

Technical Summary

Mapping Sustainable Development Goals in Turkish Municipalities

A Technical Report Prepared for
United Cities and Local Governments
Middle East and West Asia (UCLG-MEWA)
European Commission Funded Project

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This report presents the methodology and findings of a comprehensive analysis
of 2,223 municipal projects across 15 Turkish municipalities,
evaluating their alignment with UN Sustainable Development Goals.

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1 Introduction

We evaluate municipality projects based on whether, and the extent to which, each project aligns with the Sustainable Development Goals (SDGs). These projects generally relate to one primary area of the SDGs and, sometimes, to another secondary area. Given the primary and, if applicable, secondary goal of each project relating to the SDGs, the report extracts the importance of each sustainable development goal for 2,223 projects presented by the municipalities participating in our pilot project.

We consider two different approaches to extract this information, each with different implications for data collection. The first approach is to ask experts to score each goal for each project on a scale of 0 to 100. An example question would be: "From 0 to 100, what is the importance of Goal X for this project?" Because respondents rate each goal separately from other goals, they make absolute judgments between 0 and 100. Research indicates that people vary in their judgments (Friedman and Amoo, 1999). Consequently, this format makes the problematic assumption that respondents interpret the same scores in the same way. For example, a score of 70 might mean different things to different respondents, leading to both systematic measurement error (due to tendencies to choose or avoid extremes) and non-systematic measurement errors (due to inconsistent ratings at different times) (Van Herk, Poortinga and Verhallen, 2004).

The pair-comparison method overcomes the inefficiencies and biases inherent in absolute judgments. Instead of evaluating each goal separately, respondents are asked to make relative judgments: "Considering these seventeen goals, which goal describes this project the best?" to identify the primary SDG area of the project, and "Considering the remaining sixteen goals, which goal describes this project the best?" to code the secondary SDG area of the project. As a result, we adopt the more valid and reliable approach of paired comparisons.

This technical summary proceeds as follows: The next section introduces the raw data. The following section defines the substantive problem and introduces the statistical methodology. The final section presents the results of the statistical analysis.

2 Data

Our pilot project codes 2,223 projects from 15 municipalities based on the extent to which they align with the 17 Sustainable Development Goals (SDGs). The coding decisions are made based on the projects' stated purposes as well as interviews with experts representing each municipality. Among these projects, 1,192 focus on only one SDG, while 1,031 are reported to have a secondary goal in addition to their primary goal.

As shown in Table 1, the top three reported primary goals predominantly include SDG 11 (Sustainable Cities and Communities), SDG 3 (Good Health and Well-being), and SDG 4 (Quality Education). In the aggregate data for all municipalities, presented in Table 2, similar trends emerge: 30.4% of all projects (676 projects) focus on SDG 11, 11.3% (251 projects) on SDG 3, 10.6% (236 projects) on SDG 4, and 10.1% (226 projects) on SDG 16 (Peace, Justice, and Strong Institutions) as their primary goal.

Table 1: Goals of Projects by Municipalities

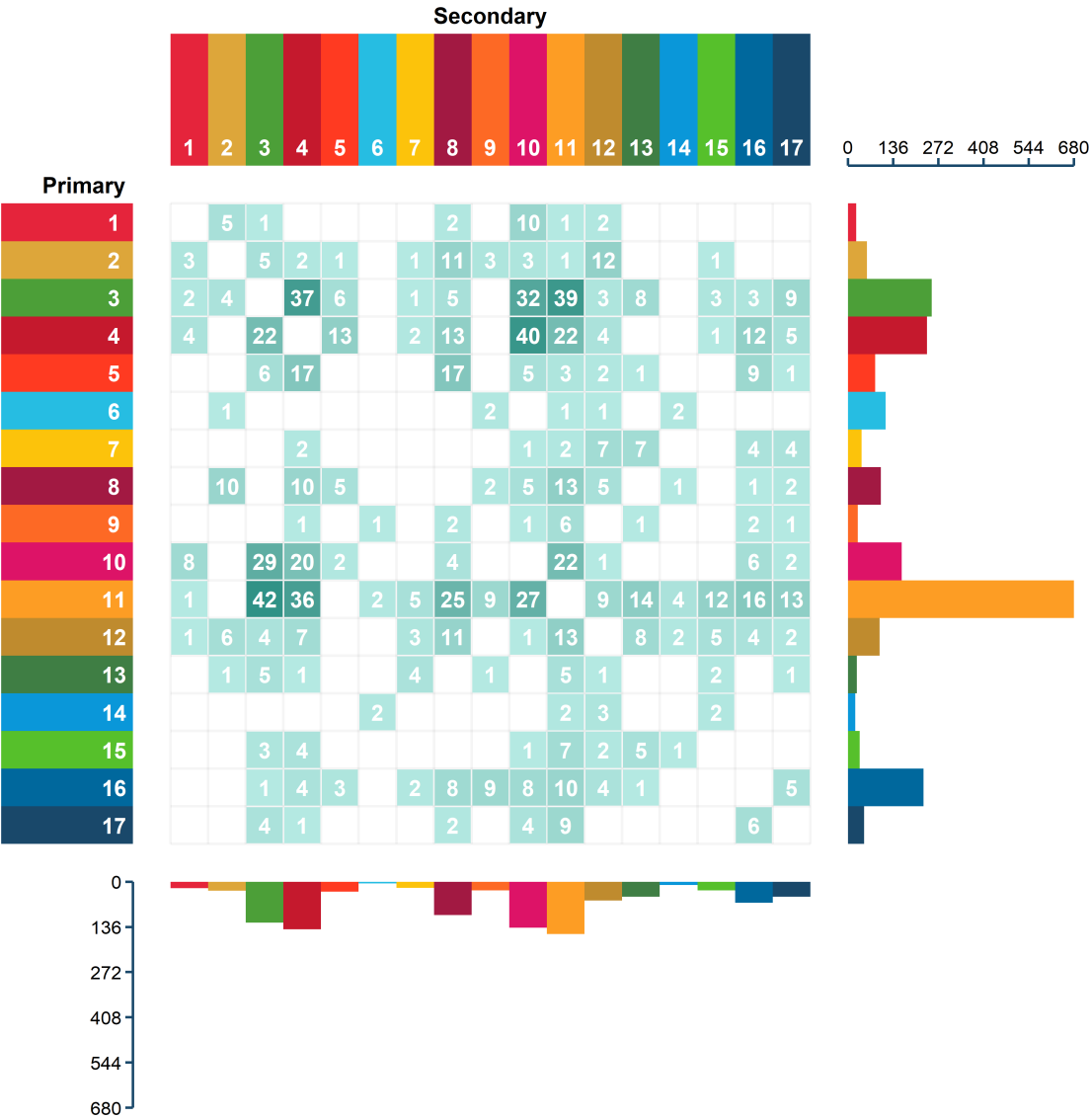
Municipality	Project	%	First	Second	Third
Eyyübiye	50	2.2%	11(17)	4(10)	3(8)
Gaziantep	216	9.7%	11(102)	4(34)	3(32)
Gebze	73	3.3%	11(24)	3(20)	10(19)
Karesi	193	8.7%	11(74)	10(47)	3(34)
Mersin	240	10.8%	6(91)	11(57)	8(30)
Mezitli	98	4.4%	4(27)	11(25)	10(21)
Nilüfer	233	10.5%	11(104)	4(52)	10(38)
Ordu	189	8.5%	11(109)	16(21)	4(20)
Pendik	153	6.9%	4(40)	3(39)	11(35)
Sancaktepe	149	6.7%	11(54)	4(32)	3(22)
Seferihisar	57	2.6%	11(22)	12(11)	16(9)
Selçuklu	138	6.2%	16(44)	11(43)	3(28)
Zeytinburnu	146	6.6%	3(47)	11(36)	4(33)
Çanakkale	157	7.1%	11(65)	3(21)	16(20)
Şişli	131	5.9%	11(67)	3(26)	16(21)

Notes: The entries under “First,” “Second,” and “Third” indicate the SDG, with the number of projects primarily or secondarily aligned with it shown in parentheses. The total number of projects is 2,223.

Table 2: Frequencies of SDGs as Primary Goals

Primary SDG	Frequency	%
1	25	1.13%
2	57	2.57%
3	251	11.31%
4	236	10.63%
5	81	3.65%
6	113	5.09%
7	41	1.85%
8	98	4.41%
9	29	1.31%
10	161	7.25%
11	676	30.45%
12	95	4.28%
13	26	1.17%
14	22	0.99%
15	35	1.58%
16	226	10.18%
17	48	2.16%

Figure 1: Heatmap and Bar Plots of Primary and Secondary Goals



Approximately 47% of all projects (1,031 projects) have an additional goal alongside their main goal. These projects represent a mixture of a primary and a secondary goal. In Figure 1, we present the intersection of primary and secondary goals in a heatmap (the central area with different shades of blue) along with horizontal and vertical bar plots that indicate the frequency of a given goal as the primary or secondary goal, respectively.

For example, there are 42 projects with SDG 11 (Sustainable Cities and Communities) as the primary goal and SDG 3 (Good Health and Well-being) as the secondary goal. The horizontal orange bar shows that 676 projects have SDG 11 as their primary area. Similarly, the red vertical bar below SDG 4 highlights that 142 projects have SDG 4 as their secondary goal.

Figure 1 highlights a few key observations for projects with dual goals. Specifically, projects frequently represent mixtures aimed at improving citizens' well-being, such as:

- SDG 3 is primary and SDG 4 is secondary in 37 projects.
- SDG 3 is primary and SDG 10 is secondary in 32 projects.
- SDG 3 is primary and SDG 11 is secondary in 39 projects.

These general findings indicate that when municipalities aim at improving the good health and well-being in the society, they also desire to improve the quality of the education (SDG 4), reduce the inequalities within the society (SDG 10), and promoting more sustainable cities and communities (SDG 11) within the same project.

Looking at the primary goal of quality education, we find the following most frequent mixtures:

- SDG 4 is primary and SDG 3 is secondary in 22 projects.
- SDG 4 is primary and SDG 10 is secondary in 40 projects.
- SDG 4 is primary and SDG 11 is secondary in 22 projects.

As in the SDG 3, we find similar mixtures: municipalities generally link good education (SDG 4) with projects relating to good health (SDG 3), inequalities within the society (SDG 10), sustainability of the living spaces (SDG 11).

The primary and secondary (if any) goals at the project level for 15 municipalities are presented in the appendix.

As indicated above, the coding decisions are made based on the projects' purpose as well as interviews with the experts representing each municipality. In Figure 2 and Table 3, we provide a representation of this text data and visualize the most common words corresponding to either of the 17 goals.

3 Problem Definition and Statistical Model

Despite important qualities of pair-comparison method, the approach does not allow for a direct quantitative comparison of the primary and the secondary goals because the

Figure 2: Word Cloud by Sustainable Development Goals

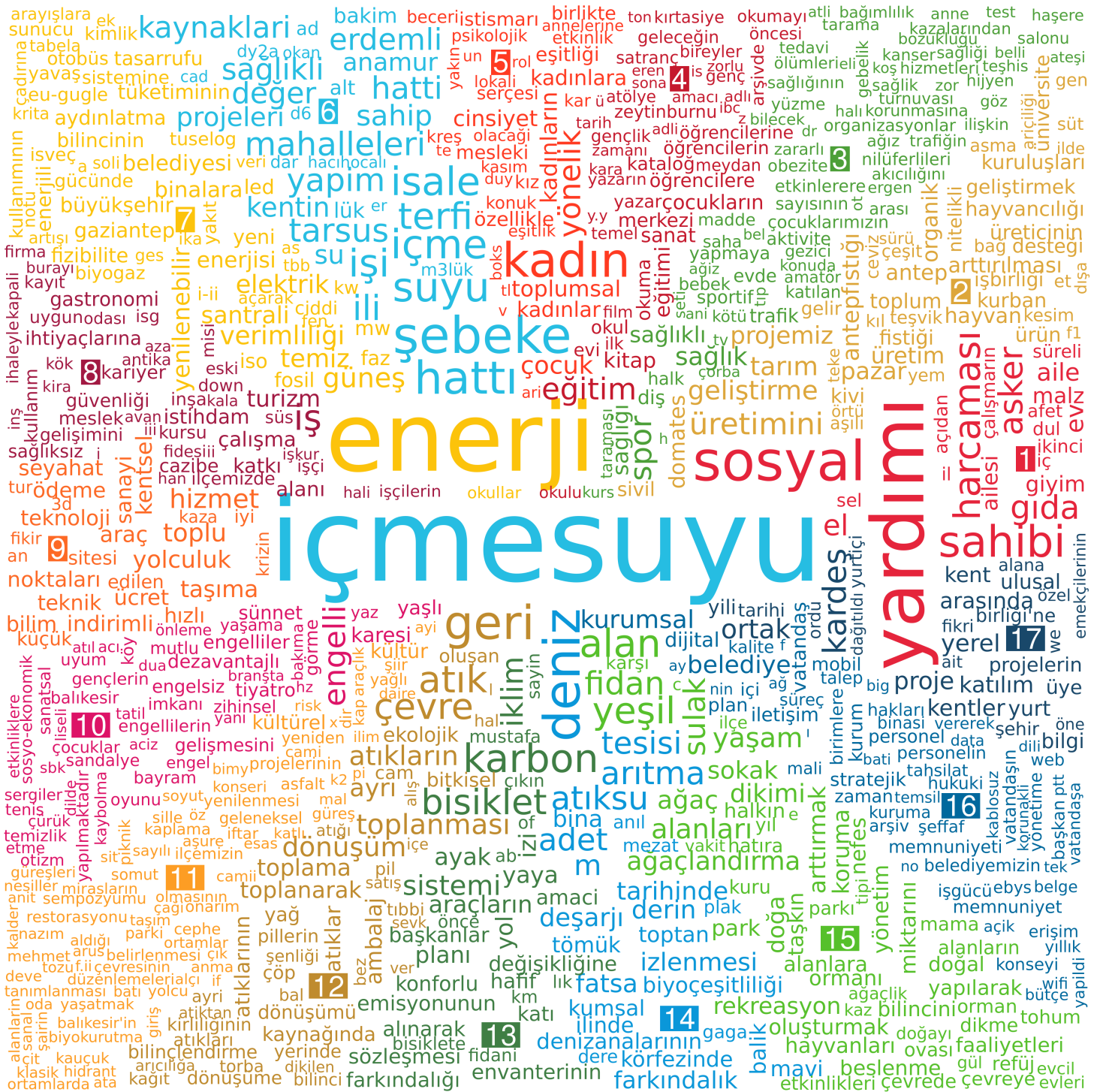


Table 3: Frequent Words in Purpose Statements by Sustainable Development Goals

SDG	Frequent Words
1	social assistance, spending, food, soldier, disaster, widow
2	tomato, agriculture, production development, market, pistachio, organic
3	health, sport, screening, dental, traffic, obesity, hygiene
4	education, school, book, chess, youth, art, future
5	female, gender, nursery, psychological, courses, disadvantaged, work
6	drinking water, water infrastructure
7	energy, solar, power plant, efficiency, electricity, biogas, bus
8	tourism, social, course, development, employment, entrepreneurship
9	public transport, travel, vehicle, travel, fare, optimization, technology
10	disabled, disadvantaged, elderly, autism, circumcision, cleansing, kids
11	culture, poetry, knowledge, mosque, landscaping, picnic, restoration,
12	recycling, waste, environment, ecological, beekeeping, packaging, battery
13	climate, carbon, bicycle, emission, awareness, seedlings, pedestrian
14	marine, purification, plant, wastewater, fish, blue, biodiversity
15	sapling, green, wetland, afforestation, nature, forest, recreation
16	access, communication, transparent, satisfaction, wifi, digital, data
17	twin town, city, national, between, dormitory, information, local

same coding decisions might result from different unobserved weights. Table 4 illustrates the coding decisions by the experts, where w_i refers to the weight of the Goal i in a given project. All the projects have the SDG 11 as the primary goal and the SDG 4 as the secondary goal, even though the weights of these goals widely differ across all the four projects: the weights of the primary goal takes the values of 40, 60, 70, and even 90, whereas the secondary goal can take the values of 10, 16, 20, 30 in this example. Therefore, our problem is to transform ranked data resulting from paired-comparisons into an interval scale so that differences between primary and secondary codings become meaningful and we can extract the average weight of the primary and the secondary areas with their precisions. Below, we explain the statistical procedure to recover these quantities of interest.

Formally, goal i is ranked higher compared to goal j if the weight of i (w_i) is greater than the weight of j (w_j). Let p denote the goal with the highest observable ranking with the unobservable weight of w_p and s the goal with the second highest observable ranking with the unobservable weight of w_s and y^* the unobservable difference between the weight of the two items as follows:

$$y^* = w_p - w_s$$

which corresponds to the observable coding decision of **primary** if $y^* \geq 0$ and **secondary** if $y^* < 0$.

$$y = \begin{cases} p & \text{if } y^* \geq 0 \\ s & \text{if } y^* < 0 \end{cases}$$

Table 4: Similar Observable Rankings with Different Unobservable Weights

	<i>SDG</i>	w_{11}	w_4	w_6	w_1	w_3	Coding Decision
Project 1	11,4,6,1,3	70	30	0	0	0	P:11 S:4
Project 2	11,4,6,1,3	60	20	19	1	0	P:11 S:4
Project 3	11,4,6,1,3	40	16	15	15	14	P:11, S:4
Project 4	11,4,6,1,3	90	10	0	0	0	P:11,S:4

The problem in its simplest form is the absence of the data on the underlying unobservable continuous difference y^* as well as the weights w_p and w_s based on the paired comparisons for each project.

We implement the Thurstonian Model of Item Response Theory ([Thurstone, 1927](#)) to recover these quantities of interest assuming that a goal's weight is a Gaussian random variable, meaning that different ranking decisions may have different values for the weights w_p and w_s , and allowing for modeling both the averages of these weights and their precision as follows: $w_p \sim N(\mu_{wp}, \sigma_{wp})$ and $w_s \sim N(\mu_{ws}, \sigma_{ws})$. They choose an assignment as the primary if

$$P(w_p > w_s) = P(w_p - w_s > 0)$$

where $w_p - w_s$ is also normally distributed $w_p - w_s \sim N(\mu_{ps}, \sigma_{ps})$, where $\mu_{ps} = \mu_{wp} - \mu_{ws}$ is the mean difference of importance and $\sigma_{ps} = \sqrt{\sigma_{wp}^2 + \sigma_{ws}^2 - 2\rho_{ps}\sigma_{wp}\sigma_{ws}}$ is the standard deviation of the random importance difference $w_p - w_s$ and ρ_{ps} is the correlation between the weights w_p and w_s . To estimate the mean and the standard deviations, we also use non-informative prior for $\mu_p \sim N(0, 1)$ and $\mu_s \sim N(0, 1)$, $\sigma_p \sim U[0, 20]$ and $\sigma_s \sim U[0, 20]$. Thus, the probability of an assignment as the primary is

$$P(w_p > w_s) = P(w_p - w_s > 0)$$

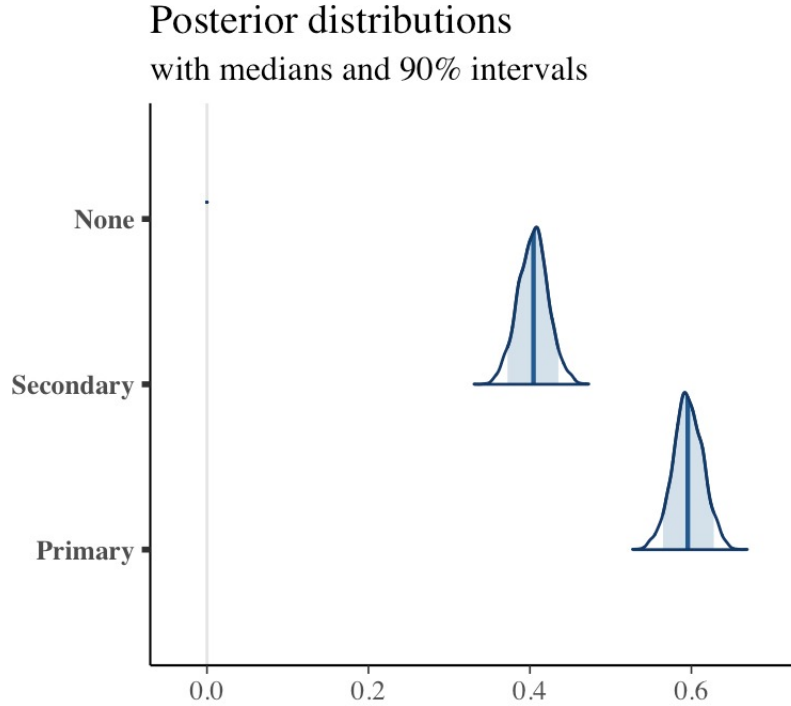
$$P(w_p > w_s) = \int_0^\infty \frac{1}{\sqrt{2\pi\sigma_{ps}^2}} e^{-\frac{(x-\mu_{ps})^2}{2\sigma_{ps}^2}} dx$$

We apply a graphical model in JAGS ([Johnson and Kuhn, 2013](#)) to derive the parameter estimates of μ_p , μ_s , σ_p , and σ_s .

4 Results

We present the results on the weights of the primary and secondary goals resulting from our Thurstonian IRT Model in Figure 3. The results indicate that the average importance of primary goal is 0.597 with 95% credible intervals of [0.559, 0.63]. The average importance of secondary goal is 0.403 and with 95% credible intervals of [0.367, 0.440]. To calculate the quantities of interest in Figure 4 and Table 5, we employ the following rule: If no secondary goal is indicated, primary is accepted as contributing to the 100 percent of a given project. If a secondary goal is present, primary goal is assumed to be contributing to the 59.7 percent of a given project (with 95% credible intervals of [55.9, 63]) and the secondary goal

Figure 3: Posterior Distribution of Weights



is accepted to be contributing to the remaining 40.3 percent with 95% credible intervals of [36.7, 44]. Using these weights, Table 5 presents the main results of the analyses¹, the distribution of projects by sustainable development goals for each municipality and Figure 4 shows the overall distribution of goals across 2223 projects. Figure 4 indicates that around 29.4 percent of 2223 projects focus on SDG 11, 10.8 percent on SDG 3, 10.7 percent on SDG 4, 10.3 percent on SDG 16, and 8 percent on SDG 10. The results at the municipality level is given below in the Appendix.

¹The entries indicate the percentage of the sustainable development goals in projects by municipality. The the lower and upper bounds of 95 percent confidence intervals are presented in parentheses. Empty cells indicate 0 percent. The results are estimated after the weights extracted from the Thurstonian IRT model.

Figure 4: Distribution of Projects by Sustainable Development Goals

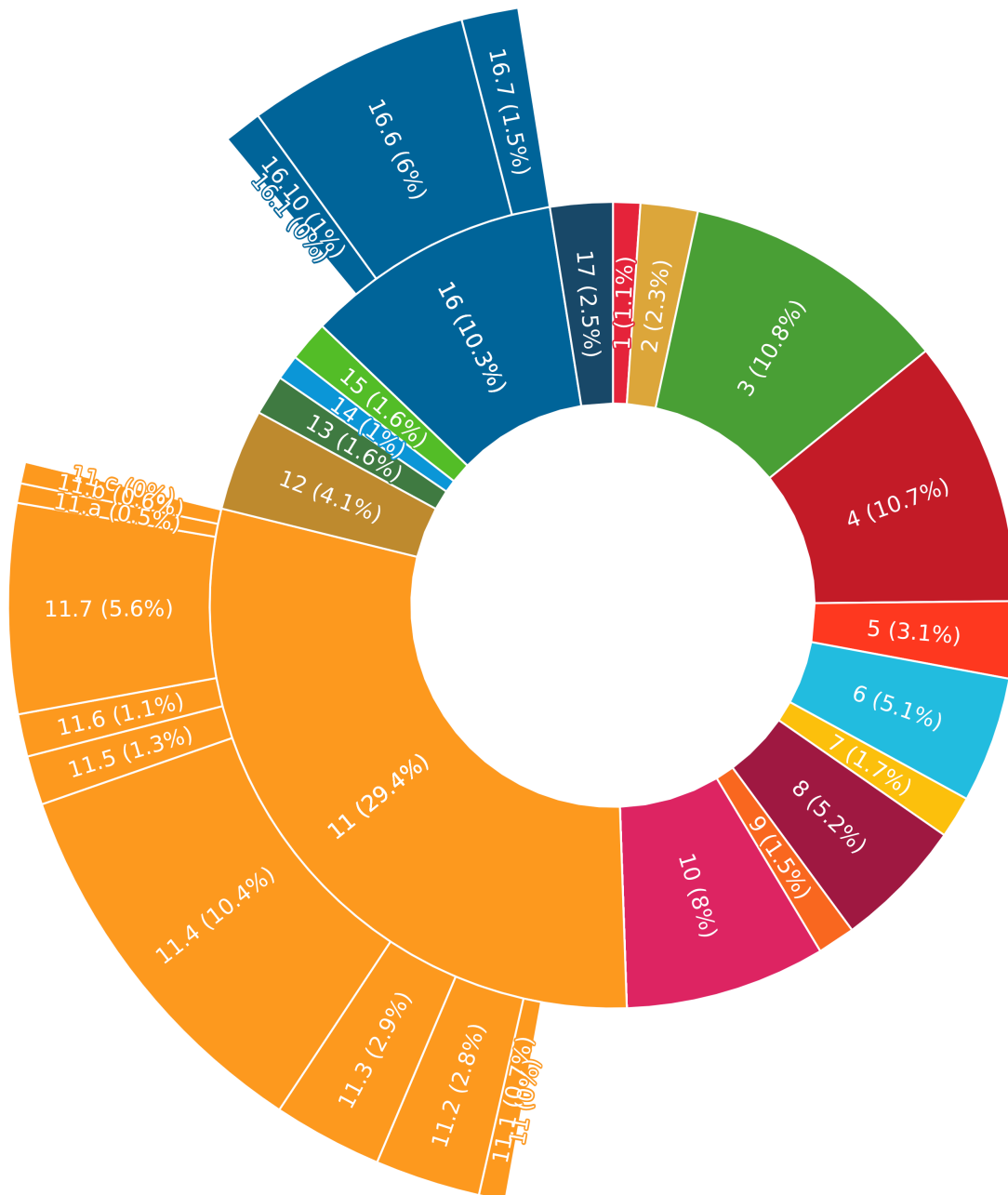
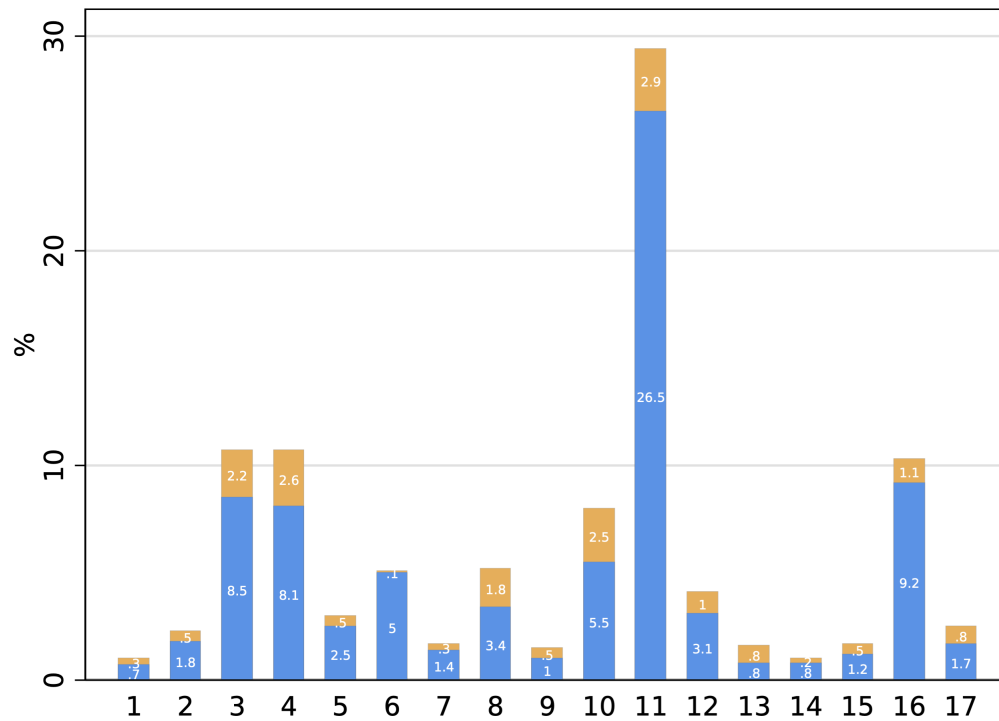


Figure 5: Distribution of SDGs by Primary (blue) and Secondary (yellow) Goals



Notes: The figure shows the weight of primary (blue) and secondary (yellow) goals in each SDG. SDGs with the percentages below 1 percent are not shown and those below 2 percent are not collapsed by the primary and the secondary weights.

Table 5: Distribution of Projects by Sustainable Development Goals

Primary	Eyyübiye	Gaziantep	Gebze	Karesi	Mersin	Mezitli	Nilüfer	Ordu	Pendik	Sancaktepe	Seferihisar	Selçuklu	Zeytinburnu	Çanakkale	Şişli
1			.6 (5,6)	1.3 (1,2,1.4)	1.9 (1,8,1.9)	1.8 (1,7,1.9)	1 (1,1.1)		2.6 (2,5,2.7)	1.9 (1,8,1.9)	1.8 (1,8,1.8)	.7 (7,7)	.4 (4,4)	1.4 (1,4,1.4)	.9 (9,1)
2		6 (5,9,6.1)	1.4 (1,4,1.4)		5.8 (5,6,6)	2.9 (2,8,2.9)	2.7 (2,6,2.7)		.7 (7,7)	.4 (4,4)	6 (5,9,6)		.4 (4,4)	1.3 (1,3,1.3)	1.1 (1,1,1)
3	14 (14,14)	9.3 (9,2,9.4)	14.8 (14,5,15.2)	11 (10,9,11)	6.5 (6,4,6.7)	7.8 (7,7,7.8)	9.4 (9,2,9.6)	5.1 (5,5,2)	16.1 (16,16,2)	10.5 (10,4,10.5)	4.9 (4,8,5.1)	13.8 (13,6,13.9)	22 (21,9,22.2)	9.9 (9,8,10.1)	11.6 (11,5,11.7)
4	16.8 (16,7,16.9)	9.5 (9,4,9.6)	15.3 (15,15,6)	9.2 (9,2,9.3)	3.9 (3,8,3.9)	15.1 (15,15,2)	13.1 (13,1,13.1)	8.5 (8,4,8.5)	16.4 (16,2,16.5)	15.3 (15,3,15.4)	7 (7,7)	11.5 (11,4,11.5)	14.5 (14,5,14.6)	6.9 (6,8,6.9)	7.2 (7,2)
5	11.2 (11,1,11.3)	.9 (9,9)	1.4 (1,4,1.4)	2.2 (2,1,2.2)	2.8 (2,7,2.8)	10.4 (10,3,10.5)	3.7 (3,6,3.8)	3.6 (3,5,3.6)	1.2 (1,1,1.2)	2 (2,2)	2.8 (2,7,2.9)	1.6 (1,5,1.6)	4.9 (4,7,5.1)	1.7 (1,6,1.8)	4 (3,9,4)
6	2 (2,2)	.3 (3,3)		.5 (5,5)	38.2 (38,2,38.2)		.4 (4,4)				2.5 (2,4,2.5)	.7 (7,7)		8.7 (8,6,8.7)	1.2 (1,2,1.2)
7		7.9 (7,8,7.9)	1.6 (1,5,1.7)	.5 (5,5)	.8 (8,8)	1.2 (1,1,1.3)	.7 (7,7)	.5 (5,5)	1 (1,1,1)		1.8 (1,8,1.8)	2.6 (2,6,2.6)	1.6 (1,6,1.7)	1.5 (1,5,1.6)	1.1 (1,1,1)
8	2.4 (2,2,2.6)	6.8 (6,6,6.9)	4.4 (4,3,4.5)	5.6 (5,6,5.6)	6.4 (6,2,6.6)	5.7 (5,6,5.9)	6 (5,9,6.1)	4.3 (4,3,4.4)	5.4 (5,3,5.4)	9.7 (9,6,9.7)	8.1 (8,8,1)	2.6 (2,6,2.6)	1.5 (1,4,1.6)	3.4 (3,4,3.5)	4 (3,9,4)
9	4 (4,4)	.7 (7,8)		3.2 (3,2,3.2)	3.4 (3,3,3.4)	1.2 (1,1,1.3)	.3 (2,3)	.6 (6,7)	.5 (5,6)	1.9 (1,8,1.9)			1 (9,1)	4.3 (4,2,4.5)	.6 (6,7)
10	9.2 (9,1,9.3)	4.7 (4,6,4.9)	15.6 (15,4,15.9)	15.4 (15,3,15.6)	4.9 (4,8,4.9)	13.5 (13,4,13.6)	8.8 (8,6,8.9)	3.6 (3,6,3.6)	8.1 (7,9,8.4)	10.3 (10,2,10.4)	5.6 (5,5,5.7)	3.3 (3,3,3.4)	10.4 (10,2,10.6)	4.7 (4,7,4.7)	9.5 (9,3,9.6)
11	32 (32,32)	35.9 (35,6,36.1)	24.4 (24,2,24.5)	31 (30,9,31)	16.3 (16,2,16.3)	14.7 (14,5,14.8)	33 (32,9,33)	51.7 (51,7,51.8)	17.2 (16,9,17.5)	28.9 (28,8,29)	25.3 (24,9,25.7)	25.7 (25,6,25.7)	21.2 (21,2,21.2)	33.4 (33,3,33.5)	39.3 (38,7,39.9)
12	2 (2,2)	3.9 (3,8,4)	3.6 (3,5,3.6)	4.3 (4,3,4.4)	2.2 (2,1,2.2)	6.1 (6,6,3)	2.9 (2,9,3)	3.6 (3,6,3.6)	5.3 (5,2,5.5)	2.5 (2,5,2.6)	10.9 (10,7,11)	3.6 (3,6,3.6)	9.2 (8,9,9.4)	3.2 (3,2,3.2)	2.9 (2,9,3)
13		3.2 (3,2,3.3)	.6 (5,6)		.8 (7,8)	1.8 (1,8,1.9)	1.2 (1,2,1.2)	2.1 (2,2,2)	2.1 (2,2,2)	.9 (9,1)	2.8 (2,7,2.9)	2.5 (2,3,2.6)	1.5 (1,4,1.6)	3.2 (3,2,3.2)	.8 (8,8)
14					2.6 (2,6,2.6)	2 (2,2)	.2 (2,2)	3.5 (3,5,3.5)	.3 (2,3)		4.6 (4,5,4.6)			2.4 (2,4,2.5)	.3 (3,3)
15		3.1 (3,3,1)	1.6 (1,5,1.7)	2.5 (2,5,2.5)	.5 (5,6)	4.7 (4,7,4.7)	2.5 (2,5,2.5)		2.5 (2,4,2.5)	1.1 (1,1,1)	2.1 (2,2,2)	1.4 (1,4,1.4)		1.1 (1,1,1.2)	1.2 (1,2,1.2)
16	3.2 (3,1,3.3)	5.8 (5,7,5.9)	11.5 (11,3,11.7)	10.3 (10,2,10.3)	1.1 (1,1,2)	6.7 (6,7,6.8)	11.2 (11,1,11.2)	9.7 (9,7,9.8)	15.9 (15,8,16)	13.3 (13,2,13.3)	9.5 (9,4,9.5)	28.4 (28,3,28.4)	9.6 (9,5,9.7)	11 (10,9,11)	10.2 (10,2,10.3)
17	3.2 (3,1,3.3)	1.9 (1,9,2)	3.3 (3,2,3.3)	3 (3,3)	2.1 (2,2,2)	4.3 (4,2,4.3)	3 (3,3)	.3 (3,3)	4.7 (4,6,4.8)	1.3 (1,3,1.3)	4.6 (4,5,4.6)	1.6 (1,5,1.7)	1.7 (1,5,1.8)	1.9 (1,9,1.9)	4.1 (4,1,4.2)

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Appendix

A1 Municipality-Level Analysis of SDG Alignments

This section presents visualizations of how individual municipalities align their projects with the UN Sustainable Development Goals (SDGs). It illustrates the SDG alignment patterns for two municipalities and present both primary and secondary development priorities at the local level. Projects are mapped against the 17 SDGs, where colored bars with stars indicate primary alignments and colored bars alone represent secondary alignments. The example visualizations below enable comparison of project portfolios across municipalities, presenting both commonalities and distinctions in their sustainable development approaches. This granular, municipality-level analysis presents insights on how local governments interpret and implement the global SDG framework through their specific projects and initiatives.

Figure A1: Example Output for SDG Alignments in Eyyubiye Municipality

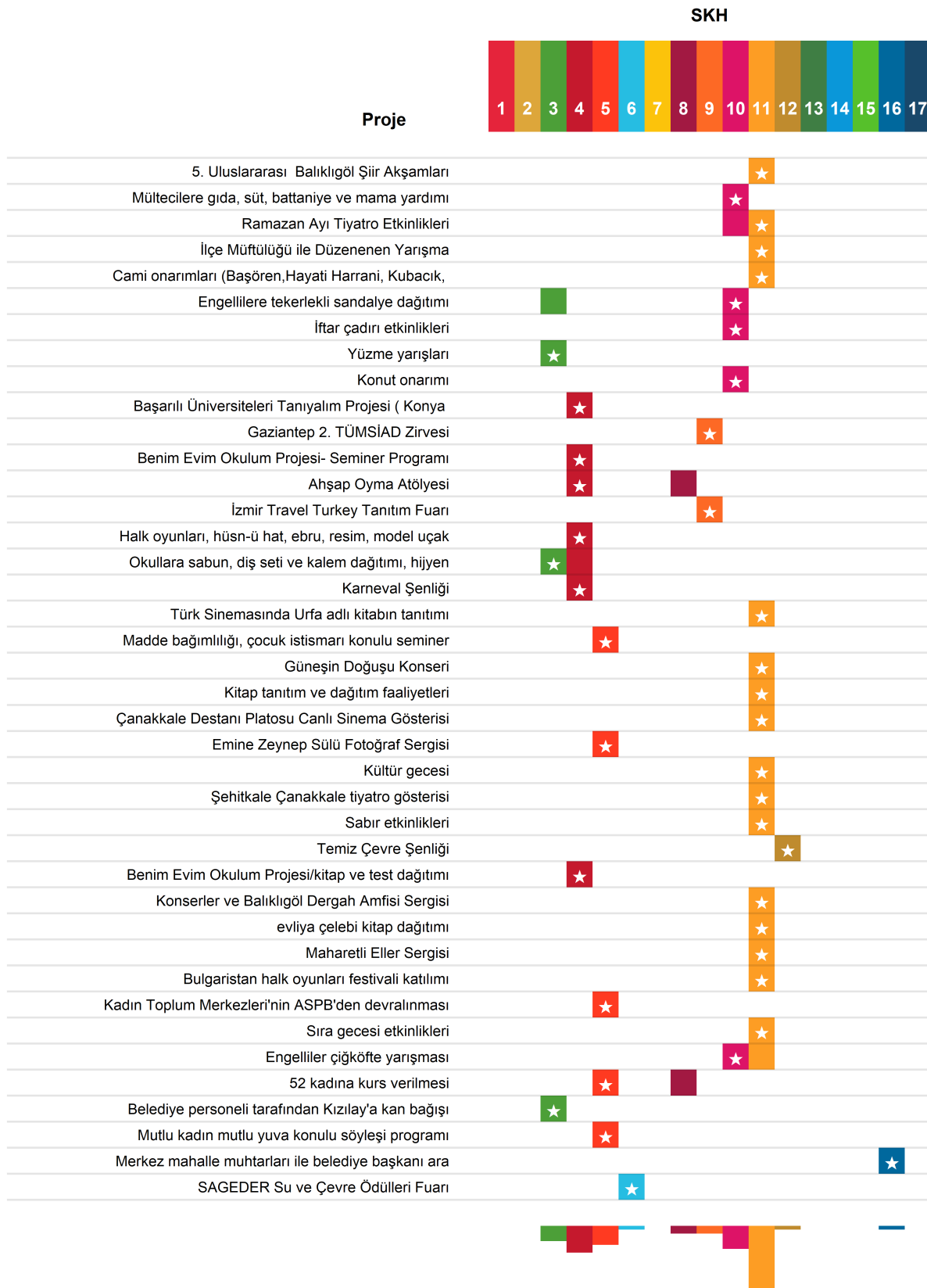


Figure A2: Example Output for SDG Alignments in Sisli Municipality

