Protect Our Health with Cleaner Cars – How to Gain Customer Acceptance for Air Pollution Decreasing Retrofit Purchase

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Abstract. Automotive service suppliers are keen to invent products that help to reduce particulate matter pollution substantial, but governance worldwide are not yet ready to introduce this retrofitting of helpful devices statutory. To develop a strategy how to introduce these devices to the market based on user needs is the objective of our research. The contribution of this paper is three-fold: we will provide an overview of the current options of particulate matter pollution solutions (I). This corpus is used to come to a more precise description of the specific needs and wishes of target groups (II). Finally, a representative empirical study via social media channels with German car owners will help to develop a strategy to introduce retrofit devices into the German market (III).

Keywords: Particulate matter pollution · Brake dust filter · Retrofit · Automotive after market · Millennials · Social media · Customer acceptance

1 Particulate Matter Pollution Retrofit Market

In Europe about 324 million cars create a 127 billion Euro after market with two categories of service providers for car repair: about 84,000 Original Equipment Service (OES) and 378,000 Independent After Market (IAM) share this market turnover nearly half-and-half [1]. Air pollution and attempts to defraud by several big car brands unsettle the automotive industry and especially the customers in the last years. Also, alternative drive systems like e-cars enter the market.

But, not only motors are a source of health hazards: even more braking causes an enormous part of particulate matter pollution worldwide. What could be a clue for this challenging situation? Brake filter technology could be an excellent solution, because emerging fine dust is directly absorbed by a filter in the brake system. The filter production company Mann+Hummel, Ludwigsburg, Germany, and Offenburg University conduct a unique research project: The objective is to identify the willingness of young health-sensitive customers to invest in a brake filter device in a representative survey in Germany.

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We try to find out, where customers would expect this innovative retrofit, how much they would spent and what additional services they would like to get offered by service and product providers. Retrofit providers can use this information to fulfill customer needs on less air polluting cars and facilitate the decision to buy and use a car nowadays.

2 Related Work

The individual generations of the German population are currently undergoing a major structural change in terms of prioritizing people´s health and environmental protection. In this chapter we describe the specific characteristics of the addressed target groups.

2.1 Target Group: Millennials

According to a study on environmental awareness from 2018 [2] there are two social milieus, which are especially environmentally aware and therefore willing to spend more money for health promoting and ecologic alternatives of consumer goods – the Critical Creatives and the Young Idealists. Both of which share the opinion that, in accordance to the future development of traffic and transport, the environment should be polluted as little as possible [3].

Critical Creatives include mainly highly-educated females in a broad age range from 30 to 70 years who are looking for self-fulfillment and independence. Further, they are tolerant, cosmopolitan and interested in social, as well as cultural topics, while considering the government's current commitment to environmental and health protection as inadequate. On average, two to three cars are owned per critical creative household. However, the median usage amounts to under 10,000 km per car and year. They highly support the utility of bicycles and public transport, but the terms of use in Germany are still considered unappealing today. Critical Creatives make up about 13% of Germany's total population [3].

Young Idealists on the other hand are willing to fully live and act actively sustainable while supporting and engaging in social and ecological projects, campaigns and lifestyles. Additionally, diversity, tolerance and respect depict important values of young idealists. They are represented by mainly females, their age ranging from 14 to 30 years who enjoy a rather high level of formal education. Furthermore, they believe that environmental and health protection portrays one of the major challenges in German society, which therefore should be prioritized in all political fields of action. In terms of transport, the Young Idealists prefer to ride their bicycles or to take public transportation.

However, over 70% of their households own one or more cars, which is most likely due to the fact that one third of the Young Idealists still live with their parents and/or are able to use their cars. Travelling and getting to know the world is a very important aspect in this group's life, so they tend to fly often. Nonetheless, they are aware of the according ecologic effects and make rather more compensation payments than others. In terms of consumer behavior, Young Idealists try to buy as many environmentally friendly products as far as possible with their current rather low income. However, they still prefer to use modern technology and tend to shop online. Overall, only 5% of the total German population are represented by Young Idealists [3].

On the contrary, more than half of the precarious milieu assumes that economical and health protection is not a basic requirement to ensure future prosperity. This group considers the contribution of citizens concerning this issue to be sufficient, but government engagement is also examined as critical. The Precarious mainly consist of people with low levels of formal education and wages, who are rather pessimistic and see themselves as losers of current social developments. In general, they are less mobile and rarely use public transport, due to the rather high costs. The majority still has at least one car per household, but averagely does not drive more than 10,000 km per year. As well as Critical Creatives, the Precarious milieu consists of 13% of the total population in Germany [3].

2.2 Challenge: Reduction of Air Pollution in Europe

As one of the first countries to adopt environmental practices and policies in the European Union, Germany constantly implements air quality and action plans, such as low emission zones in cities to reduce air pollution and the accompanied fine particle dust emissions [4, 5]. The introduction of these policies led to many Germans having to retrofit specific filters to their cars to reduce Diesel soot in order to still be able to drive in certain city areas with low emission zones [5, 6]. By 2018, over 50 of these low emission zones were in operation, reducing up to about 10% of PM_{10}-fine particles after these mass concentrations exceeded European standards and regulations in the first place [6, 7]. These zones also highly benefit human health, as they reduce the exposure to particulate matter from emission sources, which is a cause of elevated mortality rates through lung-deposited diseases [8, 9].

Besides Germany and its citizens prioritizing environmental and health protection, the European Union is taking major steps in the same direction [10]. Considering these implications and developments about the German and European society regarding their environmental awareness, the topic of retrofitting brake dust filters to reduce particulate matter could become increasingly interesting.

2.3 Quantitative Approach

In order to fully identify the target groups' requirements, their desires, needs and willingness to invest in the retrofit of a brake filter device, a survey was conducted. As the focus lied on the comprehensive quantification of human actions, behavior, and decisions of the target group, the empirical study has a quantitative approach.

Besides, this method can be used to obtain a large sample to be able to make representative statements about possible targets. Standardized, mostly written, but nowadays also electronic surveys are particularly suitable for this purpose. For these reasons, a questionnaire-based online survey was conducted.

The typical research process of an empirical study can be roughly divided into four process phases. These include the theoretical phase, the empirical phase, the evaluation phase and last but not least the practical phase. Initially, the research problem is phrased in order to be able to deduce hypotheses deductively and then evaluate them in the research process. Then the research design is used to determine the procedure for the data collection of the survey, possible variables and measurement operations. Subsequently,

the data is collected. The evaluation of the data is carried out using statistical methods. Finally, the findings are interpreted in relation to the theoretical model [11].

The research question and therefore the key findings of this empirical study lie in identifying the unknown target group. To determine the intended audience a two-step methodical approach was used. First of all, expert interviews were conducted with car repair shops to be able to narrow down a potential target group.

A total of five garage owners and employees were interviewed. These interviews revealed that rather younger people show a great interest in the topic of health protection, environment and retrofitting.

Furthermore, the experts estimated that the costs for the installation of four filters including the filter price would approximately lie around 250 €. According to the experts' experience, consumers would also be more willing to retrofit car parts if they were supported by monetary incentives. Subsequently, hypotheses were developed to investigate the central research question. The following six hypotheses were decisive:

- H1: Millennials are more willing to retrofit a brake filter.
- H2: If retrofitting is subsidized by the state, 75% of car owners are in favor of the brake filter.
- H3: If there is no legal filter obligation, potential customers would not retrofit it.
- H4: The potential target group is interested in a visible brake filter with an individually selectable design.
- H5: If the brake filter is mounted by the customer himself, he will buy it online.
- H6: Potential customers are willing to pay more than 200 € for the brake dust filter.

From these hypotheses, questions for the questionnaire could now be derived to determine the opinion of the potential target groups. All in all, the questionnaire consisted of 27 questions that not every respondent received. Depending on which answer was chosen, the survey was continued or ended earlier.

The interview included 17 closed questions with a single selection, one closed question with multiple selections, eight questions that the respondents were able to answer with a 6-point Likert scale and one open question.

The study was conducted online and disseminated through social networks to generate the highest possible reach. The advantages of using social platforms are e.g. the accessibility of different age groups and the use of paid advertisements to reach potential respondents using specific filters.

To select the appropriate social network, a channel analysis was first carried out. As a result, the platform Facebook was selected for the distribution of the survey, as it was possible to reach different age groups, while focusing environmentally-interested car lovers in bigger German cities through ad filters.

To reach as many people as possible, suitable Facebook groups and Internet forums that deal with topics such as sustainability, particulate matter or the automobile were also included. Finally, the survey was shared as a post via the author's private accounts and as a paid advertisement via the Offenburg University page.

Interested parties had time to participate in the survey from December 6th to December 15th 2019. It was conducted anonymously and without a time limit for answering the questions.

In the last step, the survey was evaluated using quantitative analyses. For this purpose, the program SPSS was used for and after preparing and filtering the data set. This enabled the following evaluation to only use data sets that were complete, including the question about retrofitting such a brake filter technology.

In order to gain further insights into the potential target group, univariate analysis methods (frequency distribution) and multivariate analysis methods (cross tables, cluster analysis) were performed.

3 Customer Acceptance Study: Evaluating the Wishes and Needs on Retrofit Services in Germany

In this survey in cooperation with MANN+HUMMEL among German car owners with a return of n = 248 completely filled and relevant questionnaires, the research was focused on the acceptance potential of retrofitting a brake filter device and the identification of the target group as well as the development of a strategy to introduce such devices into the German market.

In the following chapter an overview of the people who would retrofit, would not or are not sure about this yet will be given and the reasons for those decisions will be further described and interpreted. Afterwards, a strategy on how to bring those devices into the German market will be discussed. Finally, some more advice and ideas will conclude this paper.

3.1 Demographic Details

As shown in Table 1, 36.3% out of the 248 people who completed the questionnaire are interested in installing a brake dust filter, while 26.6% do not want to retrofit and 37.1% are not yet sure. However, comparing the proponents to the opponents suggests that there is a basic acceptance for this kind of device. We asked the participants of the survey: Would you have such a break dust filter, regardless of the cost, on your car retrofit?

Table 1. Willingness to retrofit

	Frequency	Percentage	Valid percentage	Cumulated percentage
Yes	90	36.3%	36.3%	36.3%
No	66	26.6%	26.6%	62.9%
I am not sure yet	92	37.1%	37.1%	100.0%
Total	248	100.0%	100.0%	

When describing the demographic and socioeconomic values of the target group more precisely, it is interesting to see, that 46.4% of the responding women are confident about retrofitting. Only 36.7% of men count to the proponents of a brake dust filter. If the opponents are also compared by gender, it is observable that a small part of women

is against the filter, since only 5.4% of them say no. The number of male opponents on the other hand amounts to 29.2% and is therefore way higher than that of women. Consequently, women are more likely in the target group than men.

The age of potential customers does not seem to influence their decision to retrofit a brake filter device. When looking at those who would not like to retrofit on the other hand, 64.1% of the 30 to 59 year olds are sure about their decision. The 18 to 29 year olds, as well as the 60 year olds and older, are the ones who are most likely to retrofit a brake dust filter. Only 12.6% of the 18 to 29 year olds would directly say that they are not interested in upgrading their car with devices reducing emissions.

With this result, it is possible to partly approve H1 that states that Millennials are more willing to retrofit a brake filter, as previously described in chapter two. Nevertheless, almost half of the young people (45.3%) are unsure whether they would buy a filter or not.

This age category includes students, trainees, self-employed entrepreneurs and employees. When having a closer look at those who would retrofit this filter in general out of the respondents, the 52.6% of the self-employed and 50% of trainees are the most certain about retrofitting. Those are followed by the pensioners and then the students.

However 48.8% of all participating students and 40% of trainees are quite unsure as well, which comes in hand with the description of the 18 to 29 year olds where exactly this effect occurred. The analysis of the results also shows that 44.9% of people who live in cities and 42.2% of suburb residents are the most confident about retrofitting a brake dust filter. Only of those living in the countryside, more inhabitants are still unsure about the retrofit (41.7%) than confident with it (33.3%).

3.2 Customer Characteristics

In the following, the psychographic characteristics are described. Among other things, the willingness to retrofit depends on the age of the car. The older a car the less willing people are to retrofit such a device. That means that 38.1% of the people with a car older than 20 years would not retrofit whereas only 22.5% of the ones having a car between 0 and 5 years would also not retrofit.

From the other side, cumulated 69.8% of the proponents have a car between 0 and 10 years. Looking at the different types of car drivers, it is obvious that people who say ‘economical driving is important to me’ are most certain concerning this retrofit device. 56.1% out of this category would say that they are willing to upgrade and only 14.6% directly oppose. Those economical drivers, as well as the ones who just use their car to get from one place to another, are the ones with the best potential, since most of them would retrofit and just a few of them are not interested.

Nonetheless, those who pay more attention to the appearance of their car would not retrofit such a brake dust filter. These are the ones who chose ‘I tune my car’ (with 50% who would not retrofit) or ‘I like driving a nice car’ (with 40.5% who would not retrofit). The results also show that owners of premium cars like Audi, Mercedes and BMW tend to not wanting the filter retrofitted, while owners of mid-range cars like Seat, Opel and Ford are more inclined.

When it comes to retrofitting a particulate matter filter, environmental awareness is a key factor. It is clear to see that with 88.9%, the great majority of people who are not environmentally conscious, would not retrofit such a device, whereas the majority of people who would like to retrofit a filter would certainly describe themselves as at least more environmentally conscious (83.7%). Due to the presented survey, it becomes clear that environmental protection is one of the strongest motives for retrofitting a brake dust device. Accordingly, the main target group contains people who care about the environmental protection.

3.3 Customer Motivations

To find out more about our target group further motives were queried from people keen to retrofit a filter. At the same time, reasons against retrofitting were collected from those who are not yet sure about the retrofit, as well as from those who clearly have no interest in retrofitting such a device.

The following results are derive from a basis of 87 persons interested in the retrofit. Different statements on a scale from 1 (no motivation at all) to 6 (very strong motivation) were evaluated. The outcome is summarized in Table 2.

Table 2. Evaluated motives for retrofitting a brake dust filter device

Aspects for retrofitting	Percentage in categories ≥ 4	Mean values (aspects)[a]
Reduced health risk	91.9%	5.2
Environmental protection	87.3%	5.2
State subsidies	58.5%	3.9
Cleanliness of rims	49.4%	3.6
Noticeable design	15.0%	1.9

[a]Among all proponents of the filter

Based on this study two aspects stand out particularly as motives - reduced health risk and environmental protection. 56.3% of interested people state that environmental protection is a very strong reason for retrofitting such a device. If the positive answers of the range (4 to 6) are cumulated, it becomes clear that 87.3% of those who would retrofit a device on their car values this aspect as a big motivation for doing so. Furthermore, 55.2% evaluate the reduced health risk as a very strong motivation for buying this filter. Cumulated with the positive answers of the range, a percentage of 91.9% is received, which shows the importance of this reason overall.

Looking at the mean of these answers, there are the two highest means of 5.2 for environmental protection and 5.2 for reduced health risk. These results show that people

would especially buy such a technology for health and environmental reasons, which further explains the high environmental consciousness of the proponents of the filter. As previously described in chapter two, the respondents are concerned about the environment and their health, but they are also prepared to take countermeasures.

Another reason for retrofitting the filter would be the possible state subsidy for emission-reducing devices. A narrow majority of those who would have the filter retrofitted see precisely this as a reason for retrofitting. Even though a high percentage of respondents are more likely to retrofit a brake dust filter with state subventions, hypothesis H2, as seen in chapter two, is rejected as a percentage of 75% is not quite reached.

In the study, respondents assessed if the cleanliness of their rims while using the device would be a reason to retrofit or if it is rather not a motive. This aspect has a mean of 3.6, which shows the indifference of this topic concerning the filter. Half of the people say the cleanliness of their rims would be at least rather a motive for retrofitting a brake dust filter, while also half the people find it rather no reason. This answer also has a scope, where respondents were able to choose from 1 (no motivation at all) and 6 (very strong motivation).

So, there is no clear answer which represents the majority but two answers that lead to the recognition that there is no significant connection between the cleanliness and the purchase. Eventually, another aspect was analyzed. The question was whether the noticeable design is a reason for retrofitting.

More than 84% of the people interested in the purchase evaluate this aspect in the scope between 1 (no motivation at all) to 3 (rather no motive). Out of these 84% even 58.7% say that it is clearly no reason for a purchase. Only 15% find the filter's striking design to be a reason for buying this device with the lowest mean of 1.9.

In order to identify the reasons of the respondents, who are not sure about the purchase yet, or those, who are not interested in it at all, propositions were also made at this point. These were evaluated according to 'motive against buying' or 'not a reason against buying'.

Due to this evaluation it was assessed, which aspects keep people from buying the filter and where Mann+Hummel could invest to convince potential buyers of retrofitting a brake dust filter. The following results base on 60 people who would not retrofit at all and 87 people, who are not sure about it yet.

Those statements were assessed on a scale from 1 (I don't agree at all) to 6 (I fully agree). 1 means that people don't see an aspect as a reason for not buying the device. 6 instead means that one aspect strongly prevents them from retrofitting.

Table 3 shows these evaluated aspects by opponents and doubters with their equivalent cumulated percentages and mean values.

By far the strongest reason against retrofitting this new technology represents the additional cost for installation and maintenance. Almost 70% of those who are not interested in this filter at all and even 75.8% of those who are not sure yet, say that it is at least rather a reason for not buying the brake dust device. This outcome is further supported by the mean value of 4.3 and 4.4 which shows the clear tendency that it is a stronger reason against such a retrofit. This recognition leads to the result that costs

Table 3. Evaluated aspects preventing people from retrofitting a brake dust filter device

Aspects against retrofitting	Percentage in categories ≥ 4		Mean values (aspects)[a]	
	Opponents	Note sure yet		
Noticeable design	31.7%	25.2%	2.4	2.3
Complexity of the retrofit process	35.0%	39.0%	2.7	3.0
No obligation for this filter	36.7%	37.8%	3.0	2.9
No State subsidies	46.6%	51.6%	3.3	3.5
Effort for going to the workshop	51.7%	37.8%	3.5	3.2
Costs for installation and maintenance	69.9%	75.8%	4.3	4.4

[a]Among all opponents and waverers of the filter.

besides the acquisition costs should be held minimal and communicated clearly before purchase.

Moreover Mann+Hummel should display that the installation and the change of the filter is executed with a regular brake change. This goes hand in hand with the next aspect about the effort of a garage visit. People aren't interested in such extra effort, so Mann+Hummel needs to indicate how this is not needed in the first place. Therefore, around 40% of those who are not sure about the filter yet could still be convinced to retrofit after all.

Furthermore, the lack of state laws seems to be a reason to not retrofit the filter for about half the mentioned participants. We find a half and half distribution about aspects concerning the laws. Less than 40% of both groups state that the absence of laws concerning the filter oppose them from buying a filter. Thus, hypothesis H3 from chapter two can be rejected, because as there is no legal obligation, people will not retrofit a brake particle filter. The aspect of lack of subsidies is very equally evaluated, so that there is no clear outcome if people rather see this as a reason against retrofitting a filter. The complexity of the retrofit process does not deter 60–65% of people from buying the filter either.

The least important reason against the purchase is the eye-catching design. It's mean of 2.4 shows that people would not say no to the filter because of the design. Respondents who are not convinced yet have an even lower mean of 2.3 for the aspect design which means that for them it represents an even lower motive against the technology.

3.4 Marketing Mix: Lessons Learned

Following the previous identification of the acceptance potential and the target groups, selected insights of the empirical study are assigned to the four elements of the marketing mix, in order to derive a successful strategy for the market launch of the brake filter device. This serves the purpose of developing a detailed marketing structure, which provides information about the characteristics, which the product must have in order to convince the potential target group to retrofit the brake filter. It also displays the maximum cost

of the filter, the distribution channel by which the target group wishes to purchase the product, and how the communication policy must be created to attract potential buyers.

In order to filter out characteristics of the product, the respondents were questioned about their acceptance of an individual painting for the brake filter. More than 38% of the respondents, who said yes to the filter, are very interested in an individual painting for their brake filter. If the percentages of the more interested to extremely interested persons are cumulated, a percentage of over 65% is achieved. As a result, individual painting is an attractive product design for those willing to buy, which they are happy to use. A very similar distribution can be seen for those who are not sure yet if they will retrofit the filter. Here, the cumulative percentage of the more interested to extremely interested respondents is nearly 66%.

Based on the motives for the retrofit, it could already be concluded that the noticeable, eye-catching design of the filter is no reason for retrofitting. Therefore, it can be said that the individual painting is not a decisive characteristic of the filter, but the individual design can make the product more attractive for the target group after the decision for retrofitting. Consequently, the own color choice should be offered as an option for the buyers in any case. As seen in chapter two, hypothesis H4 can partly be verified for this particular study.

Furthermore, the desire for having such a brake particle filter already integrated into the basic equipment of cars was surveyed. With 71.7%, the clear majority would like such an opportunity, while 15.5% are not interested.

Another aim of the survey was to find out if the target group is interested in having the filter professionally retrofitted in a garage or if they prefer to retrofit it by themselves. The best distribution channel for the brake filter can subsequent be chosen from the survey. While looking at the evaluation, it is clear that 67.4% of the supporters of the filter would like it to be professionally installed in a car repair shop. The remaining 32.6%, or almost a third, would like to assemble the filter on their own. A very similar distribution can be seen for those who are still uncertain to retrofit the filter. Here, almost 70% would have the filter retrofitted in the workshop, while about 30% would mount it by themselves.

Among those who are not sure whether they want to retrofit the filter yet, the high number of retrofits in garages can be explained by the fact that almost 40% had previously reported that they have reservations that the retrofitting process is very complex. It is therefore likely that many doubters do not dare to retrofit the filter themselves and prefer to visit a garage. Based on the fact that about two thirds of the supporters and still uncertain respondents would retrofit the filter in the garage, an indirect distribution should be chosen, namely via car repair shops.

However, the retrofitting process is not as complex as expected by potential buyers and could be communicated to the target group very clearly via video material. As a result, some doubters, and consequently potential customers, decide to install the filter themselves, and the main reason against retrofitting – the costs of installation and maintenance – is eliminated.

Among others, the respondents who install the filter themselves were also analyzed with regard to their preferred place of acquisition. It is clearly seen that almost everyone who installs the filter themselves is ordering it online. Among the supporters, almost

27% and among the insecure ones, exactly 25% are online buyers. Thus, hypothesis H5 from chapter two can be verified ceteris paribus. Moreover, almost 5% of the supporters and 3.6% of the insecure ones want to buy the filter in a garage. A negligible quantity $< 4\%$ will buy the filter from a car or tire dealership. In order to serve the whole target group, an additional distribution channel, namely online trade, must be opened up for the filter.

With regard to the costs of the filter including installation, it can be said that there is a very low acceptance of high costs. Approximately 59% of the supporters and those who are still uncertain have said that they do not want to spend more than 200 € for the filter including installation. About 30% accept a price between 200 € and 250 €. Only 9% find a compensation between 250 € and 350 € acceptable. The curve of cost-readiness approaches the x-axis exponentially and shows clearly that the higher the price for the filter including installation, the fewer people are willing to buy the filter. Finally, at over 450 € only one person is willing to retrofit the filter.

Overall, the cost acceptance level and willingness to purchase a brake particle filter is rather low and under 200 €, so hypotheses H6 from chapter two is rejected. It can be said that if a successful product launch of retrofit devices should be achieved on the German after-sales market, the price of the product and installation must be kept as low as possible, possibly under 200 €. A solution for this challenge could be to offer governmental support in the form of subventions for retrofit devices that are used for environmental protection, human health and the decline of air pollutions through transport and traffic.

In order to reach the right target group, a fitting communication strategy must be developed. As it is clear from the motives for retrofitting, the focus of communication needs to be on reducing health risks and protecting the environment. If a campaign is created for the filter, everything should revolve around these key points.

3.5 Multivariate Analysis: Specific Customer Segmentation

Our results from univariate and bivariate analysis mentioned so far were confirmed and further substantiated by a multivariate cluster analysis. For the proponents, we used the aspects for retrofitting as cluster variables and obtained three homogeneous and communication relevant clusters, again resulting in the central aspect of reducing health risks, that was rated as ‘strong’ to ‘very strong motivation’ in each cluster. In the first and largest cluster (51 elements) ‘protecting the environment’ was similarly high rated and we additionally found an overrepresentation for ‘State subsidies’.

The latter was not the case for cluster 2 (13 elements). ‘Cleanliness of rims’ and ‘Noticeable design’ were clearly underrepresented in both clusters. A rather small, but interesting group, that showed overrepresented ratings for ‘Cleanliness of rims’ and ‘Noticeable design’, was found in a third cluster (13 elements).

So, we have to focus on reducing health risks and protecting the environment for each cluster, but we should also pay attention to the design aspect, in order to address persons from Cluster 3. This is not conflicting with the attitudes of the other two clusters, because these persons showed not to be disturbed by the brake filter’s visibility.

In order to find more hints for an adequate communication towards the clusters, we analyzed the clusters’ matching with the types of car drivers, mentioned above.

Describing economical drivers, as well as the ones who just use their car to get from one place to another, or who are simply dependent on their car, as 'pragmatists', we have a high correspondence to clusters 1 and 2.

On the other hand, we find those who pay more attention to the appearance of their car (I tune my car, I like driving a nice car, I keep my car well maintained) clearly overrepresented in cluster 3, describing them as 'car lovers'.

Consequently, communication should focus on pragmatists. Assumed car (owner's) properties as solidity and reliability should be projected on the reduced influence on health and environment. Additionally, an attractive design could be propagated to gain the segment of car lovers – with the option of individual break filter coloring. A wish, that was overrepresented especially in this segment.

Analogously, a cluster analysis was conducted for the filter's opponents – with the aspects against retrofitting as cluster variables. The first cluster is characterized by 'Costs for installation and maintenance' as the central reason for denial, whereby all other reasons are rated not very high ($\leq$3.22 in mean values). The second cluster consists of 'fundamental sceptics'. All reasons for denial are rated high ($\geq$4.23 in mean values). In cluster 3, we have notorious opponents, as all reasons for denial are rated very low ($\leq$1.85 in mean values).

Following a pragmatic approach, communication should focus on cluster 1 and 3. The highest potential influence we should have on cluster 1, where pragmatics are overrepresented again. The goal should be to keep costs as low as possible, ideally combined with State subsidies. As the environmental consciousness is high among all respondents in the study, there seems to be a clear potential to convince this group. Car lovers are overrepresented in cluster 3. It seems to be very hard to gain this segment. But even here, we found a tendency towards more environmental consciousness.

This could be a starting point to reduce the denying attitude, potentially supported by design aspects, if we further assume, that this group's low rating of that aspect was induced by the general refusal.

4 Conclusion

Mann+Hummel is able to develop a strategy to increase the acceptance of retrofit purchases in accordance with customer requirements based on the explained survey results from Offenburg University.

The right target group is essential for the company for a successful sale. The empirical study shows which reasons induce the defined target group to retrofit and thus to purchase the filter in Germany. It should be noted, that the intrinsic motivation such as health risk minimization and environmental protection is extended by the extrinsic motivation in form of monetary compensation.

4.1 Recommendations

After all, five recommendations are the most important for the introduction and future development of the brake dust filter:

- Recommendation 1: Keep costs low for the target groups
  Since here the ideal of an extrinsic motivation prevails and the filter reaches acceptance, it is recommended that the costs of the product including retrofitting in workshops should not exceed the limit value: According to the research results, the limit is 200 € including workshop services for the end customer. Furthermore, attention should be paid to the General Operating Permit in accordance with the German Road Traffic Licensing Regulations, which is helpful in the event of retrofitting by a garage or customer. It is important to point out that this should not result in any additional costs for the end consumer.
- Recommendation 2: Filter as basic equipment for new cars and competitive advantage for car producers
  Starting from the retrofit business field, Mann+Hummel should arrange co-operations with the automotive suppliers in order to deliver future basic equipment devices for rake dust filters in all new cars. Then the filter would be already integrated in the product and would facilitate market entry at the outset.

This way the innovative product would achieve a wide range of popularity and reputation in the beginning of the launch. Also car producers could communicate this new health-promotion device in their cars and use this fact to find higher acceptance by the addressed target groups: the brake dust filter would attract new customers to buy this specific car brand. This recommendation of a basic equipment is based on assessments of potential customers and therefore respondents of the underlying survey.

- Recommendation 3: Legal equipment obligation for fast and powerful market entrance
  The chance of a future governmental filter obligation could offer Mann+Hummel a fast market entry and growth of success in the brake dust filter market: a legal equipment obligation would speed up the distribution in the market. The brake dust filter is an easy to install and economic technology, which is combined with the brake change routine and can to filter fine dust particles that emerge while braking until the next service interval for the car brakes comes up.
- Recommendation 4: Economies of scale and garage owners' acceptance
  High volume production could not only reduce production costs but would also generate additional public range for this innovative product, as well as an acceptable purchase price for final customers. Garage owners could be invited for trainings on the installation of the product, which is important because they are the direct contact to the customers – the car owners. If the mechanics in the workshop can show the advantages of the brake dust filter, customers will listen to them and accept the higher costs probably more easily. As output increases, the costs of the individual product are lower for the final customer.

This innovative product represents an opportunity for Mann+Hummel in order to generate acceptance of retrofitting by end customers in cooperation with the garage owners and workshop mechanics. It is important that the ministry of health also provides support in the form of monetary funding and communication of benefits. With this intention, the extrinsic motivation is further encouraged.

– Recommendation 5: Segment-oriented communication to address additional target groups
  The results from cluster analysis show, that there should be a concentration on Pragmatists with communication focus on health and environment. Additionally, an attractive design should be propagated to gain the segment of Car Lovers – with the option of individual break filter coloring. This is not conflicting with the Pragmatists' attitudes, as the showed not to be disturbed by the brake filter's visibility.

Another insight was surprising but also very interesting, because it is an absolute new target group for retrofitting: we found in our survey a very high acceptance potential by young female car owners. This is not a classic target group for car retrofitting, but these women are highly sensitive for health-promotion and environmental-friendly products.

Addressing this new target group with e.g. an emotional appealing social media campaign in YouTube or Instagram, there is a high potential for selling the innovative brake dust filter system. Even for older cars the retrofit at a reasonable price would be interesting for the female car owners. Also new cars with the brake dust filter system could be used by a car manufacturer brand as a unique selling proposition e.g. a brake dust filter supported BMW Mini as a women-preferred car model.

The results of this underlying study show that retrofitting the filter will be accepted and the motives are clearly based on intrinsic and extrinsic motivation. Important aspects are monetary incentives as well as a legal regulation, which should thus be taken into account when introducing the filter to the after-sales market.

4.2 Limitations and Future Work

The initial hypotheses regarding the potential target group could mostly be fully, or at least partly confirmed by the study carried out. Provided, that a brake dust filter is desired and retrofitted, the results show a strong interest especially by a young and female target group. The previous results of the survey also show how powerful external incentives as governmental subsidies are to potential consumers.

Extrinsic motivation might show very attractive for Mann+Hummel market entry with the brake dust filter system – alongside motives such as minimizing health risks and environmental protection are also very important. [12, 13] For this reason, it is important to tweak and tune all relevant aspects of the levers for external motivation additionally. However, motivating and convincing the target group not only extrinsic will be a great challenge for the company.

For this reason, it is advisable to put the customer benefit of a cleaner environment and the reduction of health risks at the center of the communication strategy, while still proposing potential reasons to buy the filter as well, such as being able to customize the design of the brake dust filter to fit the appearance of the vehicle. Overall, it can be said that an optimal interplay of extrinsic and intrinsic motivation should be focused as a strategy of Mann+Hummel.

From the many comments made in the survey, one factor can be identified that needs to be illustrated in the context of communication. Many respondents are unsure how to dispose of the filter. Some people fear a complicated disposal. For this reason,

information about disposal should be provided. A video could also be helpful, which illustrates the disposal process in detail and clarifies all open questions.

Another marketing tool to increase awareness of the filter and establish it in society after introducing it to the German market can be the sponsoring of car sharing companies, such as “car2go”. On the one hand, this serves the advertising purpose, but the filter can also increasingly be seen as a health protecting product by inhabitants of German cities on the other hand.

The filter introduction to the after-sales market is a future horizontal product expansion. Which enables a transfer of the technology to other means of transport such as buses, trucks, trains and motorcycles or airplanes and thus a future corporate strategy.

New value streams are created by opening up new markets, winning new customers and reducing production costs. As a young, female and health-sensitive target group has been identified, the initiative can be taken to implement fitting communication instruments such as social media channels.

Finally, the research results show that there is high potential for a brake dust filter in the future especially for the young target group of ‘Young Idealists’ with environmental and health-promotion reasons. Car manufacturers could also make their contribution to the well-being of people by equipping their own company vehicles with this filter. Therefore, they can act as a role model for all economic players.

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