

Improving Weeding Efficiency in a Home Garden

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Business Case

- Manual weeding consumes a significant portion of productive gardening time – averaging 20 minutes per section – which could otherwise be allocated to other high-value tasks such as planting, pruning, or harvesting.
- **Goal:** Reduce the average weeding time by approximately 50% to recover around 3-4 hours per month for yield-enhancing tasks.
- **Cost considerations:** Tool upgrades (\$30-\$60), minor layout modifications (seasonal labor)
- **Benefits:** Improved garden productivity, higher yield, reduced physical pain.

Problem & Goal Statement

- **Y Metric:** Average weeding time per garden section (in minutes)
- **Problem:** Over a one-week observation period, the average weeding time for each garden section was 20 minutes, which significantly limits the time for high-impact gardening activities.
- **Goal:** Reduce the average weeding time of each garden section to under 10 minutes by July 20, 2025.

CTQs (Critical to Quality)

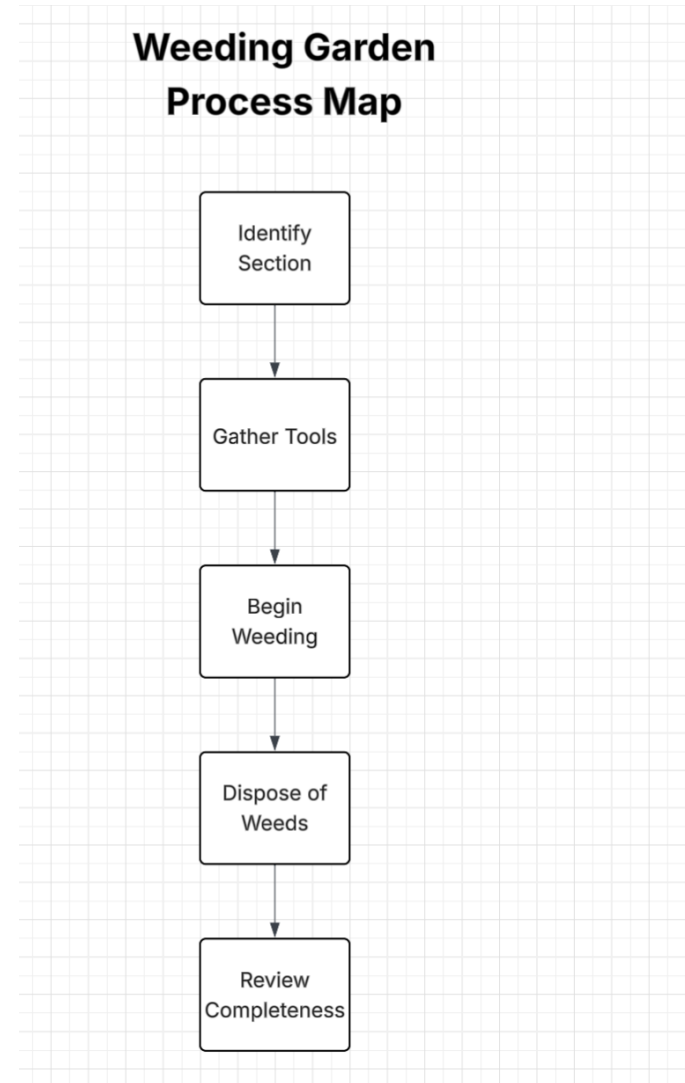
- Grouped by Driver Type
 - **Tool-Related:** Ergonomic comfort, sharpness, durability
 - **Environmental:** Soil moisture, temperature
 - **Process:** Garden layout accessibility, time of day, weeding frequency

Operational Definition

- **Y metric:** Time in minutes to weed a single garden section from start to finish
- **Tool:** Stopwatch
- **Observer:** Same individual across all sessions
- **Conditions Logged:** Soil moisture, weather, time of day
- **Sample Size:** 31 sessions across 3 garden sections (over 7 days)

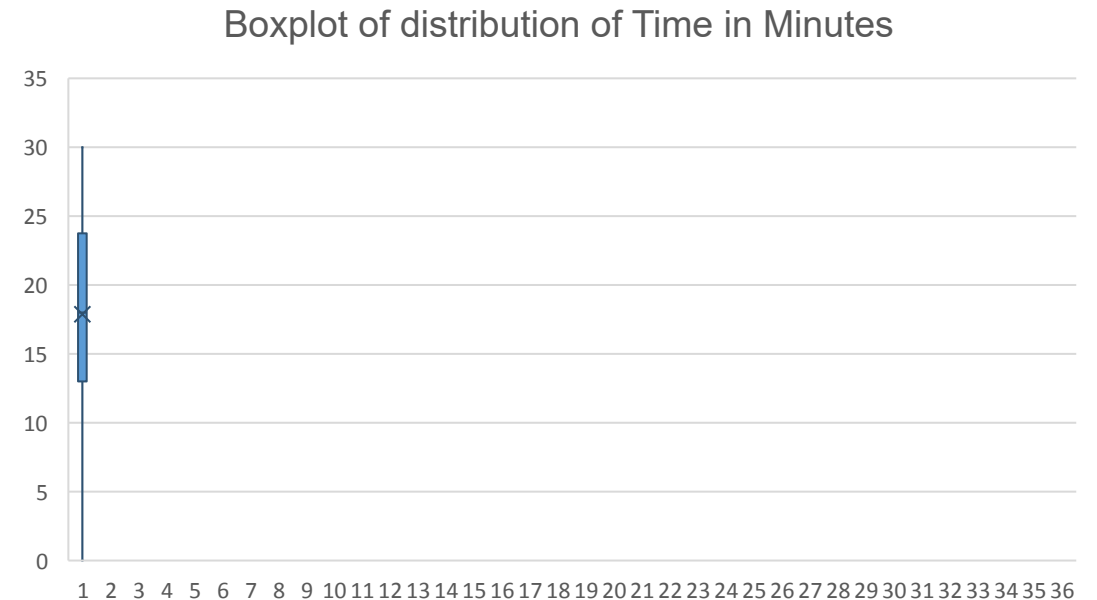
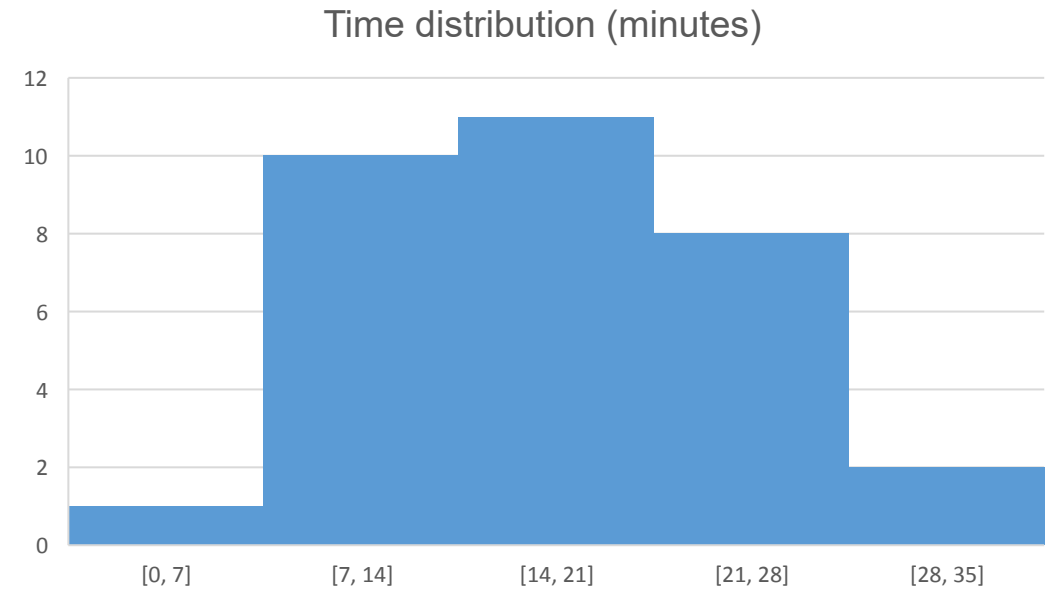
Current State – Process Map

1. Identify garden section
2. Gather weeding tools
3. Begin weeding
4. Remove and dispose weeds
5. Review Completeness of weeding



Measure – Summary Statistics

- Data Summary
 - Total observations: 31
 - Mean Time: 18.45 minutes
 - Median: 18.0 minutes
 - Standard deviation: 6.28 minutes
 - Range: 8.0 minutes to 30.0 minutes
- Boxplot on the right reveals presence of outliers
- Histogram shows mild right skew, indicating a few longer weeding times stretching the distribution.



DPMO & Sigma Justification

- To assess the current process capability of weeding efficiency, we defined a defect as any weeding session that exceeds 15 minutes.
- Calculation details:
 - $D = 19$ defects
 - $N = 31$ total observations
 - $O = 1$ opportunity per observation

$$DPO = D/(N*O) = 19/(31*1) = 0.6129$$

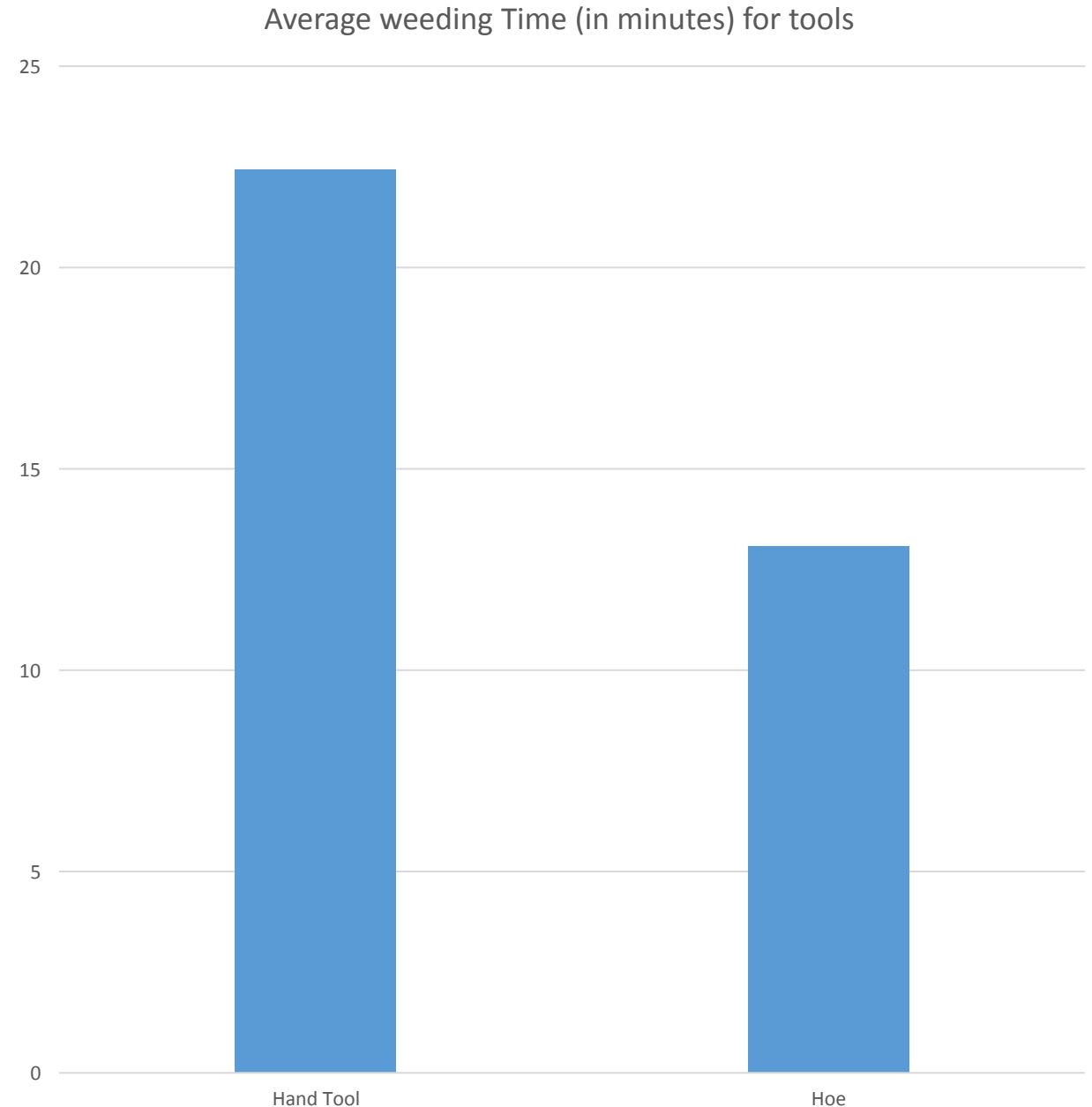
$$DPMO = DPO * 1,000,000 = 0.6129*1,000,000=612,903$$

$$\text{Yield} = (1-DPO)*100 = (1-0.6129)*100 = 38.71\%$$

- Sigma Level = 1.21
- Insight: Upgrading to ergonomic hoes may reduce the time by over 10 minutes per session.

Analysis - Tool Type Impact

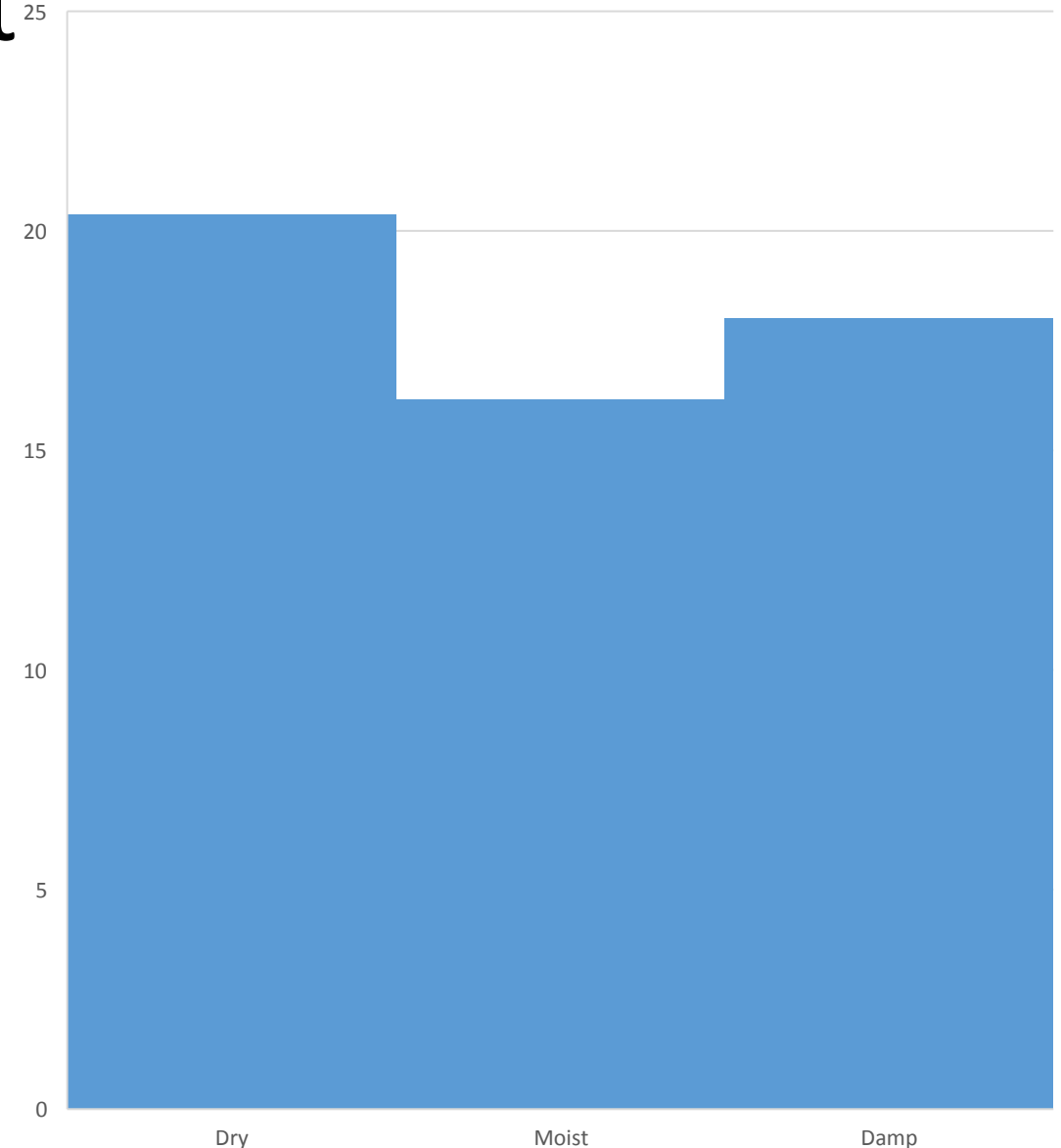
- Average Time by Tool:
 - Hand Tool: 22.43 minutes
 - Hoe: 13.07 minutes
- Efficiency gain: ~9.34 minutes per session
- Insight: Tool type has the largest observed impact on weeding time.
- Root cause (X): Ergonomic/tool performance difference.
- Recommendation: Transition to ergonomic hoes for faster, lower-strain weeding.



Analysis – Soil Moisture Impact

- Average Time (minutes):
 - Dry = 20.38 min
 - Moist = 16.17 min
 - Damp = 18.00 min
- Root cause (X): Soil condition
- Efficient Ways to Moisten soil:
 - Weed after rain (no added effort)
 - Mist lightly or weed early (dew present) as moist soil reduces effort.

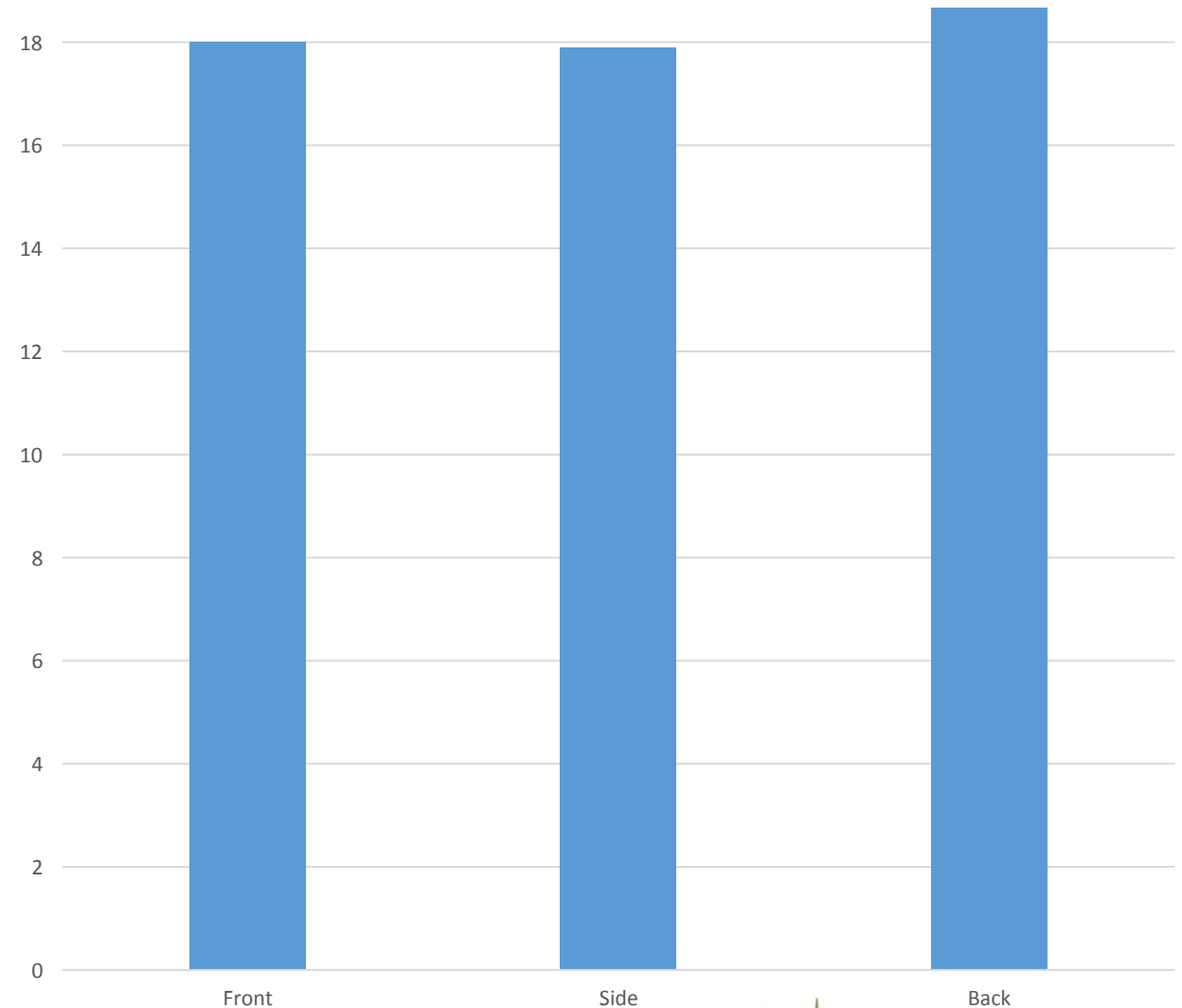
Average weeding time based on Soil Conditions



Analysis – Garden Layout & Obstructions

- Average Time by Section
 - Front: 18 minutes
 - Side: 17.9 minutes
 - Back: 18.67 minutes
- Insight:
 - Back section takes the longest – 0.77 minutes more than Side and 0.67 minutes more than the Front
- Possible Cause
 - Increased time may be due to denser planting or limited access to weeds in tight corners.
- Recommendation:
 - Redesign the Back layout to improve access.
 - Consider wider spacing and clearing obstructions.

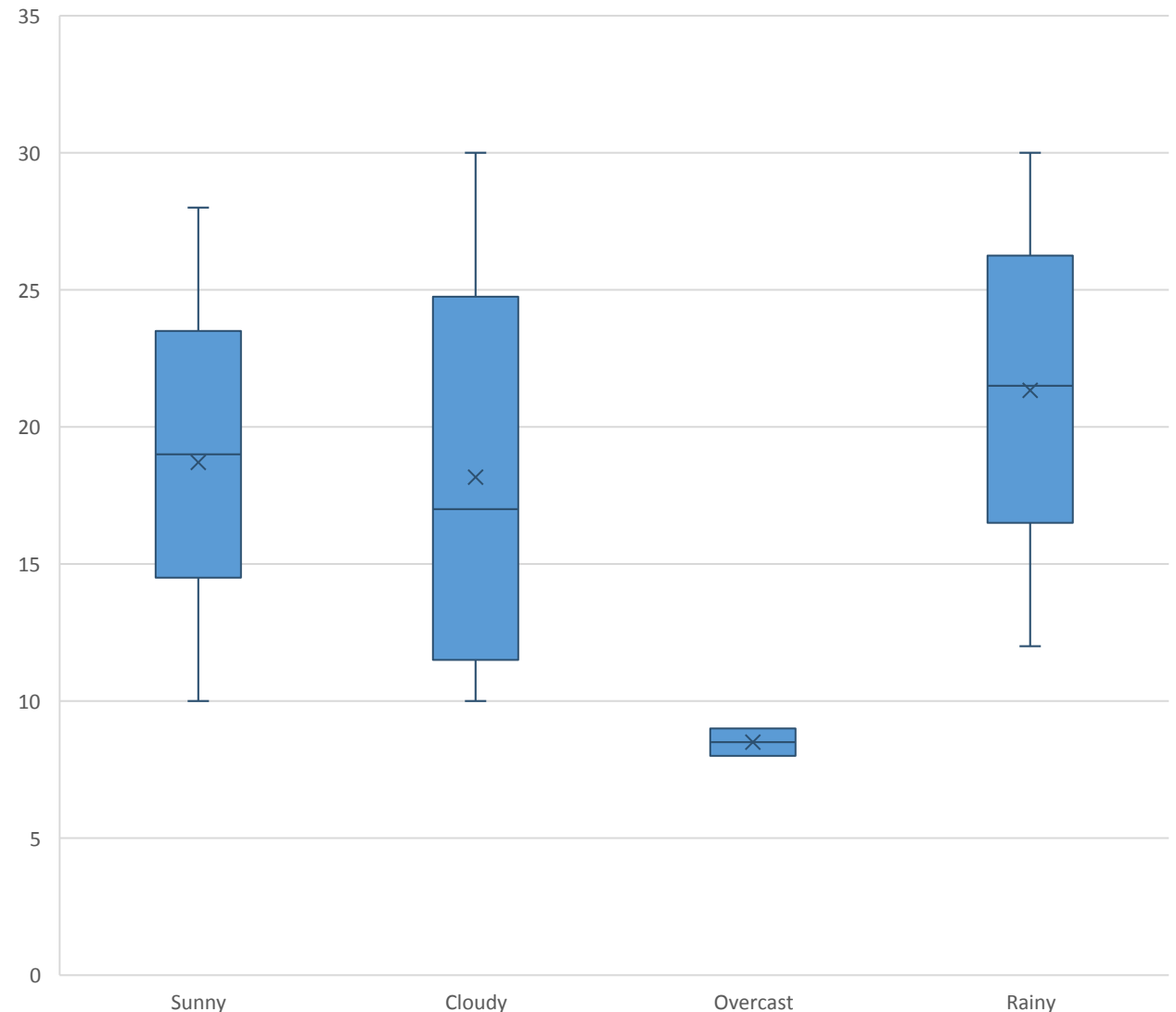
Average Weeding Time in Minutes based on each Garden Section



Analysis – Boxplot: Weeding Time by Weather

- The boxplot on the right compares the weeding time across four weather conditions: Sunny, Cloudy, Overcast, and Rainy.
 - Sunny days show the highest median and widest range, with several high-time outliers.
 - Cloudy and Overcast days tend to have more consistent and lower weeding times.
 - Rainy days show the lowest median weeding time, likely due to softer soil easing weed removal
- Root Cause (X): Soil hardness and physical strain increase during sunny (or often drier) conditions.
- Recommendation: Prioritize weeding during Rainy or Overcast days for efficiency gains or immediately after rainfall when the soil is moist but manageable.

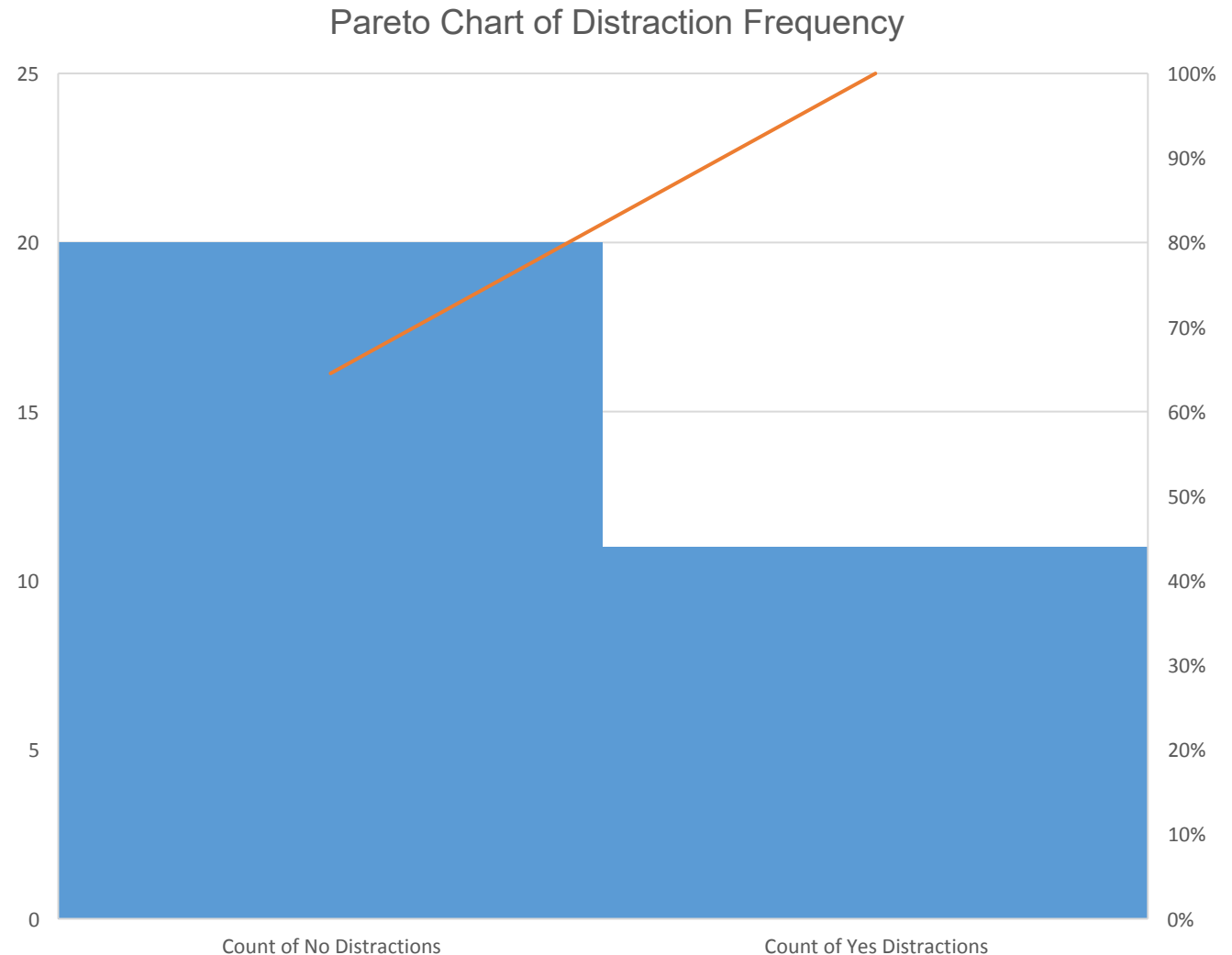
Boxplot of Weeding Time by Weather



Analysis – Pareto Chart: Distraction Frequency

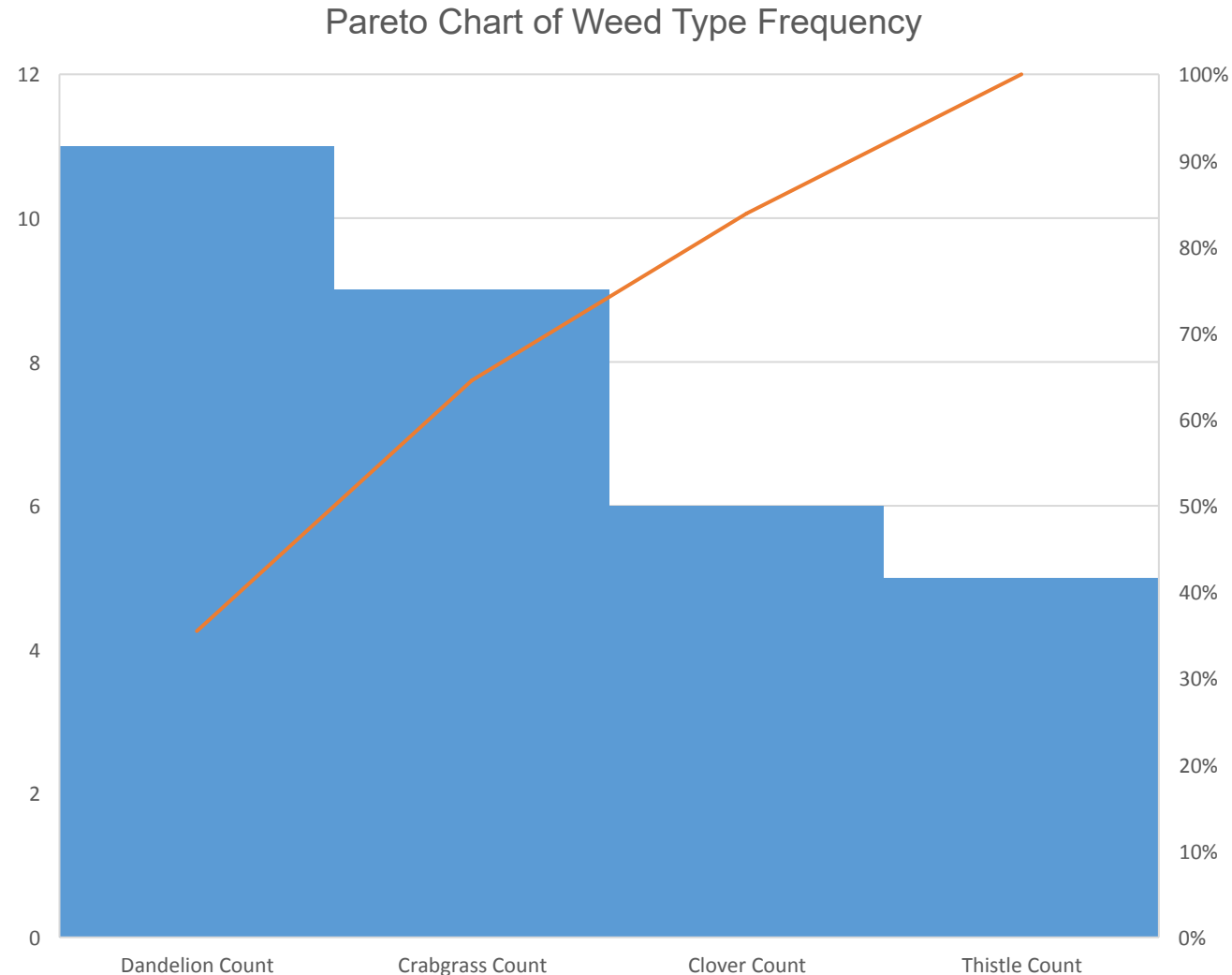
- Majority of weeding sessions occurred without distractions.
- Possible distraction types:
 - Phone alerts
 - Pet interruptions
- Outlier sessions (>25 minutes) often had over 1 distraction
- Insight: Distractions correlate with longer weeding times
- Root Cause (X): Environmental interruption during weeding.
- Recommendation: Schedule uninterrupted blocks (e.g. early morning hours or quiet hours).

ANALYZE



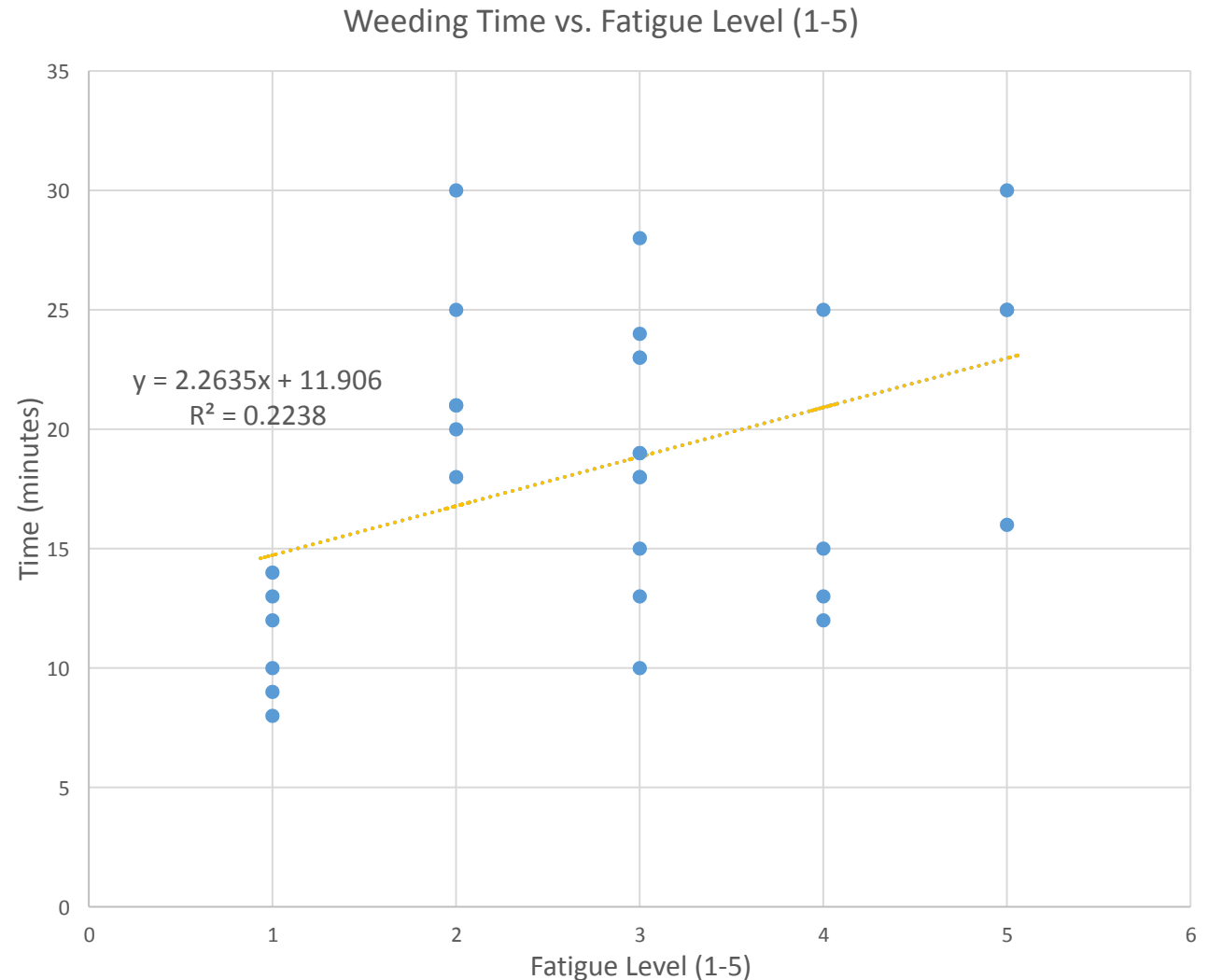
Analysis – Pareto Chart: Weed Type Frequency

- Dandelions and Crabgrass are the most frequently encountered weed types, which make up approximately 70% of all observations.
- Dandelion is the top contributor, with 11 occurrences (35% of total).
- Weeds with complex root structures (e.g., Dandelion, Crabgrass) likely contribute more to weeding time than less frequent or shallower-rooted types such as Thistles.
- Insight: The majority of time-consuming weeding sessions likely correlate with the two most common, labor-intensive weed types.
- Root Cause (X): Variation in weed root depth and density affects removal time.
- Recommendation: Use more effective tools (e.g., claw hoes or weed pullers) specifically suited for high-frequency types such as Dandelion and Crabgrass to reduce time and effort.



Analysis – Scatterplot: Weeding Time vs. Fatigue Level

- Strong positive trend: higher self-reported fatigue = longer weeding sessions.
- Sessions with a fatigue rating above 4 averaged about 22.5 minutes of weeding time.
- Lower fatigue (1-2) sessions are typically less than 15 minutes.
- Insight: Energy level is a significant factor in weeding efficiency.
- Root Cause (X): Human fatigue as a performance limiter.
- Recommendation: Prioritize weeding when physically rested; avoid post-meal or late-day times.



Recommendations

Priority	Recommendation	Justification	Estimated Time Saved
High	Upgrade to ergonomic hoes	Largest reduction in average tool usage time has been observed.	Approximately 9.34 minutes/session
Medium	Schedule weeding post-rain	Moist soil significantly improves weeding speed	Approximately 2-4 minutes
Low-Medium	Redesign the Back garden layout	Back section has the highest average weeding time compared to other sections	Approximately under 1 minute

Control Plan

- To Sustain improvements:
 - Tool Maintenance: Sharpen tools bi-monthly, store dry
 - Calendar Reminders: Schedule alerts for post-rain weeding
 - Quarterly Layout Reviews: Ensure clear paths, re-mulch where needed.

Appendix A: Data Collection

- Sample = 31 Sessions Logged
 - Time, Tool Used, Section
 - Soil Moisture, Weather, Distraction, Weed Type
- Analysis included segmentation by tool, soil condition, and section layout.

Date	Section	Tool	Time (min)	Soil Moisture	Time of Day	Weather	Fatigue	Distraction	Weed Type	Temperature (F)	Weather
6/20/25	Front	Hand Tool	21	Dry	Evening	Sunny	2	No	Dandelion	85	Sunny
6/21/25	Side	Hoe	13	Moist	Morning	Cloudy	1	No	Crabgrass	91	Cloudy
6/22/25	Back	Hand Tool	24	Dry	Afternoon	Sunny	3	Yes	Clover	91	Sunny
6/23/25	Front	Hoe	9	Damp	Morning	Overcast	1	No	Dandelion	100	Overcast
6/24/25	Side	Hand Tool	18	Moist	Evening	Sunny	2	No	Thistle	103	Sunny
6/25/25	Back	Hoe	12	Damp	Morning	Cloudy	1	No	Crabgrass	101	Cloudy
6/26/25	Front	Hand Tool	25	Dry	Afternoon	Sunny	4	Yes	Dandelion	90	Sunny
6/27/25	Side	Hoe	10	Moist	Afternoon	Cloudy	1	No	Clover	69	Cloudy
6/28/25	Back	Hand Tool	19	Dry	Evening	Sunny	3	Yes	Thistle	89	Sunny
6/29/25	Front	Hoe	8	Damp	Morning	Overcast	1	No	Dandelion	94	Overcast
6/30/25	Back	Hoe	12	Damp	Afternoon	Rainy	4	No	Dandelion	91	Rainy
7/1/25	Front	Hand Tool	25	Moist	Evening	Rainy	5	Yes	Crabgrass	87	Rainy
7/2/25	Side	Hoe	15	Dry	Evening	Sunny	3	No	Dandelion	85	Sunny
7/3/25	Front	Hand Tool	30	Damp	Evening	Rainy	5	Yes	Crabgrass	90	Rainy
7/4/25	Side	Hand Tool	25	Dry	Evening	Sunny	2	No	Clover	86	Sunny
7/5/25	Front	Hoe	15	Dry	Morning	Sunny	4	No	Crabgrass	91	Sunny
7/6/25	Back	Hoe	13	Moist	Morning	Sunny	3	No	Crabgrass	93	Sunny
7/7/25	Side	Hand Tool	21	Moist	Evening	Cloudy	2	No	Dandelion	90	Cloudy
7/8/25	Front	Hoe	16	Moist	Morning	Sunny	5	Yes	Clover	93	Sunny
7/9/25	Back	Hoe	18	Damp	Evening	Rainy	3	Yes	Dandelion	90	Rainy
7/10/25	Front	Hand Tool	30	Damp	Evening	Cloudy	2	No	Thistle	83	Cloudy
7/11/25	Side	Hand Tool	25	Damp	Morning	Rainy	5	Yes	Thistle	87	Rainy
7/12/25	Back	Hoe	18	Moist	Evening	Rainy	3	Yes	Dandelion	87	Rainy
7/13/25	Front	Hoe	20	Dry	Morning	Sunny	2	No	Clover	87	Sunny
7/14/25	Back	Hand Tool	23	Moist	Morning	Cloudy	3	No	Crabgrass	86	Cloudy
7/15/25	Side	Hand Tool	28	Dry	Evening	Sunny	3	Yes	Dandelion	86	Sunny
7/16/25	Side	Hoe	14	Moist	Evening	Sunny	1	No	Crabgrass	87	Sunny
7/17/25	Back	Hand Tool	23	Dry	Evening	Sunny	3	No	Thistle	87	Sunny
7/18/25	Side	Hoe	10	Moist	Morning	Sunny	3	Yes	Dandelion	84	Sunny
7/19/25	Back	Hand Tool	19	Dry	Evening	Sunny	3	No	Crabgrass	82	Sunny
7/20/25	Front	Hand Tool	13	Moist	Morning	Sunny	4	No	Clover	86	Sunny