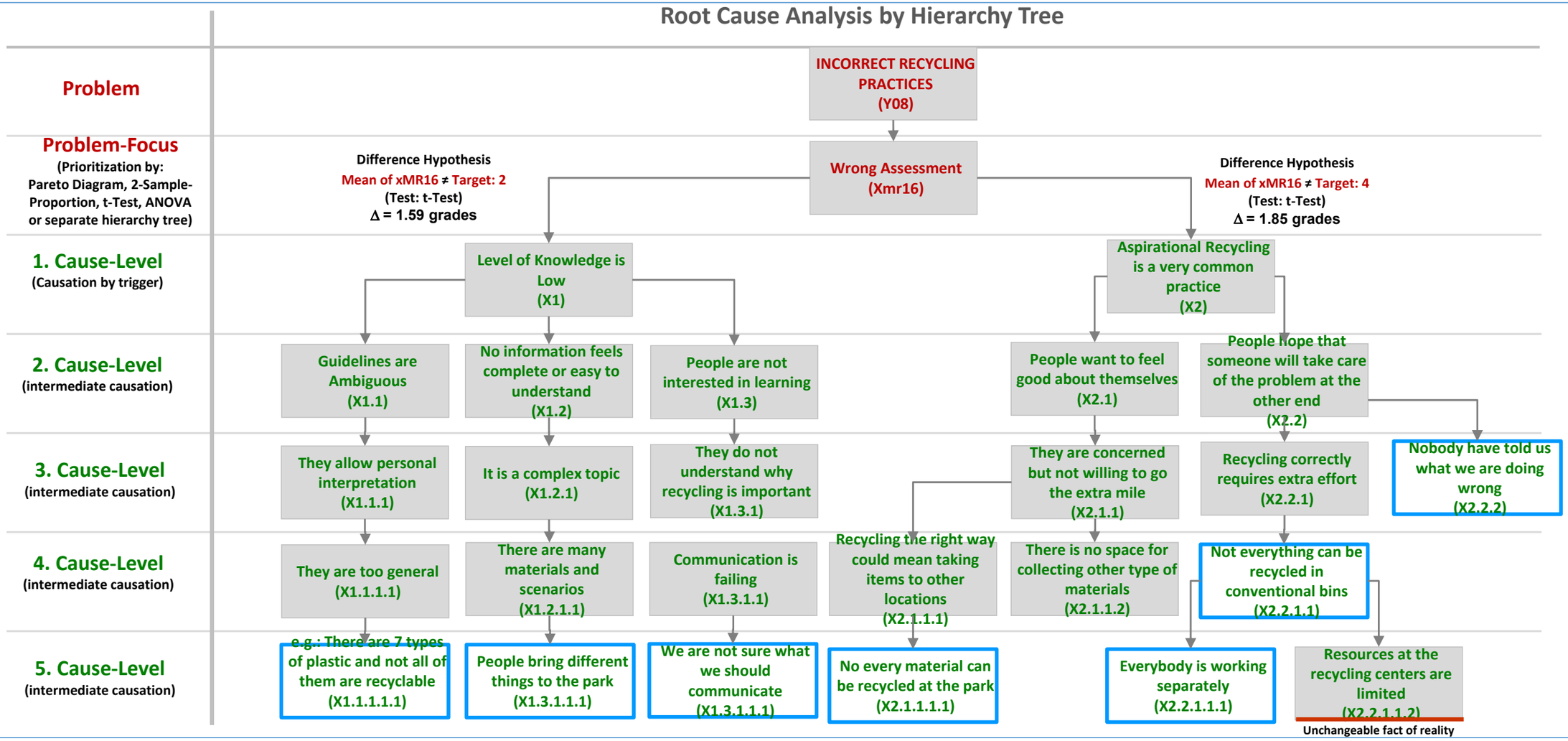
Analysis strategy: why are recycling practices incorrect?



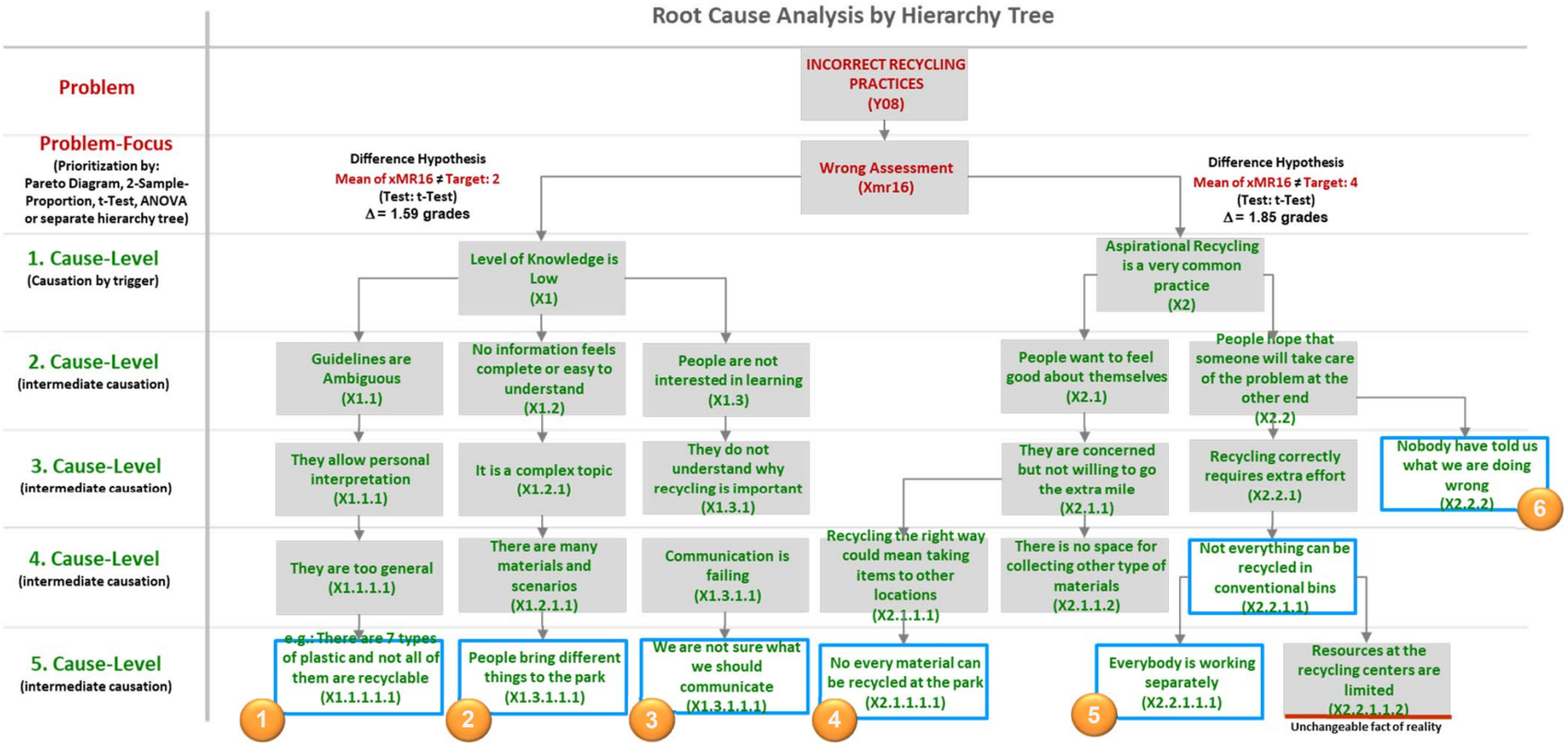
Results | Identified root causes

1. The fact that trash bin type 1 has two entries, and the recycling logo is just in one of them. People could think that the second entry is for not recyclables when is not.
2. Bins and surrounding that are dirty create a bad experience for the customer who could ignore guidelines in order to discard ASAP.
3. The park has just 3 types of bins, 2 for 4 types of materials and 12 for cans and bottles.
4. In order to recycle correctly, the type of material must be analyzed.
5. Guidelines at the park are found to be too general and limited to plastic, all type of paper, cans and bottles. The population of materials and are not limited to that.

Analysis strategy: How can we recycle the right way?



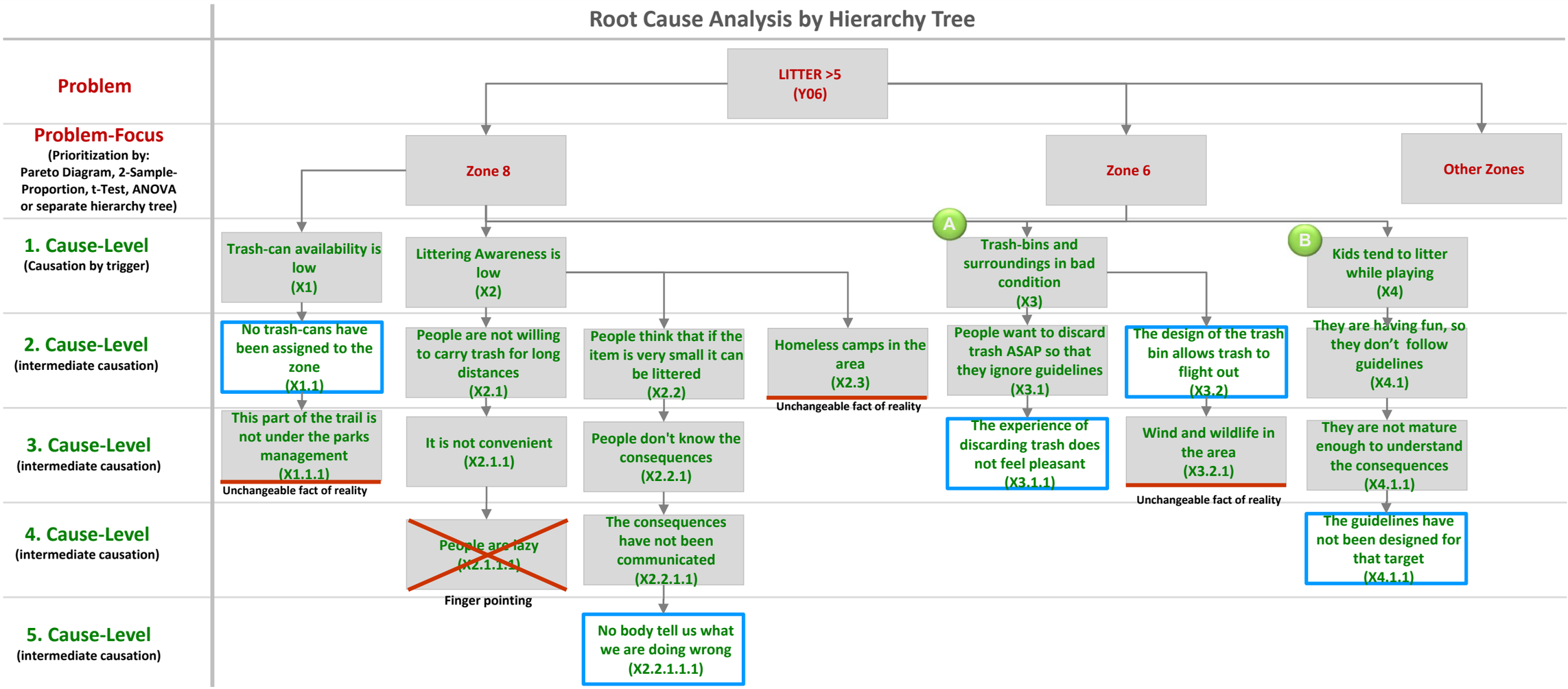
Analysis strategy: why are recycling practices incorrect?



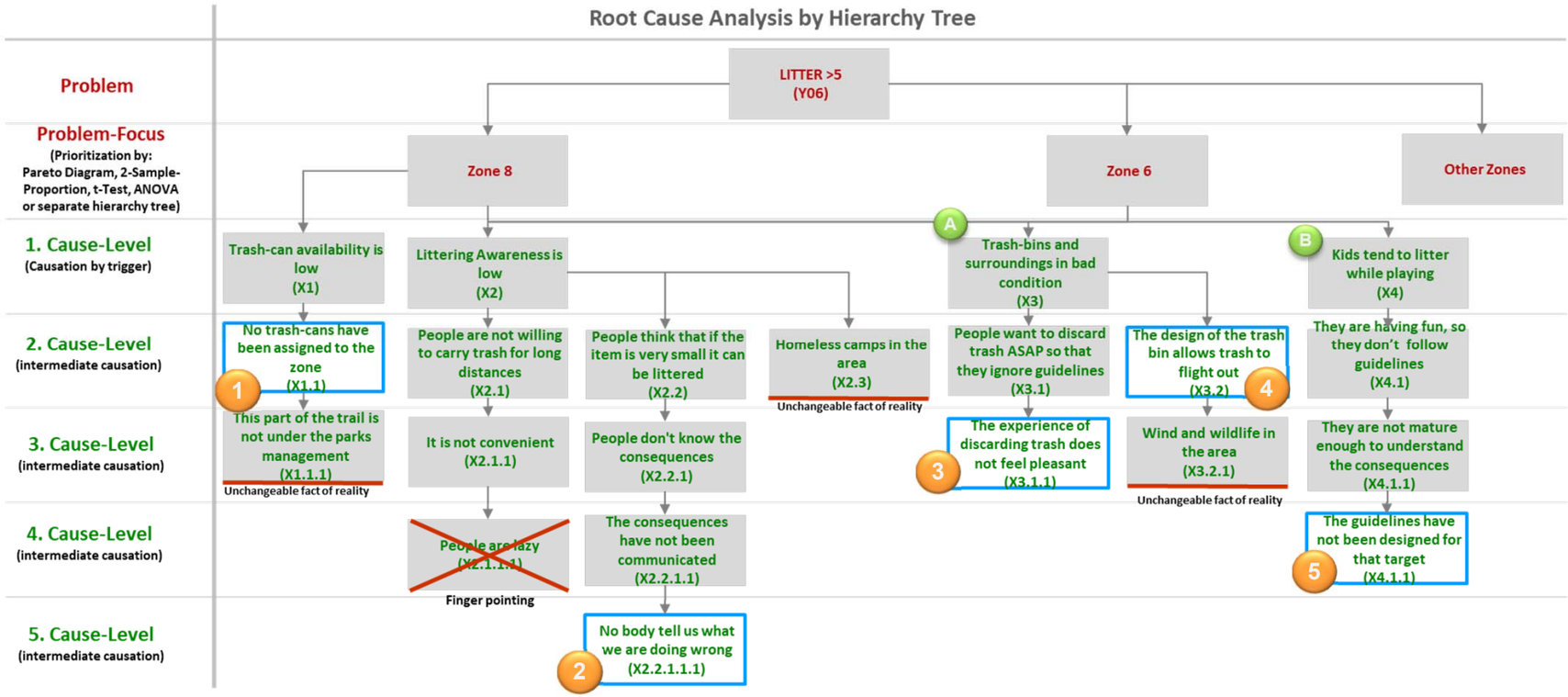
Results | Identified root causes:

1. We find a recycling bin and there is a compartment for plastic. Does it mean all types of plastic? Plastic that is dirty? We don't know.
2. Recycling is a complex topic, finding solutions could require us to identify the main items people bring to the park.
3. Communication is key to increase recycling effectiveness, but we don't really know if what we are communicating is really creating and impact.
4. We must realize that not every material will be able to be recycled at the park.
5. Locally we have seen many initiatives to increase recycling effectiveness, However, there is not synergy between them.
6. There in not feedback in terms of recycling effectiveness.

Analysis strategy: why do we litter?



Analysis strategy: why are recycling practices incorrect?



A **Relationship Hypothesis**
Y=f(x)
Test: Correlation / Regression
R-sq: 43.19%

B **Difference Hypothesis**
Process ≠ Target
Test: Chi-Square Goodness-of-Fit
Differ: Higher from the target

Results | Identified root causes
Base of the results show by the previews analysis, zone 6 and 8 will be prioritized.

1. There are no trash bins in zone 8.
2. We think that feedback related to littering is key.
3. If the environment that surrounds trash cans is not pleasant, it could make people to litter in order to avoid the physical contact or proximity with it.
4. The bins at Almaden lake park do not have any type of lid on top in order to prevent the trash to flight out of it due to windy conditions or wild animals witch present is very common in the area.
5. Current guidelines are not design for kids to understand.

Results of the ANALYSE-Steering

Analyse-Steering				
Tool	**Application**	**Documentation**	**Comment**	**Decision**
Graphical Analysis	ok	ok		**Master-Black-Belt**
Process-Capability	ok	ok		Dr. Reiner Hutwelker reiner.hutwelker@tum.de
Control-Charts	ok	ok		29-Aug-2022
Statistical Tests of Hypotheses	ok	ok		**passed**
Root-Cause-Analysis	ok	ok		**Sponsor**
				name/ email
				1-Jan-2021
Additonal Notes			Wonderful, Excellent! Dear Julietta, you take the most out of your project. I appreciate your work so much, as you not only apply and document all tools correctly, but you clearly go beyond with your own ideas. – Please continue this way. You are already on my list for next year Sustainability Green Belt Award – even without having a sponsor. Reiner	**passed/ failed**

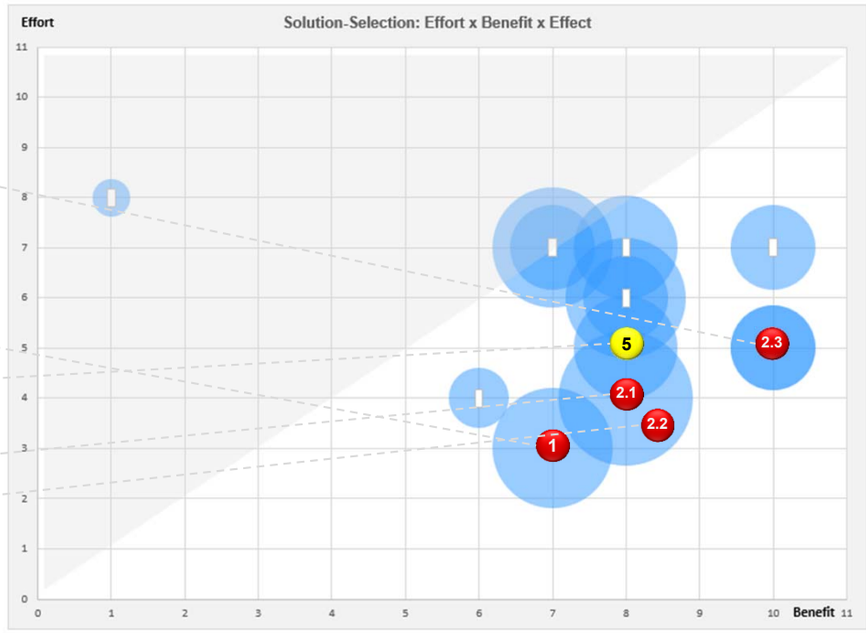
Only proceed to the next phase after a positive decision of MBB and Sponsor

IMPROVE

Development and selection of Solutions, Measures and risk prevention, Implementation

Lets think about possible solutions for the identified root causes…

Rank	Kano-Category	Costs of the Problem / Year:	Problem	Root-Causes	Cause determines the Problem to:	Sum of Determination	Solutions	Benefit	Effort	Rank (Effort/ Benefit)	Reduction of Problem-Costs
2	Must-Be	11.50 €	Y_06 | Problem: GROUND (TRASH-FREE) LITTER >5	X1.1 No trash-cans have been assigned to the zone	15%	82%	Contact city of San Jose, present situation and suggest instaling trash bins. Install trash bins in location.	8	7	10	1.725 $
				X2.2.1.1.1 No body tell us what we are doing wrong	25%		Collect info from City of San Jose, Almaden Lake Park, Recycling	8	4	2~	2.875 $
				X3.1.1 The experience of discarding trash does not feel pleasant	20%		Enhance trash bins	7	7	11	2.3 $
				X3.2 The design of the trash bin allows trash to flight out	2%		Contact city of San Jose, present situation	1	8	13	0.23 $
				X4.1.1 The guidelines have not been designed for that target	20%		Design a marketing campain which target is children.	8	6	8	2.3 $
3	More/Less-Is-Better	11.50 €	Y_08 | Problem: TRASH-CAN (FULL) RECYCLING-PRACTICES INCORRECT	X1.1.1.1 Design of the trash bin type 1: There are two entries	20%	90%	Reinforce guidelines - Present situation to city of San Jose.	7	3	1	2.3 $
				X2.1.1 Bin or surroundings are dirty	15%		Create an Event: invite friends to clean the park - Find support with	8	5	5	1.725 $
				X2.2.2.1.1 Availability of bins for all posible of materials is limited	5%		Analize current availability, present report to the city of san jose.	6	4	6	0.575 $
				X3.1.1 Gudelines are too general X2.2.2.1.2 Recycling requires analyzing method vs material	10%		Reinforce guidelines.	10	5	2	1.15 $
				X1.3.1.1.1 People bring different things to the park	10%		Analyze type of objects people bring to the park, classified and find solutions by most frecuent.	10	5	2 –	1.15 $
				X1.3.1.1.1 We are not sure what we should communicate	10%		Design campain people friendly.	7	7	11	1.15 $
				X2.1.1.1.1 No every material can be recycled at the park X2.2.1.1.1 Everybody is working separately	10%		Present alternatives for other materials - sinergy with other institutions	8	6	8	1.15 $
				X2.2.2 Nobody have told us what we are doing wrong	10%		Collect info from City of San Jose, Almaden Lake Park, Recycling services and community. Include results in local news	10	7	7	1.15 $



Results:

We have evaluated the relative benefits and efforts of the different solutions. The resulting ranking allows us to select appropiate solutions.

Interpretation and implication

Based on the results, five solutions were selected:

1. Reinforce guidelines on bins type 1 - Present situation to city of San Jose.
2. Reinforce recycling guidelines.
3. Analyze type of objects people bring to the park, classified and find solutions by most frequent.
4. What are we doing wrong? Collect info from City of San Jose, Almaden Lake Park, Recycling services and community.
5. Create an Event: invite friends to clean the park - Find support with the city of San Jose

This is our Action-plan:

Rank (Effort/ Benefit)	Reduction of Problem-Costs	Solutions	Measure-No.	Measure (What has to be done?)	Result (What will be achieved?)	Risk-Reduction-Measure (from FMEA)	Costs of Implementation	Cost center	Deadline	Responsibility	Decision on implementation	Implementation-Status in %
2	2.875 $	Collect info from City of San Jose, Almaden Lake Park, Recycling services and community.	4	1. Research. DONE 2. Contact city of San Jose, recycling centers and landfild services. DONE 3. Ask the community. DONE 4. Create newsletter and present to the city of San Jose. 5. Publish in Nextdoor media.	Understanding what we are doing wrong in terms of recycling.	**Assure good digital marketing techniques**	20.00 €	1	Oct 31 2022	Julieta D	yes	30%
1	2.3 $	Reinforce guidelines - Present situation to city of San Jose.	1	1. Design sign. DONE 2. Present idea to City of san Jose. Ask them to authorize to install signs in zone 6. DONE 3. Place sign in trash cans located in Zone 6	Reduce or eliminate the number of items wrongly disposed.	**Teach people**	50.00 €	2	Oct 31 2022	Julieta D City of San Jose	partially	70%
5	1.725 $	Create an Event: invite friends to clean the park - Find support with the city of San Jose	5	1. Contact city of san Jose and ask to sponsor the activity: DONE 2. Invite friends and communnity: DONE 3. Clean the park, zone 6. DONE 4. Documment activity in social Media. DONE	Zone 6 will be clean, free of trash; Community involvement.	**Find more volunteers**	20.00 €	3	Sep 23 2022	Julieta D	yes	100%
2	1.15 $	Reinforce guidelines.	3	1. Research for the top-10-ranking of items people bring to the park: - Good Recycling Practices; - City of San Jose Recycling requirements. DONE 2. Reinforce current guidelines. DONE 3. Present idea to City of san Jose. Ask them to authorize to install signs in zone 6. 4. Install signs at zone 6.	Guidelines will be less general and adjusted to the park needs.	**Assure good graphic design techniques**	40.00 €	4	Oct 31 2022	Julieta D City of San Jose	partially	50%
2	1.15 $	Analyze type of objects people bring to the park, classified and find solutions by most frequent.	2	1. Based on observations and research, list commun items people bring to the park. DONE 2. Create ranking 1 to 10. DONE 3. Contrast previews list with current solutions to dispose.	Knowledge about type of waste generated at the park and requirements for its management.	**Create research plan**	20.00 €	5	Oct 15 2022	Julieta D	partially	60%

Results:

It was certainly a very helpful tool to use!

For each solution, tasks were defined and organized in chronological order. The tool guide us in orden to establish: the expected result, responsabilities and dedlines, etc.

Interpretation and implication

Tasks were defined so, we started working on them. Here you can see our implementation status up to date.

FMEA: Risks and countermeasures to reduce them

FMEA (Failure Mode and Effects Analysis)		Risk-Analysis								Improvement	new Risk-Analysis			
Measure-No.	Measure (What has to be done?)	potential Failures/ Problems	actual controls to detect the Failures/ Problems	Detection of the Problem	potential Effects of the Failures/ Problems	Severity of the Effect	potential Causes of the Failure/ Problem	Probability of Cause	RPN	Countermeasures (integrated in Action-Plan)	Severity of the Effect	Probability of Cause	Detection of the Problem	RPN
		Which Failures/ Problems can result from the Measures?	By which existing Controls can the Failure/ Problem be detected, before it occurs?	Rating: 1= each time - 10= never	Which Effect results from the Failure/ Problem?	Rating: 1= minimal - 10= disastrous	Which Influence triggers the Failure/ Problem?	Rating: 1= never - 10= always	Risk-Priority-Number	How could the trigger of the Failure/ Problem, i.e. their Root-Causes be eliminated?	Rating: 1= minimal - 10= disastrous	Rating: 1= never - 10= always	Rating: 1= each time - 10= never	Risk-Priority-Number
4	1. Research. DONE 2. Contact city of San Jose, recycling centers and landfild services. DONE 3. Ask the community. DONE 4. Create newsletter and present to the city of San Jose. 5. Publish in Nextdoor media.	The community is still not interested.	Social media reports	10	Lack of improvement	5	Publication content is not interesting	5	250	Assure good digital marketing techniques	5	1	10	50
1	1. Design sign. DONE 2. Present idea to City of san Jose. Ask them to authorize to install signs in zone 6. DONE 3. Place sign in trash cans located in Zone 6	People ignore the new sign	Content of the recycling bin at the end of the day	4	Incorrect recycling practices	8	The sign is small, it is not noticeable enough	4	128	Teach people	8	1	1	8
5	1. Contact city of san Jose and ask to sponsor the activity: DONE 2. Invite friends and communnity: DONE 3. Clean the park, zone 6. DONE 4. Documment activity in social Media. DONE	Zone 6 is not completely clean	Final inspection	8	The cleaning up activity does not have a real impact.	7	The number of volunteers is not enough	5	280	Find more volunteers	7	1	4	28
3	1. Research for the top-10-ranking of items people bring to the park: - Good Recycling Practices; - City of San Jose Recycling requirements. DONE 2. Reinforce current guidelines. DONE 3. Present idea to City of san Jose. Ask them to authorize to install signs in zone 6. 4. Install signs at zone 6.	Lack of response by the city.	City involment, feedback	7	Lack of improvement	5	Publication content, is not interesting	3	105	Assure good graphic design techniques	5	3	6	90
2	1. Based on observations and research, list commun items people bring to the park. DONE 2. Create ranking 1 to 10. DONE 3. Contrast previews list with current solutions to dispose.	Lack of research	None	10	Lack of improvement	9	Number of hours assign for research are not enough	3	270	Create research plan	9	1	3	27

Results:

- We followed the FMEA methodology in order to qualitative analyze and quantitative evaluate the ploblem, its causes and effects.
- As result risk priority numbers RPN were determined.

Interpretation and implication:

- Countermeasures were necesary for the 5 solutions since RPN >100.
- After conducting a second risk analysis, the new RPN < 100 which lead us to finish the analysis.

Our Journal


From: MyImpactPage.com
Sent: Wednesday, September 14, 2022 3:10 PM
To: Julieta Duarte
Subject: Anti-Graffiti & Anti-Litter - Welcome Message

Hello Volunteer,
Thank you for your interest in our services and signing up for additional information to become a volunteer. BeautifySJ recruits' new volunteers to assist with litter clean ups. We can provide possible clean up locations or you can adopt your own neighborhood.
BeautifySJ is proud to provide a litter cleanup kit to individuals who would like to clean up litter in San José. Whether you are with a club, family members and friends, church members, coworkers or even gym buddies, we want to partner with you to help keep our community clean, green, and environmentally aware!
Included in the Kit:
Gloves
Grabber
Garbage Bags
Garbage Stickers
If you are ready to volunteer with BeautifySJ, please schedule an appointment by calling our office at 408-975-7181 or emailing annie.gambelin@sanjoseca.gov
Preventing and removing litter through community involvement, eradication, and enforcement.

Looking forward to working with you,

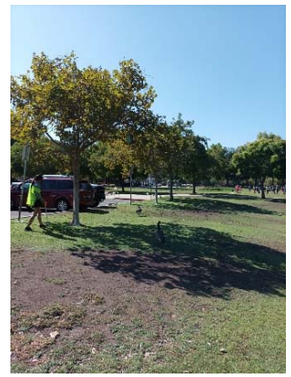
Annie Gambelin, *BeautifySJ*
City of San José | Parks, Recreation and Neighborhood Services Department
1601 Foxworthy Avenue, San Jose, CA 95118
Tel: 408.975.7181 | Fax: 408.298.7020

The city of San Jose sponsor our litter clean ups, through their program BeautifySJ

We received kits for our volunteers that include:

- Gloves
- Grabber
- Garbage Bags
- Garbage Stickers
- Vests

The clean ups are posted in Next-door, our community App



For this type of bin, we suggested to the Park including the following instruction:
In this bin RECYCLE bottles **ONLY*** . Also, and ⇩ arrow that shows people that the two containers are connected.

Results of the IMPROVE-Steering

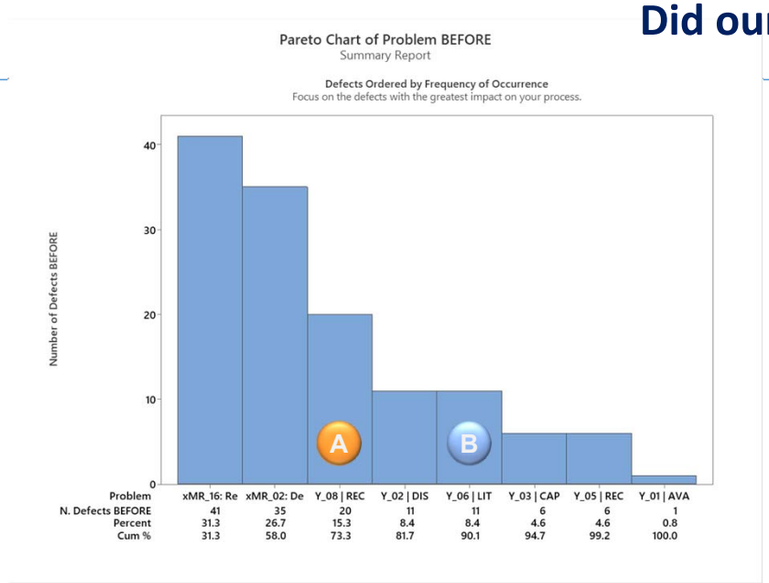
Improve-Steering				
Tool	**Application**	**Documentation**	**Comment**	**Decision**
Solution-Ideas	ok	ok		**Master-Black-Belt**
DoE (optional)	ok	ok		Dr. Reiner Hutwelker reiner.hutwelker@tum.de
Action-List	ok	ok		3-Nov--2022
FMEA	ok	ok		**passed**
				Sponsor
				name/ email
				1-Jan-2021
Additonal Notes			Dear Julia, I again very appreciate what you are doing and how you did this. Wonderful story-book. Looking for your results in CONTROL - Reiner	**passed/ failed**

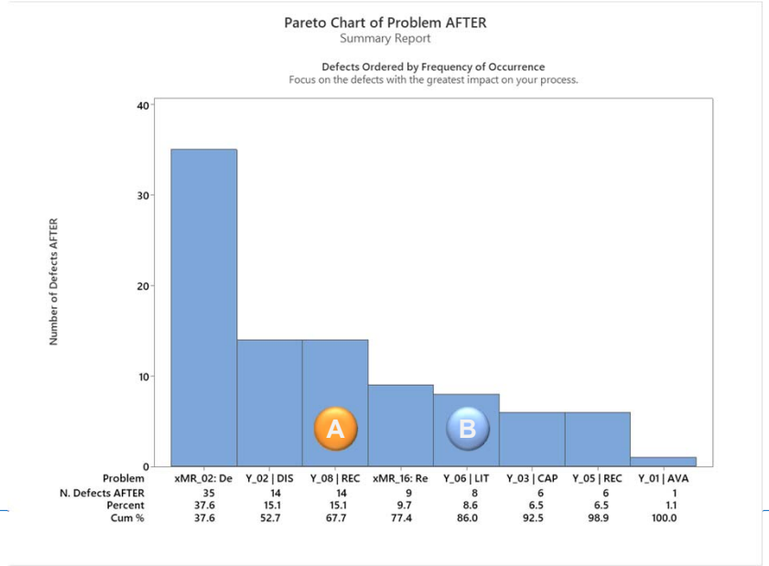
Only proceed to the next phase after a positive decision of MBB and Sponsor

CONTROL

Data-Evaluation, Process-Performance, Improvements & Benefits, Process-Management-Plan & Finalization

Did our Measurements impact the new sample?





Results

The overall number of defects were reduced by 29% (131 to 93).

In terms of the specific problems Y06 y Y08 the following reductions in the number of defects were identified:

A Y08 | Problem: TRASH-CAN (FULL) RECYCLING-PRACTICES INCORRECT: 10%

B Y_06 | Problem: GROUND (TRASH-FREE) LITTER >5: 28%

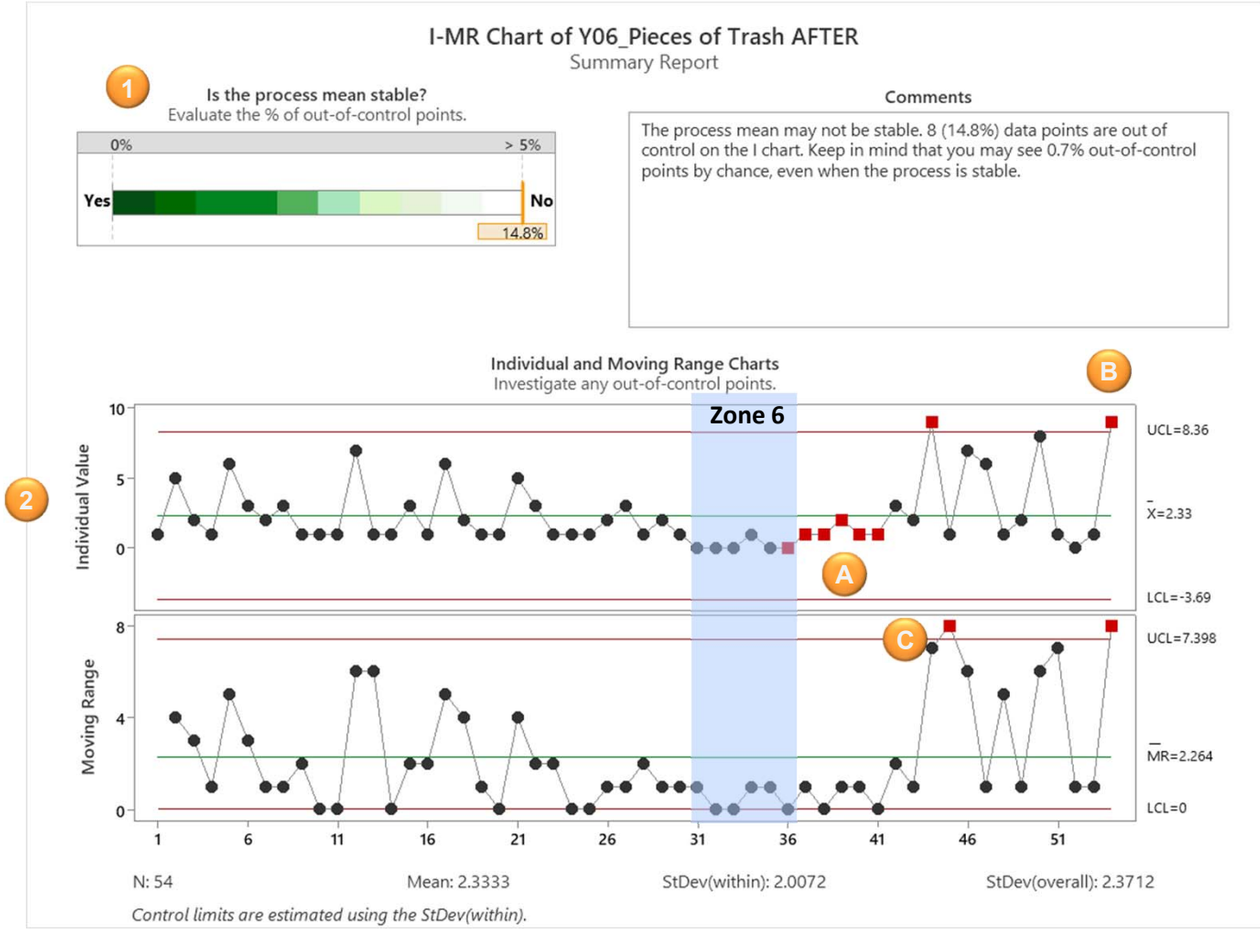
1 Before the improvement, the number of items incorrectly disposed in the recycling bin scattered from 0 to 14.

2 After the measurements were implemented, the values range from 0 to 8.

Interpretation and implication

Our measurements did have positive impact on the new sample indeed!

Control Chart: Y06 Pieces of trash – NEW DATA

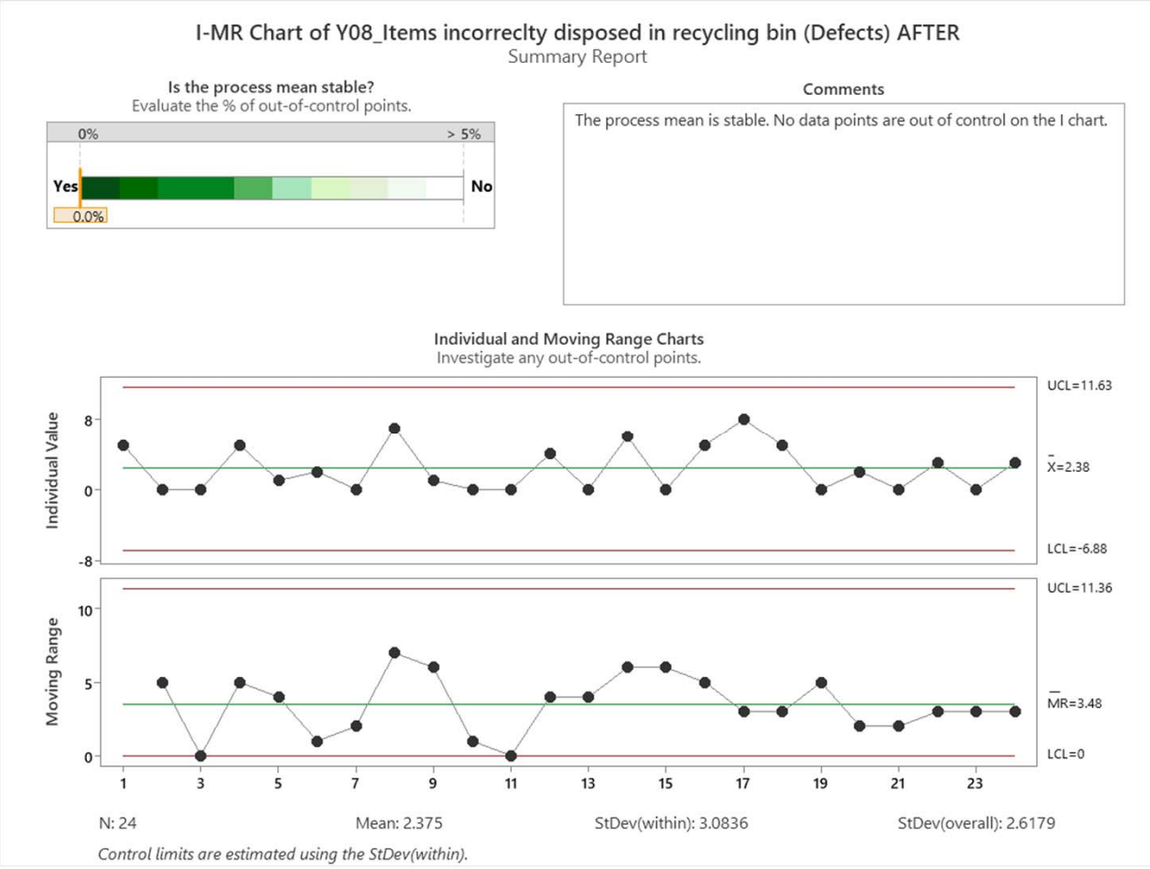


Important Results:

1. The proces mean is not stable.
2. The **Individual values** chart shows 8 outliers (red points):
   A. Shift in the mean from the 36th to the 41st value. this event correspond to the change in zone from 6 (Zone where our process improved continuosly) to 7.
   B. Data points outside control limits.

3. The **Moving Range** chart shows 2 points outside control limits.

Control Chart: Y08 Items incorrectly disposed in recycling bin – NEW DATA

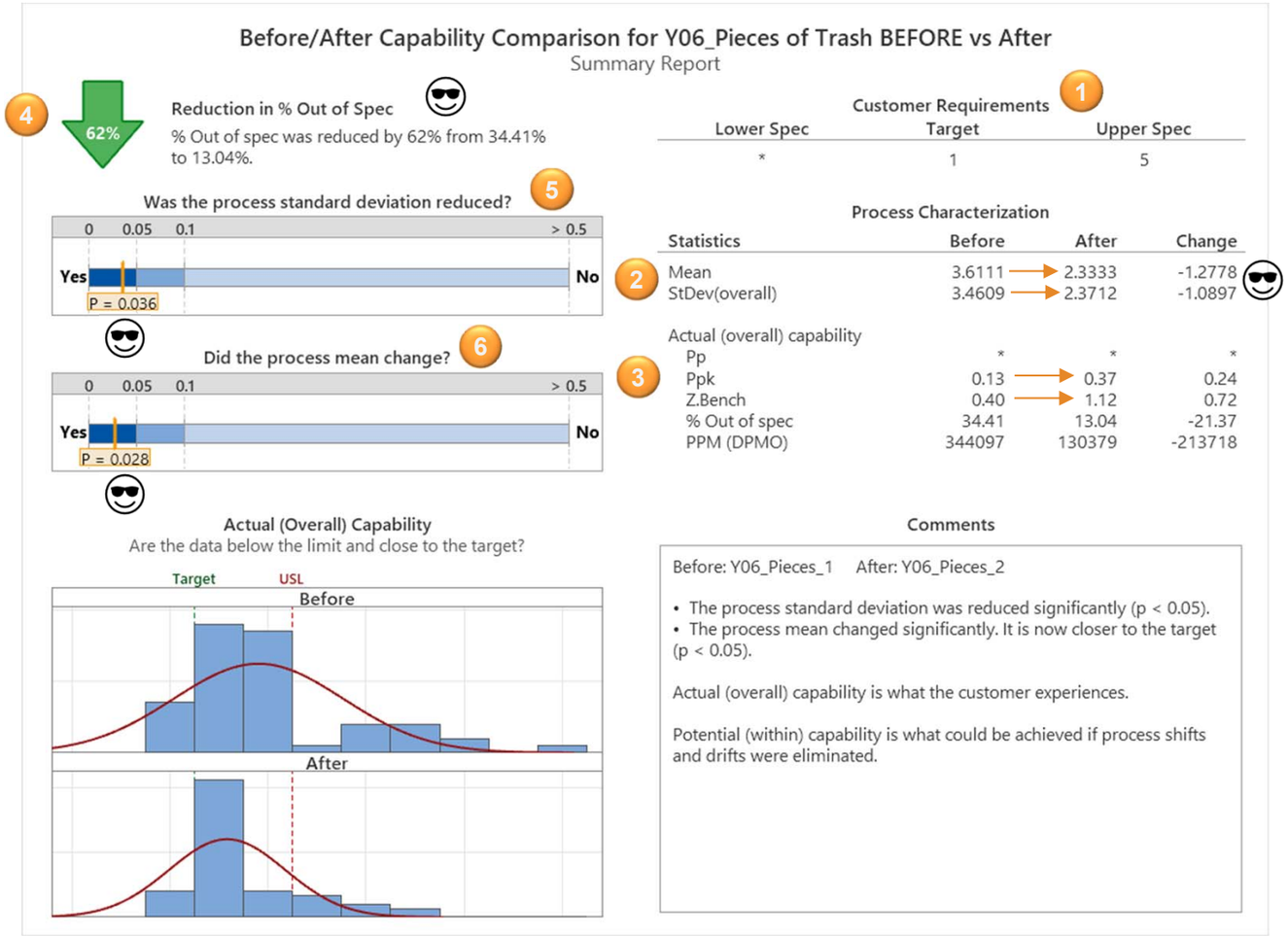


Important Results:

1. The proces mean is stable.
2. The **Individual values** chart shows no outliers.
3. The **Moving Range** chart shows no points outside control limits.

yessss!

Are we capable of maintaining Almaden lake Park litter free? Are we improving?



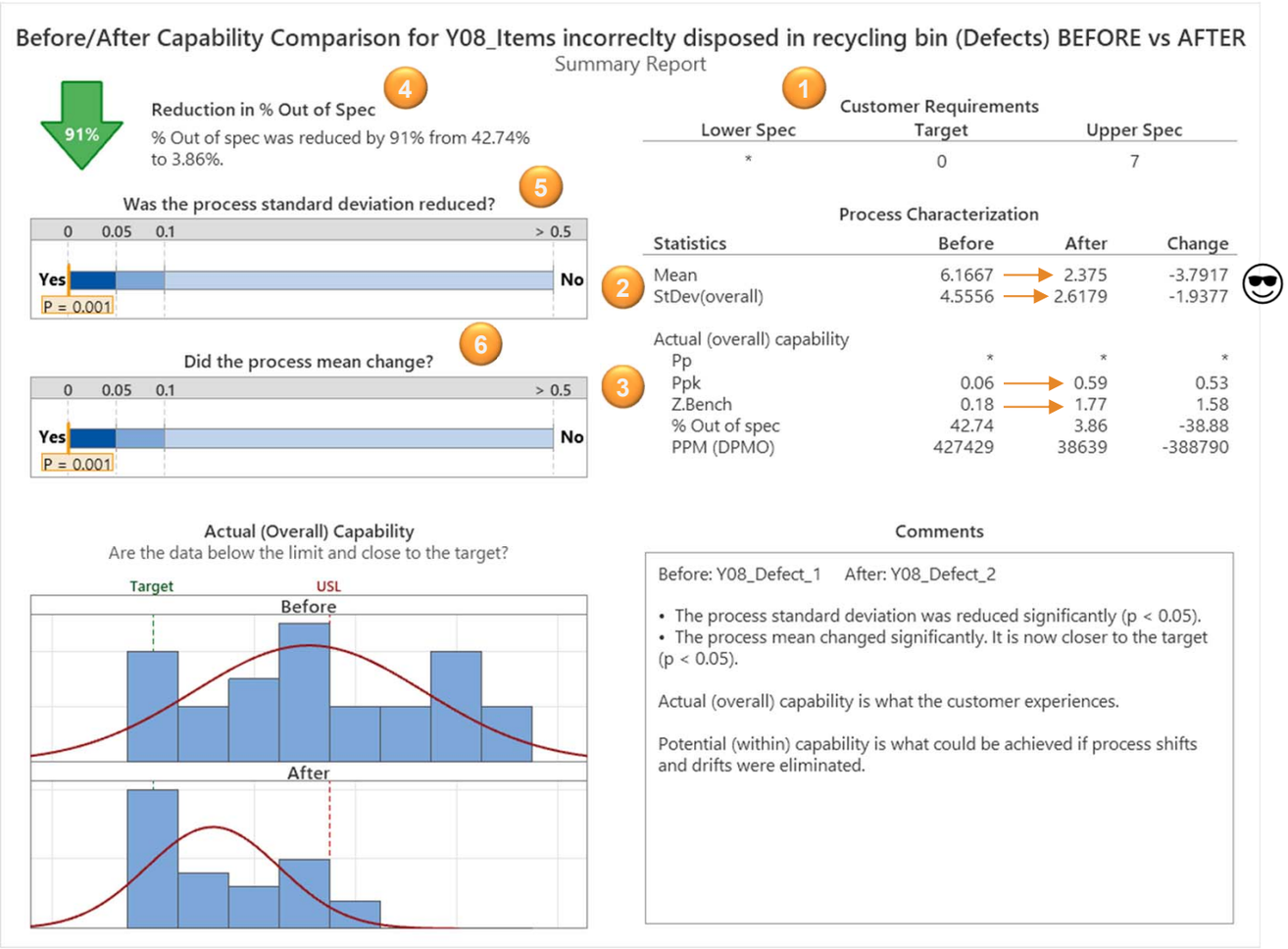
Results:

1. The customer requirements are defined as specification limits on the number of pieces of trash within a radius of 5 meters around a trash-can.
2. Statistical parameters were improved.
3. Capability indices were improved.
4. 62% reduction in % Out of Spec.
5. The process standard deviation was reduced significantly ($p<0.05$)
6. The process mean changed significantly ($p<0.05$).

Interpretation and implication

Even though the process capability improved by 0.72 sigma, it is still very low. The Z-Value indicate an actual sigma level of 1.12.

How effective are our recycling practices? Are we improving?



Results:

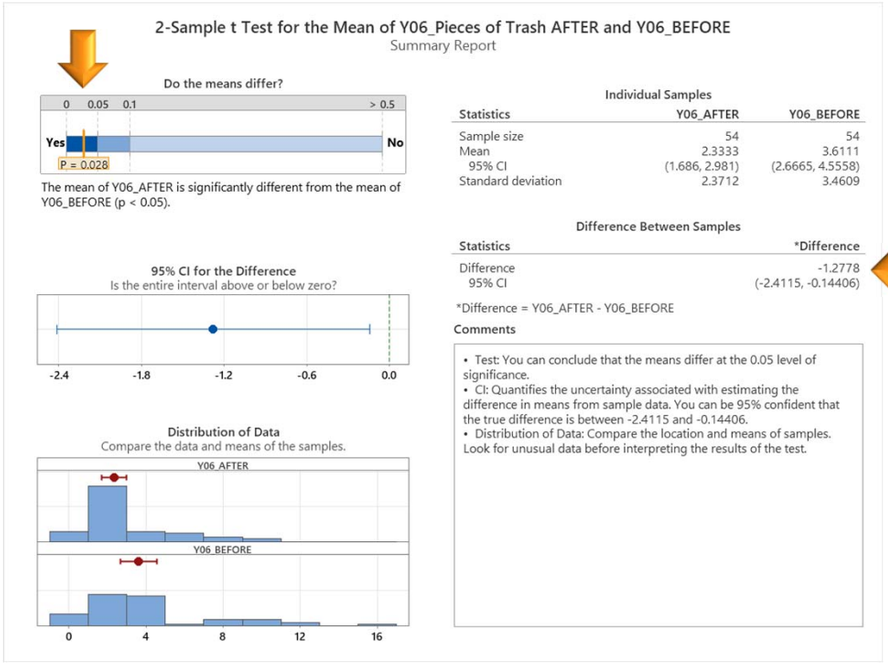
1. The customer requirements are defined as specification limits on the number of items incorrectly disposed in recycling bin.
2. Statistical parameters were improved.
3. Capability indices were improved.
4. 91% reduction in % Out of Spec.
5. The process standard deviation was reduced significantly (p<0.001)
6. The process mean changed significantly (p<0.001).

Interpretation and implication

Even though the process capability improved by 1.58 sigma, it is still relatively low. The Z-Value indicate an actual sigma level of 1.77.

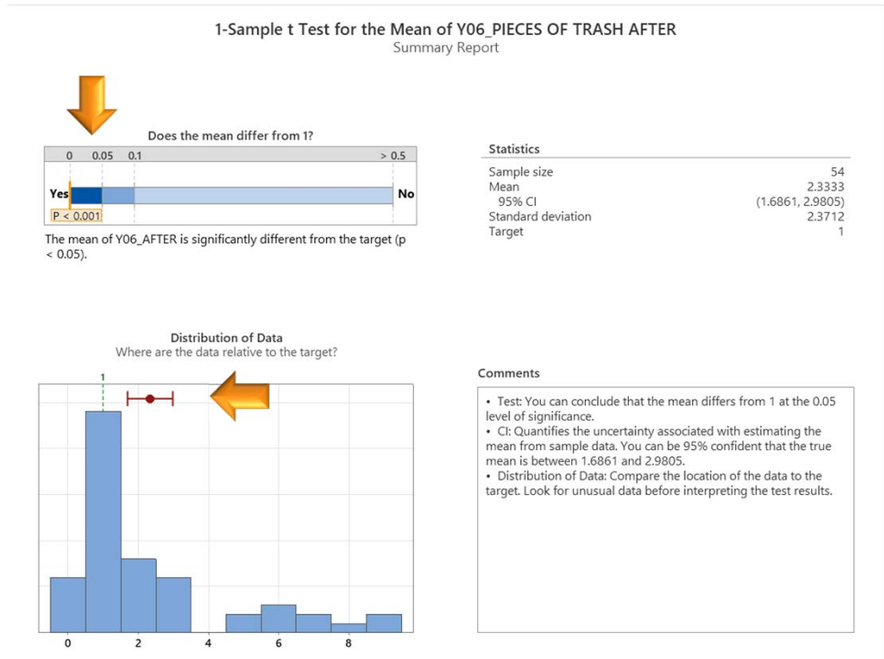
Did we reduce the number of pieces littered Y06? How well the target was achieved?

Is there a/no difference in Y06 Pieces of Trash between the states of x_before vs. x_after.



The number of pieces of trash littered in Almaden lake park was reduced by 1.2 grades and this result is statistically significant, our improvement is statistically confirmed!

Is there a/no difference in the amount (Y) between the number of pieces found and the target?



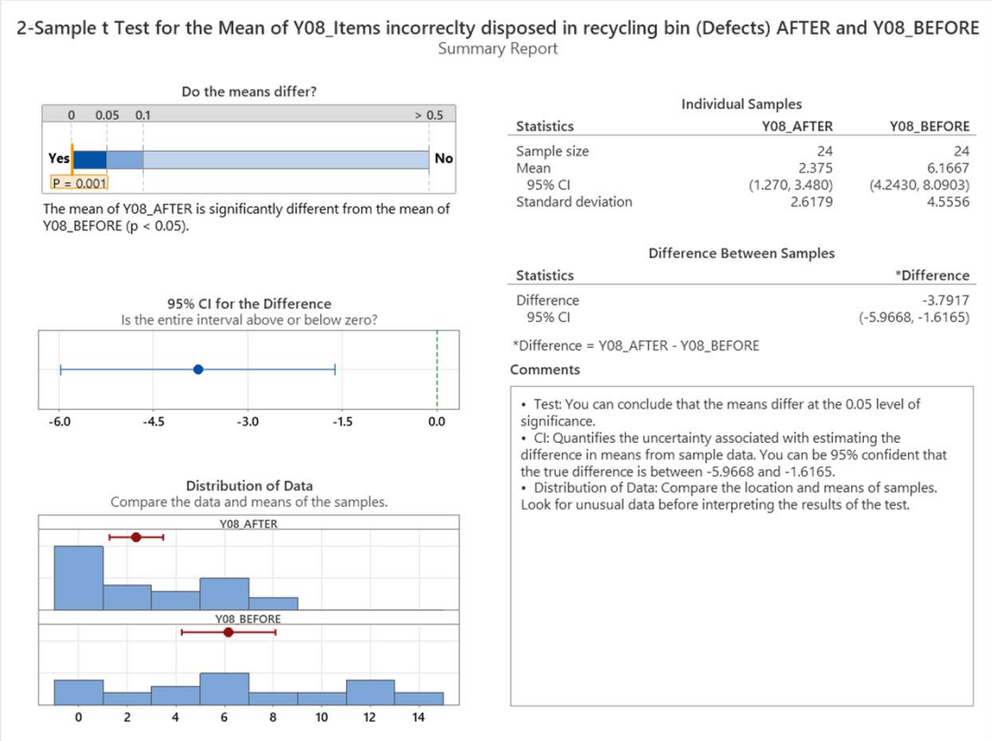
The mean is 2.33 and its confidence interval ranges from 1.68 to 2.98. The target value 1 is not included. The result is significant (p<0.001) meaning the target of 1 was not achieved.

We did improve our process, but we did not reach our target.

With results of stistical tests please always 1. refer to the statistical significance (p).
If the result is significant then evaluate its practical relevance, expressed by the size of the effect, e,g,:

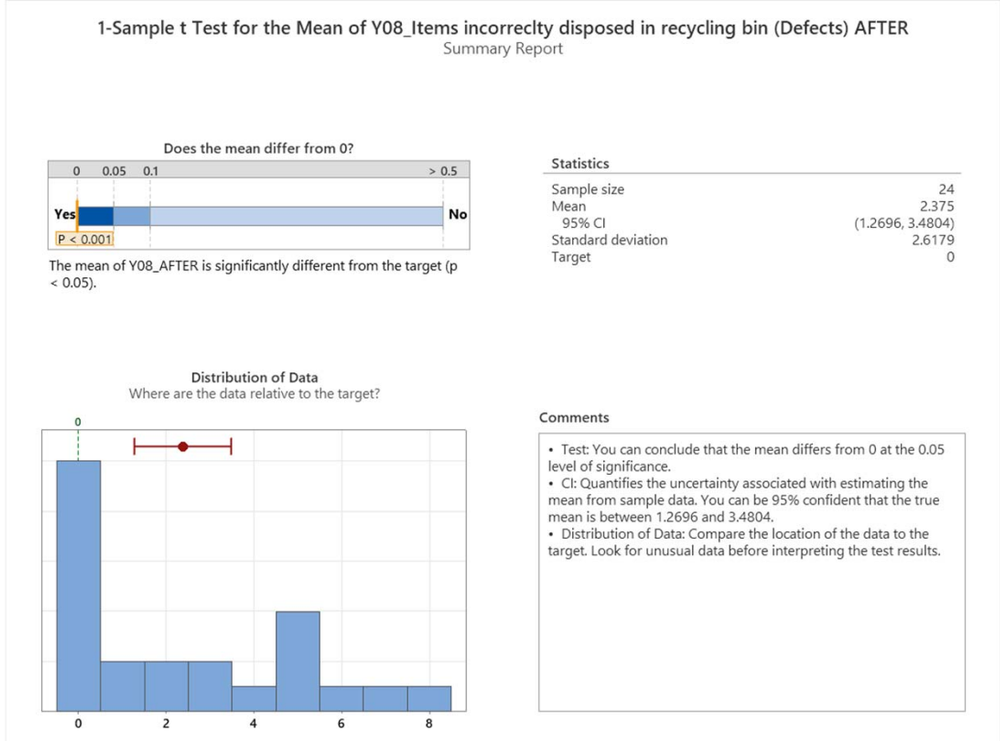
- Size of the difference of means (delta, t-Test) in Difference Hypotheses
- Strength of a relationship (R-sq %, Regression) in Relationship Hypotheses

between the states of x_before vs. x_after.



The number of pieces incorrectly recycled in Almaden lake park was significantly reduced by 3.79 grades and this effect size is also practically relevant. ~~result is statistically significant which means our improvement is statistically confirmed!~~

pieces incorrectly disposed and the target?



The mean is 2.37 and its confidence interval ranges from 1.26 to 3.48. The target value 0 is not included. The result is significant (p<0.001) meaning the target of 0 was not achieved.

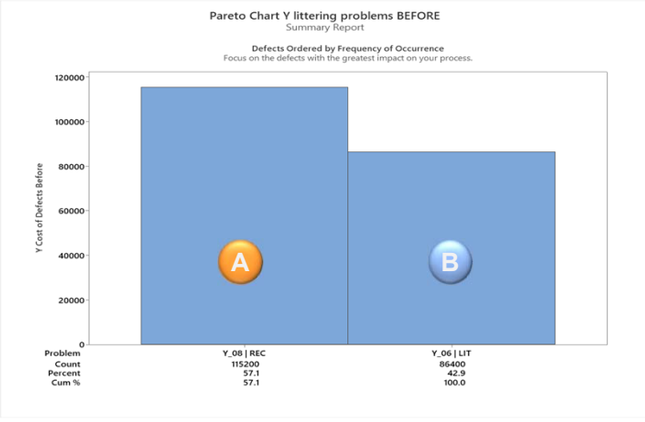
We did improve our process, but we did not reach our target.

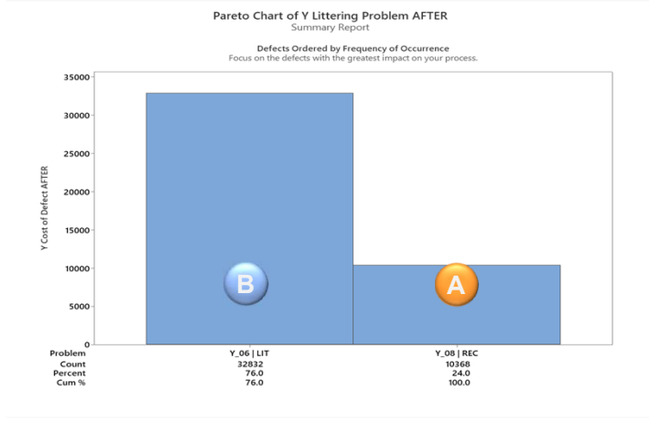
As a Belt we are only responsible for a draft, an idea how to calculate benefits.
In a business project you might invite a person from finance (Project-Charter) to evaluate the potential (before) and the ganined benefit (after).
basically we are responsible for the x´s and Y´s. The sponsor is responsible for the derived effects on satisfaction and costs.
This is my conviction, as we are no finance experts.

Summ

Problems	Root Causes	Implemented Measures	Financial Benefits	Other Benefits
Y_06 | Ground (trash-free) Trash on the ground and waterways	X1.1 No trashcans have been assigned to the zone X2.2.1.1.1 Nobody tell us what we are doing wrong X3.1.1 The experience of discarding trash does not feel pleasant X3.2 The design of the trash bin allows trash to flight out X4.1.1 The guidelines have not been designed for that target	Contact city of San Jose, present situation and suggest installing trash bins. Install trash bins in location. Collect info from City of San Jose, Almaden Lake Park, Recycling services and community. Enhance trash bins Contact city of San Jose, present situation Design a marketing campaign targeted to children.	$86.400 Year Expected $53,568.00 Worst case $48,568.00 Best Case $58,568.00	Healty soils and waterways Increase in littering awareness Sustainable future
Y_08 | Trash-can (full) Organic and reciclyng materials mixed	X1.1.1.1 Design of the trash bin type 1: There are two entries X2.1.1 Bin or surroundings are dirty X2.2.2.1.1 Availability of bins for all posible of materials is limited "X3.1.1 Gudelines are too general X2.2.2.1.2 Recycling requires analyzing method vs material" X1.3.1.1.1 People bring different things to the park X1.3.1.1.1 We are not sure what we should communicate "X2.1.1.1.1 No every material can be recycled at the park X2.2.1.1.1 Everybody is working separately" X2.2.1.1.1 No body tell us what we are doing wrong	Reinforce guidelines - Present situation to city of San Jose. Create an Event: invite friends to clean the park - Find support with the city of San Jose Analize current availability, present report to the city of san jose. Reinforce guidelines. Analyze type of objects people bring to the park, classified and find solutions by most frequent. Design campain people friendly. Present alternatives for other materials - sinergy with other institutions Collect info from City of San Jose, Almaden Lake Park, Recycling services and community. Include results in local news	$115.200 Year Expected $104,832.00 Worst case $99,832.00 Best Case $109,832.00	Preserve the world's natural resources Keep plastic out of the oceans Improve community knowledge

This was a very hard slide to develop. The fact that I dont have an sponsor and a direct source for the actual numbers make me wander a little.
Please forgive me if I have made any mistakes.





	Cost Before	% Reduction	Cost After	Savings
Y_06 | LITTER >6	$ 86,400.00	62%	$ 32,832.00	$ 53,568.00
Y_08 | RECYCLING-PRACTICES INCORRECT	$ 115,200.00	91%	$ 10,368.00	$ 104,832.00
			Expected	$ 158,400.00
			Worst case	$ 148,400.00
			Best Case	$ 168,400.00

Process Management Plan

Process-Management-Plan		Define measures to sustainably maintain the process-improvements														
Ranking of Outputs (Y)	Outputs (Y)	Measurand	Unit	Target and specification limits (USL; LSL)	Scale-Level	In which time intervals will the control chart be actualized?	How large will the sample size be in each time interval?	How many data points should the control chart represent?	I-MR Chart (if N <= 100)	xbar-R Chart (if N > 100 and if subgroup size <= 8)	xbar-S Chart (if N > 100 and if subgroup size > 8)	p-Chart (if ok vs. ko is discriminated)	u-Chart (if ok vs. different defect opportunities are discriminated)	Which control limits should be used? (LCL; Center-Line; UCL)	Who is responsible for creating the control charts?	In which document is the reaction plan specified?	Who is responsible for maintaining the reaction plan?
Output (Y)			Data from Data-Collection-Plan														
5	Y_01 | Problem: DECISION 2: DISPOSAL OPTIONS AVAILABILITY <3 IN LOCATION	Amount	Trash cans available	Target: 3 LSL: 1	Data discrete or continuous (Cardinal-Scale)	quarterly	9	9	9 data points; no subgrouping				9 data points; (for discrete values: treated as number of defects per output)	None, estimate from the data	Analist	Reaction Plan.xls	Process Owner - Management Almaden Lake Park
7	Y_02 | Problem: TRASH-CAN (FULL) DISPOSAL AREAS BAD	Ranking	4 Very Good, 3 Good, 2 Not Good, 1 Very Bad	Target: 4 LSL: 3	Data Rank Ordered (Ordinal-Scale)	biweekly	25	25	25 data points; no subgrouping					None, estimate from the data	Analist	Reaction Plan.xls	Process Owner - Management Almaden Lake Park
6	Y_03 | Problem: DECISION 3: DISPOSAL LOCATION CAPACITY EXCEED	Degree	1 Empty, 2 Half filled, 3 Full, 4 Overfilled	USL: 3 Full	Data Rank Ordered (Ordinal-Scale)	biweekly	25	25	25 data points; no subgrouping					None, estimate from the data	Analist	Reaction Plan.xls	Process Owner - Management Almaden Lake Park
4	Y_04 | Problem: TRASH-CAN (FULL) LOCATION WRONG	Category	Deposit; Litter	Target Deposit	Data in > 2 Levels (Nominal-Scale)	monthly	25	25				25 data points	25 data points; (for discrete values: treated as number of defects per output)	None, estimate from the data	Analist	Reaction Plan.xls	Process Owner - Management Almaden Lake Park
1	Y_05 | Problem: DECISION 1: DISPOSAL REQUIREMENTS RECYCLING-BINS <60%	Amount	Recycling bins available	LSN: 60%	Data discrete or continuous (Cardinal-Scale)	quarterly	25	25	25 data points; no subgrouping				25 data points; (for discrete values: treated as number of defects per output)	None, estimate from the data	Analist	Reaction Plan.xls	Process Owner - Management Almaden Lake Park
2	Y_06 | Problem: GROUND (TRASH-FREE) LITTER >5	Amount	Pieces of trash within a radius of 5 meters around a trash-can	Target: 1 USL: 5	Data discrete or continuous (Cardinal-Scale)	weekly	25	25	25 data points; no subgrouping				25 data points; (for discrete values: treated as number of defects per output)	**I-Chart** UCL: 8.36 CL: 2.33 LCL: -3.69 **MR-CHART** UCL: 7.398 CL: 2.264 LCL: 0	Analist	Reaction Plan.xls	Process Owner - Management Almaden Lake Park
8	Y_07 | Problem: GROUND (TRASH-FREE) CLEANING-EFFORT > 8 WORKING HOURS PER WEEK	Time	Working hours	Target: 8 USL: 8,5	Data discrete or continuous (Cardinal-Scale)	quarterly	25	25	25 data points; no subgrouping				25 data points; (for discrete values: treated as number of defects per output)	None, estimate from the data	Analist	Reaction Plan.xls	Process Owner - Management Almaden Lake Park
3	Y_08 | Problem: TRASH-CAN (FULL) RECYCLING-PRACTICES INCORRECT	Amount	Items incorrectly disposed in recycling bin	USL: 7 Target: 0	Data discrete or continuous (Cardinal-Scale)	weekly	25	25	25 data points; no subgrouping				25 data points; (for discrete values: treated as number of defects per output)	**I-Chart** UCL: 11.63 CL: 2.38 LCL: -6.88 **MR-CHART** UCL: 11.36 CL: 3.48 LCL: 0	Analist	Reaction Plan.xls	Process Owner - Management Almaden Lake Park

The process management plan was documented. The Contol limits for the Outputs Y06 and Y08 are specified based on the metodology.

Results of the CONTROL-Steering

Control-Steering				
Tool	**Application**	**Documentation**	**Comment**	**Decision**
Graphical Analysis	ok	ok		**Master-Black-Belt**
Process-Capability	ok	ok		Dr. Reiner Hutwelker reiner.hutwelker@tum.de
Control-Charts	ok	ok		30-Nov-2022
Statistical Test of Improvement	ok	ok	please see my notes	**passed**
Project-Management-Plan	ok	ok		**Sponsor**
Summary & Benefits	ok	ok		name/ email
Lessons Learned				1-Jan-2021
Additonal Notes			Dear Julieta, you have implemented an extraordinary, excellent project. You demonstrated a perfect use of the tools and delivered not only a comprehensible, but also target group specific (sponsor) documentation. In each of your slides your extraordinary motivation becomes transparent. Your project belongs to the best practices of this course in several aspects. That's great overall! Congratulations, Reiner Hutwelker p.s. I would have liked to also read your "lessons learned"	**passed/ failed**

Only proceed to the next phase after a positive decision of MBB and Sponsor

End of this Project-Story-Book

Six Sigma process improvement methods and tools