



SINTENO AI ::

REDEFINING CONSUMER INSIGHTS ANALYTICS

Consumer and Product Profiles are crucial for ensuring consumer satisfaction with products now and in the future. The process begins with surveys to gather data on consumer opinions about product attributes. However, the analysis of survey data is often inadequate, leading to incorrect conclusions about consumer preferences and misleading recommendations for product improvement and advertising.

SINTENO addresses survey analysis problems through innovative statistical and machine-learning methods and proprietary algorithms, creating Consumer and Product Profiles in a scalable manner. SINTENO delivers accurate conclusions about individual consumer preferences and provides quantitative estimations of profile components.

Consumer insights researchers, market researchers, product designers, manufacturers, retailers, and marketers can leverage SINTENO Consumer and Product Profiles to develop products that align with customer needs, create targeted advertising, personalize and optimize product pricing, and more.

This paper provides an overview of SINTENO's capabilities and features and presents a [real-life case study](#).

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INTRODUCTION

The Consumer and Product Profile (C&PP) is a tool for understanding consumer attitudes toward product attributes and advertising. It helps align product features with consumer preferences to meet current and future needs.

Market researchers, retailers, product designers, manufacturers, and marketers use C&PPs to create products that meet consumer needs, develop marketing strategies, and personalize product features and prices.

The C&PP development process starts with collecting consumer opinion survey data on product attributes and advertising. However, inadequate analysis of this data can lead to incorrect conclusions about consumer preferences and misleading product recommendations.

The inadequate analysis often arises from the misuse of survey data (consumer responses to survey questions). It is tempting to manipulate survey data using simple mathematics. However, researchers agree that using raw survey data to assess and compare consumers' preferences is erroneous¹.

Rating Scales

Survey data analysis assumes that a consumer's response to a survey question is influenced by their attitude toward the product. Surveys use rating scales like Strongly Agree (SA), Agree (A), Disagree (D), and Strongly Disagree (SD), which are encoded as 4, 3, 2, and 1. However, performing mathematical operations with these scores assumes equal intervals between adjacent rating categories, which may not be accurate. For example, the interval from "Strongly

Agree" to "Agree" may not be the same as from "Agree" to "Disagree." While "Strongly Agree" indicates more agreement than "Agree," and "Agree" indicates more agreement than "Disagree," the intervals between adjacent rating categories may not be equal.

Item 1	SA	A	D	SD
Item 2	SA	A	D	SD
Item 3	SA	A	D	SD

Figure 1. Ordinal Rating Scale

The spacing between rating categories varies, and the pattern differs from item to item. These rating categories are considered "ordinal" data. It's important to note that not all survey items are equally agreeable. For example, an "Agree" response to item 1 may not indicate the same level of agreement as answering "Agree" to item 2 (as shown in Figure 1).

SINTENO addresses this issue using its modified Polytomous Rasch Measurement Model to analyze rating categories. This model considers unequal difficulties across all survey items, allowing for a more accurate assessment of actual consumer preferences.

Difficulty of Items and Preferences of Consumers

The difficulty of an item reflects how easy or hard it is to satisfy consumer preferences. Not all items in a

¹ Wright BD, Stone MH. Best Test Design. Chicago: MESA Press; 1979

survey have the same difficulty meeting consumer preferences. For example, satisfying consumer preferences for product features may be easier than meeting their preferences for price, especially for an expensive brand. Ignoring the different difficulties of the items can lead to a misleading assessment of consumer preference.

SINTENO utilizes the Modified Polytomous Rasch Measurement Model to correctly analyze survey data, considering the varying difficulty of items and consumer preferences.

Foundational Items

Respondents' attitudes toward different items (questions) are interdependent in any survey.

For example, in the case study we are reviewing, the assessment of product features and the relationship to the product brand are interrelated. Poor perception of the product features leads to negative brand perception. In contrast, satisfaction with the product's features creates a positive attitude toward the brand. Identifying foundational items in a survey allows identifying essential product attributes for consumer preferences. SINTENO uses the Relational Bayesian Networks (RBN) methodology to solve this problem successfully.

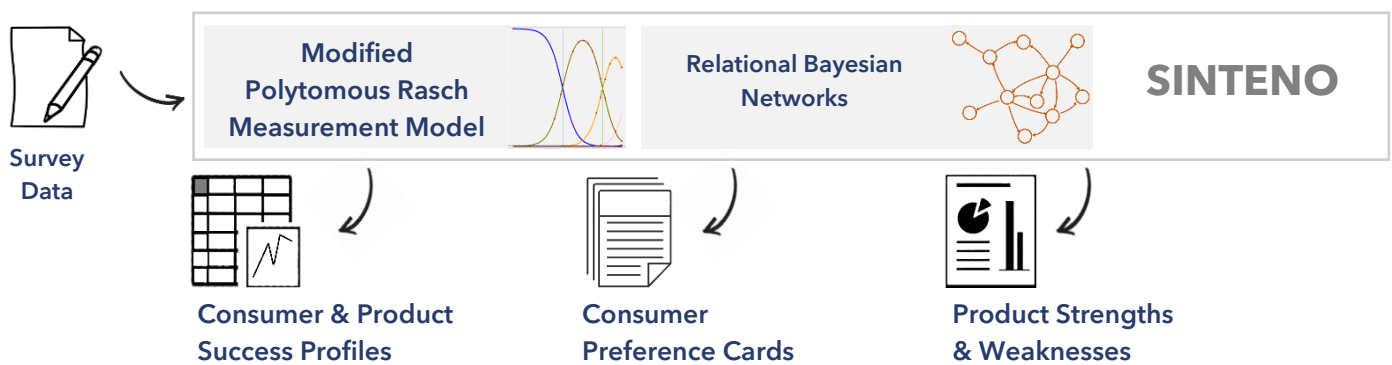


Figure 2. Architecture of SINTENO

SINTENO – Overview and Benefits

The SINTENO methodology, methods, algorithms, and software solutions are designed to extract actionable insights from consumer and market research survey data (see Figure 2). The SINTENO software-as-a-service can be accessed through an Internet browser and a simple API. SINTENO offers five core functionalities not found in traditional survey data analysis methods. These functionalities enable businesses to gain deeper insights from their

survey data and make informed decisions based on the analysis.

1. Consumer Preferences and Items Difficulties

SINTENO's modified Polytomous Rasch Measurement Model (PRMM) can handle incomplete data, such as missing values, and accurately estimate item difficulty and consumer

preferences. It can also identify and exclude improbable survey responses, ensuring an accurate analysis of consumer preferences. Additionally, SINTENO improves survey quality by identifying and removing malfunctioning (faulty) items.

2. Causal Relationships Among Items

SINTENO can identify causal relationships among survey items and determine which items are foundational. This functionality is implemented using the RBN methodology and proprietary algorithms. Identifying foundational items and their relationship with other items and consumer preferences is crucial in developing Consumer and Product Profiles (C&PPs).

3. Consumer and Product Profile

SINTENO creates Consumer and Product Profiles (C&PPs) by combining consumer preferences and product attributes and by identifying foundational items. This provides a quantitative assessment of the qualitative attributes of C&PPs, allowing for the identification of crucial product attributes that align with consumer preferences. This ensures that the

product meets consumer needs and will be in demand in the future.

4. Consumer Preferences Cards

SINTENO develops Consumer Preferences Cards that capture consumer preferences for each survey item. These cards gauge consumer attitudes toward the product and its advertising. By analyzing consumer preferences, SINTENO generates recommendations for enhancing the product, ultimately contributing to its success.

5. Product Strengths and Weaknesses

SINTENO aggregates individual Consumer Preferences Cards data to analyze product strengths and weaknesses. This information can be used by consumer and market researchers, marketing strategists, and product designers to understand consumer attitudes, identify target audiences, and develop tailored marketing strategies and products.

CASE STUDY

This case study is based on data from a consumer survey on branded hygiene products. Consumers rated product attributes such as quality, price, and product advertising on a scale of 5 categories:

- Very Unsatisfied - 1
- Unsatisfied - 2
- Neutral - 3
- Satisfied - 4
- Very Satisfied - 5

The Market Research client team analyzed the survey data to understand consumer preferences. They calculated the average scores for each survey item

and presented the results in a bar chart (Figure 3), with the items ordered by their average score.

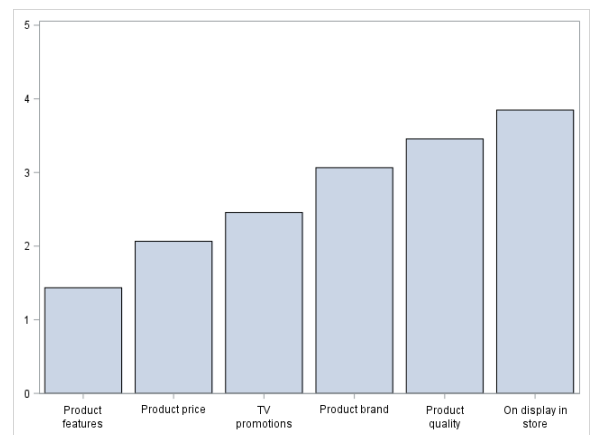


Figure 3. Averages of Scores per Item

The averaging of scores disregards the ordinal nature of the survey data and the varying difficulties of the survey items. Despite being fundamentally flawed, such calculations are still commonly used.

The analysis revealed that consumer preferences are low for "Product features," "Product price," and "TV promotions."

The client opted to utilize SINTENO to analyze the survey data, develop a Consumer and Product profile, and provide actionable recommendations for enhancing the product and advertising.

Consumer Preferences, Items Difficulties

The survey framework acknowledges that items (questions) vary in difficulty in meeting consumer preferences, and consumers have different preferences for product attributes and advertising. SINTENO's modified Polytomous Rasch Measurement Model (PRMM) estimates item difficulty and consumer preference simultaneously. This allows for ranking items based on their difficulties and ordering consumers based on their preferences.

Items Difficulties

The PRMM estimates the difficulty of a survey item, which can be interpreted as the level of difficulty in satisfying consumer preferences.

In this case study, 46 consumers were asked to rate the brand's hygiene product based on attributes such as "Product Features," "Product Price," "Product Quality," "Product Brand," and advertising methods like "On Display in Store" and "TV Promotions." Items with lower difficulty indicate attributes that are more likely to satisfy consumers, while items with higher difficulty present challenges for consumer satisfaction. Figure 4 illustrates a significant difference in item difficulties. Ignoring this in the analysis can lead to false conclusions.

PRMM not only evaluates the difficulty of the items but also determines their sensitivity to outliers, indicated by the OutFit value. An OutFit value greater than 1.3 suggests that the item's difficulty is not consistently related to consumer preferences.

For example, some consumers with mostly high preferences rate the item very low, while others rate it very highly. This discrepancy may occur when, among the consumers with the mostly low preference, some rate the item very highly while others rate the same item very low.

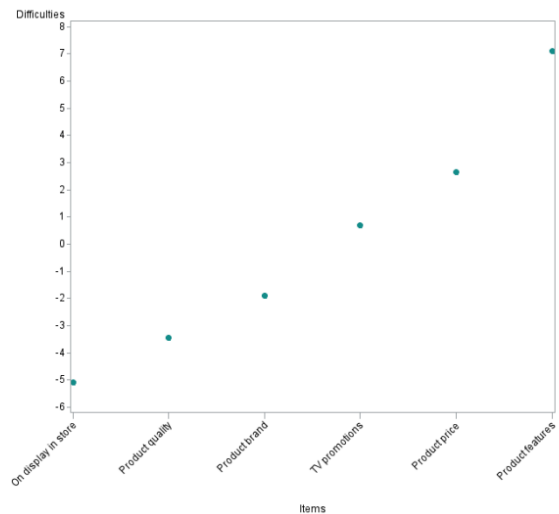


Figure 4. Items Difficulties

Table 1 presents item difficulties and OutFit values. One item, "On display in store," has an OutFit value of 1.27, close to the 1.3 threshold. There are several potential reasons for the item's malfunction, such as unclear formulation of the question, use of unfamiliar terms, or other factors leading to consumer misunderstanding.

Table 1. Items Difficulty

#	Item	Difficulty	OutFit
1	On display in store	-5.10	1.27
2	Product quality	-3.45	0.82
3	Product brand	-1.91	0.67
4	TV promotions	0.70	0.55
5	Product price	2.66	0.97
6	Product features	7.10	0.49

Consumer Preferences

When drawing conclusions about consumer preferences, it is important to take into account the complexity of the survey questions. This allows for a more accurate reflection of actual consumer preferences rather than just raw survey data. The PRMM method evaluates consumer preferences based on the difficulty of the survey questions: lower numbers indicate lower consumer preferences for product attributes, while higher numbers indicate higher preferences. Figure 5 illustrates the varying preferences of consumers, highlighting the need to consider this diversity when analyzing the data.

In Table 2 an OutFit value greater than 1.3 indicates that some consumers have been assigned scores for items that do not align with their preferences. This suggests that their choice of scores for these items deviates significantly from what was expected by PRMM. There are nine consumers (shaded gray) in Table 2 for whom OutFit is greater than 1.3; these consumers are excluded from the analysis.

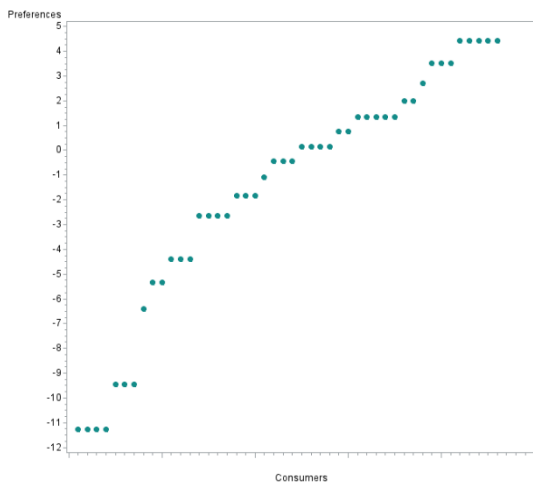


Figure 5. Consumer Preferences

Table 2. Consumer Preferences

#	Consumer	Preference	OutFit	#	Consumer	Preference	OutFit
1	PID006	-11.26	0.16	24	PID042	-0.44	0.55
2	PID012	-11.26	0.16	25	PID009	0.16	0.68
3	PID014	-11.26	0.16	26	PID033	0.16	0.87
4	PID041	-11.26	0.78	27	PID036	0.16	0.87
5	PID015	-9.46	0.16	28	PID044	0.16	0.47
6	PID023	-9.46	0.16	29	PID030	0.75	3.11
7	PID031	-9.46	0.16	30	PID037	0.75	0.53
8	PID047	-6.39	0.36	31	PID003	1.35	3.04
9	PID026	-5.32	1.60	32	PID004	1.35	0.29
10	PID048	-5.32	0.83	33	PID020	1.35	1.46
11	PID025	-4.38	1.02	34	PID028	1.35	0.29
12	PID038	-4.38	0.31	35	PID043	1.35	0.62
13	PID049	-4.38	0.43	36	PID011	2.00	1.93
14	PID018	-2.65	0.95	37	PID022	2.00	1.82
15	PID034	-2.65	2.00	38	PID032	2.71	0.19
16	PID005	-2.65	0.94	39	PID021	3.52	1.00
17	PID035	-2.65	0.38	40	PID046	3.52	1.16
18	PID002	-1.84	1.06	41	PID050	3.52	0.26
19	PID010	-1.84	0.13	42	PID001	4.41	1.50
20	PID019	-1.84	0.13	43	PID013	4.41	0.13
21	PID040	-1.10	0.64	44	PID016	4.41	0.13
22	PID007	-0.44	0.55	45	PID024	4.41	0.13
23	PID008	-0.44	1.15	46	PID029	4.41	1.33

Item Characteristic Curve

The Polytomous Rasch Measurement Model (PRMM) models the relationship between a consumer's latent attitude toward a product and the probability of the consumer choosing a specific score for an item. This relationship is represented by the Item Characteristic Curve (ICC) created for each item in the survey. Figure 6 displays the ICC created for the "Product Price" item. Each ICC curve represents the probability of assigning a specific category (score) to "Product Price" based on the consumer's preference. For example, the yellow curve represents the probability of assigning Category 3 (Neutral) to the "Product Price" item. The thresholds (solid vertical lines) indicate the preferences at which adjacent categories are equally likely to be assigned to the item. Threshold 2 (solid green vertical line) intersects the Preference axis at 1.74. This means that when a consumer's estimated preference is 1.74, they have an equal likelihood of assigning Category 2

(Unsatisfied) or Category 3 (Neutral) to "Product Price." The red dots on the curves represent the actual categories assigned by consumers. The red dots at the top of the curves indicate that consumers' chosen categories align with their preferences.

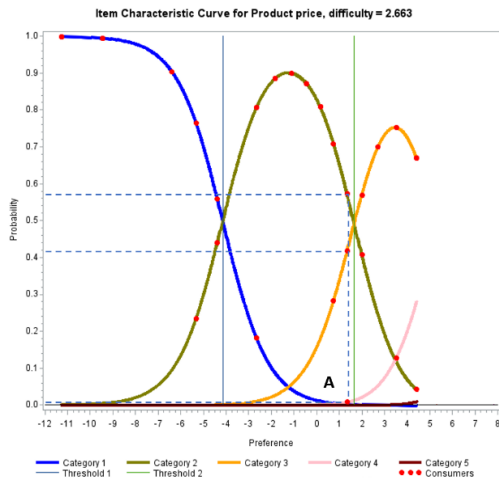


Figure 6. ICC for "Product Price"

In Figure 6, point A is located on the pink curve (Category 4, Satisfied) and represents a consumer with an estimated preference of 1.35. The probability that this consumer will choose this category is almost 0 (as indicated by the value on the vertical axis, Probability). The most probable category to be chosen by a consumer with a preference of 1.35 would be Category 2 (Unsatisfied), with a probability of 0.57 (as shown by the vertical dashed blue line crossing the green curve of Category 2). Another example is shown in Figure 7. We know that the "On Display in Store" item has a high OutFit value of 1.27, indicating a possible malfunctioning (see Table 1). The ICC reveals the reasons for that. Points B, C, and D in Figure 7 represent consumers' chosen categories for this item. However, the expected categories that these consumers will choose are different. For example, the most likely category to be chosen by consumer PID025 (point B) is Category 3 (the vertical dashed blue line crosses the yellow

curve) rather than Category 2. Table 3 below summarizes the differences between the chosen and expected categories:

Table 3. Assigned and Expected Categories

Point	Consumer	Preference	Actual Category/Probability	Expected Category/Probability
B	PID025	-4.38	Unsatisfied (2) / P = 0.14	Neutral (3) / P = 0.75
C	PID030	0.75	Neutral (3) / P = 0.01	Very Satisfied (5) / P = 0.66
D	PID011	2.00	Satisfied (4) / P = 0.13	Very Satisfied (5) / P = 0.87

SINTENO creates ICCs for each survey item.

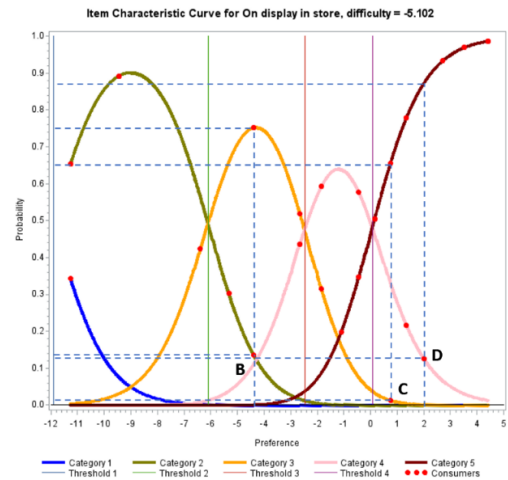


Figure 7. ICC for "On display in Store"

Causal Relationships Among Items

Understanding the causal relationships among items helps identify which product attributes ("Product Features," "Product Price," "Product Quality," "Product Brand") and advertising ("On Display in Store," "TV Promotions") determine consumer preference. SINTENO uses RBN methodology to identify probabilistic causal relationships among survey items and consumer preferences. RBN graphically visualizes dependency or influence among items. The arrows in the graph reflect that the

consumer's opinion on one item affects their opinion on another item.

According to the RBN created by SINTENO in this case study, consumer preferences are directly influenced by "Product Brand" and "Product Features" items.

Using a proprietary algorithm, SINTENO identifies foundational items crucial for consumers' attitudes toward the product and advertising. The following three items are identified as foundational:

- On Display in Store
- Product Price
- Product Features

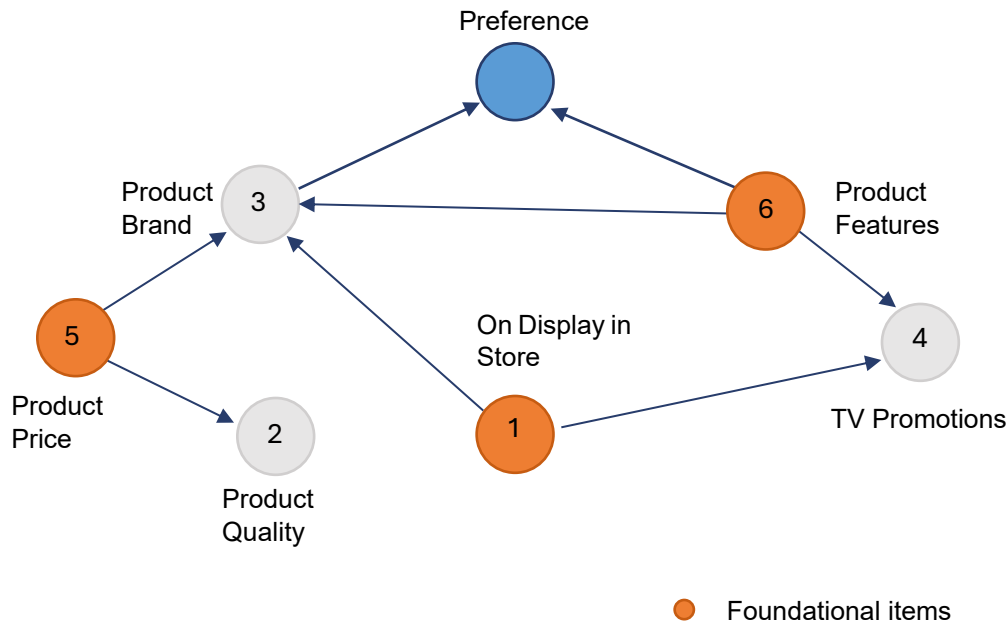


Figure 8. Relational Bayesian Network Diagram

Consumer and Product Profile

SINTENO creates a Consumer and Product Profile (C&PP) to determine the appropriate rating category for each item, ensuring consumer satisfaction with the product.

Table 4 below displays the Consumer and Product Profile for the hygiene product. The "Category" column indicates the minimum category a consumer must choose for each item to show a positive attitude. The "Item Importance" column identifies foundational items (red-bordered) as determined by RBN.

As depicted in Figure 8, the foundational items "On Display in Store," "Product Price," and "Product Features" have a causal relationship with the "Product Brand" item. This implies that changes in the rating categories for the foundational items will impact the "Product Brand" item rating categories.

The C&PP created in this case study revealed an interesting consumer attitude toward the product. While "Product Price" is one of the most challenging items to satisfy consumers, even a low Category 2 score is sufficient for overall consumer satisfaction.

Table 4. Consumer and Product Profile

#	Item	Difficulty	Category	Item Importance
1	On Display in Store	-5.10	5	Foundational
2	Product Quality	-3.45	4	
3	Product Brand	-1.91	4	
4	TV Promotions	0.70	3	
5	Product Price	2.66	2	Foundational
6	Product Features	7.10	2	Foundational

Consumer Preference Cards

SINTENO differentiates consumers (survey respondents) according to their preferences and creates Consumer Preference Cards for each consumer. These Cards are created using the assessed difficulty of items, consumer preferences, and the Consumer and Product Profile (C&PP).

Consumer Preference Cards present the following data:

- Foundational items are enclosed in red borders.
- The “Prob. Assigning Category n” columns show probability for the consumer to choose categories.
- The highest probability of a category to be assigned is highlighted in light green.

- The “Actual Category” column shows the categories assigned to each item.
- The “Most Likely Category” column shows the categories that are most likely to be assigned.
- The “Degree of Satisfaction” column indicates the level of satisfaction.
- The title of the Preference Card includes:
 - The consumer identifier,
 - The value of the consumer preference (as determined by the PRMM), and
 - The attitude toward the product as a whole.

Below are two examples of Consumer Preference Cards.

Preference Card for Consumer PID028, Preference 1.35, Satisfied

Item	Actual Category	Prob. Assigning Category 1	Prob. Assigning Category 2	Prob. Assigning Category 3	Prob. Assigning Category 4	Prob. Assigning Category 5	Most Likely Category	Consumer & Product Profile	Degree of Satisfaction
On display in store	5	0.00	0.00	0.01	0.22	0.78	5	5	Satisfied
Product brand	4	0.00	0.00	0.32	0.59	0.09	4	4	Satisfied
Product features	2	0.26	0.74	0.01	0.00	0.00	2	2	Satisfied
Product price	2	0.00	0.57	0.42	0.01	0.00	2	2	Satisfied
Product quality	4	0.00	0.00	0.06	0.55	0.38	4	4	Satisfied
TV promotions	3	0.00	0.15	0.75	0.10	0.00	3	3	Satisfied

Preference Card for Consumer PID003, Preference 1.35, Unsatisfied

Item	Actual Category	Prob. Assigning Category 1	Prob. Assigning Category 2	Prob. Assigning Category 3	Prob. Assigning Category 4	Prob. Assigning Category 5	Most Likely Category	Consumer & Product Profile	Degree of Satisfaction
On display in store	4	0.00	0.00	0.01	0.22	0.78	5	5	Unsatisfied
Product brand	3	0.00	0.00	0.32	0.59	0.09	4	4	Unsatisfied
Product features	1	0.26	0.74	0.01	0.00	0.00	2	2	Unsatisfied
Product price	4	0.00	0.57	0.42	0.01	0.00	2	2	Satisfied
Product quality	5	0.00	0.00	0.06	0.55	0.38	4	4	Satisfied
TV promotions	3	0.00	0.15	0.75	0.10	0.00	3	3	Satisfied

SINTENO vs. Scores Averaging

To demonstrate the superiority of SINTENO over averaging of scores (which is fundamentally wrong, but still widely used), we aim to compare consumer attitudes toward the product using raw survey data and Preference Cards of consumers PID003 and PID028. The results of this comparison are presented in Table 5.

Table 5. Comparison of Consumers

Items	Consumer PID028	Consumer PID003	Success Profile
On display in store	5	4	5
Product brand	4	3	4
Product features	2	1	2
Product price	2	4	2
Product quality	4	5	4
TV promotions	3	3	3
AVERAGE SCORE	3.33	3.33	
SINTENO SCORE	Satisfied	Unsatisfied	

According to the average score calculation by the client's Market Research team, consumers PID003 and PID028 have the same attitude toward the product, as they both have the same average score of 3.33. However, SINTENO revealed that these consumers' attitudes toward the product are significantly different. According to the Consumer Preference Card, consumer PID028 is Satisfied with all items and thus Satisfied with the product as a

whole. On the other hand, consumer PID003 is Unsatisfied with two out of three foundational items in the C&PP profile. Table 5 shows that this consumer assigned categories to items lower than those defined in the C&PP (orange-shaded cells). Therefore, consumer PID003 is Unsatisfied with the product.

The approach of averaging scores did not show any significant differences between these consumers.

Attitude to the Product

SINTENO evaluates consumer attitudes toward the product based on the identified foundational items, rather than all the items, some of which may have low importance or be derived from foundational items.

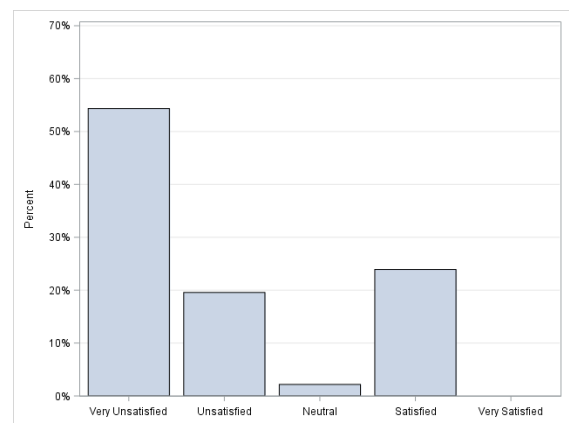


Figure 9. Consumers Attitude Based on SINTENO

According to SINTENO (see Figure 9):

- 23.91% of consumers are Satisfied with the product,
- 2.17% of consumers have Neutral attitude,
- 19.57% of consumers are Unsatisfied,
- 54.35% of consumers are Very Unsatisfied with the product.

The consumer attitude identified by SINTENO differs significantly from the average scores. According to the average scores (see Figure 10):

- 23.91% of consumers are Satisfied with the product,
- 39.13% of consumers have Neutral attitude,
- 21.74% of consumers are Unsatisfied,
- 15.22% of consumers are Very Unsatisfied with the product.

SINTENO discovered a completely different perspective on consumer opinions about the product. It identified foundational items that have the most significant impact on consumer preferences and determined the minimum score that should be assigned to each item to indicate a positive consumer attitude.

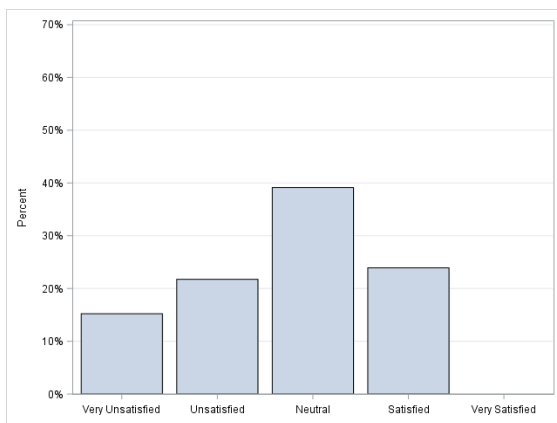


Figure 10. Consumers Attitude Based on Average Scores

The main advantage of SINTENO is its ability to uncover consumers' genuine and realistic attitudes.

Strengths and Weaknesses of the Product

SINTENO assesses the strengths and weaknesses of the product and its advertising. The bar chart (Figure 11) reveals the following insights:

- Foundational items such as "On Display in Store" and "Product Feature" have dissatisfaction rates of over 55% among consumers.
- Over 67% of consumers are satisfied with the "Product Price."
- The "Product Brand" has a low reputation among consumers, with over 60% expressing dissatisfaction.

Compared to Figure 3, SINTENO's analysis provides a more accurate understanding of consumer attitudes toward the product. Therefore, business decisions based on SINTENO's analysis will be more realistic and different from those based on average scores.

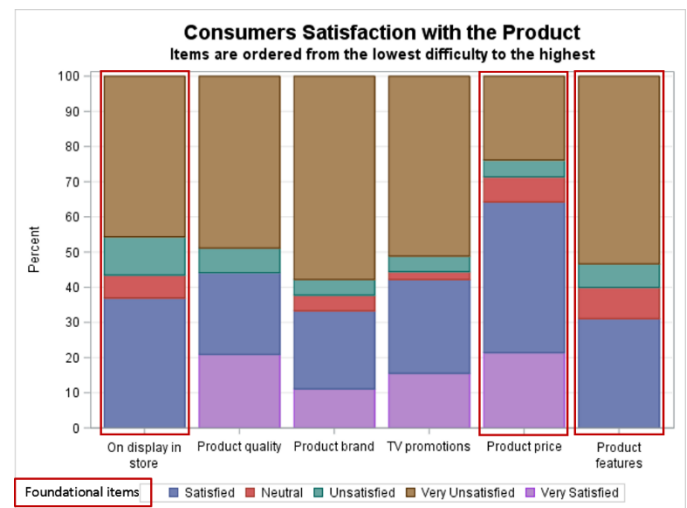


Figure 11. Consumer Satisfaction

Recommendations About the Product

The analysis conducted by SINTENO enables us to provide recommendations for enhancing the product and its advertising. In this case study, it is evident that there is a minimal number of Neutral and Unsatisfied opinions. This suggests that there

are two distinct consumer groups: those who are Very Satisfied and Satisfied with the product and its advertisement and those who are Very Unsatisfied. This indicates the potential for creating a new and

distinct product version with attributes aimed at satisfying the currently unsatisfied consumers.

CONCLUSION

In this white paper, we demonstrate that the common practice of averaging scores to evaluate consumer opinions collected through surveys can lead to inaccurate estimations of consumer attitudes and produce misleading results. SINTENO provides solutions that accurately assess consumer attitudes and offer practical, actionable insights for enhancing products and advertising.

Innovative methods and algorithms used by SINTENO reveal a true and realistic situation with consumer opinions about products and advertising. SINTENO helps to identify critical product attributes and to align them with consumer preferences, thereby providing effective and actionable recommendations for product improvement. SINTENO delivers insights that bring remarkable benefits to product designers, manufacturers, retailers, and marketers.