Bikesharing in Spain

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Abstract

The data provide information from a face-to-face survey of 370 potential dock-based e-bike-sharing users in Santander, Spain. The survey was designed to collect information about the current and future use of the city's bike-sharing service, including frequency of use, trip purpose, and Willingness to Pay (WTP) for a future e-bike-sharing service. This is structured in two sections. The first section relates to the characterisation through socio-economic data and information on bike-sharing services. The characterisation questions were intended to clearly distinguish between potential recurrent users (locals) and occasional users (visitors). The second section corresponds to a stated preference (SP) exercise that reveals the WTP(Willingness To Pay) for using e-bike-sharing considering different payment structures: fee per use, annualised registration, and a combination of the above. The data provide a valuable reference for municipal managers, private bikesharing service providers, and the scientific community about users' preferences and intentions to use bike-sharing and e-bikesharing according to sociodemographic characteristics and pricing scenarios.

Introduction

Urban mobility is undergoing rapid transformation, with shared transportation systems like bikesharing playing a key role in reducing traffic congestion and promoting sustainability. Understanding public perception and usage patterns is crucial for the successful implementation of these systems.

Objective

This study focuses on analyzing survey data from Santander to assess how individuals engage with bikesharing services and their willingness to adopt electric bicycles. Through statistical tools such as descriptive analysis, hypothesis testing, and chi-square evaluation, we aim to uncover key behavioral trends and demographic influences.

The findings can inform policymakers and urban planners in designing effective, inclusive, and user-friendly mobility solutions for the city.

Background

In recent years, many cities have introduced bikesharing programs as part of broader efforts to encourage sustainable transportation. These systems offer an alternative to private car use, contributing to reduced emissions and improved urban mobility.

Santander, like many European cities, is exploring the expansion of its bikesharing network, including the introduction of electric bicycles. However, the success of such initiatives depends largely on public acceptance and usage.

To better understand the factors influencing bikesharing behavior, a survey was conducted, collecting data on demographics, mobility habits, and opinions on various transport scenarios. This analysis builds the foundation for data-driven decision-making in urban planning.

Dataset Overview

The dataset consists of the collected data with the compiled census of the 172,655 inhabitants of the city of Santander for the year 2023, according to the Spanish National Institute of Statistics.

The first part is related to socioeconomic variables, the current use of the bike-sharing service, and the intention to use e-bike-sharing.It includes key variables such as:

- Gender
- Age
- Employment
- Education
- Residence
- Bike Sharing Use (yes/No)
- Frequency
- City
- Trip Type
- Use E-Bike?
- E-Bike Frequency
- E-Bike Trip Type

The second part of the survey consisted of 9 SP scenarios that varied the payment structure for using an e-bike-sharing service.

Some Graphs Given in our Datapaper

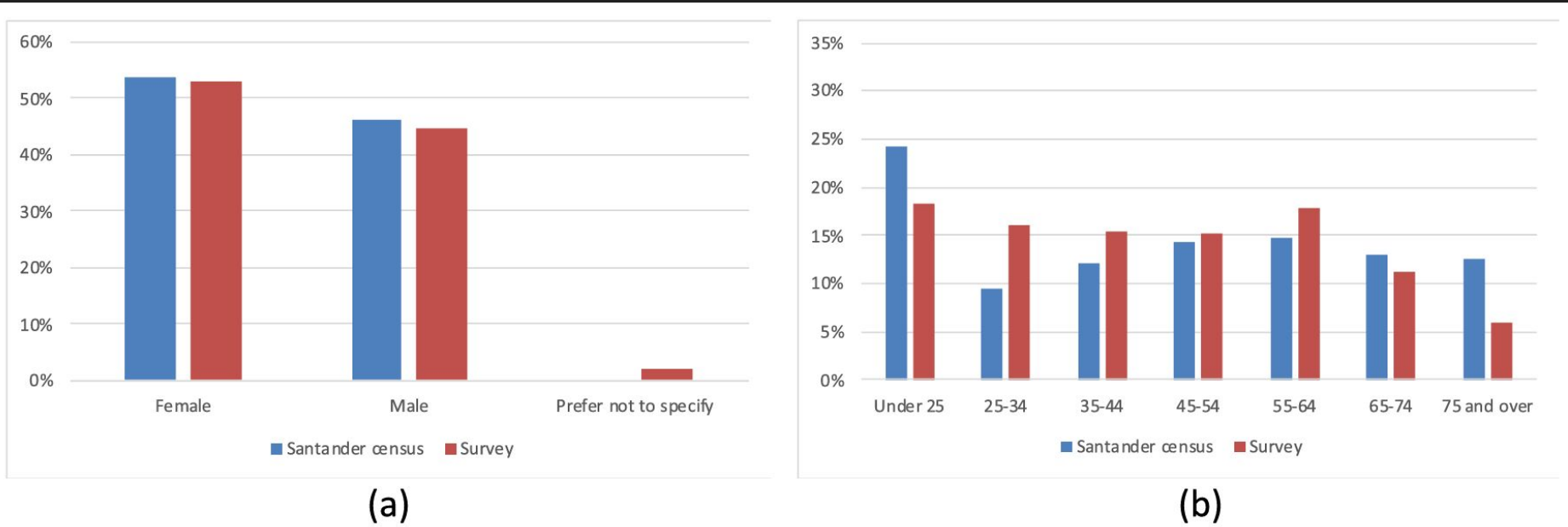


Fig. 1. Comparison of responses between the actual census and the sample.

Table 3
Scenarios of the SP experiment.

Scenario	Type Fare	Subscription fare (€)	Price per 30 min (€)
1	Annual	35	0,5
2	susbscrip-	20	0,25
3	tion + Price	50	0
4	per 30 min	50	0,25
5		20	0,5
6		35	0
10	Price per 30	0	1,5
11	min	0	1
12		0	0,5

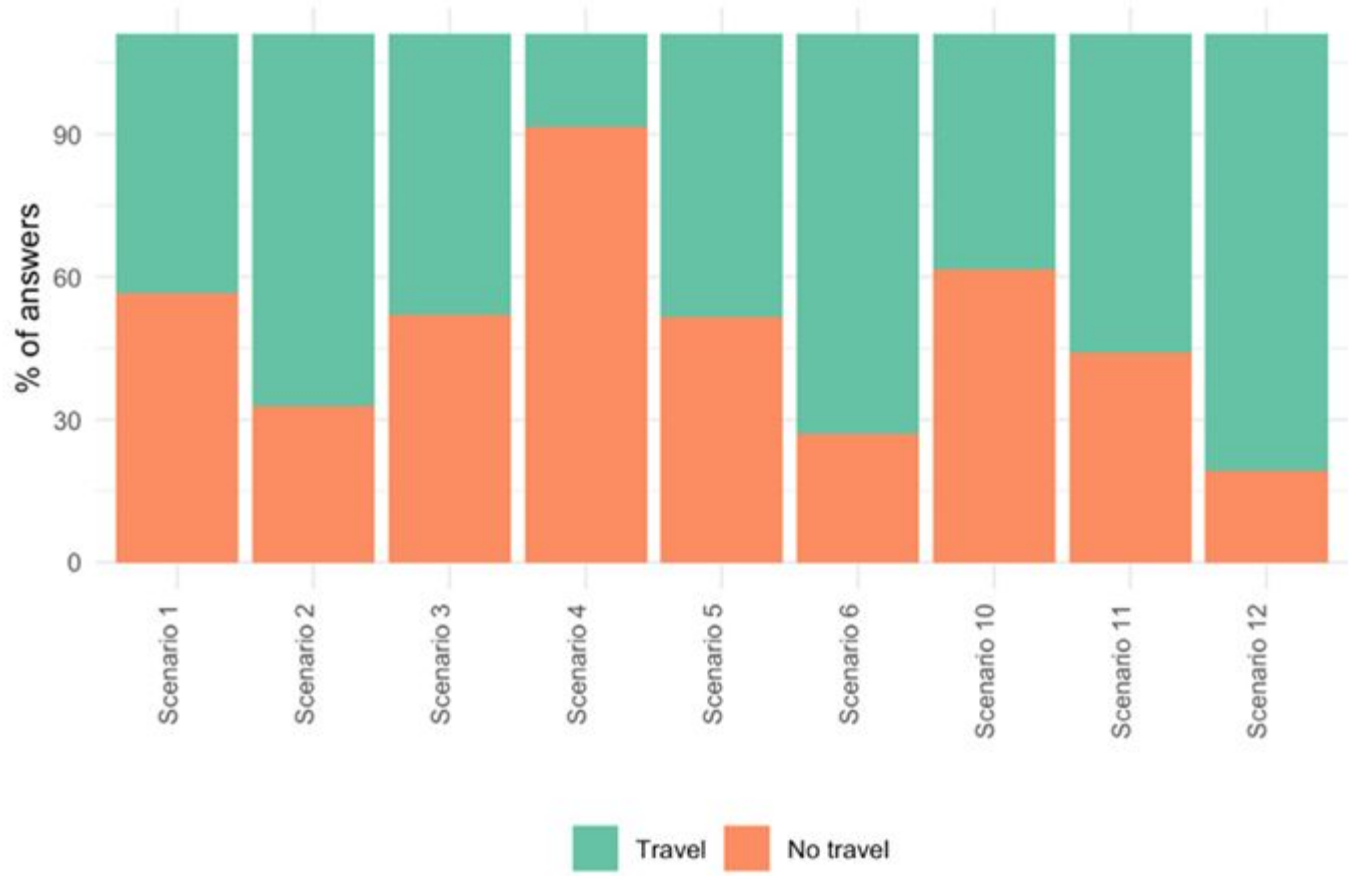
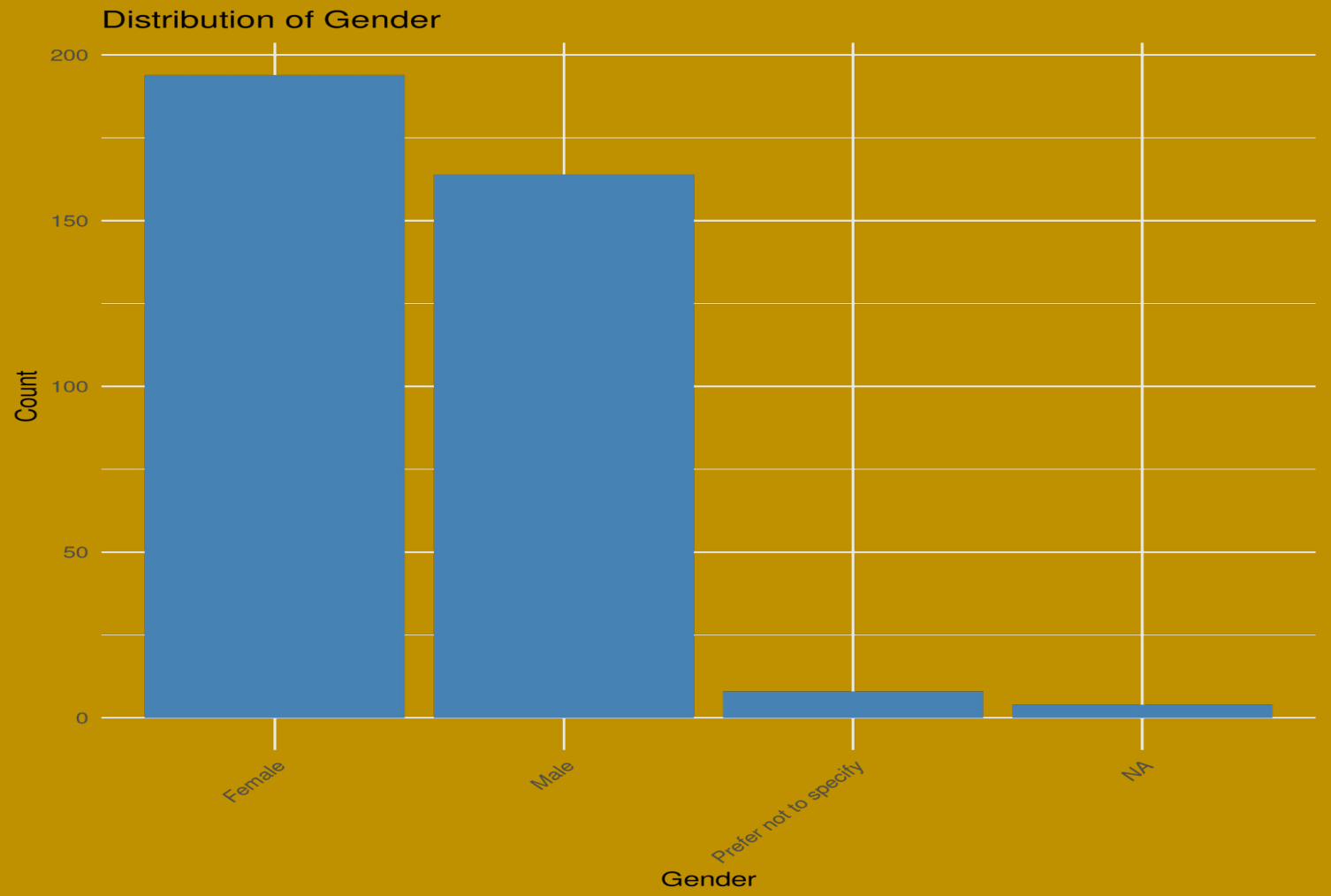


Fig. 2. Distribution of responses in the SP scenarios.

Data Overview

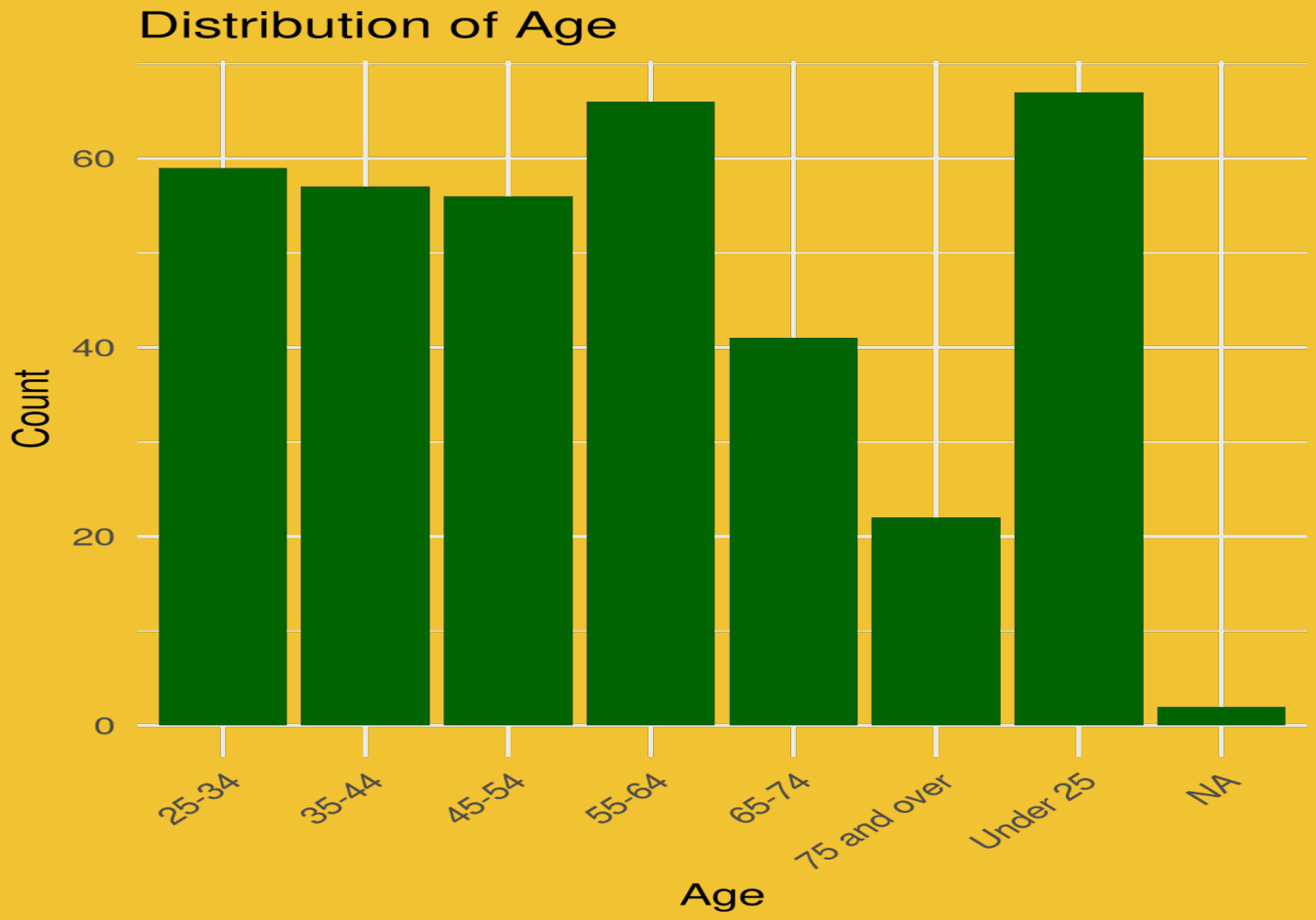

Distribution of Gender
200
150
100
50
0
Count
Female
Male
Prefer not to specify
NA
Gender

Gender Ratio in Spain

The gender ratio in Spain is approximately **96 men to 100 women**.

Source : UN (World Population Prospects 2024)

From the gender ratio in Spain and Gender Ratio of people using bikesharing services, it appears that the percentage of male population using bikesharing services is similar to the percentage of female population using bikesharing services.


Distribution of Age
Count
60
40
20
0
25-34
35-44
45-54
55-64
65-74
75 and over
Under 25
NA
Age

There is a slight decrease in the number of citizens surveyed older than 75 because they aren’t the main target group for this bike sharing system. Also, the decrease in citizens under 25 is because the survey started at 16.

And from the above Bar Graph, we can see that there is a reasonable decrease in people using Bikesharing Services older than 65. Some possible reasons :

- Physical limitations and **safety concerns** while biking.
- Less familiarity or comfort with **digital platforms** required to rent bikes.
- Less need for daily travel if they are **retired** and mostly at home.


Distribution of Employment
Count
150
100
50
0
1
Employee
Housework
Retired
Self-employed
Student
Unemployed
Employment Status

Inferences and Reasons:

1. Employees are the largest group of users

- Many employees use bikes for **daily commuting** to work, especially in congested urban areas.
- Some workplaces may **encourage sustainable commuting** or offer bike-related perks

2. Students are also frequent users

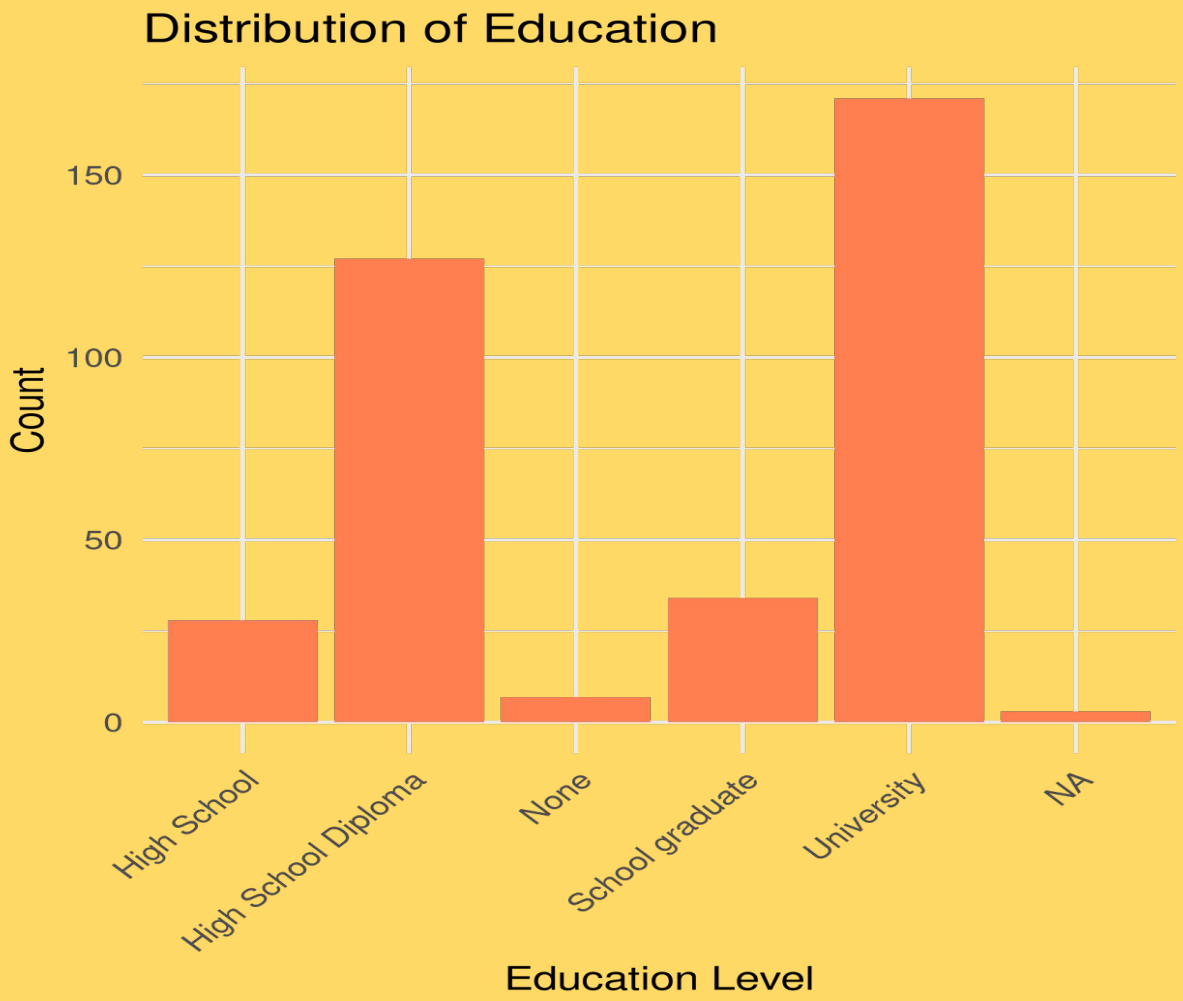
- They may not own cars and prefer **budget-friendly transport**.
- Young users are **tech-savvy**, easily adapting to bikesharing apps and systems.

3. Retired individuals show notable usage

- Retirees may use bikes for **exercise, leisure, or short trips**.
  This Reflects a trend of **active aging** and focus on maintaining health

4. **Moderate Use by "Self-Employed" and "Unemployed"**

5. Low Usage from "Housework" Category


Distribution of Education
Count
150
100
50
0
High School
High School Diploma
None
School graduate
University
NA
Education Level

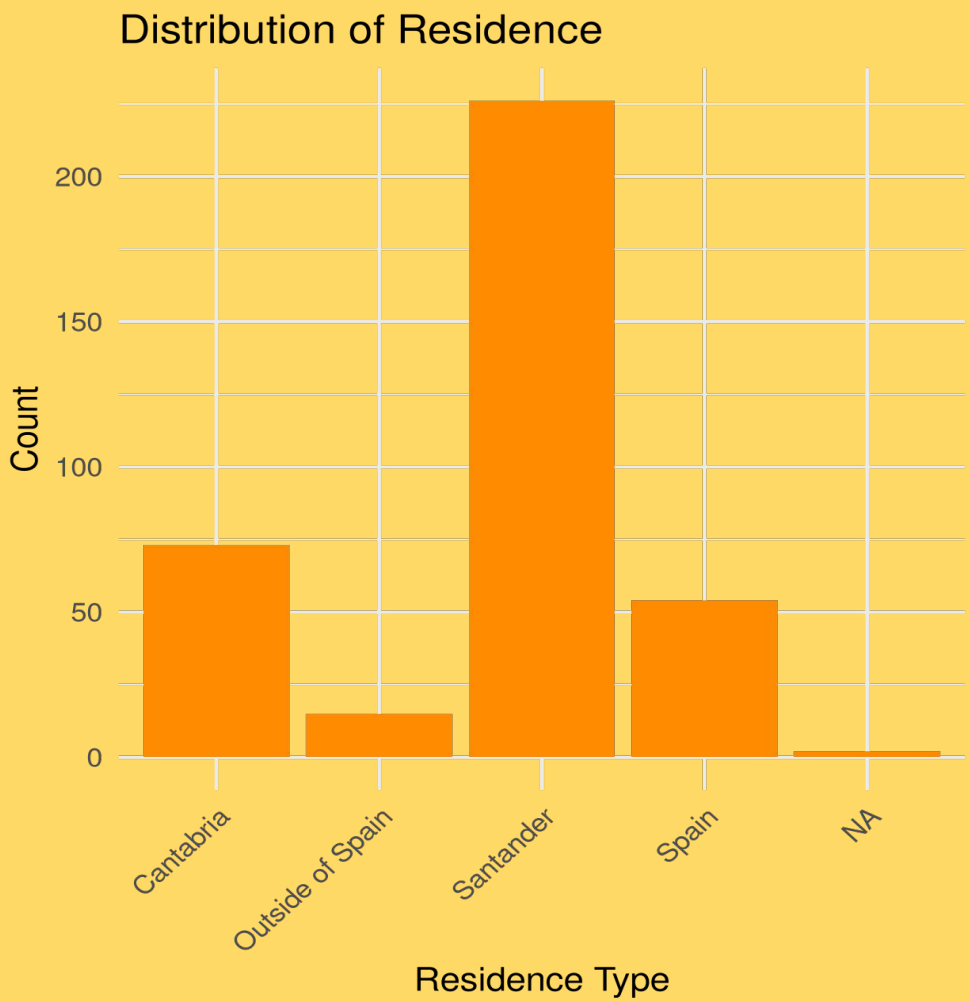
Inferences and Reasons:

1. **University-Educated Individuals Dominate**
   - University-educated individuals are more likely to live in **urban areas** where bikesharing services are available.
   - Higher likelihood of being **tech-savvy** and comfortable using app-based services.
2. High Participation by High School Diploma Holders
   - These users might prefer bikesharing for **cost-efficiency and convenience**
   - **They may not own a car or prefer biking for short to medium travel.**

3. Moderate Use by School Graduates and High School Only

4. Very Low Usage from "None" Category

- This group may have **limited access to technology**, infrastructure, or awareness of such services.


Distribution of Residence
Count
200
150
100
50
0
Cantabria
Outside of Spain
Santander
Spain
NA
Residence Type

Inferences and Reasons:

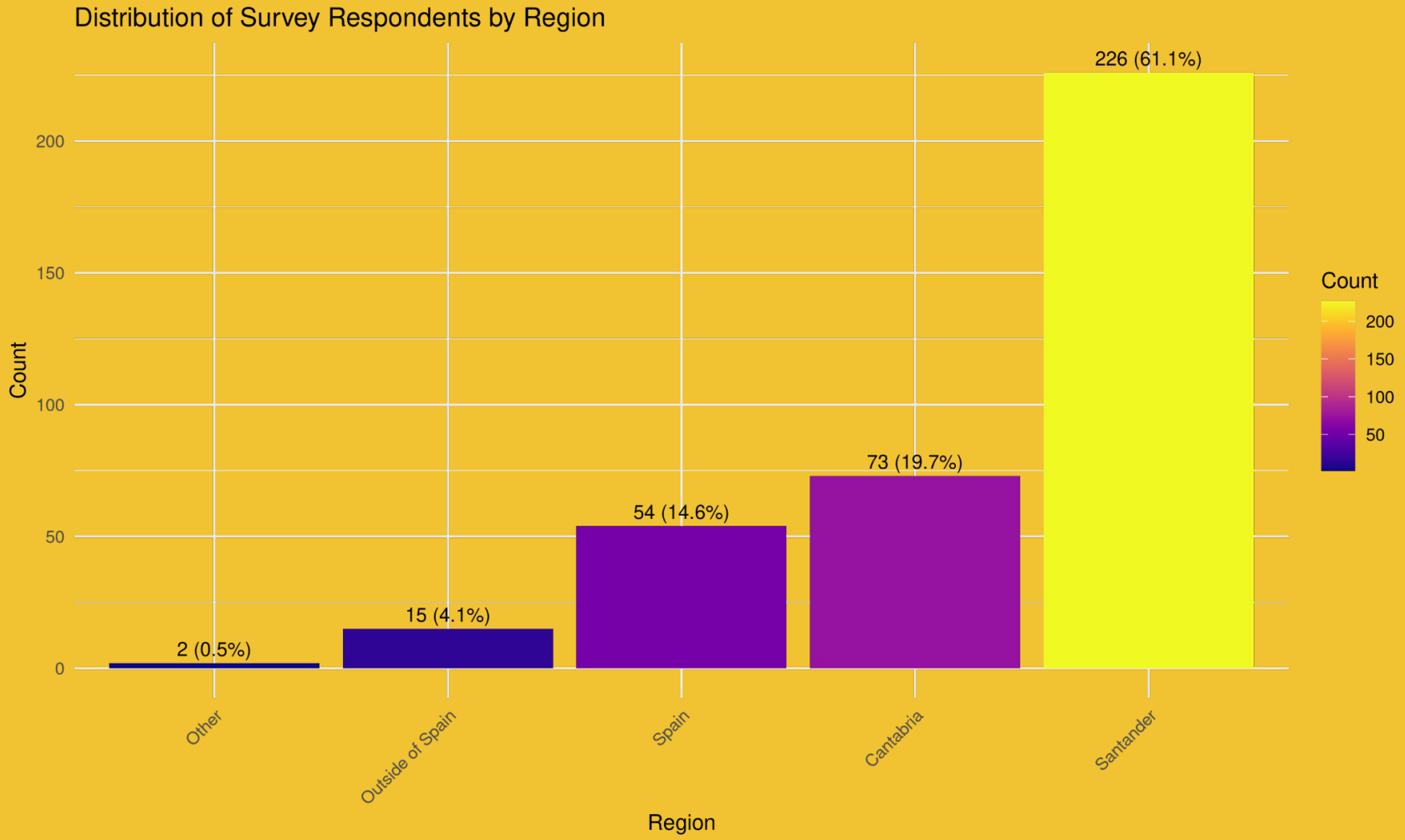
1. Santander Dominates Bikesharing Usage

- Santander likely has a **well-established bikesharing infrastructure**, making it convenient and accessible.

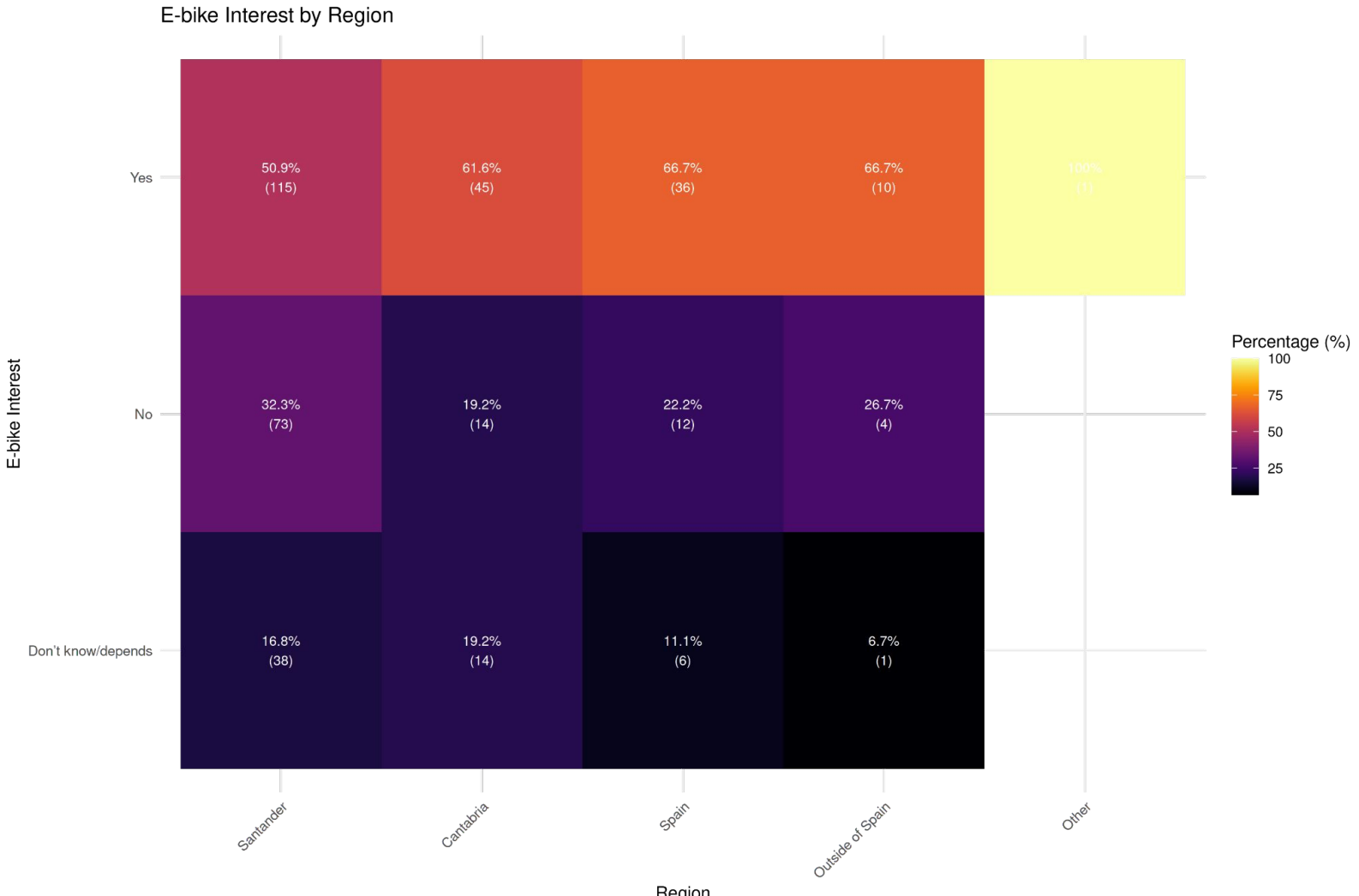
2. Moderate Usage from Cantabria

3. Moderate Usage from Other Parts of Spain

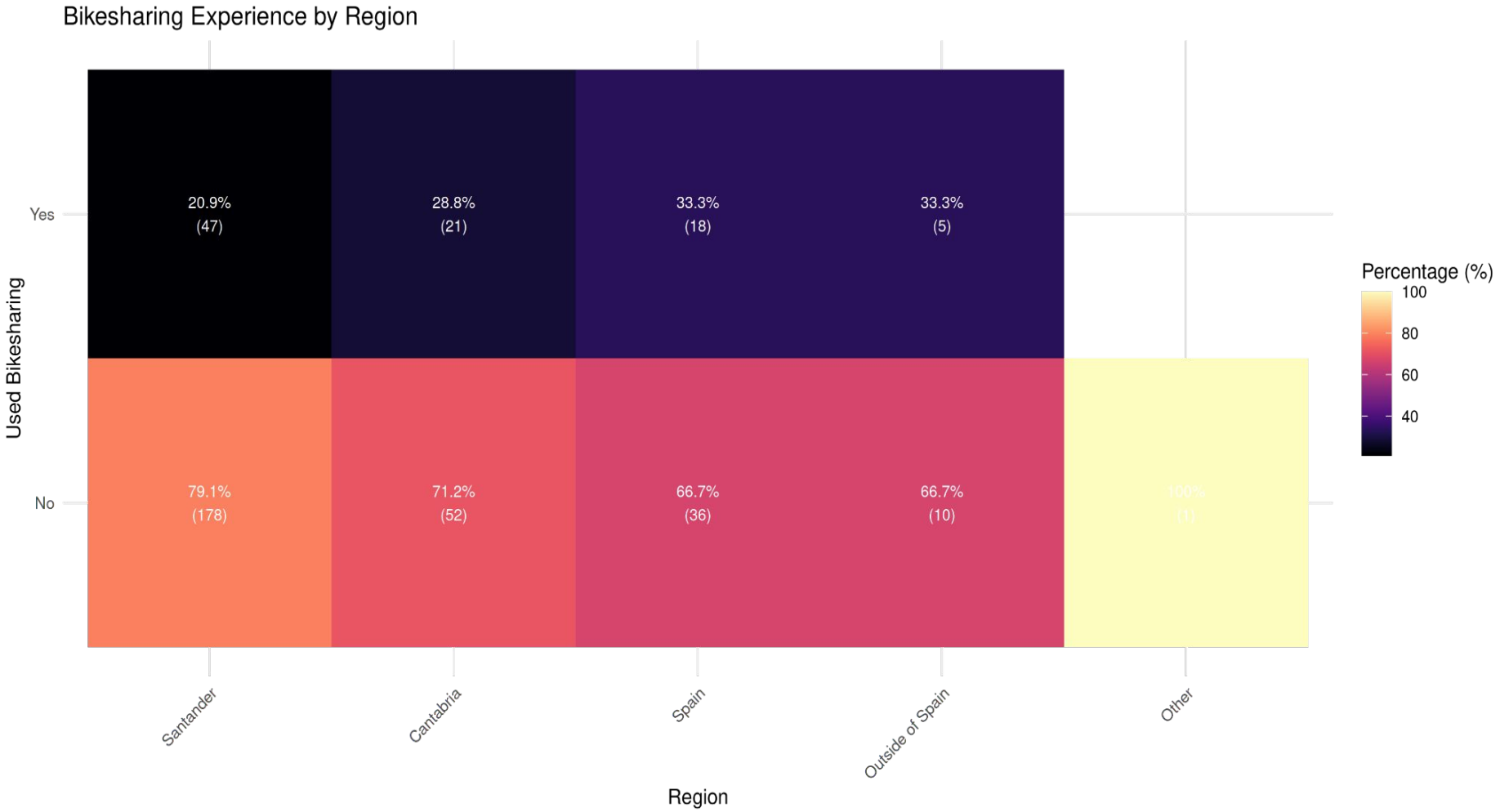
4. Minimal Usage from Outside Spain


Distribution of Survey Respondents by Region
Count
200
150
100
50
0
2 (0.5%)
15 (4.1%)
54 (14.6%)
73 (19.7%)
226 (61.1%)
Other
Outside of Spain
Spain
Cantabria
Santander
Region
Count
200
150
100
50

This graph clearly highlights the concentration of bikesharing users across different regions in Spain. It is evident that **Santander** dominates in terms of user base, followed by **Cantabria** and **other parts of Spain**. The lower participation from regions outside of Spain suggests that bikesharing remains a locally driven initiative. This strong local engagement, especially in Santander, may be attributed to better infrastructure, awareness campaigns, and integration with other modes of public transport.


E-bike Interest by Region
E-bike Interest
Yes
No
Don't know/depends
50.9%
(115)
61.6%
(45)
66.7%
(36)
66.7%
(10)
100%
(1)
32.3%
(73)
19.2%
(14)
22.2%
(12)
26.7%
(4)
16.8%
(38)
19.2%
(14)
11.1%
(6)
6.7%
(1)
Santander
Cantabria
Spain
Outside of Spain
Other
Region
Percentage (%)
100
75
50
25

This heatmap visualizes the willingness of individuals from different regions to use e-bikes. It is evident that **interest is highest in areas outside Spain and in less represented regions**, with **100%** of respondents from "Other" regions and **66–67%** from places like Spain, Cantabria, and outside Spain indicating a **strong preference** for using e-bikes. Santander also shows significant interest, although there's a larger portion of respondents who are unsure or hesitant. This could reflect either infrastructure readiness or awareness levels in different regions. Overall, the trend suggests a **positive attitude toward sustainable transport**, especially in less saturated or more open-minded areas.


Bikesharing Experience by Region
Used Bikesharing
Yes
No
20.9%
(47)
28.8%
(21)
33.3%
(18)
33.3%
(5)
79.1%
(178)
71.2%
(52)
66.7%
(36)
66.7%
(10)
100%
(1)
Santander
Cantabria
Spain
Outside of Spain
Other
Region
Percentage (%)
100
80
60
40

This heatmap presents the willingness of individuals in different regions to use **non-electric (regular) bikes**. The results show a contrasting trend compared to e-bikes—**a significant majority across all regions expressed disinterest** in using regular bikes, with **Santander showing the highest proportion of "No" responses (79.1%)**. Interestingly, the willingness to use regular bikes was slightly higher outside Spain and in other regions, indicating **potential cultural or infrastructural differences** influencing these decisions. These findings highlight a strong **preference for e-bikes over traditional bikes**, likely due to convenience, terrain, or modern lifestyle choices.


Age Distribution by Region
Under 25
75 and over
65-74
55-64
45-54
35-44
25-34
Age Group
17.3% (39)
19.2% (14)
20.4% (11)
20% (3)
7.1% (16)
5.5% (4)
3.7% (2)
11.6% (26)
12.3% (9)
9.3% (5)
6.7% (1)
17.3% (39)
13.7% (10)
24.1% (13)
20% (3)
100% (1)
14.2% (32)
20.5% (15)
9.3% (5)
26.7% (4)
17.3% (39)
11% (8)
16.7% (9)
6.7% (1)
15.1% (34)
17.8% (13)
16.7% (9)
20% (3)
Santander
Cantabria
Spain
Outside of Spain
Other
Region
Percentage (%)
100
75
50
25

This heatmap shows the **distribution of bike sharing users across different age groups and regions**. We can observe that **younger and middle-aged groups (under 25 to 55-64)** are more actively involved, especially in **Santander and Cantabria**, whereas participation decreases notably among those aged **65 and above**, especially in **Spain and outside Spain**. The **55-64 age group** shows relatively higher engagement outside major regions, indicating a **broadening interest in sustainable transport even among older demographics**. These patterns emphasize the importance of **age-inclusive infrastructure and promotional strategies** to enhance bike sharing participation across all age groups.

Chi-squared Test

The **Chi-Square Test** is a statistical method used to determine whether there is a significant association between categorical variables or if observed frequencies differ from expected ones.

There are two main types:

- **Test for Independence**: Checks if two variables are related.
- **Goodness-of-Fit Test**: Checks if data fits a theoretical distribution.

Formula: $$X^2 = \sum_i \frac{\left(O_i - E_i\right)^2}{E_i}$$

Oi = **Observed frequency** in each category
Ei = **Expected frequency** in each category (under the assumption of no association)
The sum is taken over **all cells** in the contingency table.

Why Chi-Square?

We used the Chi-square test to examine relationships between categorical variables in our survey data, such as age, gender, education, and bikesharing/e-bike usage. Since both the independent and dependent variables are categorical, the Chi-square test is appropriate for identifying whether there are statistically significant associations between them.Most other tests only deal with numerical data.

List of all the relationships for performing Chi-Square Test

- Place of residence vs bikesharing
- Indicate your age vs e-bike
- Place of residence vs e-bike
- Indicate your gender vs bikesharing
- Indicate your age vs bikesharing
- What is your employment status? Vs bikesharing

- Bikesharing vs e-bike
- Indicate your gender vs e-bike
- Level of education vs e-bike
- Level of education vs bikesharing
- What is your employment status? vs e-bike!

P-value and significance

The **p-value** is the probability of getting the observed results (or more extreme) **if the null hypothesis were true**.

- A **low p-value** means the observed data is **unlikely** under the assumption of no association.
- A **high p-value** means the observed data is **likely** under the null hypothesis.

A result is **statistically significant** if the **p-value is less than a chosen threshold** (commonly **0.05**).

- If **p < 0.05** → we **reject the null hypothesis** → the result is **significant**.
- If **p ≥ 0.05** → we **fail to reject the null hypothesis** → the result is **not significant**.

Chi-square test: Indicate your age x Have you ever used bikesharing (shared bicycles)?

	No	Yes
25-34	40	19
35-44	36	19
45-54	44	11
55-64	53	13
65-74	31	10
75 and over	19	3
Under 25	51	15

Chi-square value: 7.776459

Degrees of freedom: 6

Chi-square test: Indicate your age x Have you ever used bikesharing (shared bicycles)?

	No	Yes
25-34	40	19
35-44	36	19
45-54	44	11
55-64	53	13
65-74	31	10
75 and over	19	3
Under 25	51	15

Chi-square value: 7.776459

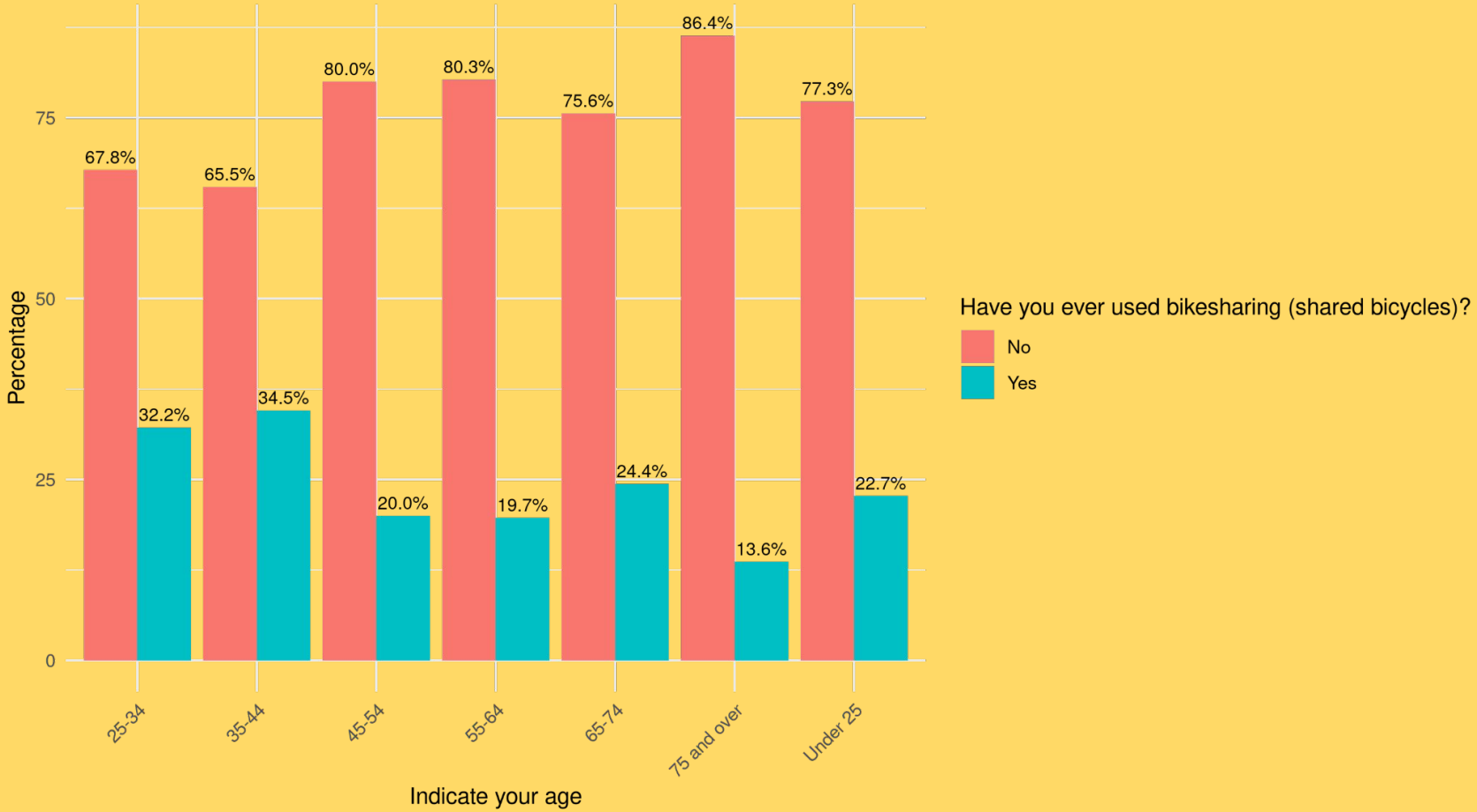
Degrees of freedom: 6

p-value: 0.2549422

Significant (p < 0.05): FALSE

Chi-square test: Indicate your age x Have you ever used bikesharing (shared bicycles)?

p-value = 0.2549 (not significant)



Chi-square test: Indicate your age x If available, would you use a shared electric bike system in Santander?

	Don’t know/depends	No	Yes
25-34	12	11	36
35-44	8	15	33
45-54	6	14	35
55-64	13	19	34
65-74	6	17	18
75 and over	5	10	7
Under 25	7	16	43

Chi-square value: 17.06092

Degrees of freedom: 12

Chi-square test: Indicate your age x If available, would you use a shared electric bike system in Santander?

	Don’t know/depends	No	Yes
25-34	12	11	36
35-44	8	15	33
45-54	6	14	35
55-64	13	19	34
65-74	6	17	18
75 and over	5	10	7
Under 25	7	16	43

Chi-square value: 17.06092

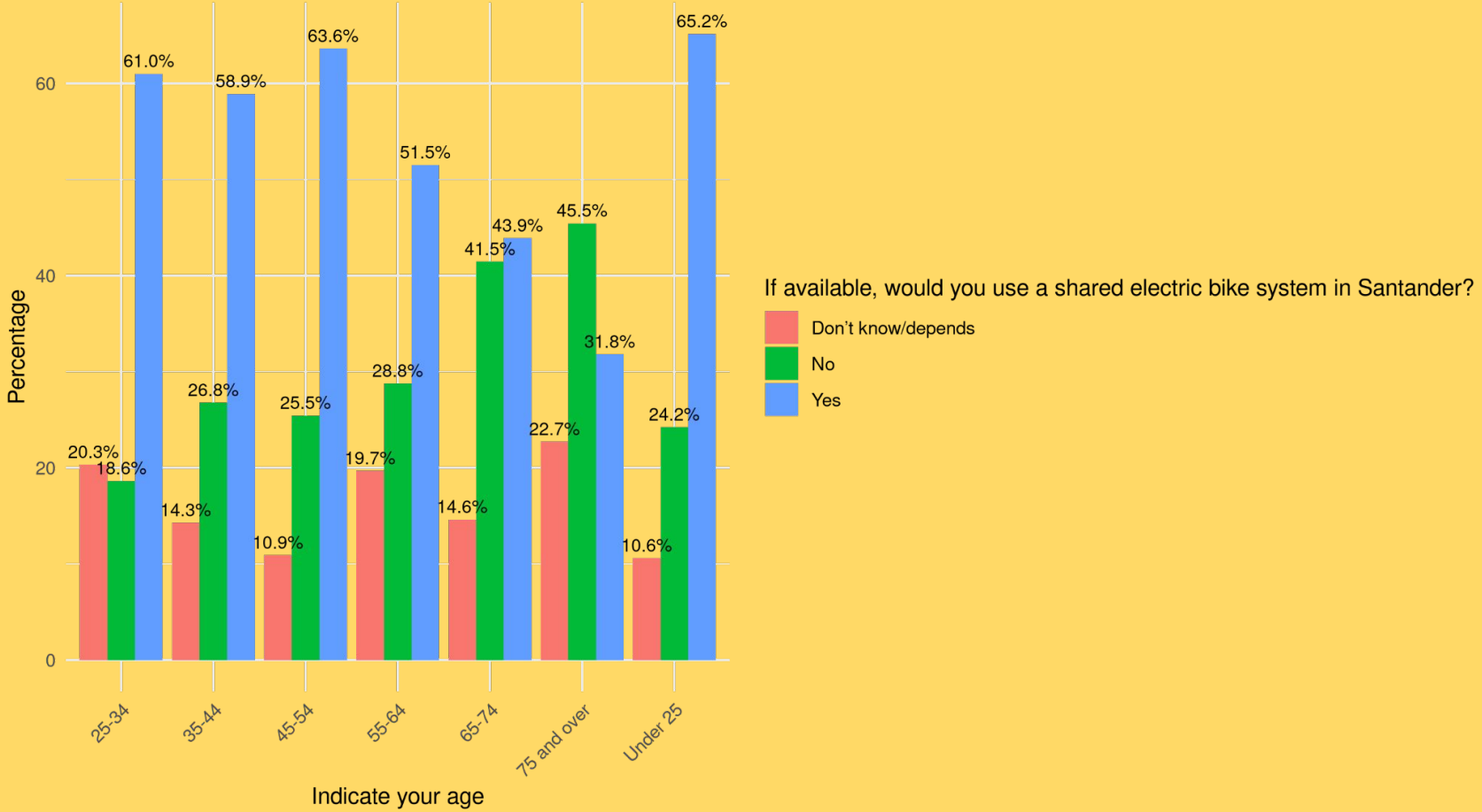
Degrees of freedom: 12

p-value: 0.1473201

Significant (p < 0.05): FALSE

Chi-square test: Indicate your age x If available, would you use a shared electric bike system in Santander?

p-value = 0.1473 (not significant)



Chi-square test: Indicate your gender x Have you ever used bikesharing (shared bicycles)?

	No	Yes
Female	151	42
Male	116	47
Prefer not to specify	7	1

Chi-square value: 3.031914

Degrees of freedom: 2

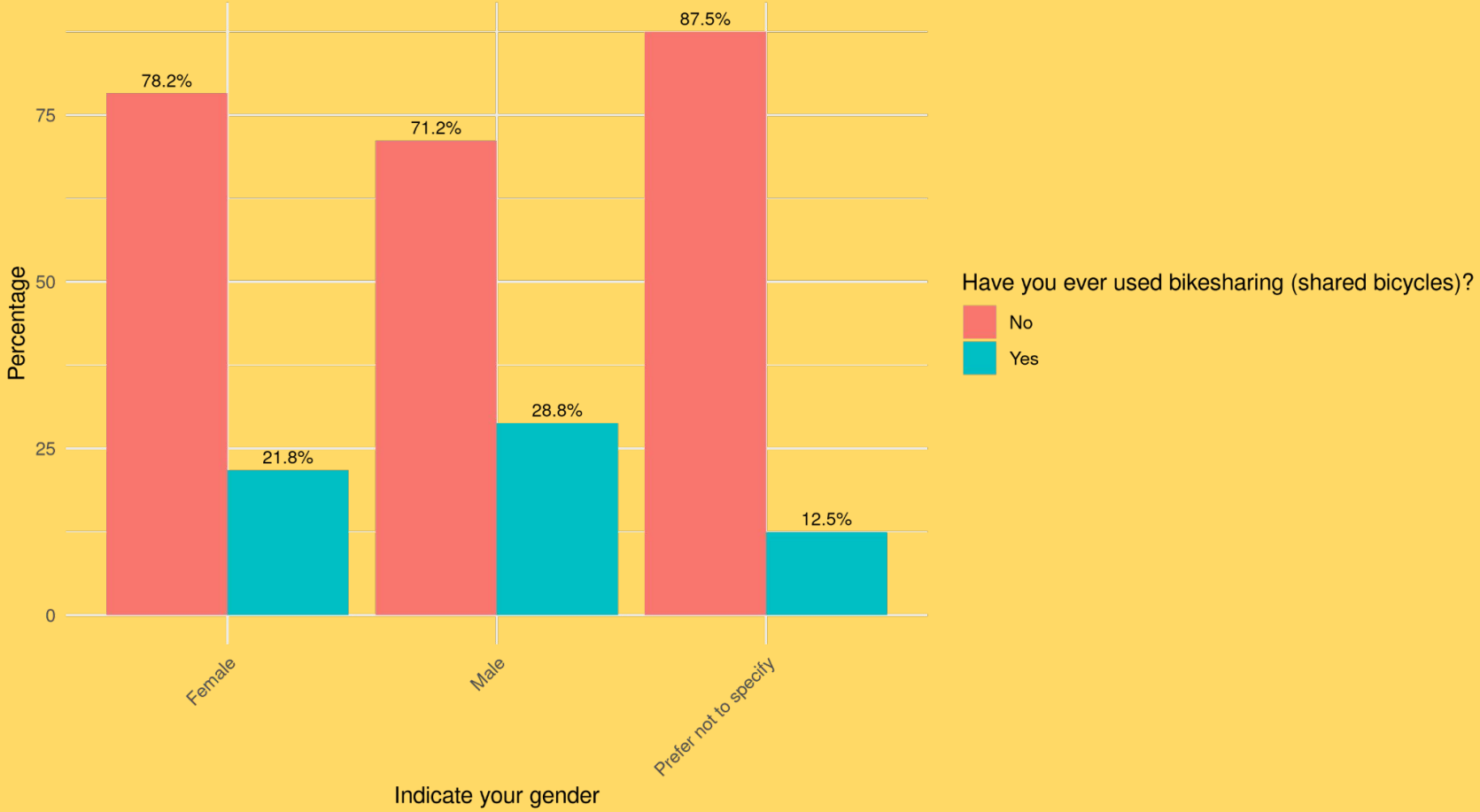
```
Chi-square test: Indicate your gender x Have you ever used bikesharing (shared bicycles)?
----------------------------------------


                         No Yes
  Female                151  42
  Male                  116  47
  Prefer not to specify   7   1

Chi-square value: 3.031914
Degrees of freedom: 2
p-value: 0.2195979
Significant (p < 0.05): FALSE
```

Chi-square test: Indicate your gender x Have you ever used bikesharing (shared bicycles)?

p-value = 0.2196 (not significant)



Chi-square test: Place of residence x If available, would you use a shared electric bike system in Santander?

	Don’t know/depends	No	Yes
Cantabria	13	14	45
Outside of Spain	1	4	10
Santander	37	72	114
Spain	6	12	36

Chi-square value: 8.741993

Degrees of freedom: 6

:Chi-square test: Indicate your gender x If available, would you use a shared electric bike system in Santander

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	Don’t know/depends	No	Yes
Female	24	60	109
Male	27	41	96
Prefer not to specify	6	1	1

Chi-square value: 24.12986

Degrees of freedom: 4

Chi-square test: Place of residence x If available, would you use a shared electric bike system in Santander?

	Don’t know/depends	No	Yes
Cantabria	13	14	45
Outside of Spain	1	4	10
Santander	37	72	114
Spain	6	12	36

Chi-square value: 8.741993

Degrees of freedom: 6

p-value: 0.1886165

Significant (p < 0.05):Chi-square test: Indicate your gender x If available, would you use a shared electric bike system in Santander

---

	Don’t know/depends	No	Yes
Female	24	60	109
Male	27	41	96
Prefer not to specify	6	1	1

Chi-square value: 24.12986

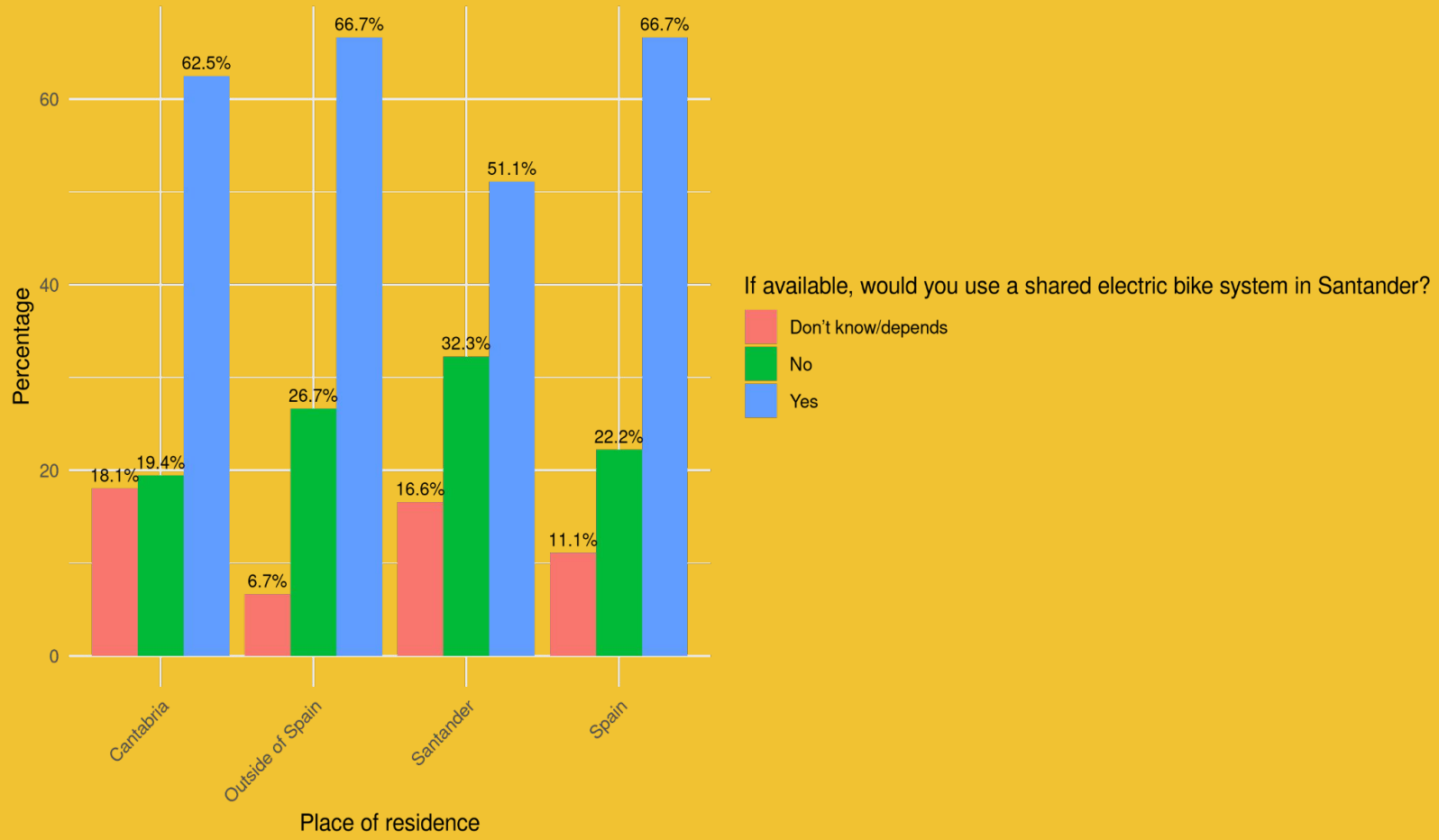
Degrees of freedom: 4

p-value: 7.522731e-05

Significant (p < 0.05): TRUE FALSE

Chi-square test: Place of residence x If available, would you use a shared electric bike system in Santander?

p-value = 0.1886 (not significant)



Chi-square test: Level of education x Have you ever used bikesharing (shared bicycles)?

	No	Yes
High School	18	9
High School Diploma	106	19
None	6	1
School graduate	29	4
University	114	56

Chi-square value: 16.6201

Degrees of freedom: 4

Chi-square test: Level of education x Have you ever used bikesharing (shared bicycles)?

	No	Yes
High School	18	9
High School Diploma	106	19
None	6	1
School graduate	29	4
University	114	56

Chi-square value: 16.6201

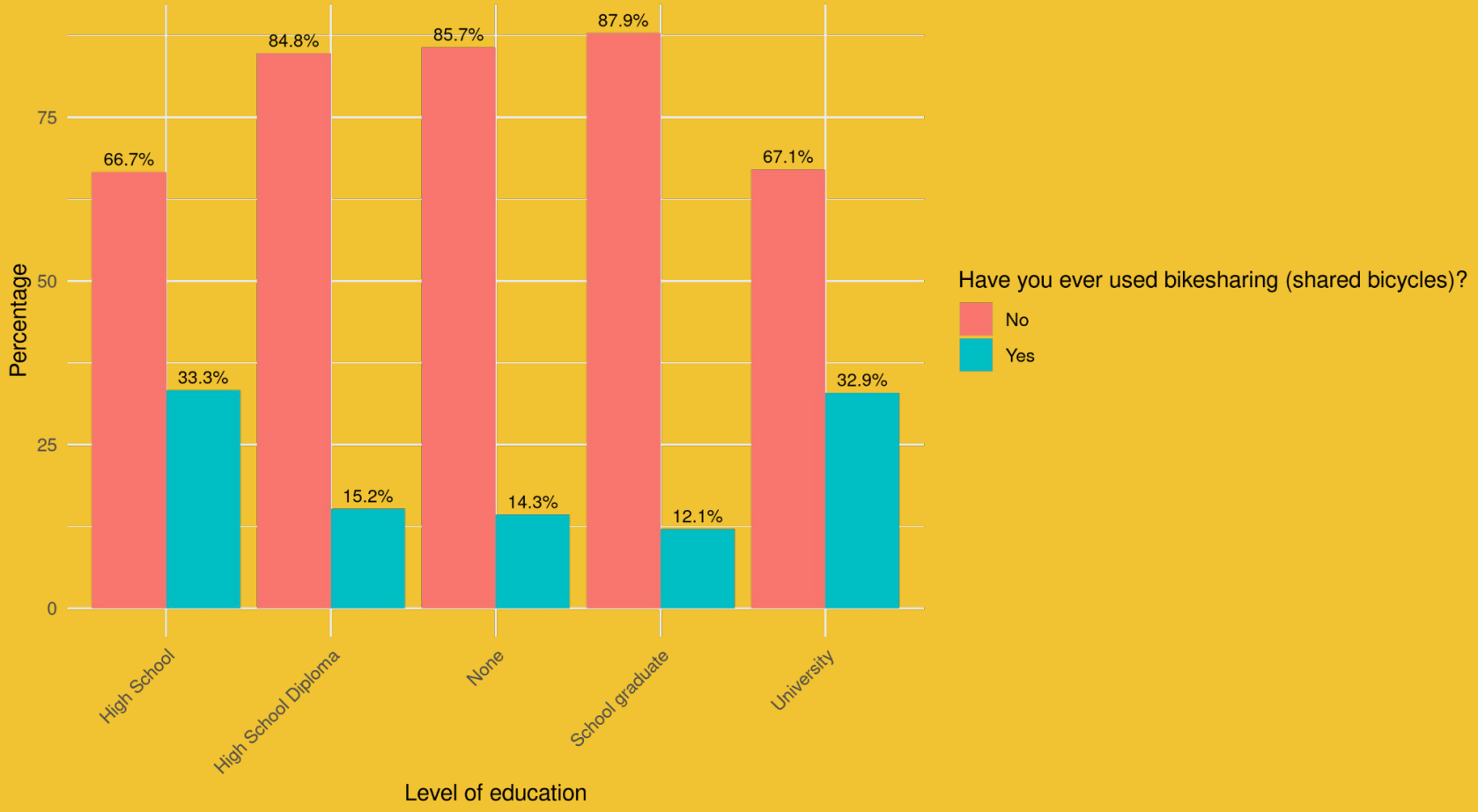
Degrees of freedom: 4

p-value: 0.002290571

Significant (p < 0.05): TRUE

Chi-square test: Level of education x Have you ever used bikesharing (shared bicycles)?

p-value = 0.0023 (significant)



Chi-square test: Level of education x If available, would you use a shared electric bike system in Santander?

	Don’t know/depends	No	Yes
High School	6	7	14
High School Diploma	21	34	70
None	4	2	1
School graduate	6	17	11
University	20	42	108

Chi-square value: 24.17076

Degrees of freedom: 8

Chi-square test: Level of education x If available, would you use a shared electric bike system in Santander?

	Don’t know/depends	No	Yes
High School	6	7	14
High School Diploma	21	34	70
None	4	2	1
School graduate	6	17	11
University	20	42	108

Chi-square value: 24.17076

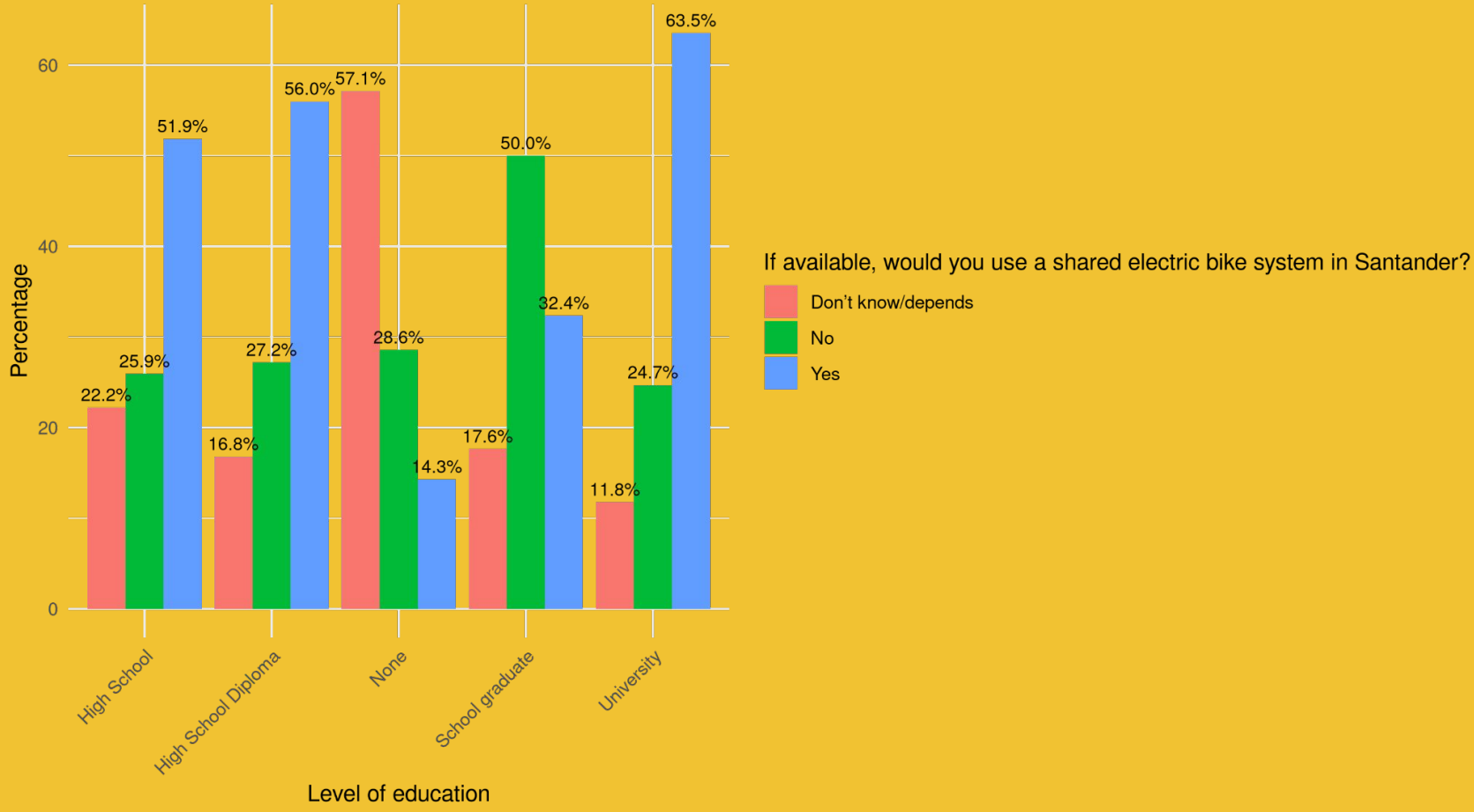
Degrees of freedom: 8

p-value: 0.00214545

Significant (p < 0.05): TRUE

Chi-square test: Level of education x If available, would you use a shared electric bike system in Santander?

p-value = 0.0021 (significant)



Chi-square test: Place of residence x Have you ever used bikesharing (shared bicycles)?

	No	Yes
Cantabria	51	21
Outside of Spain	10	5
Santander	176	46
Spain	36	18

Chi-square value: 5.412068

Degrees of freedom: 3

Chi-square test: Place of residence x Have you ever used bikesharing (shared bicycles)?

	No	Yes
Cantabria	51	21
Outside of Spain	10	5
Santander	176	46
Spain	36	18

Chi-square value: 5.412068

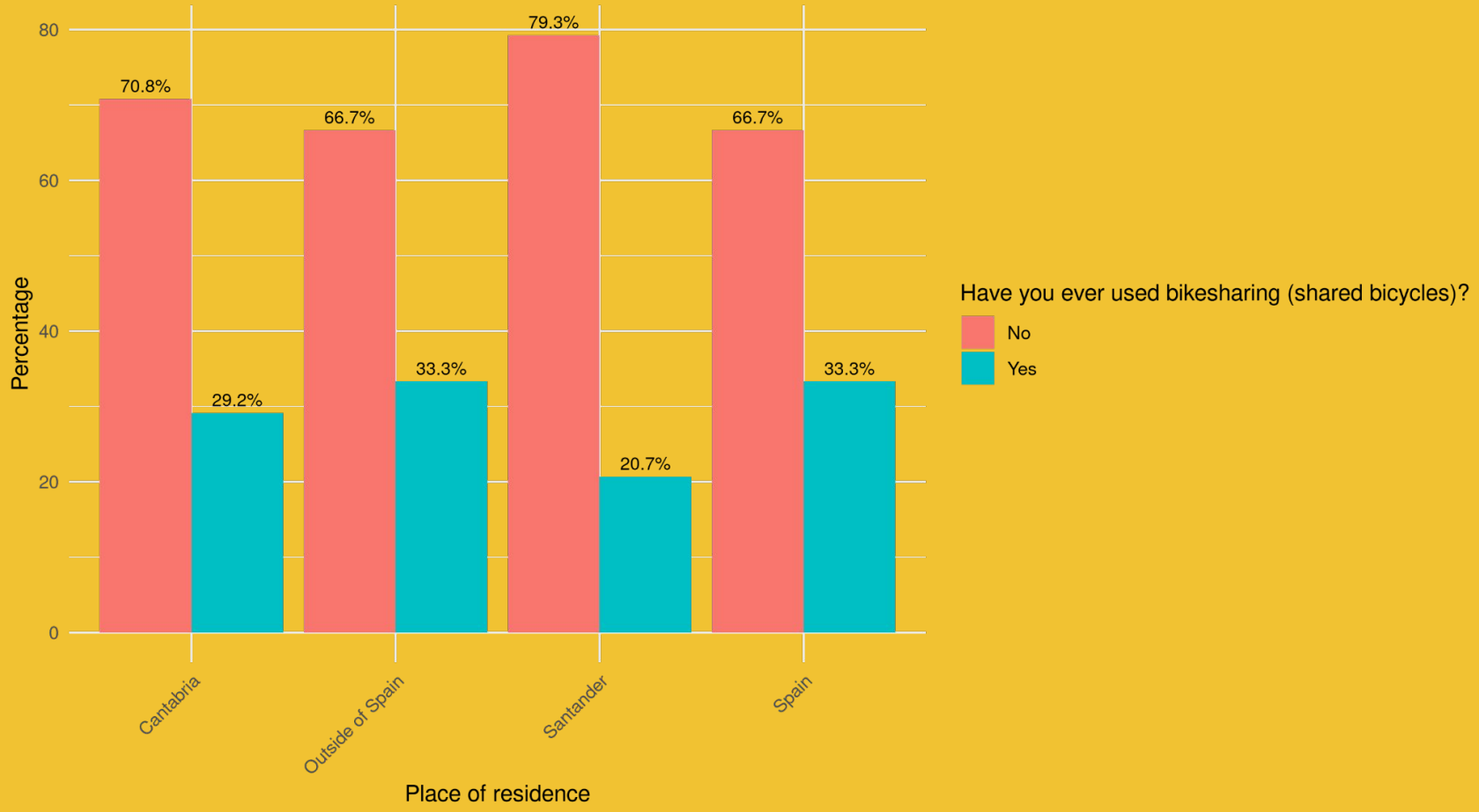
Degrees of freedom: 3

p-value: 0.1439936

Significant (p < 0.05): FALSE

Chi-square test: Place of residence x Have you ever used bikesharing (shared bicycles)?

p-value = 0.144 (not significant)



Chi-square test: Place of residence x If available, would you use a shared electric bike system in Santander?

	Don’t know/depends	No	Yes
Cantabria	13	14	45
Outside of Spain	1	4	10
Santander	37	72	114
Spain	6	12	36

Chi-square value: 8.741993

Degrees of freedom: 6

Chi-square test: Place of residence x If available, would you use a shared electric bike system in Santander?

	Don’t know/depends	No	Yes
Cantabria	13	14	45
Outside of Spain	1	4	10
Santander	37	72	114
Spain	6	12	36

Chi-square value: 8.741993

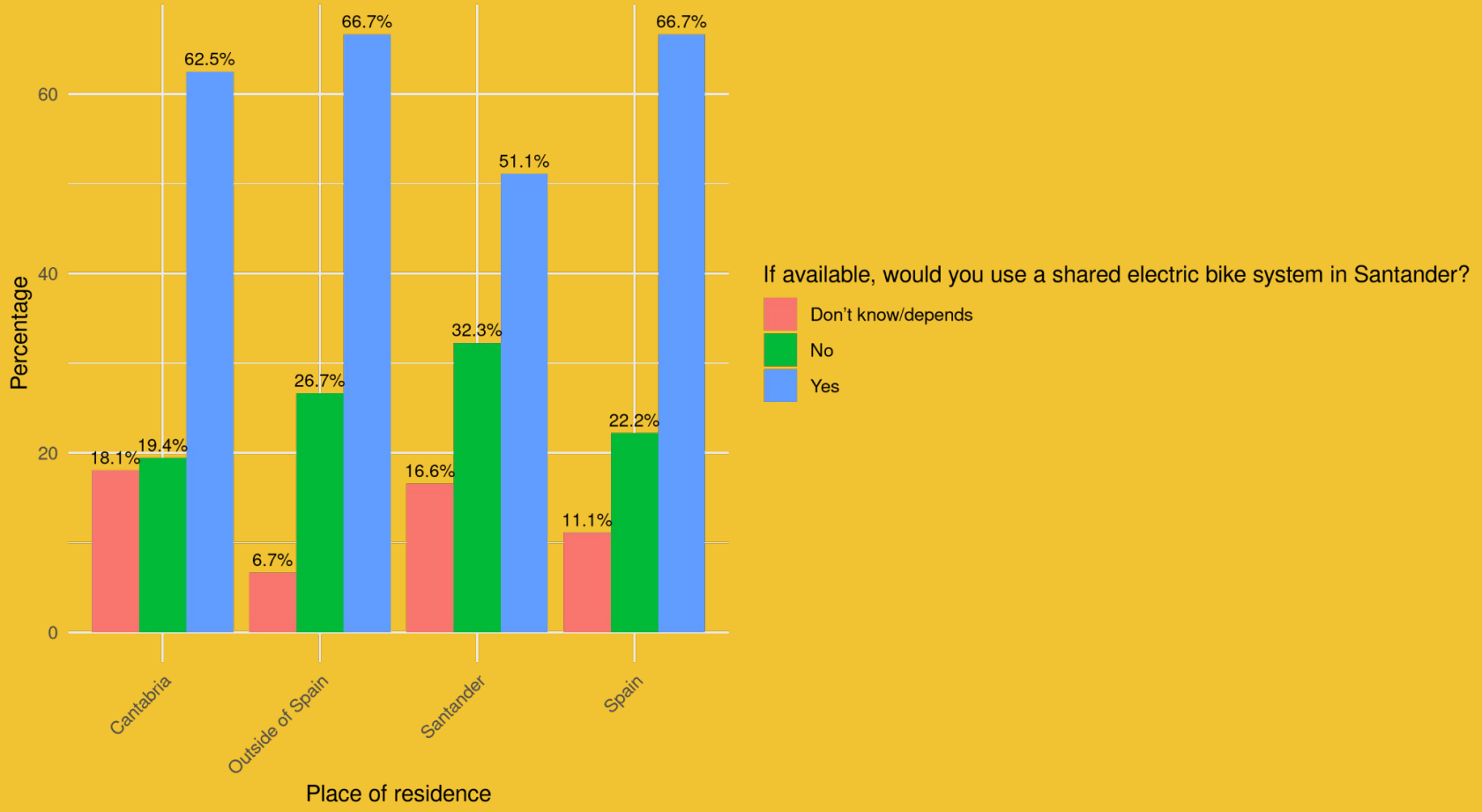
Degrees of freedom: 6

p-value: 0.1886165

Significant (p < 0.05): FALSE

Chi-square test: Place of residence x If available, would you use a shared electric bike system in Santander?

p-value = 0.1886 (not significant)



```
Chi-square test: What is your employment status? x Have you ever used bikesharing (shared bicycles)?
---------------------------------------


                 No Yes
  1               1   0
  Employee      117  43
  Housework       9   5
  Retired        58  14
  Self-employed  17   8
  Student        47  15
  Unemployed     25   5

Chi-square value: 4.47996
Degrees of freedom: 6
```

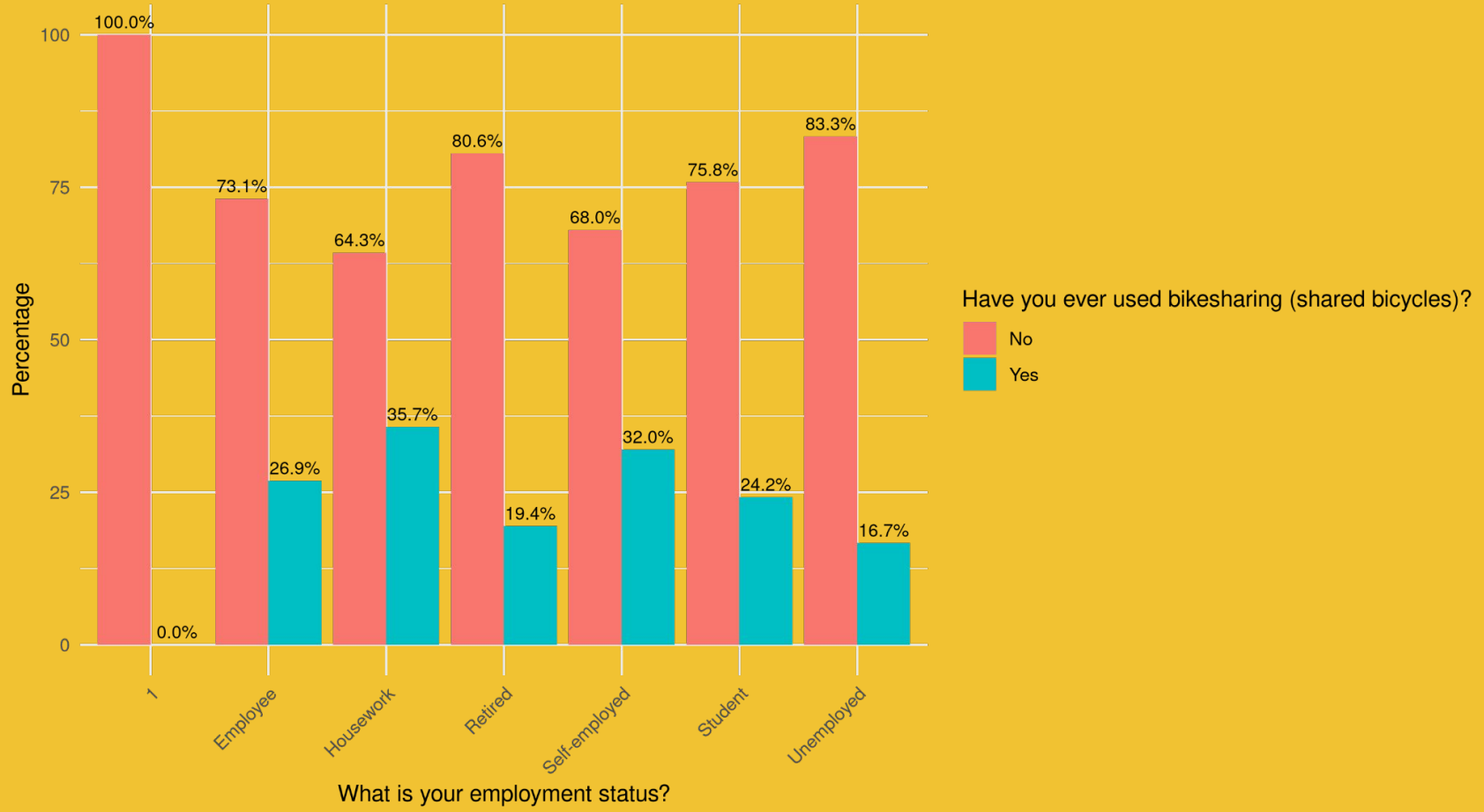
```
Chi-square test: What is your employment status? x Have you ever used bikesharing (shared bicycles)?
----------------------------------------

                No Yes
  1              1   0
  Employee     117  43
  Housework      9   5
  Retired       58  14
  Self-employed 17   8
  Student       47  15
  Unemployed    25   5

Chi-square value: 4.47996
Degrees of freedom: 6
p-value: 0.612014
Significant (p < 0.05): FALSE
```

Chi-square test: What is your employment status? x Have you ever used bikesharing (shared bicycles)?

p-value = 0.612 (not significant)



Chi-square test: What is your employment status? x If available, would you use a shared electric bike system in Santander?

	Don’t know/depends	No	Yes
1	0	1	0
Employee	21	39	100
Housework	6	4	4
Retired	13	27	32
Self-employed	6	6	13
Student	7	13	42
Unemployed	4	12	15

Chi-square value: 24.39431

Degrees of freedom: 12

Chi-square test: What is your employment status? x If available, would you use a shared electric bike system in Santander?

	Don’t know/depends	No	Yes
1	0	1	0
Employee	21	39	100
Housework	6	4	4
Retired	13	27	32
Self-employed	6	6	13
Student	7	13	42
Unemployed	4	12	15

Chi-square value: 24.39431

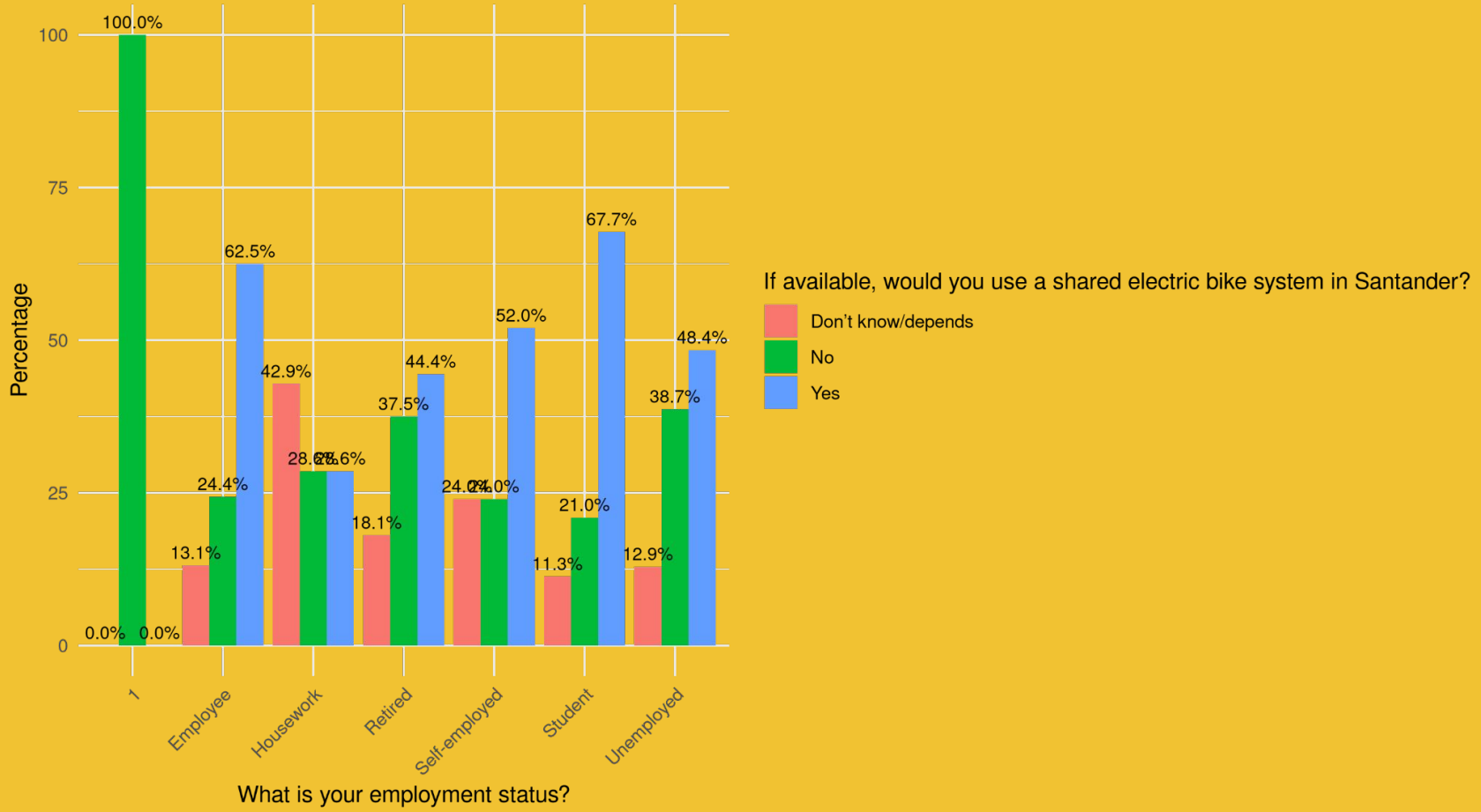
Degrees of freedom: 12

p-value: 0.01796873

Significant (p < 0.05): TRUE

Chi-square test: What is your employment status? x If available, would you use a shared electric bike system in Santa

p-value = 0.018 (significant)



	Relationship	ChiSquare	DoF	PValue	Significant
X-squared4	Place of residence vs bikesharing	5.412068	3	1.439936e-01	FALSE
X-squared6	Indicate your age vs e-bike	17.060918	12	1.473201e-01	FALSE
X-squared9	Place of residence vs e-bike	8.741993	6	1.886165e-01	FALSE
X-squared	Indicate your gender vs bikesharing	3.031914	2	2.195979e-01	FALSE
X-squared1	Indicate your age vs bikesharing	7.776459	6	2.549422e-01	FALSE
X-squared3	What is your employment status? vs bikesharing	4.479960	6	6.120140e-01	FALSE
X-squared10	bikesharing vs e-bike	35.999092	2	1.523689e-08	TRUE
X-squared5	Indicate your gender vs e-bike	24.129855	4	7.522731e-05	TRUE
X-squared7	Level of education vs e-bike	24.170757	8	2.145450e-03	TRUE
X-squared2	Level of education vs bikesharing	16.620097	4	2.290571e-03	TRUE
X-squared8	What is your employment status? vs e-bike	24.394309	12	1.796873e-02	TRUE

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Limitations :

A limitation of the study is that data has been collected in a city with the specific characteristics described. Future research should explore various populations and settings to compareand analyze the findings.

Conclusion :

This study of bikesharing service usage across Spain reveals meaningful trends in user demographics. The findings suggest that bikesharing is predominantly embraced by younger, educated, and employed individuals, especially those residing in urban areas like Santander. These insights not only help in understanding current user behavior but also offer direction for future improvements in service accessibility and outreach.

Acknowledgement

Thank you all for your time and attention. I hope this presentation offered some useful insights into bikesharing trends in Spain.

And Special Thanks to our Professor Rituparna Sen for providing us this opportunity as it helped us to learn a lot.