1 Data and analysis

1.1 Data collection

For the purpose of this thesis, data was collected through a Google Forms survey, mainly distributed via social media and various online channels. To ensure the validity of the results and lower the risk of fake responses, the survey was shared within the author's immediate social circles. Overall, **281 respondents** residing in Poland, from various social and economic backgrounds, participated in the questionnaire from March 6th to April 3rd, 2024.

The survey was structured into three sections with a total of 22 closed questions (a list of questions can be viewed in Attachment 1). The initial section gathered demographic information from the respondents. Its final question served as a screening tool, asking the respondents whether they purchase sustainable cosmetics. This question was preceded with a definition of them. Respondents who indicated that they buy sustainable cosmetics were directed to a series of questions concerning their consumer behaviours and preferences. Those who claimed they did not buy them were redirected to a brief section prompting them to point out their reasons for not purchasing sustainable cosmetics.

1.2 Demographic data

Starting with gender (question D1), a majority of the respondents were women: 233 out of 281 (83%). Men made up 15% of the group. The remaining 2% were 5 people who identified in a different way or preferred not to disclose their sex. Although women made up the vast majority of the group, there were enough men to warrant including them in the data analysis and agent-based model. This disparity in gender was expected, as it is widely recognised that women purchase sustainable and conventional cosmetics more frequently than men, so consequently, more women were interested in filling in the survey.

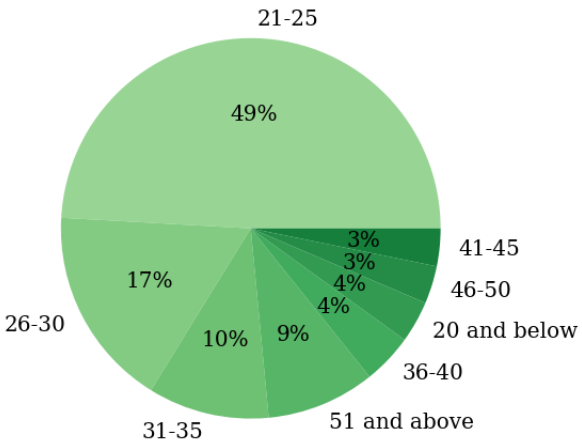

Figure 1: The distribution of survey respondents by age (question D2).
Source: own work.

The breakdown of respondents by age is illustrated in Figure 8 (question D2). Considerable majority of survey participants were young, with 49% of respondents aged 21-25, followed by 17% aged 26-30, 10% aged 31-35, 9% aged 51 and above, 4% each for ages 36-40 and 20 and below, and 3% each for ages 46-50 and 41-45. Such an outcome is likely due to a specific bias, as the survey was distributed among close friends and acquaintances, most of them being young.

Regarding place of residence (question D3), a vast majority of respondents marked a city with more than 500,000 inhabitants as their place of residence (47%), followed by a

village (19%), city up to 250,000 inhabitants (16%), city up to 100,000 inhabitants (14%) and, lastly, city up to 500,000 inhabitants (4%), as illustrated in Figure 9. The outcome is probably a result of the survey being distributed mostly in Wrocław, which has over 600,000 inhabitants.

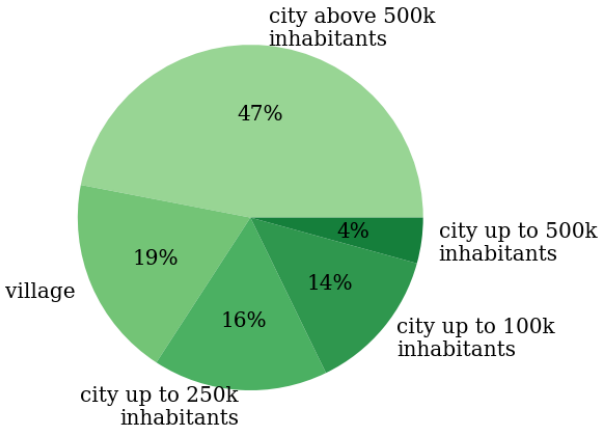

Figure 2: The distribution of survey respondents by their place of residence (question D3). *Source:* own work.

Conversely to the three first questions, where a dominating answer could be observed, the responses regarding wages were more balanced (question D5). As seen in Figure 10, the most common salary range was 4001-5000 net PLN, reported by 20% of respondents. It was followed by an almost identical percentage of answers earning 3000 and below, 3001-4000 and 7001 and above (15-16%). Similarly, around 15% of respondents did not want to disclose their salary. Lastly, 11% selected the 5001-6000 PLN net range, and 6% chose 6001-7000 PLN net.

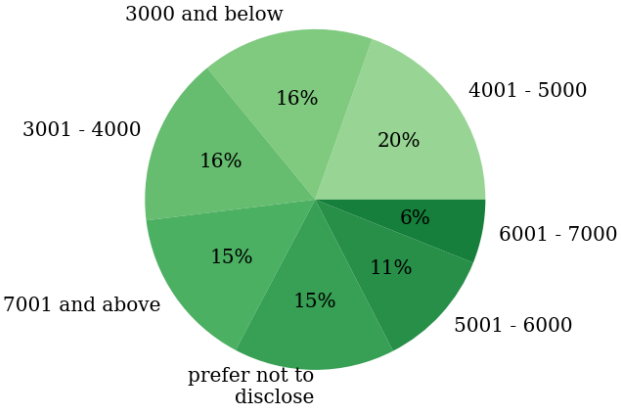

Figure 3: The distribution of survey respondents by their salaries (question D5). *Source:* own work.

The reason for this surprisingly equal distribution of wage ranges could be attributed the different economic and educational backgrounds of participants. However, this hypothesis does not hold when their education level is analysed (question D4). The survey showed that a vast majority of respondents (74%) have a higher education, followed by 24% with secondary education and only 1% each for primary education and respondents preferring not to disclose it.

1.3 Screening question

Following the demographic questions, survey participants were given the following definition: "**Sustainable cosmetics are products characterised by at least one of the following features: ecological, natural, bio, organic, vegan, not tested on animals, packaging made from recycled materials, etc.**". This definition was constructed in a simple way to ensure respondents understood the subject of the matter well. It was presented alongside an image of cosmetics surrounded by green leaves in order to catch the attention of participants and maximise the probability that they will acquaint themselves with the definition.

The question that followed was a screening question (S1), determining the section of the survey a respondent would be then moved to. It read, "Do you ever buy sustainable cosmetics?" with plain yes and no options. 89% of respondents answered that they buy such products and were subsequently redirected to a section, analysed in sub-chapters **6.4 Product characteristics** and **6.5 Purchase behaviours and preferences**. The remaining 11%, who indicated they do not buy sustainable cosmetics, were transferred to a section discussed in sub-chapter **6.6 Reasons for not buying sustainable cosmetics**.

1.4 Product characteristics

Respondents who indicated positive responses to the screening question were redirected first to a section devoted to product characteristics. The first question (A1) involved a list of the 10 most popular attributes that can be found in sustainable cosmetics. Respondents were asked to select up to 3 features that were most important or decisive for them when purchasing. The results are shown in Figure 11.

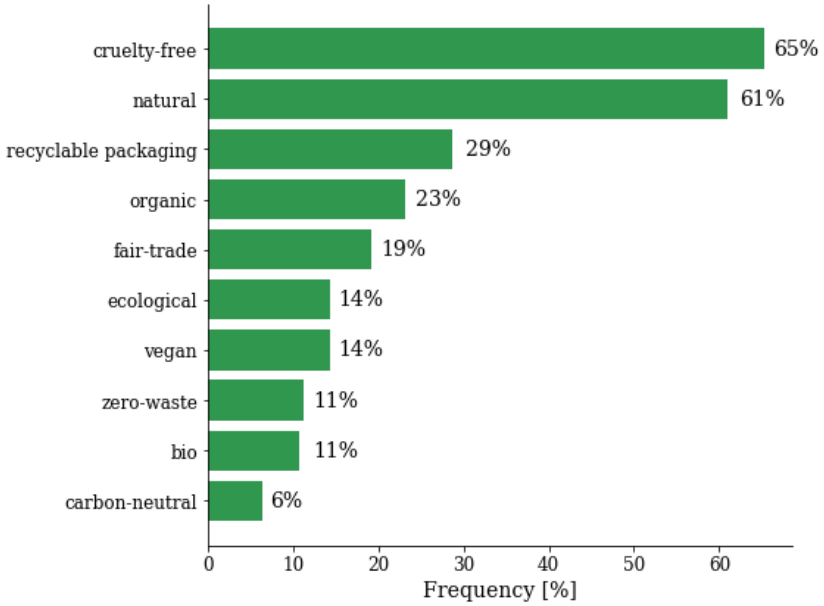

Figure 4: Most important features of sustainable cosmetics that can be decisive when purchasing (question A1).
Source: own work.

The two attributes most highly valued by survey participants were "cruelty-free" (selected by 65%) and "natural" (chosen by 61%). These preferences highlight consumers' concern that the products they purchase are not tested on animals and that at least 95% of its ingredients are of natural origin. These clear favourites were followed by "recycled-packaging" with 29%, "organic" (containing at least 95% ingredients of natural origin and

from organic farming) with 23%, and "fair-trade" with 19%. Respondents assigned the same importance to both "ecological" and "vegan" with a frequency of 14% each and both "zero-waste" and "bio" with 11% each. The least commonly chosen attribute was "carbon-neutral", with only 6% frequency. This might be due to the carbon footprint being only quite recently discussed more widely, which may not yet be fully understood or valued by consumers.

In the next 5 questions, respondents were asked to indicate how important a certain factor of a product is for them while deciding to purchase it. A 5-point Likert scale was used with the following options: "very important", "important", "somewhat important", "slightly important", "not important at all". The factors taken into consideration were: price (F1), ingredients (F2), brand (F3), packaging (F4), and quality certificates (F5).

Figure 12 illustrates the breakdown of answers in regard to price. A majority of respondents indicated that it was either important (43%) or very important (26%) to them. A comparable portion of survey participants selected somewhat important (16%) and slightly important (14%). An interesting observation is that no respondents claimed that price is not important at all.

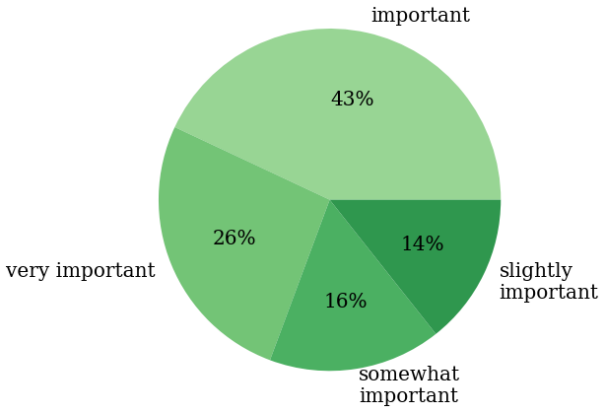

Figure 5: The importance of price (question F1).
Source: own work.

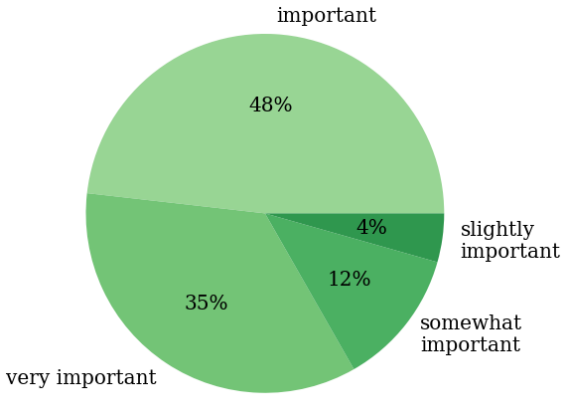

Figure 6: The importance of ingredients (question F2).
Source: own work.

As for ingredients, respondents indicated that this factor is even more important to them than price. Figure 13 shows that 48% of survey participants stated that ingredients are important for them, 35% indicated that they are very important, and 12% chose the somewhat

important option. Only 4% indicated that ingredients are slightly important. Again, similarly to price, no respondents claimed that ingredients are not important at all. This is certainly a reassuring outcome, showing that consumers are becoming more aware of cosmetic ingredients and their effectiveness, as well as their environmental and health impacts.

A more balanced distribution can be observed in the case of the importance of a cosmetics brand (Figure 14). Overall, respondents indicated that they do not value it too much, with 31% of them stating it is somewhat important, 27% saying it is slightly important, and 26% claiming it is not important at all. Only a total of 16% participants indicated that brand is important or very important. This outcome can also be attributed to the growing consumer awareness. Buyers are now critically assessing the value of a product and are not only blindly following the popular brand name.

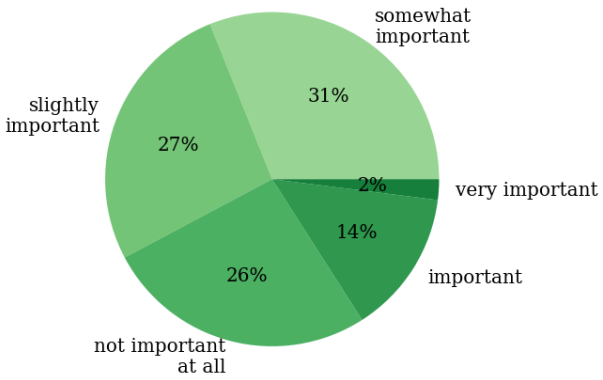

Figure 7: The importance of brand (question F3).
Source: own work.

A similar distribution of responses was recorded for the importance of aesthetic packaging. As depicted in Figure 15, 31% of respondents find it slightly important, 28% say it is somewhat important, and 22% indicate it is not important at all. Less than a fifth of survey participants claim that aesthetic packaging is important (14%) or very important (3%) to them.

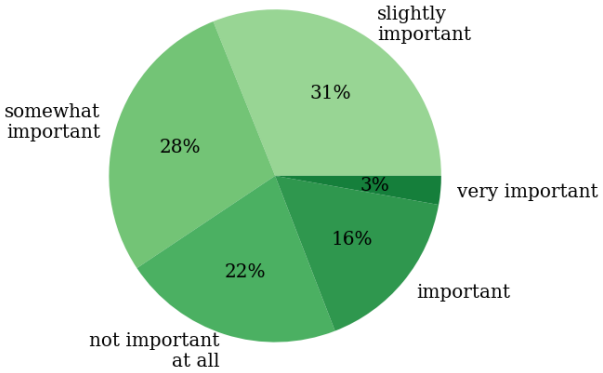

Figure 8: The importance of aesthetic packaging (question F4).
Source: own work.

Lastly, respondents were asked to evaluate the importance of quality certificates. The results, shown in Figure 16, are quite balanced, with an indication towards greater importance. In general, over half of respondents agreed that certifications are essential, with 37% stating

they are important and 20% indicating they are very important. For 25% of survey participants, this factor is somewhat important, and for 14%, it is slightly important. Interestingly, 3% of respondents pointed to quality certificates being not important at all.

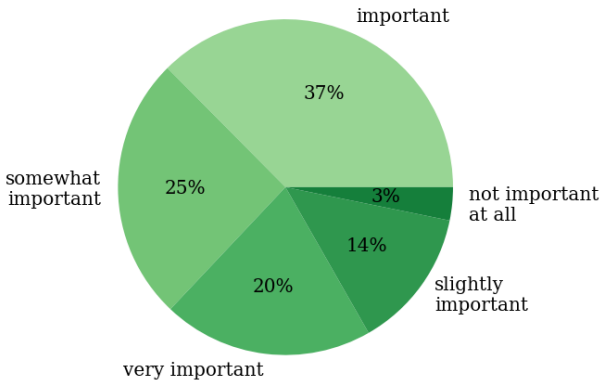

Figure 9: The importance of quality certificates (question F5).
Source: own work.

For the purposes of further analysis, correlation assessment and modelling, the qualitative responses were translated into quantitative answers. This conversion was implemented as follows: "very important" - 5, "important" - 4, "somewhat important" - 3, "slightly important" - 2, "not important at all" - 1. The translation enabled statistical analysis and interpretation of the data, the results of which are presented in Table 4.

Table 1: Descriptive statistics for product characteristics questions F1-F5.
Source: own work.

Question	**Mean**	**Median**	**Standard deviation**
F1	3.81	4	0.99
F2	4.14	4	0.81
F3	2.39	2	1.08
F4	2.48	2	1.09
F5	3.59	4	1.06

As can be observed in Table 4, question F2, regarding the importance of ingredients, has the highest mean of 4.14, a high median of 4 and the lowest standard deviation of 0.81. It can be concluded that respondents mostly agreed on the very high importance of this product factor. Price (F1) and quality certificates (F5) have also been marked quite high, with a mean of 3.81 and 3.59, respectively, and a median of 4 for both. This indicates that these factors are also quite important to survey participants. In contrast, the importance of brand (F3) and aesthetic packaging (F4) received the lowest mean scores of 2.39 and 2.48, respectively, and a median of 2 for both. This summarises modern consumers' rather cautious attitude towards brand names and aesthetic aspects well. Nowadays, the focus is shifted more towards product substance.

1.5 Consumers' behaviours and preferences

The next part of the survey included 13 questions regarding respondents' consumers' behaviours and preferences. They were grouped into 5 different categories:

- susceptibility to be influenced (SI) - questions SI1, SI2 and SI3,
- power to influence (PI) - questions PI1, PI2 and PI3,
- influence of external campaigns and recommendations (MC) - questions MC1, MC2 and MC3,
- intent to buy (IB) - question IB1,
- environmental awareness (EA) - questions EA1, EA2 and EA3.

All of the questions were structured as indicative sentences, written from a first-person perspective, and focused on opinions, habits, or preferences. For example, "I often recommend sustainable cosmetics that I have tried to my friends" (question PI2) or "I pay attention to saving electricity" (question EA3). The purpose of this format was to check the extent to which recipients agree or disagree with these statements. For all of the questions in this section, a 5-point Likert scale was used. Respondents were asked to select from the following options: "strongly agree", "somewhat agree", "no opinion/difficult to say", "somewhat disagree", and "strongly disagree".

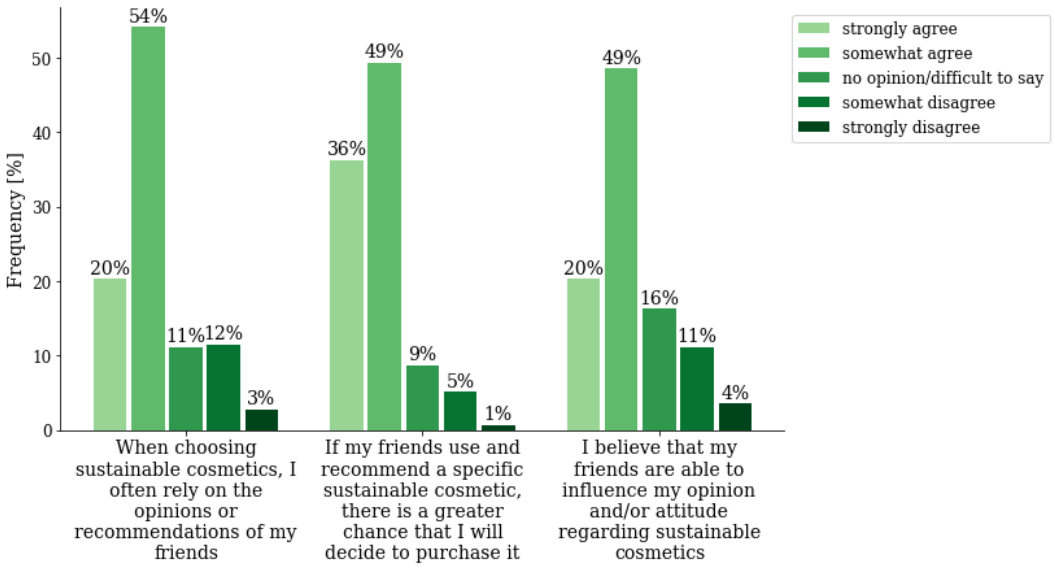

Figure 10: Susceptibility to be influenced (questions SI1, SI2 and SI3).
Source: own work.

The first category of questions was susceptibility to be influenced (SI). It consisted of three statements, as illustrated in Figure 17. For the first one, "When choosing sustainable cosmetics, I often rely on the opinions or recommendations of my friends" (SI1), over half of the respondents (54%) indicated that they somewhat agree with it, and 20% stated they strongly agree with the statement. Overall, 15% disagreed with it (somewhat or strongly), and 11% did not have an opinion. Very similar responses were registered for the third statement, "I believe that my friends are able to influence my opinion and/or attitude regarding sustainable cosmetics" (SI3), with 49% for "somewhat agree", 20% for "strongly agree" and 16% with no opinion. Similarly, overall, 15% of respondents disagreed with the statement. Much more polarised responses were noted for the second statement that read, "If my friends use and recommend a specific sustainable cosmetic, there is a greater chance that I will de-

cide to purchase it" (SI2). In general, 83% of respondents agreed with this question (36% of them agreed strongly), only 6% overall disagreed with it, and 9% did not have an opinion.

Based on the results for this category of questions, it can be concluded that, in general, people tend to trust the opinions and recommendations of their loved ones. They are often following it when making purchase decisions for sustainable cosmetics. The responses to SI2 particularly highlight that this tendency is even stronger when the buyer is aware that the friend has used the product in the past and is recommending it.

The next category included questions regarding power to influence (PI). The breakdown of answers for each of the three questions is shown in Figure 18. Conversely to the first category, responses to these questions were much more varied. Over 50% of respondents disagreed with the first statement that read: "I often talk with my friends about sustainable cosmetics" (PI1), with 30% somewhat disagreeing and 21% strongly disagreeing. Only 9% strongly agreed with it, 20% somewhat agreed, and another 20% did not have an opinion. Such a distribution of answers can suggest that respondents rarely discuss sustainable cosmetics or simply do not associate conversations with recommending products. In the second statement, "I often recommend sustainable cosmetics that I have tried to my friends", the responses are overall more positive. 34% of respondents somewhat agree with it, 21% agrees strongly, 19% somewhat disagrees, 16% does not have an opinion and 10% strongly disagrees. The majority of positive answers can be attributed to the fact that people generally like to share good (and bad) products with their family and friends, so they are keen to recommend cosmetics that they have tried themselves. The distribution of responses in the third statement, "I believe that I am able to change the attitude or opinion of my friends regarding sustainable cosmetics" (PI3), is very interesting. Most respondents indicated that they do not have an opinion (36%), 33% somewhat agree, 14% somewhat disagree, while only 9% strongly agree and 8% strongly disagree. The likely reason for this is that people do not often think about changing others' opinions or attitudes; instead, they tend to influence others unconsciously.

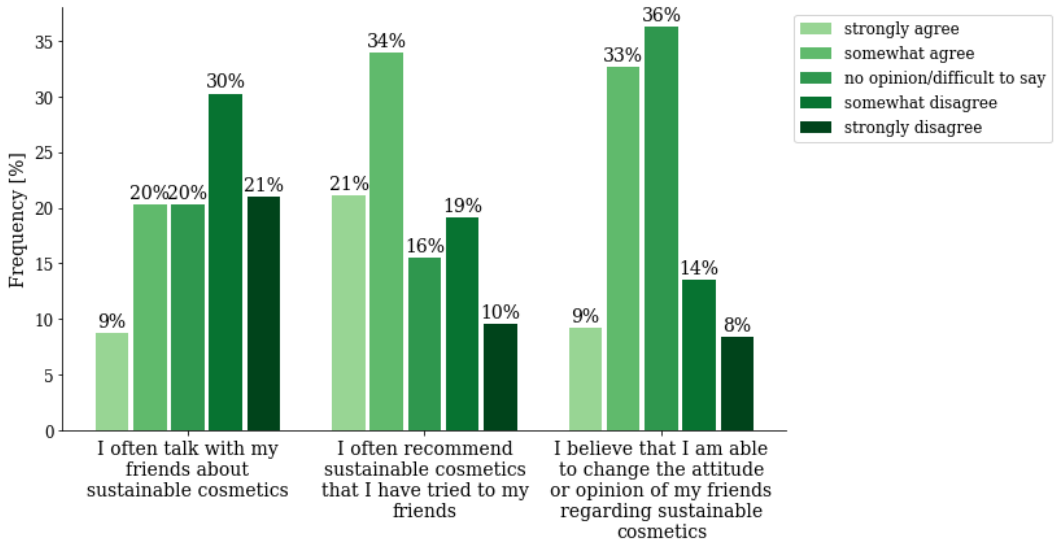

Figure 11: Power to influence (questions PI1, PI2 and PI3).
Source: own work.

Overall, the responses to questions from the PI category were generally less affirmative than those from the SI category. This suggests that people are more likely to listen to others' recommendations than to recommend products themselves.

After studying whether survey participants were more likely to influence others or be influenced, the next category aimed to assess how external factors impact consumers' purchases of sustainable cosmetics (MC). A breakdown of the three questions from this category can be observed in Figure 19. The first statement reads, "If I see an advertisement for a sustainable cosmetic, there is a greater chance that I will decide to purchase it" (MC1). Overall, half of the respondents agreed with it, 41% stating they somewhat agree and 9% indicating they strongly agree. 27% did not have an opinion, 17% somewhat disagreed and 6% strongly disagreed. The results for the second statement, "If a sustainable cosmetic is recommended by an influencer, social media creator or celebrity that I like, there is a greater chance that I will decide to purchase it" (MC2), were quite different. Answers "somewhat agree" and "somewhat disagree" were chosen with similar frequencies, 33% and 29%, respectively. 17% of respondents did not have an opinion, 11% disagreed strongly, and 10% agreed strongly. A more positive outcome was noted for the third statement, "If I see a sustainable cosmetic in an educational or environmental campaign, there is a greater chance that I will decide to purchase it" (MC3). 44% of respondents somewhat agreed, and 16% strongly agreed with it, while 21% stated it is difficult to say, 13% somewhat disagreed, and 6% disagreed strongly.

When comparing the three MC statements, a clear hierarchy of effectiveness can be noted. Educational and environmental campaigns were found the most influential by the respondents, followed by traditional advertisements. Recommendations from influencers and celebrities ranked the lowest. This can be attributed to the general scepticism towards them and the fact that they may recommend products primarily for financial gain, rather than genuine belief in the product.

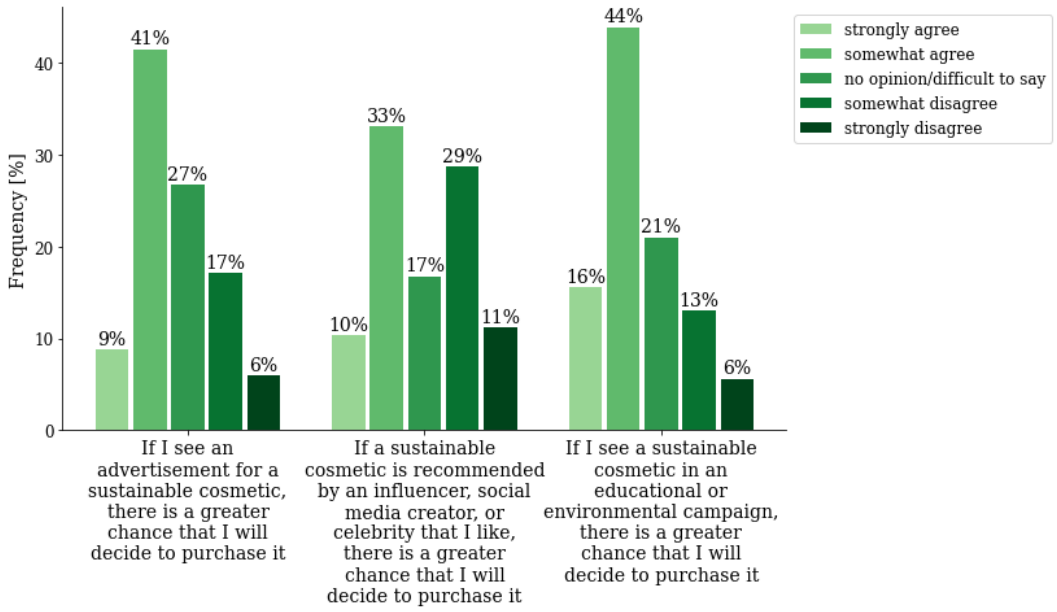

Figure 12: Influence of external campaigns and recommendations (questions MC1, MC2 and MC3).
Source: own work.

The next question was about the intent to buy. This time, it was not a series of questions but rather a single, specific one. The results can be observed in Figure 20. It reads, "I will purchase sustainable cosmetics, even if they are more expensive than regular cosmetics" (IB1). The majority of the respondents agreed with this statement; specifically, 46% somewhat agreed and 20% strongly agreed. 19% of the survey participants did not have an

opinion, 12% somewhat disagreed, and 4% strongly disagreed. The dominating positive responses are a sign that even though respondents consider price to be an important factor (as was discussed in question F1), they are still willing to pay more for a sustainable alternative to a conventional cosmetic.

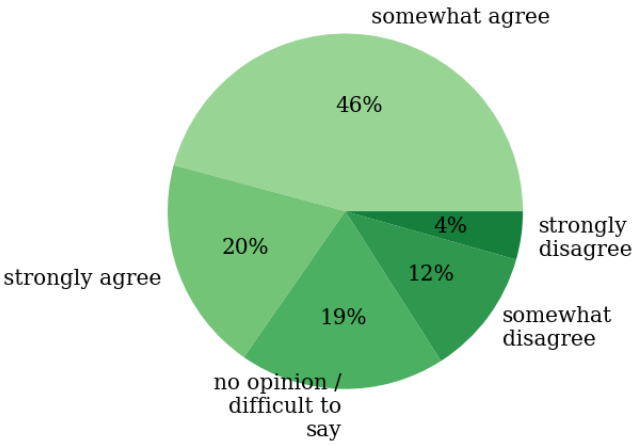

Figure 13: Intent to buy (question IB1).
Source: own work.

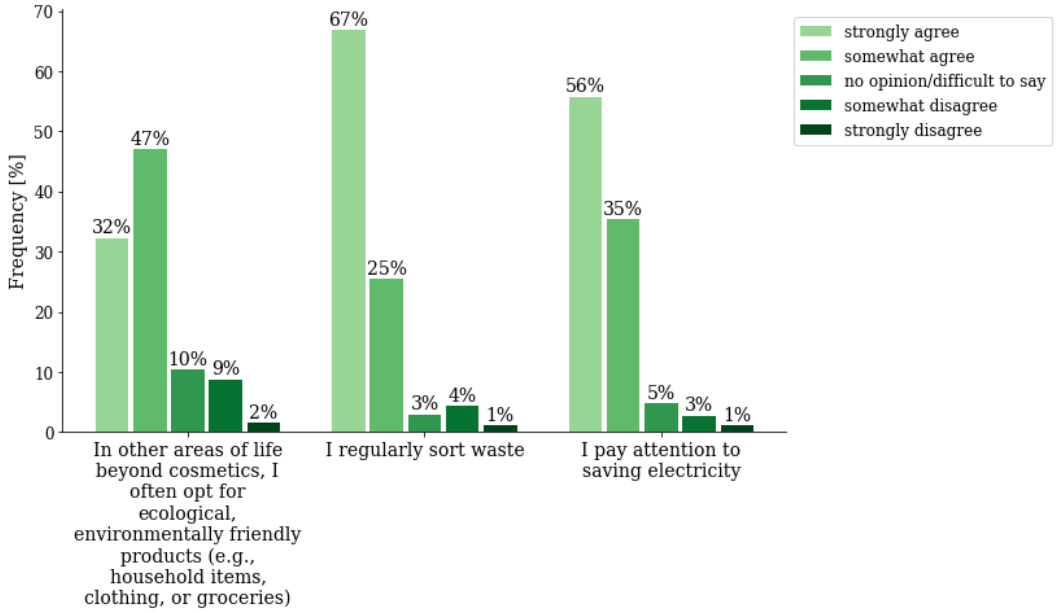

Figure 14: Environmental awareness (questions EA1, EA2 and EA3).
Source: own work.

The last category of questions in the section dedicated to consumers' behaviours and preferences was not strictly connected to habits surrounding the purchase of sustainable cosmetics. It focused on general environmental awareness and ecological practices (EA) of the respondents. The breakdown of the answers to these questions is illustrated in Figure 21.

The first statement, "In other areas of life beyond cosmetics, I often opt for ecological, environmentally friendly products (e.g., household items, clothing, or groceries)" (EA1), resulted in mostly positive responses. 47% of survey participants somewhat agreed with it, 32% strongly agreed and 10% did not have an opinion, while only 9% somewhat disagreed

and 2% disagreed strongly. The results for the next two statements were even more remarkable. For statement EA2, "I regularly sort waste", an overwhelming majority of respondents strongly agreed with it (67%). It was followed by 25% somewhat agreeing and only a mere couple of respondents indicating otherwise (3% for no opinion, 4% for somewhat disagree and 1% for strongly disagree). A similar result was observed for the third statement that read, "I pay attention to saving electricity" (EA3). 56% of respondents strongly agreed with it, 35% somewhat agreed, while only 5% did not have an opinion, 3% somewhat disagreed and 1% strongly disagreed.

Such positive responses to questions from this category show that survey participants are generally ecologically aware and care for the environment. Apart from buying sustainable cosmetics, they are also looking for ways to stay sustainable in other parts of their lives.

Similarly, as for the F1-F5 questions, the qualitative responses to statements regarding consumers' preferences were translated into quantitative answers. The conversion was implemented as follows: "strongly agree" - 5, "somewhat agree" - 4, "no opinion/difficult to say" - 3, "somewhat disagree" - 2, "strongly disagree" - 1. The translation enabled statistical analysis and interpretation of the data, the results of which are presented in Table 5.

Table 2: Descriptive statistics for consumers' behaviours and preferences questions (categories SI, PI, MC, IB and EA).
Source: own work.

Question	**Mean**	**Median**	**Standard deviation**
SI1	3.78	4	0.99
SI2	4.16	4	0.82
SI3	3.71	4	1.03
PI1	2.67	2	1.25
PI2	3.39	4	1.27
PI3	3.21	3	1.06
MC1	3.30	3	1.04
MC2	3.03	3	1.22
MC3	3.50	4	1.08
IB1	3.65	4	1.06
EA1	4.00	4	0.96
EA2	4.53	5	0.84
EA3	4.42	5	0.81

Overall, survey participants showed to be strongly environmentally aware, with EA2 and EA3 having the highest average scores of 4.53 and 4.42 and a median score of 5. Respondents showed a greater susceptibility to being influenced, indicated by average scores of 3.78 for SI1, 4.16 for SI2, and 3.71 for SI3, compared to their likelihood to influence others, with PI1, PI2, and PI3 averaging 2.67, 3.39, and 3.21 respectively. When it comes to the external influence of various campaigns, they appeared to be somewhat divided, with a median score of 3 for both MC1 and MC2. Lastly, the intention to buy sustainable cosmetics, even at higher prices than traditional ones, received a respectable average score of 3.65.

1.6 Reasons for not buying sustainable cosmetics

The last section of the survey was visible only to those participants who had responded negatively to the screening question (S1), so answering "no" to "Do you ever buy sustainable

cosmetics?". The percentage of such respondents was 11%. After marking the answer, they skipped all the sections dedicated to product characteristics and consumers' behaviours and preferences and were immediately directed to the last section with only one question; "If you do not use sustainable cosmetics, which of the following reasons resonates with you?" (R1). Respondents could choose up to 3 answers. The distribution of them has been depicted in Figure 22.

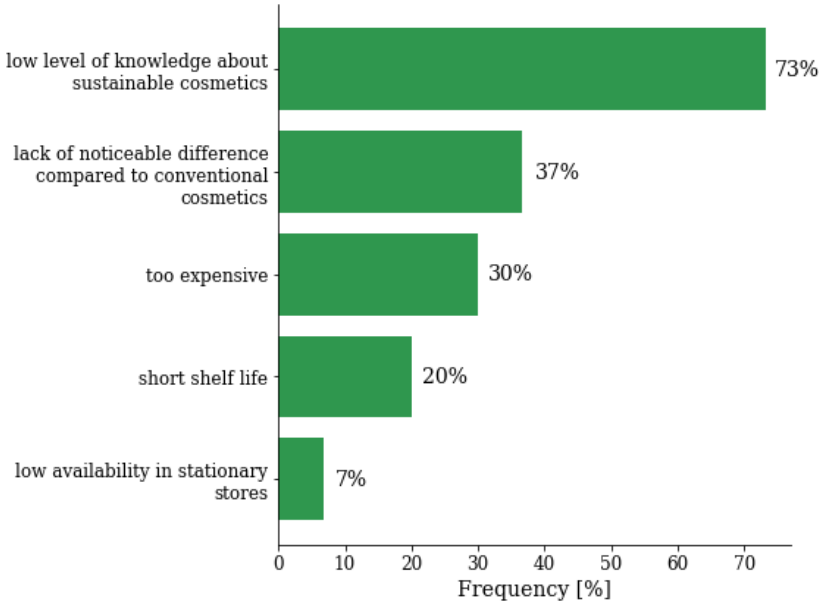

Figure 15: Reasons for not buying sustainable cosmetics (question R1).
Source: own work.

The by far most commonly chosen reason for not buying sustainable cosmetics was the "low level of knowledge about sustainable cosmetics", indicated by 73% of respondents. This was followed up by the "lack of noticeable difference compared to conventional cosmetics", selected by 37%, then "too expensive" with 30% and "short shelf life" with 20%. Only 7% of respondents stated that the reason for not purchasing sustainable cosmetics is their "low availability in stationary stores".

1.7 Correlation

After descriptive analysis of survey results, a search for correlations was attempted. In order to compare and correlate qualitative responses they were translated into quantitative data.

For **demographic questions**, the following scheme was introduced:

- for D1 on gender: "women" - 1, "men" - 3, "other/prefer not to disclose" - 2,
- for D2 on age: "20 and below" - 1, "21-25" - 2, "26-30" - 3, "31-35" - 4, "36-40" - 5, "41-45" - 6, "46-50" - 7, "51 and above" - 8,
- for D3 on the place of residence: "village" - 1, "city up to 100k inhabitants" - 2, "city up to 250k inhabitants" - 3, "city up to 500k inhabitants" - 4, "city above 500k inhabitants" - 5,
- for D4 on education level: "other/prefer not to disclose" - 1, "primary" - 2, "secondary vocational" - 3, "secondary" - 4, "higher" - 5,
- for D5 on salaries: "prefer not to disclose" - 1, "3000 and below" - 2, "3001-4000" - 3, "4001-5000" - 4, "5001-6000" - 5, "6001-7000" - 6, "7001 and above" - 7.

For the **screening question**: "yes" - 1, "no" - 2.

For **product characteristics questions**: "very important" - 5, "important" - 4, "somewhat important" - 3, "slightly important" - 2, "not important at all" - 1.

For **consumers' behaviours and preferences**: "strongly agree" - 5, "somewhat agree" - 4, "no opinion/difficult to say" - 3, "somewhat disagree" - 2, "strongly disagree" - 1.

Questions A1 and R1 were not taken into consideration for correlation checks.

Correlation analysis was conducted using Python, specifically the Pandas library and the function "pandas.DataFrame.corr". A for loop was used to check all columns against each other in search of correlations. This process was repeated three times using different methods: Pearson, Spearman, and Kendall. The results were identical across all three methods.

However, the results did not show strong correlations between questions that were not strictly related to each other. While strong positive correlations were observed for questions within the same category (e.g., SI1-SI2: 0.66, PI1-PI2: 0.60, SI2-SI3: 0.55), these were expected due to the similarity in question structure. Unfortunately, only very weak and negligible correlations were found concerning responses to demographic questions. Some noteworthy moderate and weak correlations between different questions have been presented in Table 6.

Table 3: Correlation coefficients for selected pairs of questions.
Source: own work.

Question 1	**Question 2**	**Correlation coefficient**
SI1	PI2	0.54
F2	F5	0.47
IB1	EA1	0.43
F3	F4	0.36
F1	F4	0.30
F1	IB1	-0.32

As it can be observed, the importance of ingredients (F2) and quality certificates (F5) show a positive correlation of 0.47, suggesting that consumers who prioritise one are likely to value the other. A similar relationship can pointed out for the importance of brand (F3) and aesthetic packaging (F4) with a positive correlation of 0.30. Interestingly, there is a notable negative correlation of -0.32 between price (F1) and readiness to pay more for sustainable cosmetics (IB1), implying that those who are price-sensitive are less willing to pay a premium for sustainable products.