Incentives for the Acceptance of Mobility Equipment by Elderly People on the Basis of the Kano Model: A Human Factors Perspective for Initial Contact with Healthcare Products

C. Brandl, P. Rasche, C. Bröhl, S. Theis, M. Wille, C.M. Schlick and A. Mertens

Abstract Personal mobility, such as, for example, the ability to get up and sit down independently, decreases by age. In Germany, one out of ten people older than 75 years needs long-term care and thereby support in personal mobility. Within the age group of 80+ years this number increases even more. Personal immobility is one of the main reasons for the necessity of a caregiver. To improve older persons' independent mobility, supporting technical devices like walking sticks, walkers and wheel chairs established themselves. However, these devices can just be used after the patient gets up or sits down. For these special situations, technical solutions are also available. They are able to support a user even during situations in which he or she needs to be lifted. But they are not used frequently due to various reasons such as high costs and high stigmatization potential. In this

C. Brandl (✉) · P. Rasche · C. Bröhl · S. Theis · M. Wille · C.M. Schlick · A. Mertens
Institute of Industrial Engineering and Ergonomics, RWTH Aachen University,
Bergdriesch 27, 52062 Aachen, Germany
e-mail: c.brandl@iaw.rwth-aachen.de

P. Rasche
e-mail: p.rasche@iaw.rwth-aachen.de

C. Bröhl
e-mail: c.broehl@iaw.rwth-aachen.de

S. Theis
e-mail: s.theis@iaw.rwth-aachen.de

M. Wille
e-mail: m.wille@iaw.rwth-aachen.de

C.M. Schlick
e-mail: c.schlick@iaw.rwth-aachen.de

A. Mertens
e-mail: a.mertens@iaw.rwth-aachen.de

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study, the Kano model was used to analyze different customer requirements for initial contact with such a technical mobility aid. Investigated requirements were, for example, design, acceptance of mobility aids' sharing solutions, usability and usage sites of such aids. The study revealed individual design to be an attractive customer requirement whereas a pooling solution and hence sharing the mobility aid leads to a decreased customer value. All in all, this study stresses customers' acceptance of mobility aids and identifies several customer requirements for a positive initial contact.

Keywords Acceptance · Elderly · Human factors · Incentives · Initial contact · Kano model · Mobility equipment

1 Introduction

The performance and independence of people are both characterized by individual differences and intraindividual changes through life, occurring during the process of aging, illnesses or accidents. With regard to the musculoskeletal system, these changes may cause temporary or permanent limitations in terms of personal mobility (e.g. to get up and walk), resulting in an individual's need for support. This demand for compensation of limitations is mostly covered by caregivers or supporting techniques. Technical devices support independent mobility like walking sticks, walkers and wheel chairs have established themselves. Other devices which support the patient in situations where they need to be lifted to get up or sit down are not common in private households yet. However, they are already available within the health and care sector. Due to various reasons, such as high costs and high stigmatization potential, they are only conditionally accepted and therefore uncommon. Consequently, the corresponding potential is less exploited.

The present study was conducted in order to adequately react to the continuously increasing demand of target group specific assistance. As the decision of the future user is not voluntary but prescribed by their physician and the need for these systems often occurs at short notice, for example through accidents or diseases, the initial contact and certain incentives within this contact have a crucial significance in terms of long-term acceptance and adherence [1].

An analysis was conducted testing specific variables relevant for acceptance before and after the initial contact with a mobility aid in accordance with the supply offer for people with limitations in their individual mobility. Besides these variables for initial contact, we wanted to capture technical affinity and subjectively perceived added value. Due to the fact that about 65 % of all people in long-term care in Germany are female according the federal statistical office of Germany [2], this study focused primarily on the proposed customer requirements within an

exclusively female group of participants. According to technology acceptance theory, women are less attracted to technology than men [3]. The goal of this paper is to present obstacles and incentives for an initial contact of older female people with a mobility aid which could be used independently and is able to support the user in case of a necessary lift to get up or sit down.

2 Theoretical Background

The user acceptance has a great impact on the sustainable integration of technical systems in medical care, supply processes and patients' therapy adherence. However, user acceptance changes throughout the whole product lifecycle. Based on this knowledge, a model-based approach for empirical measurement of expectations of the elderly towards the initial contact with a mobility aid was applied. The approach bases on the Kano-Model, known from client oriented corporate management and product development [4]. Thus, this established construct to capture expectations was adapted to the context of patient research and can be used for formalization of satisfaction measurements [5].

2.1 Levels of Quality

The Kano-model is divided into five levels of quality:

- *Must-be Quality (M)*. These attributes are taken for granted when fulfilled but result in dissatisfaction if they are not fulfilled.
- *One-dimensional Quality (O)*. These attributes result in satisfaction when fulfilled and dissatisfaction when not fulfilled. These are attributes that are spoken and the ones in which companies compete.
- *Attractive Quality (A)*. These attributes provide satisfaction when achieved fully, but do not cause dissatisfaction when not fulfilled. These attributes are not expected by a normal customer and thereby have the potential to please the customer.
- *Indifferent Quality (I)*. These attributes refer to aspects that are neither good nor bad, and they do not result in either customer satisfaction or customer dissatisfaction.
- *Reverse Quality (R)*. These attributes refer to a high degree of achievement resulting in dissatisfaction and to the fact that not all customers are alike. For example, some customers prefer high-tech products, while others prefer the basic model of a product and will be dissatisfied if a product has too many extra features

- *Questionable (Q)*. Attributes in this category should be reviewed. It is most likely that the questions for this attribute were not appropriate for the application of the Kano model concept.

Therefore, the model represents an extension of Herzberg's Two-Factor-Theory, which was developed to measure and influence motivation during work. The basic attributes are in accordance with Herzberg's hygiene factors, while the performance attributes as well as the excitement attributes can be compared with Herzberg's motivational factors [6].

It has to be noted that the expectation towards a product attribute is not identical for individuals. For person A an attribute can be classified as an Attractive Quality attribute, whereas for person B it appears as a Must-be Quality attribute and person C classifies it as a Reverse Quality attribute.

The attributes change over time due to the development of a habituation effect. An excitement attribute may develop into a performance attribute and later into a basic attribute [7].

2.2 Satisfaction Measurement

This measurement is based on the assumption that satisfaction originates from two factors, namely:

- Expectations
- Perceived Quality/Performance

The Kano model can be used to measure expectations as an element of satisfaction measurement. Therefore, questions regarding assessment of concrete products or theoretical scenarios are asked. In this process axiomatic function are subordinated to Kano attributes, which describe the connection between assessment and satisfaction value.

3 Methodology

The measurement of expectations was carried out by means of a paper based survey using bipolar answer possibilities with regard to the evaluated product attributes. Each attribute was judged twice: first by a functional (positively formulated) and second by a dysfunctional (negatively formulated) question. Both questions were asked straight after each other. Five possible answers were available for both questions:

Customer Requirements		Dysfunctional				
		1. like	2. must-be	3. neutral	4. live with	5. dislike
Functional	1. like	Q	A	A	A	O
	2. must-be	R	I	I	I	M
	3. neutral	R	I	I	I	M
	4. live with	R	I	I	I	M
	5. dislike	R	R	R	R	Q

Customer Requirement is:

A: Attractive
M: Must-be
R: Reverse
O: One-dimensional
Q: Questionable
I: Indifferent

Fig. 1 Kano evaluation Table [4]

- I would be very happy
- I take that for granted
- I don't care
- I barely accept this
- That would annoy me

Through the combination of answers of the functional and dysfunctional question the classification was derived according to Fig. 1.

In case of single unanswered questions, the corresponding attribute was classified as Q (questionable) and thereby illogical answers were not taken into account during analysis. For the analysis of the results of this encoding Kano model provides different rules and methods.

1. *Evaluation rule M > O > A > I*. If the individual product attribute cannot be explicitly assigned to one single category, the evaluation rule "M > O > A > I" can be used to do so. When making decisions about product developments, mainly those features which show the greatest influence on the perceived product quality have to be taken into account. Therefore chose the category for which the rule is valid.
2. *Category strength*. If a dominant pattern does not appear, Lee and Newcomb [8] recommended that two additional measures, category strength, and total strength, may be used to define Kano categories. Category strength is the difference (in percentage) between the highest and the second highest categories. A value greater than 6 % for category strength would indicate a statistical difference between the highest and the second highest category. Total strength is

calculated as the total proportion of must-be (M), one-dimensional (O), and attractive (A) attributes. If the category strength of a product is lower than 6 % and the total strength exceeded 60 %, it is not possible to categorize the item; such an attribute would be assigned to the questionable (Q) category [8]. This method was used in the current study to categorize evaluated attributes.

3. *Customer satisfaction coefficient (CS coefficient)*. The customer satisfaction coefficient explains whether satisfaction can be increased by meeting a product requirement, or whether fulfilling the product requirement solely prevents the customer from being dissatisfied [9]. The CS-coefficient is an indicator for how strongly a product feature can influence satisfaction or customer dissatisfaction in case of its absence. Therefore the coefficient is divided into two components, first "Extent of satisfaction" (CS+) and second "Extent of dissatisfaction" (CS−).

$$CS+ = (A+O)/(A+O+I+M). \tag{1}$$

$$CS- = (O+M)/((-1)*(A+O+I+M)). \tag{2}$$

In case coefficients are greater in magnitude than 0.5, the variable is recommended to be significant in context of increasing or decreasing customers' satisfaction [9].

4. *Fong-test*. Fong stated in 1996 a different approach to determine the significance of the classification of an evaluated attribute [10]. Therefore the so-called Fong-Test as described in notation (3) was introduced.

$$|a-b| < 1.65 * \sqrt{(((a+b)*(2*n-a-b))/2*n)}. \tag{3}$$

'a' represents the absolute frequency of the response category with the largest number of entrants, 'b' the frequency of response category with the second largest number of entrants and 'n' indicates the total number of entries in all response categories. If the inequality is valid, the assignment of the attribute to the category is significant. This method was applied in case category and total strength method led to an indifferent result.

3.1 Dependent Variables

In this study 15 variables that were considered relevant for acceptance were investigated before and after the initial contact in accordance with the supply offer for people with limitations in their individual mobility (see Table 1).

Table 1 Dependent variables

Nr.	Description
K1	To ease the burden for relatives
K2	Noticeable design
K3	Space-saving design
K4	Be safe and look safe (design)
K5	Individual design
K6	Humanlike design
K7	Health insurance pays for aid
K8	Measuring vital signs to avoid a fall
K9	Easy usability
K10	Usability within all rooms of user's home
K11	Environmentally friendly product
K12	Sharing the mobility aid with others (pooling)
K13	Testing the product at home before purchase
K14	Detect a dizzy spell and react autonomously
K15	Doctor orders to use the mobility aid

3.2 Questionnaire

The questionnaire started by presenting a scenario of a mobility aid which supports personal mobility, designed especially for users that cannot get up, sit down or walk without assistance or only with great pain. For this purpose, 30 questions were developed, describing 15 attributes for the integration of technical systems, the social environment as well as medical care. According to the Kano-Model, the functional and dysfunctional questions for each attribute were asked one after another. Apart from these attributes, demographic data such as age, living situation, previous experience with mobility aid and limitations in personal mobility as well as any symptomatic pain in this context was also captured. Furthermore, the questionnaire asked the participants whether they would prefer that the mobility aid approaches from the front, back or from the side. They were also asked where they would like to have the mobility aid while they move with it: in front, by their side or behind them.

3.3 Participants

In total 72 women took part in this study, seven participants needed to be excluded for analysis due to incomplete answers. The mean age was 70.70 years (SD = 6.1086). All participants live autonomously in a flat or house. 15 % live together with their family. The level of education reaches from unskilled without an educational degree to post-secondary degree. All participants had no experience at

Table 2 Results

	Description	Category	Category strength (%)	Total strength (%)	Fong test
K01	To ease the burden for relatives	O	21.5	75.4	–
K02	Noticeable design	R	61.5	4.6	–
K03	Space-saving design	O	10.7	76.9	Sig.
K04	Be safe and look safe (design)	O	1.5[a]	60.0	Sig.
K05	Individual design	A	12.3	52.3	Sig.
K06	Humanlike design	I	20	36.9	–
K07	Health insurance pays for aid	O	20	78.5	–
K08	Measuring vital signs to avoid a fall	O	20	83.1	–
K09	Easy usability	O	4.6[a]	50.8	Sig.
K10	Usability within all rooms of user's home	O	20	81.5	–
K11	Environmentally friendly product	O	30.7	76.9	–
K12	Sharing the mobility aid with others (pooling)	R	67.7	6.2	–
K13	Testing the product at home before purchase	O	3.1[a]	70.8	Sig.
K14	Detect a dizzy spell and react autonomously	O	1.5[a]	55.4	Sig.
K15	Doctor orders to use the mobility aid	I	13.8	16.9	Sig.

[a]Category Strength greater than 6 % indicates a statistical difference

all with the investigated type of mobility aid or robotic systems. About 62 % of all participants suffer sometimes up to regularly from pain while moving (Table 2).

The recruitment of participants was carried out via several family physicians; thereby a representative sample for Germany is present, limited to the female gender. All women participated voluntarily. No financial compensation was given for participation.

4 Results

This section provides an overview about the results. Data was analyzed with SPSS 22 and Microsoft Excel 2010. 63 % of all participants reported to understand the described scenario before answering the Kano model questions, further 30 % reported they did not understand the scenario and 7 % did not answer this question.

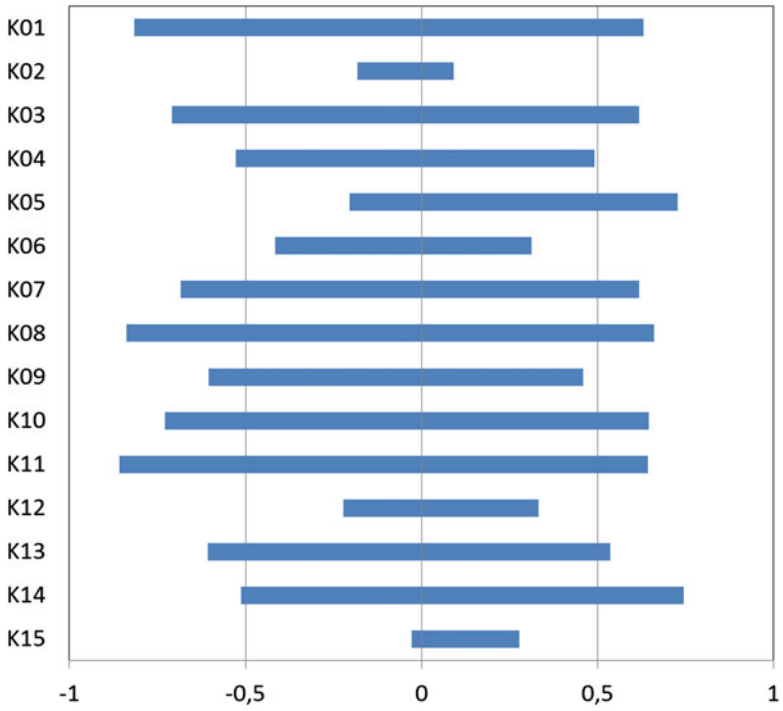

Fig. 2 Customer satisfaction coefficient

Table 2 presents the investigated attributes assigned to the corresponding category according the Kano Model. Furthermore, the category strength and total strength of each attribute are provided. The Fong-Test was performed in the cases of category strength as well as total strength and found no statistical difference. According to these tests all categorizations are valid and significant. Figure 2 provides customer satisfaction coefficients for each variable. For the questions about the preferred approach direction as well as position during movement most participants preferred the mobility aid to be in front as well as to them approach from the front (Fig. 2).

5 Conclusion

The results indicate that, despite individual preferences of the participants, specific requirements for the integration of technical support systems within health and care processes are present. These requirements have an above-average influence on the satisfaction of potential customers and users of the relevant support systems.

Independent from age in the group of older women, individual design turned out to be an excitement attribute of a mobility aid. Further, none of the investigated attributes was determined to be a "Must-Be-attribute". Although it was possible to identify two "Reverse attributes", these are requirements which decrease customer satisfaction if they are fulfilled. In this study 'noticeable design' as well as 'sharing the mobility aid' were determined to be reverse attributes. Participants were indifferent about whether or not the mobility aid should have a humanlike design. This corresponds with results of another recent study by Mertens et al. [11]. The requirement that a "Doctor orders to use the mobility aid" was also revealed to be an indifferent customer requirement.

'To ease burden for relatives' is a high significant attribute in terms of customer satisfaction, it increases as well as decreases customer satisfaction depending on if it is present or absent. The same can be said for 'space-saving design', 'health insurance pays for aid', 'measuring vital signs to avoid a fall', 'usability within all rooms of users home', 'environmentally friendly product', 'testing the product at home before purchase' and 'detect a dizzy spell and react autonomously'. In all these cases the customer satisfaction coefficients CS− and CS+ exceed −0.5 or +0.5. This is reasonable because all of these attributes were revealed to be one-dimensional attributes and thus these attributes result in satisfaction when fulfilled and dissatisfaction when not fulfilled.

6 Limitations and Outlook

Future research should investigate the presented attributes more deeply to develop best practice solutions for initial contact with innovative products in the context of the elderly. Further, the group of participants should be extended to male participants in order to identify gender differences. As described earlier, expectations change over time. This means that satisfaction decreases although service performance remains constant or increases—this happens when the user previously considered the examined service performance as excitement attributes, but currently as basic attributes. Therefore, future research should evaluate the same attributes again to investigate time related differences in customer requirements for an initial contact with innovative products like a mobility aid which is able to lift the user.

All in all, participants seem to have a performance-oriented positive view of the initial contact with a mobility aid as defined in the context of this study.

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