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EVALUATION OF PRODUCT DESIGN ANALYSES FOR THE IDENTIFICATION OF PERCEPTION-DEFINING CHARACTERISTICS

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ABSTRACT

In most cases, customers evaluate a product based on the first impression, which is propagated by the product itself. These impressions are often subjectively engraved in the products, difficult to describe thus making them difficult to handle. Technical specifications on the other hand are less considered at first sight. In the case of leisure products such as Motorbikes (motorcycles), subjective factors are considerably intensified. Thus, such products are suitable to describe as "difficult-to-quantify" characteristics. Subjective and difficult to quantify features for products such as motorcycles could be; the design, the dynamics (vitality) as well as the price (value) impression.

Thus, amid a DFG research project, a method will have to be developed that allows the scaling of difficult to quantify characteristics in other to support a requirement-orientated product development. For this purpose, four different levels were developed to contain scaling based on usage. To support the scaling development, methods such as the AHP or the Multivariate Analysis Method can be used.

In the following analysis it will be shown how perception-defining characteristics for motorcycles can be derived from design analyses. The first step is the design analyses conducted with the help of the analytic hierarchy process (AHP) scale based on Thomas L. Saaty. The advantage of this approach is a direct comparison of all alternatives to themselves. If, for example, five motorcycles are compared with regards to design, then a benchmark for good design implicitly arises. These scales build up dynamically depending on the analyzed alternatives. Based on the previous example, the more alternatives are used the more valid the scale.

The systematic arrangement of the perception-defining characteristics in product development can be a deciding factor for a better product design and its related product perception. Special gender specific perception differences for motorcycles will be evaluated in this paper. Thus, it is shown that there are specific motorcycle models that appeal to women while other specific models are preferred by men. In this case, perception-defining characteristics can be derived from a detail analysis of a preliminary assessment which can aid the description of female and male preferences for motorcycles.

In this paper a method to concatenate the perception-defining characteristics and products will be presented. Above all, these characteristics should be considered in the product planning phase. This approach offers producers the possibility, through identification of important perception-defining characteristics, to differentiate themselves from competitors because important product characteristics are deigned to relate to the various target groups.

KEYWORDS

perceived quality, perception-defining characteristics, quality management, analytical hierarchy process, requirements engineering.

Introduction

The design and its related overall impression of a product are constantly gaining significant value in customer awareness [1]. In most cases customers rate a product and its performance subjectively and minimally based on its technical specifications. This is especially eminent in leisure products such as motorcycles where emotions and perceptions play a vital role. Kroeber-Riel et al. define perception as a complex information-handling process where an individual receives information about himself and his environment [2].

The growing number of products and product variants in a market always provide new challenges for industries to generate competitive advantages over their competitors. The individuality of a customer offers industries the possibility to achieve success, even in concentrated markets [3]. Companies have to understand how the various product characteristics affect the creation of consumer perceptions [4]. Characteristics such as design, perceived value, or sportiness are difficult to quantify but can help to generate differentiators in relation to competing products. In order to handle difficult to quantify characteristics in product development, scales for evaluations are necessary.

The goal of the DFG (German Research Association) research project MeGeQuS, which is operated by the chairs of quality management as well as marketing and innovation management of the BTU Cottbus, is the development of scales for difficult to quantify characteristics. The developed scales are arranged in a universal valid level model [5]. Transferability to other products and industries using this approach can thus be guaranteed.

In the following analysis, it will be shown how knowledge for product development can be gained based on qualitative statements of 68 test persons with regard to the design of motorcycles. These statements were obtained using the analytic hierarchy process (AHP) scale developed by Thomas L. Saaty. The result of this analysis is a ranking of the studied alternatives with respect to their design. Previous studies have already demonstrated the applicability of the AHP to evaluation and selection of difficult to quantify characteristics [6].

In addition, multivariate methods were employed to determine the influences on the rank order of the procedure. To do this, four research hypotheses were examined. In the process gender-specific aspects of perceptions at different motorcycle models were also taken into account. This paper presents an approach which allows the identification, assignment and interpretation of key perception-defining characteristics. The concept of "perception-defining characteristics" will be used in the following analysis. Henceforth, to provide a consistent understanding of this concept and the related term "Quality awareness", the terms will be defined and delineated.

A perception-defining characteristic is a sensory characteristic which renders certain impressions of an object with regard to its nature that can be transferred to an individual, which in turn depends on certain expectations of the individual on the object.
If the expectation matches the perception, it is referred to as "perceived quality"

The subsequent described procedure can contribute to a targeted product design and should therefore be taken into account in the product development process.

This approach offers producers the possibility, through identification of important perception-defining characteristics, to differentiate themselves from competitors because important product characteristics are deigned to relate to the various target groups.

Use of the analytical hierarchy process to assess qualitative data

The importance of decision problems in companies is becoming increasingly important [7]. The AHP offers an approach to support decision-making. It was developed by the American mathematics Professor Thomas L. Saaty for the assessment of alternative courses of action regarding complex objectives [8, 9]. Complex decisions should be simplified by AHP and structured so that decision-making can be obtained optimally. The fields of application of AHP are diverse. For example, the AHP was used to determine the importance of total quality management [10]. Another application of the AHP is shown by Lee and Ross in a study on the application of the AHP in sports sponsoring [11]. Also, another example showed that the AHP was suitable to be applied in the selection of an appropriate maintenance strategy [12]. The basic idea of the AHP can be described by three essential criteria analytical, hierarchical and process-oriented [13].

Meixner and Haas recommend the following approach to decision-making with AHP [14, 15]:
- Setting up a decision hierarchy.
- Implementation of pair comparisons of decision elements.

- Calculation of the priorities within the elements of the decision.
- Aggregation of the priorities of decisions elements.

Decision-making is structured in hierarchical form. The creation of such hierarchies is used for the simplification of complex facts or issues. The weighting of the criteria is carried out through pair comparison. All elements of a hierarchy are compared with each other. Through the application of a priority estimate, the relative importance of a criterion can be determined when compared to any other criterion. The priorities in the AHP are determined by the creating eigenvectors of the paired comparison matrix. Target priorities are determined relative to the overall objective, transferred into a new matrix to determine priorities for each alternative.

In order to support the pairwise comparisons the AHP scale is implemented (Fig. 1).
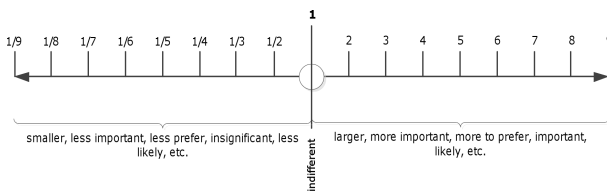

Fig. 1. 9-Point scale according to SAATY [14].

Data collection and evaluation using eigenvectors

In the study, 68 test persons were asked to evaluate five naked bikes based on the designs. The categorization of the test persons can is shown in Table 1.

Table 1
Categorization of the test persons.

Summary of the 68 test persons	
Gender	38 male
	30 female
Faculty	30 Business Administration
	28 Industrial Engineering
	5 Mechanical Engineering
	5 Others
Motorcyclist	13 Motorcyclists
	55 non-Motorcyclists

The test persons were asked to compare each motorcycle in a pair comparison against each other. Analysis of the priorities was determined using the same scheme. Every alternative on the design level was linked to all other alternatives of the same. From the five motorcycles 10 possible motorcycle combinations were derived. These 10 combinations were evaluated with the help of the Saaty scale with regard to optical appearance.

In total, 68 individual evaluations resulted from the five motorcycles regarding their design. An example of a single result from the design evaluation is shown in Table 2. The detailed procedure for using the AHP is represented in [8, 9, 14].

Table 2
Example of an individual result.

Motorcycle	Priority
Model 1	0.14
Model 2	0.25
Model 3	0.07
Model 4	0.51
Model 5	0.04

Since there were a total of 68 individual results, 68 individual rankings were also obtained each reflecting the personal design evaluation of the test person. In order to aggregate individual decisions to the overall result, Saaty proposes the use of the geometrical mean when summarizing. The summarized evaluation matrix and the resulting rankings are shown in Table 3.

Table 3
Calculated total rank of design evaluation.

Motorcycle	Priority
Model 1	0.25
Model 2	0.13
Model 3	0.22
Model 4	0.19
Model 5	0.21

Table 3 shows the cumulative result of the test person's perception regarding the presented models of the motorcycles. The calculated total rank shows that motorcycle 1 on average was the most visually appealing. Motorcycle 3 closely follows with rank 2. Motorcycle 2 was identified as the least visually appealing.

Evaluations through the use of multivariate analysis methods

Through the use of multivariate analysis in general and analysis of variance in particular, it will be investigated in this section if specific groups significantly differ from others based on their evaluation of motorcycle design. To do so, the following research hypotheses were set up:

- Hypothesis 1: All models are not significantly different regarding the design.

- Hypothesis 2: All test persons assess the motorcycle design the same regardless of their response to difficulty of evaluating a design from images.
- Hypothesis 3: The field of studies has no influence on the evaluation of motorcycle designs.
- Hypothesis 4: Gender does not affect the evaluation of motorcycle designs.

Analysis of hypothesis 1: All models do not differ significantly regarding the evaluation of the design

The accuracy of the first hypothesis will be examined by applying an analysis of variance. It should be determined whether there are significant differences between the motorcycles. At this point, it would be conceivable that all motorcycles are similar, equally rated and therefore no significant difference exist since they all come from the same segment. The software SPSS version 21 is used to support the evaluation process.

Table 4 shows the descriptive statistics of the examined data for the analysis of hypothesis 1.

Table 4
Descriptive statistics for hypothesis 1.

Descriptive Statistics

Dependent Variable: Evaluation

Modell	Mean	Std. Deviation	N
Motorcycle1	.2431494	.14966189	68
Motorcycle2	.1339918	.10310558	68
Motorcycle3	.2095549	.13019806	68
Motorcycle4	.1949488	.14655714	68
Motorcycle5	.2183551	.15831558	68
Total	.2000000	.14288263	340

Each test person evaluated five motorcycles so that a resulting 340 individual assessment were obtained. Furthermore, information on the averages and deviations of the individual models can be obtained from the table. The necessary conditions for the application of analysis of variance were checked in advanced. Thus, a Levene's test is performed at each analysis to check the homogeneity of the variance. A further requirement is the normal distribution of the measured values. Tests on normal distribution showed that the measured values are not normally distributed. This violation of the requirement of application can be neglected at this point

since the analysis of variance proved robust against the violation [16, 17].

The equality of the variances of the errors is also investigated with the help of the Levene's test. The Levene's test checks whether the variance of the errors of the investigated variables is equal across all groups. In the analysis of hypothesis 1, the Levene's Test showed much significance, i.e. the variances of the data vary in size and thus violate the conditions for applying analysis of variance [18]. SPSS offers in this case the possibility through a post-hoc procedure to perform the analysis, even in a case of violation of the application conditions for an analysis of variance. Special post-hoc procedures that can be applied even when variance homogeneity is absent include for example Games-Howell or Dunett-C test.

Table 5 shows that motorcycle 2 differs significantly from all other tested models. SPSS indicates significant differences with a *. Moving the rankings from table 3 into table 5, it can be concluded that motorcycle 2 is visually not appealing when compared to the other tested models.

If an analysis of variance is carried out without motorcycle 2, then it can be shown that the remaining 4 models do not significantly differ from each other regarding the design. In this case the application of analysis of variance is possible since eliminating motorcycle 2 in the data set will produce roughly equal variances of errors in all groups. Therefore, all other models have a homogeneous design as shown in Table 6.

The p-value for the factor called model is given by 0.277. The p-value indicates the probability of the obtained results, based on the validity of the null hypothesis. The smaller the p-value, the safer the null hypothesis can be discarded. The result from table 6 is insignificant, because the threshold value is not less than 0.05.

Generally, from the evaluation of hypothesis 1 it can be observed that, with the exception of motorcycle 2, the models of the naked bike segment do not differ significantly regarding their design. This means that customers who evaluated these motorcycles did not or only subconsciously perceive the individual differences that undoubtedly exist. Motorcycle 2 was already perceived as the least visually appealing of all the tested models in the AHP analysis. This statement is confirmed by the multivariate analysis.

Table 5
Dunett-C Test for hypothesis 1.

Multiple Comparisons

Dependent Variable: Evaluation

Dunnett C

(I) Modell	(J) Modell	Mean Difference (I-J)	Std. Error	95% Confidence Interval	
				Lower Bound	Upper Bound
Motorcycle1	Motorcycle2	.1091576*	.02203922	.0473717	.1709435
	Motorcycle3	.0335945	.02405576	−.0338447	.1010337
	Motorcycle4	.0482007	.02540197	−.0230125	.1194139
	Motorcycle5	.0247943	.02641927	−.0492709	.0988595
Motorcycle2	Motorcycle1	−.1091576*	.02203922	−.1709435	.0988595
	Motorcycle3	−.0755631*	.02014006	−.1320248	−.0191014
	Motorcycle4	−.0609570*	.02173022	−.1218766	−.0000373
	Motorcycle5	−.0843633*	.02291114	−.1485936	−.0201330
Motorcycle3	Motorcycle1	−.0335945	.02405576	−.1010337	.0338447
	Motorcycle2	.0755631*	.02014006	.0191014	.1320248
	Motorcycle4	.0146062	.02377299	−.0520403	.0812526
	Motorcycle5	−.0088002	.02485705	−.0784858	.0608853
Motorcycle4	Motorcycle2	−.0482007	.02540197	−.1194139	.0230125
	Motorcycle2	.0609570*	.02173022	.0000373	.1218766
	Motorcycle3	−.0146062	.02377299	−.0812526	.0520403
	Motorcycle5	−.0234064	.02616206	−.0967505	.0499377
Motorcycle5	Motorcycle2	−.0247943	.02641927	−.0988595	.0492709
	Motorcycle2	.0843633*	.02291114	.0201330	.1485936
	Motorcycle3	.0088002	.02485705	−.0608853	.0784858
	Motorcycle4	.0234064	.02616206	−.0499377	.0967505

Based on observed means.

The error term is Mean Square(Error) = .019.

*The mean difference is significant at the .05 level.

Table 6
Univariate analysis of variance for the analysis of hypothesis 1 without motorcycle 2.

Tests of Between-Subjects Effects

Dependent Variable: Evaluation

Source	Type III Sum of Squares	df	Mean Square	F	Slg.
Corrected Model	.083[a]	4	.028	1.294	.277
Intercept	12.749	1	12.749	593.738	.000
Modell	.083	3	.028	1.294	.277
Error	5.755	268	.021		
Total	18.588	272			
Corrected Total	5.838	271			

Analysis of Hypothesis 2: All test persons evaluate the motorcycle design the same, regardless of their response to the difficulty of evaluating designs from images

Due to the fact that the evaluations of the different motorcycle designs were carried out based on images, the test persons were additionally asked whether the evaluation posed difficulty or if it was less problematic using the images. Out of the 68 interviewed persons 63 provided information about the level of difficulty of the evaluation. The test persons were asked based on the images to evaluate the design as "very easy", "easy", "ok", "difficult", and "very difficult". The question that arises here is: Are there significant differences in the evaluations between the test persons that feel it can be difficult to assess the design using images and those for whom

it is less difficult? To investigate this question, the evaluations were summarized into two groups. One groups contained "difficult" and "very difficult" and the other contained "ok", "easy" and "very easy". The first group showed 44 percent. This means 44 percent of those interviewed felt the evaluation of design from images was difficult. The remaining 56 percent felt it was at least "ok" to carry out the evaluation. Through the application of analysis of variance, it should be shown whether both groups significantly differ from each other.

The Levene's test showed no significant difference in the survey, thus implying a possibility for the application of analysis of variance. Table 7 shows an overview of the results from the analysis of variance.

The illustration shows that there is no significant difference between the two groups. That is, the test persons who viewed the evaluation of design using images as "very difficult" and "difficult" rated motorcycle designs insignificantly different from those for whom it is "ok", "easy" and "very easy".

In summary, it can be stated for hypothesis 2 that the estimated degree of difficulty of an evaluation of design using images has no influence on the outcome. At this point, it should be checked whether design evaluations differ on real objects and from evaluations using images. This approach will be further investigated in the research project, in the coming months.

Table 7
Results of the analysis of variance for hypothesis 2.

Tests of Between-Subjects Effects

Dependent Variable: Evaluation

Source	Type III Sum of Squares	df	Mean Square	F	Slg.
Corrected Model	.000[a]	1	.000	.000	1.000
Intercept	12.343	1	12.343	602.310	.000
Difficulty	.000	1	.000	.000	1.000
Error	6.414	313	.020		
Total	19.014	315			
Corrected Total	6.414	314			

Table 8
Results of the analysis of variance for hypothesis 3.

Tests of Between-Subjects Effects

Dependent Variable: Evaluation

Source	Type III Sum of Squares	df	Mean Square	F	Slg.
Corrected Model	1.044E-013[a]	3	1.015E-013	.000	1.000
Intercept	6.822	1	6.822	331.218	.000
Education	.000	3	.000	.000	1.000
Error	6.921	336	.021		
Total	20.521	340			
Corrected Total	6.921	339			

Table 9
Results of the analysis of variance for hypothesis 4.

Tests of Between-Subjects Effects

Dependent Variable: Evaluation

Source	Type III Sum of Squares	df	Mean Square	F	Slg.
Corrected Model	1.062E-013[a]	1	1.062E-013	.000	1.000
Intercept	13.412	1	13.412	655.004	.000
Gender	.000	1	.000	.000	1.000
Error	6.921	338	.020		
Total	20.521	340			
Corrected Total	6.921	339			

Analysis of hypothesis 3: The field of studies has no influence on the evaluation of motorcycle designs

The content of analysis in hypothesis 3 is to analyze whether the field of studies, where the test persons were chosen from, have an influence on the results of the evaluation of design. These 68 persons were clustered according to their specified fields of study. These included:

- Field of Business Administration: 30 persons.
- Field of Industrial Engineering: 28 persons.
- Field of Mechanical Engineering: 5 persons.
- Others: 5 persons.

The summarization of environmental engineering, biochemistry, process engineering as well biomedical device technology into the group "others" was due to the low count of the information cells. Recommendations suggest that the cells, in this case a count of the test person's field of studies, should not be less than 5.

Hypothesis 3 has also been evaluated with the aid of an analysis of variance. An overview of the results is shown in Table 8. The Levene's test for equality of the variances of the errors showed not significance also in the analysis of hypothesis 3, so that the conditions for the use of analysis of variance were existent.

In Table 8 it can be shown that there is also no significant difference that can be identified in the evaluation of design with regard to the field of studies. The significance of the field of studies will be indicated with 1.000 in the table. This means that the null hypothesis can be assumed, so that the field of studies has no influence on the evaluation of the design. Motorcycles of the naked bike segment are evaluated equally by all test persons, no matter what personal interests or field of studies they emerge from. Engineers therefore do not significantly evaluate the design differently than, for example, business administrators.

By evaluating hypothesis 4, it will be investigated whether gender preferences have an impact on the evaluation of design. It will be checked whether men evaluate motorcycle design differently from women or whether for example particular motorcycles are appealing to women due to their design.

A total of 30 female and 38 male test persons were interviewed. The first step of the investigation analyses whether gender has an influence on the evaluation of motorcycle design at all. The results of the analysis of variance for the above question are shown in Table 9.

The evaluation of the equality of the variances of the errors shows again no significant result. Thus,

from Table 9 it can be suggested that the influence of gender on the evaluation of motorcycle design is insignificant. For hypothesis 4, the null hypothesis can as well be assumed. Gender has therefore no overall influence on the evaluation of motorcycle models. At this point, the investigation will be expanded, because it is possible that gender has a significant influence on the evaluation of particular motorcycle models.

To investigate this supposition, the data set was restructured so that model-related statements were possible. With this model-related record a variance analysis can now be performed for each model, in order to determine whether gender has a significant influence on the evaluation of design for a model. The descriptive statistics for the data set is shown in Table 10.

Table 10
Descriptive statistics of the model-related record.

Descriptive Statistics

	Gender	Mean	Std. Deviation	N
Motorcycle1	female	.2291333	.14221177	30
	male	.2542632	.15629471	38
	Total	.2431765	.14967257	68
Motorcycle2	female	.15646667	.112129461	30
	male	.11623684	.092900829	38
	Total	.13398529	.103020139	68
Motorcycle3	female	.1752667	.12052899	30
	male	.2366053	.13259867	38
	Total	.2095441	13015002	68
Motorcycle4	female	.1275667	08735804	30
	male	.2481316	.16221577	38
	Total	.1949412	.14653296	68
Motorcycle5	female	.3114333	.13938700	30
	male	.1448458	.13249903	38
	Total	.2183235	.15827507	68

The results for the individual ANOVA are shown in Table 11. The general conditions for the application of an analysis of variance were tested before and no abnormalities were shown.

Motorcycle 1 and motorcycle 2 showed no abnormalities with regard to the evaluation of design in one of the two groups. Men and women evaluate both designs less different. Somewhat different is the case for motorcycle 3. This model is evaluated at a supposed error probability of 5 percent not significantly different, but it lies very close to the limit of significance.

Motorcycle 4 and motorcycle 5 were significantly evaluated differently. Here, the two groups differ concerning the evaluation. The models are highly significant.

Table 11
Overview of the individual ANOVAS of the model
evaluations.

ANOVA

Motorcycle1

	Sum of Squares	df	Mean Square	F	Slg.
Between Groups	.011	1	.011	.469	.496
Within Groups	1.490	66	.023		
Total	1.501	67			

ANOVA

Motorcycle2

	Sum of Squares	df	Mean Square	F	Slg.
Between Groups	.027	1	.027	2.618	.110
Within Groups	.684	66	.010		
Total	.711	67			

ANOVA

Motorcycle3

	Sum of Squares	df	Mean Square	F	Slg.
Between Groups	.063	1	.063	3.884	.053
Within Groups	1.072	66	.016		
Total	1.135	67			

ANOVA

Motorcycle4

	Sum of Squares	df	Mean Square	F	Slg.
Between Groups	.244	1	.244	13.460	.000
Within Groups	1.195	66	.018		
Total	1.439	67			

ANOVA

Motorcycle5

	Sum of Squares	df	Mean Square	F	Slg.
Between Groups	.465	1	.465	25.323	.000
Within Groups	1.213	66	.018		
Total	1.678	67			

At this point, it is now to examine which model is preferred by which group. To answer this question, two average charts were created as shown in Fig. 2.

From the representation in Fig. 2, it is clear that motorcycle 4 on the average was evaluated better by men compared to women. The reverse is true for motorcycle 5. Here, the design of this model was evaluated better by women compared to men. It can be stated therefore that motorcycle 4 is positively perceived by men, while motorcycle 5 is preferred by women. In the following it is important to determine which perceptions are responsible for these differences.

The application of AHP and Multivariate Analysis Methods (MVAM) show that it is possible, on the one hand to make an evaluation on the visual perception of motorcycles and on the other hand with the help of multivariate methods, examine possible influencing factors. More detailed analysis should join in at this point, in order to correlate the identified influences through perception-defining characteristics with description and products.
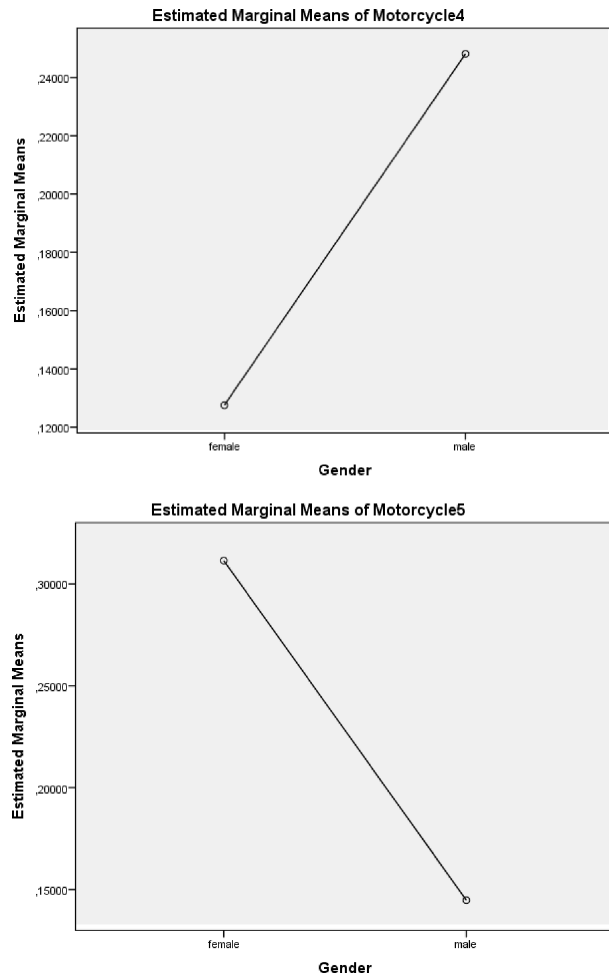

Fig. 2. Mean diagram of motorcycle 4 and motorcycle 5.

As an example, the results from a repertory grid can be used for the identification of perception-defining characteristics. Within the framework of the DFG research project MeGeQuS, different motorcycle models with regard to customer perception were analyzed with the help of the Repertory Grid Technique [19]. In total 5 motorcycles from the naked bike segment were analyzed: motorcycle 1, motorcycle 2, motorcycle 3, motorcycle 4, motorcycle 5 as well as an additional naked bike. This motorcycle was used as a placeholder for another machine of the naked bike segment. In the Repertory Grid, each triad is generated from the total of the evaluated models. Two similar models in the triads can be

determined through the test persons. Additionally, a relation that links the properties of the two models is named. Furthermore, the test person is asked which property represents the opposite of the binding property. These two properties are called construct system [20]. To a great extent, the properties preferred by the test persons should be named. For 5 models, a total of 10 triads must therefore be investigated. For 27 interviewed test persons, 270 construct systems resulted for which the perceptions of the persons were reflected based on the analyzed motorcycles.

From the test person's statements that were recorded in writing using an evaluation form, as well as through audio recordings, characteristics can be filtered out that specifically reflect the differences between motorcycle 4 and motorcycle 5. In order to identify gender specific characteristics tied to hypothesis 4, statements from 6 female and the 21 male persons, who participated in the Repertory Grid process, were analyzed separately. Only the triads were examined, which included the direct comparison of 4 motorcycle and motorcycle 5.

With 10 triads, 3 triads remain that refer to both models. The triad motorcycle 4-motorcycle 5-standby model was not considered. Because the standby model had a much older production dates than all other models, this comparison was not included in the analysis. Similarly, triads with motorcycle 4 and motorcycle 5 where the evaluations are the same were not considered because there were no differentiating characteristics generated from the test persons. Even triads with a distinguishing characteristic based on color were not included, since in the product development phase these characteristics would be easy to influence and not difficult to quantify.

Because motorcycle 5 was identified as a motorcycle which in its design is rather appealing to women, all statements from the female test persons involving the comparison of motorcycle 4 and motorcycle 5 were filtered out from the records. The extracted result is established in Table 12.

The table provides an overview of different perceptions between the two models, which were evaluated by female test persons. The characteristic preference is marked with (+) in the overview. It is shown that the majority of perceptions are positively related to motorcycle 5. These are marked in blue. Thus, it can be stated that motorcycle 5 is perceived by women among others through "shared riding pleasure", "streamlined" design or through the "safety" factor. These characteristics are at the same time most preferred. Above all the perception as "shared riding pleasure" and "motorcycle for couples" leads

to the assumption that women like to experience the hobby of motorcycling as a couple activity.

Table 12
Statements of female test persons on motorcycle 5 and motorcycle 4.

	Motorcycle 5
1	shared driving pleasure (+)
2	proportionate arrangement of exhaust system (+)
3	motorcycle for couples (+)
4	suitable for long-distance driving (+)
5	safe (+)
	Motorcycle 4
1	rapid driving is in focus (−)
2	disproportionate arrangement of exhaust system (−)
3	motorcycle for singles (−)
4	suitable only for short-distance driving (−)
5	daring (−)

Motorcycle 4 is rather negatively perceived by women. In this case, it is assumed to be "rapid" and has "aggressiv" driving. Furthermore, it seems only "suitable for short-distance driving" and has a "disproportionate exhaust arrangement" in perception of the female test persons. These properties are assigned a (−) in Table 12 and represent the less preferable characteristics by women.

This disproportionate arrangement may indicate that women prefer more linear and symmetric forms. This hypothesis however should be further investigated extensively. At this point, it should be noted that individual characteristics were identified, which suggest a positive perception of motorcycle 4. These were largely in significant minority, so that they can be neglected.

Table 13 gives an overview of the perceptions of the male test persons. As already shown in Figure 2, motorcycle 4 is positively perceived by men on average. From the male persons motorcycle 4 is perceived as a "futuristic, performance-intensive fun machine" with an overall "good first impression". Therefore, the technical components project in the forefront. Motorcycle 5 is rather perceived as a "traditional means of transport" with a "not outstanding and tame appearance".

According to the analysis, it can be proven that there are models evaluated differently by women and men based on their designs. The use of statistical methods, analysis of variance in particular supports this statement. If the results are further analyzed and the interview results, for example from a Repertory Grid, are included, then these differences can

also be characterized through concrete perception-defining characteristics.

Table 13
Statements from male test persons to motorcycle 5 and motorcycle 4.

	Motorcycle 5
1	means of transport (−)
2	traditional (−)
3	tame appearance (−)
4	obvious exhaust (−)
5	not outstanding (−)
	Motorcycle 4
1	fun maschine (+)
2	futuristic (+)
3	performance-intensive (+)
4	elegantly exhaust (+)
5	good first impression (+)

Conclusion

The results presented in this paper show that the AHP offer an approach to identify, organize as well as evaluate categories and criteria. Specifically, the design criterion was taken into consideration. The evaluation of categories, criteria and at the base level characteristics is a prerequisite for the development of scales. The advantage of applying the AHP, is the direct comparison of all alternatives with each other. If, for example, five products regarding the design are compared, a scale for good design arises implicitly. These scales build up dynamically, depending on the studied alternatives. Resilient scales emerge only when a large number of alternatives are compared with each other. Because, only in the case where test persons evaluate a large number of alternatives in relation to another alternative then a meaningful result can be expected. The AHP scale provides help for such an evaluation process.

Through this paper, it can be shown that by applying multivariate analysis methods, a first impression on product perception can be derived even from a small number of tests persons. Specifically, the optical perception was an artifact of this research. Research hypotheses could be investigated with the aid of analysis of variance. As a fact, it was shown that in general there are no significant perceptible differences in the designs for the evaluated models of the naked bike segment. Motorcycle 2 was the only model that was significantly perceived different from the other four models. Furthermore, it was irrelevant what field of studies the test persons originated from. Their evaluation of motorcycle designs did not dif-

fer significantly. The introduced approaches presented here can contribute to the development of products in the interest of the customer, since in the early stages of product development target groups can better be taken into account, as important aspects of perception are already known. If, for example, women are specifically the target group, then the aforementioned perceptions should be rather included in naked bike segment.

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