Design of walking and sitting aids for the elderly using the Kano method

Muhamad Mukafi[1]*, Ahmad Dzulfikri[2]

[1]Industrial Engineering Department, Universitas Islam Indonesia, Sleman, Yogjakarta
[2]Mechanical Engineering Department, Politeknik Negeri Malang, Malang, Jawa Timur

*Corresponding author: 20916013@students.uii.ac.id

Received 06th November, 2022; Revised 16th April, 2023; Accepted 18th April, 2023

Abstract. *Normal human growth with age in the process of life tries to adapt to environmental conditions. It is often found that those who experience a decrease in walking activity, this is due to decreased function of the muscles and limbs. A walker (Walker) is the right solution to help with their activities. The design development of walking aids (Walker) continues to be developed for the needs of consumers, especially the elderly and injured feet. The purpose of this product design, which is to facilitate Walker users in resting to sit after a long walk without having to look for a place to sit and is available directly with the Walker, besides that it can also be used as a wheelchair with the help of ot hers. The features needed can be identified based on the results of a questionnaire which is the basis for the design development of walkers (Walkers) that have been on the market. The output of the questionnaire was analyzed by noting important features using the Kano Method. The research results are in the form of two features, with categories in the form of attractive that need to be developed. The features in question are the addition of seats, backrests, and wheels.*

Keywords: design, elderly, ergonomics, Kano, walkers.

1. Introduction

Every human being must experience the aging process. According to the Minister of Health Regulation (2016) and Law No. 13 of 1998 explains that an elderly person is someone over the age of 60 (Idiar & Yunus, 2021). The aging process can cause a decline in physical, mental, and social conditions. Along with increasing age, human physical abilities experience decreased function, including limitations in moving limbs, and the ability to maintain body balance (Yang & Li, 2020). An elderly person tends to have a high level of dependence because naturally the physiological abilities of elderly organs have decreased functions such as increasingly rigid muscle movements, stability of shaking hand movements, increasingly unstable balance control, and decreased function of motion organs or legs. The elderly often experience falls, this is due to many factors, both intrinsic (from within the elderly) and extrinsic factors (from outside the elderly. Kurnia (2017) explain intrinsic factors such as lower limb muscle weakness,stiff joints, gait disturbances, syncope, dizziness, and diseases suffered by the elderly.

In accommodating these limitations, many elderly people use walking aids. A walker is a helper for patients who experience decreased muscle power and fractures in the lower limbs which are also unbalanced. The reason the elderly used a walker is that they are afraid of falling. One of the most widely used walkers is the walker (Nugraha & Aprillia, 2020). Walker is a waist-high walker made of metal and equipped with two algae where the function is to hold on and is equipped with four sturdy legs as a support and is easy to move when used to walk. In addition, the use of walkers provides a senseof comfort and keeps users when walking, but there are still problems that must be found when viewed by the physically elderly who cannot stand for long. This is in line with statement from (Tarwaka, 2014) whichexplains that the limited ability to move is a consideration in designing tools for the elderly.

Product design and innovation is one way to increase value and make products have advantages in competition (Kamp et al., 2022). This product design and innovation is a part of the industrial world. Design and innovation is an activity in which doing something increases the value and advantages of the previous condition. Product development should pay attention to work principles, the added value of tools or innovations, ergonomics and consumer comfort.

Some research on walker design has been carried out. Alfadhlani, et al (2013) improved the design of walking aids (crutches) for people with leg injuries. The material chosen is stainless steel where this material can reduce the weight of crutches by 28.6%. The crutch handle is designed with an adjustable degree of tilt with an adjustment ratio of 14.4° which aims to get comfort in the hand and wrist when this crutch tool is used by the user. In addition to this research, Djumharianto (2014) successfully designed a Walker that is safe to use. The data obtained and compiled through the House of Quality resulted in a Construction Quality Performance (CQP) weight of less than 5 kg with a result of 15.18%, a temporary seat with a CQP weight of 13.59%, there is a place to carry goods with a CQP weight of 9.88%, and aluminum material with a CQP weight of 9.58%. Whereas in this study the attributes developed are based on questionnaires to find out which attributes consumers want. The method used is the Kano method with a focus on attractive attributes. The new Walker concept will be developed in the form of additional functions, and mechanical systems, while still paying attention to ergonomic principles inits design.

There are three types of walkers, namely standard-walker, front-wheeled walker, and four-wheeled walker (Arrayan et al., 2022). The functions of the standard-walker and front-wheel walker have the same two functions, namely a height adjustment system that uses pins that can be adjusted at a certain distance. These two types of walkers can also be folded when not being used by walker users so that itcan facilitate the storage of tools. Based on this, it is known that the types of walkers on the market still havelimited functions so it is necessary to develop the design of one type of walker that can function multiplefunctions in one walker construction, and has a seating system. The design carried out is a combinationof the concept of a stick (Walker) with a reclining chair or wheelchair. The purpose of this product design, which is to facilitate Walker users in resting to sit after a long walk without having to look for a place to sit and is available directly with the Walker, besides that it can also be used as a wheelchair with the help of others.

2. Research Methods

Research Stages

The stages in the research to develop a walker and sitting design for the elderly using the Kano method as seen as in Figure 1 (Dewi, 2019; Aljabar & Hasibuan, 2021).

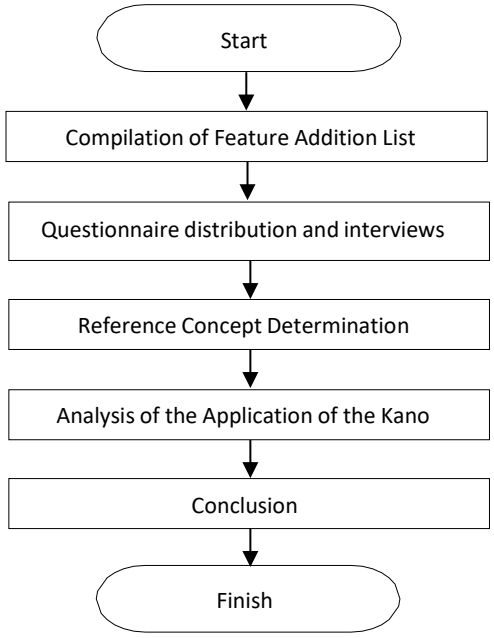


Figure 1 Research Flowchart.

Walker's redesign research was conducted in the following stages:

1. Identify functionality from a questionnaire with 20 elderly respondents who use *walkers.*
2. Create and distribute Kano questionnaires to find out what consumers/users want,
3. Conducted interviews with 20 elderly people regarding the difficulties encountered while using the *walker*. The questions asked were open-ended, allowing the researcher as the interviewer to discover the true wishes of the customer. These interviews lasted about 10 - 30 minutes and the results were recorded.
4. Analyzing by applying the Kano Method from the results of the questionnaire conducted
5. Prioritization of actions based on the results of questionnaires and interviews.

Object of Research

The object of this research is a multifunctional Walker with the addition of a seat, backrest, and wheels. In addition to the addition of these features, this Walker can also be used as a wheelchair, there are front and rear algae where the front algae function to hold on while the back is to push as a wheelchair (Yoga et al., 2021).

Kano Method

The Kano method is a method developed by Noriaki Kano (Priyono & Yulita, 2017). The Kano modelis a model that aims to categorize product attributes in a company or service and to measure how well the product or service satisfies its customers (Tang et al., 2020). Kano suggests that there are two aspects to each quality attribute, namely objective aspects involving quality fulfillment and subjective aspects involving consumer perceptions of satisfaction. In the Kano method, the category of a product can be divided into:

1. Must-be or Basic needs or threshold: customers are not satisfied if the performance of the attribute in question is low. But customer satisfaction will not increase much above neutral even if the performance of the attribute is high.
2. One-dimensional or performance needs or linear: the level of customer satisfaction is linearly related to attribute performance, so high attribute performance will lead to high customer satisfaction.
3. Attractive or Excitement needs or delighters: the level of customer satisfaction will increase very high with an increase in attribute performance, but a decrease in attribute performance will not cause a decrease in the level of satisfaction.
4. Reverse if the level of customer satisfaction is inversely proportional to the attribute performance results, Questionable Result if the level of customer satisfaction cannot be defined (there are contradictions in customer answers), or Indifferent if the level of customer satisfaction has no effect on the attribute performance results.
5. Indifferent, customers do not care about the existence of the attributes offered so the presence or absence of these attributes will not affect the increase or decrease in customer satisfaction levels.

Kano questionnaire process steps model show in the Figure 2.

Kano Evaluation Table

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; O: One-dimensional; M: Must-be; Q: Questionable result; R: Reverse; I: Indifferent

Figure 2 Kano Questionnaire Process Steps.

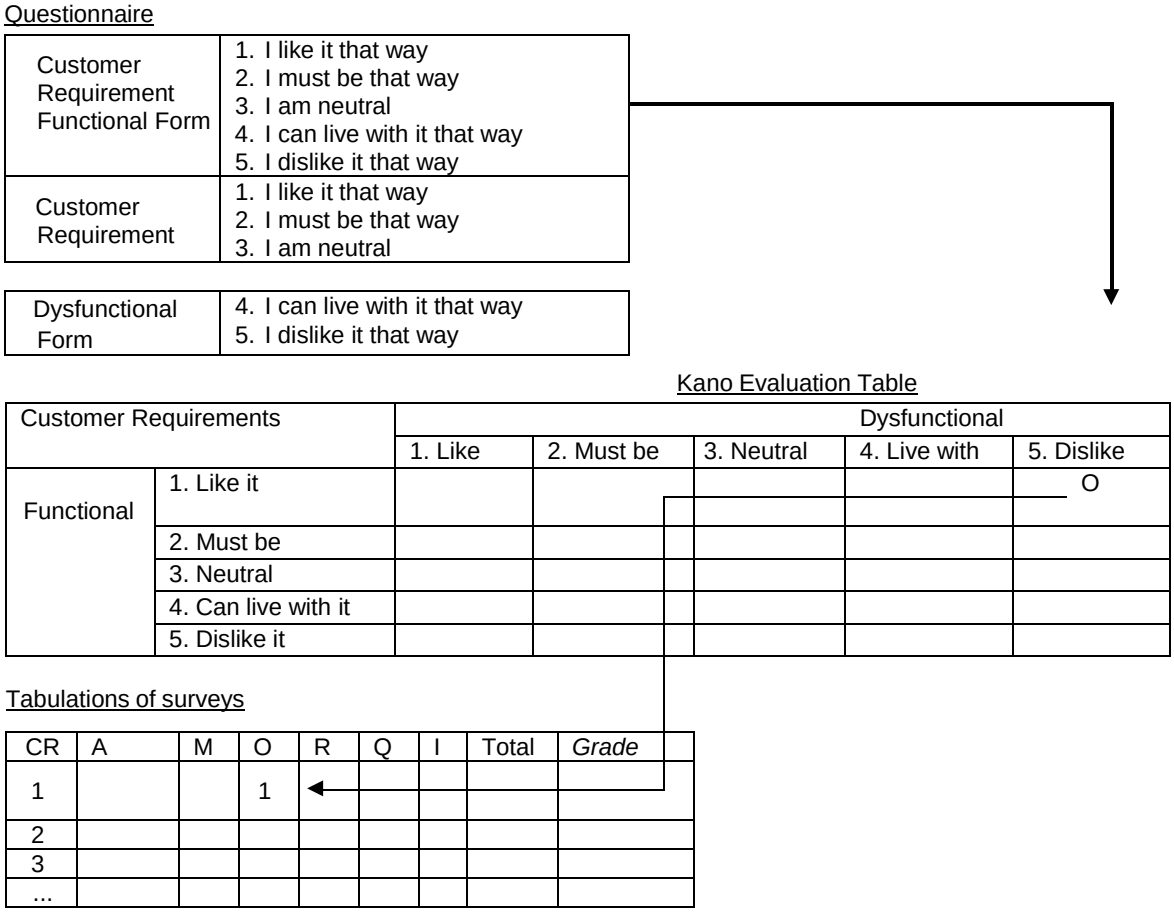


Figure 2 Kano Questionnaire Process Steps.

Based on the table results are entered into the formula:

$$Satisfaction\ Index = \frac{A + O}{A + O + M + I} \quad (1)$$

$$Dissatisfaction\ Index = \frac{M\ +\ O}{(A + O\ +\ I) * (-1)} \quad (2)$$

3. Results and Discussion

Compilation of Feature Addition List

The initial step in this research is problem observation by observing the elderly around, reading research journals, and discussing with elderly walker users. The following are the problems experienced by elderly walker users.

1. Standard walkers reduce walking speed as it is necessary to lift the walker first to take a step. Itis also difficult to use in elderly people with upper limb weakness.
2. Front-wheeled walkers/ Two-wheeled walkers/ Rolling walkers/ Gliding Walkers can maintain a more normal gait than standard walkers and are suitable for someone who walks quickly but, they are less stable than standard walkers.
3. Four-wheeled walkers are safe for use in people who do not need assistance to reduce the load on the limbs and can walk a considerable distance. Wheels make it easier for users.
4. Seats and backrests are needed because the elderly cannot stand for long periods of time.
5. It would be better if the walker could be folded.

Based on these problems, researchers compiled a list of feature additions as follows: 1) Wheels, 2) Seat and Backrest, 3) Fold, and 4) Handle.

Reference Concept Determination

The type of walker to be developed is the Four-wheeled walker (Rollator). Mohite & Bagchi (2020) describe a rollator as a walker with wheels on all four legs that offers the greatest ease and range of movement. It also offers pivoting wheels and a hand brake to improve control of the walker. Rollators with larger wheels offer the most mobility. Rollators are often equipped with seats and baskets to help users socialize easily without worrying about carrying items. Here are the types of rollators on the market can be seen in Figure 3.

Figure 3 Rollators on the Market.

The development idea that will be carried out based on the limitations of existing products on the market, namely:

1. The seat and backrest attributes are made of rubber while the wheels are made of PBT.
2. Foldable
3. Addition of handle

Questionnaire and Interview Distribution

Questionnaires and interviews were distributed to twenty elderly respondents using walkers. The following are results of the questionnaire recapitulation can be seen in Table 1. The following are the results of the interviews that have been conducted can be seen Table 2.

Table 1 The Results of the Questionnaire Recapitulation

Respondents	Product Development Features							
	Walker can be folded		Seat and Backrest		Wheel		Handle	
	Positive	Negative	Positive	Negative	Positive	Negative	Positive	Negative
Respondents 1	Must be	Live with	Like	Live with	Must be	Live with	Live with	Live with
Respondents 2	Must be	Live with	Like	Live with	Like	Dislike	Must be	Dislike
Respondents 3	Like	Neutral	Must be	Like	Live with	Like	Like	Live with
Respondents 4	Like	Neutral	Must be	Live with	Like	Neutral	Must be	Neutral
Respondents 5	Like	Neutral	Like	Neutral	Like	Neutral	Like	Neutral
Respondents 6	Neutral	Live with	Live with	Must be	Live with	Must be	Must be	Neutral
Respondents 7	Like	Live with	Neutral	Neutral	Dislike	Must be	Neutral	Neutral
Respondents 8	Must be	Live with	Neutral	Neutral	Dislike	Must be	Must be	Neutral
Respondents 9	Must be	Live with	Like	Live with	Like	Neutral	Must be	Neutral

Respondents	Product Development Features							
	Walker can be folded		Seat and Backrest		Wheel		Handle	
	Positive	Negative	Positive	Negative	Positive	Negative	Positive	Negative
Respondents 10	Neutral	Must be	Neutral	Neutral	Dislike	Must be	Neutral	Neutral
Respondents 11	Like	Neutral	Neutral	Live with	Live with	Must be	Neutral	Live with
Respondents 12	Live with	Dislike	Like	Dislike	Dislike	Must be	Like	Dislike
Respondents 13	Like	Live with	Must be	Neutral	Neutral	Neutral	Neutral	Neutral
Respondents 14	Must be	Dislike	Like	Live with	Like	Live with	Must be	Live with
Respondents 15	Must be	Live with	Must be	Live with	Like	Neutral	Neutral	Neutral
Respondents 16	Must be	Like	Like	Like	Like	Dislike	Like	Dislike
Respondents 17	Must be	Live with	Like	Dislike	Must be	Live with	Like	Dislike
Respondents 18	Like	Live with	Like	Live with	Like	Neutral	Like	Neutral
Respondents 19	Like	Dislike	Like	Live with	Like	Must be	Like	Like
Respondents 20	Must be	Dislike	Like	Live with	Neutral	Must be	Like	Live with

Table 2 The Following are the Results of the Interviews That Have Been Conducted.

Respondents	Interview Results
Respondents 1, 2, 5, 8, 11, 16, 18, 19, 20	Standard user walker Walking speed is reduced as the walker has to be lifted to move forward. it is difficult to lift the walker. If you get tired, you have to find a place to sit down, and you can't rest anywhere.
Respondents 2, 7, 9, 12, 13, 14, 15	Gliding walker users Five out of seven users have slipped while using a walker. If you get tired, you have to find a place to sit down, and you can't rest anywhere.
Respondents 3, 4, 6, 10, 17	Rollator Users There is a basket and can be used to rest if you get tired of using. It would be nice if there was a feature so that it could be used for others to push when tired or in an emergency.

Analysis of the Application of the Kano Method

Four kinds of Voice of Customers result through Questionnaire. From the results of the respondents' wishes, the attributes were entered into the Kano questionnaire (Avikal et al., 2020). The results are continued and evaluated into the Kano Evaluation Table and analyzed to determine the results of the Satisfaction Index and Dissatisfaction Index (Muktiyono, 2015). Calculation of Kano category frequency values, SI and DI values in the table below. The determination of functionality is carried out using the Bloth Formula with the following conditions:

1. If the sum of the data [one-dimensional + attractive + must-be] > sum of the data [indifferent + reverse + + questionable] then the category selected from the maximum sum of the data amongthe three categories [O, A, and M].
2. If the sum of the data [one-dimensional + attractive + must-be] < sum of the data [indifferent + reverse + + questionable] then the category is selected from the maximum sum of the data among the three categories [I, R, and Q].
3. If the sum of the data [one-dimensional + attractive + must-be] = the sum of the data [indifferent + reverse + + questionable] then the category is selected from the highest value of [O, A, M, I,R, and Q].

The formulas used to measure the Satisfaction Index (SI) and Dissatisfaction Index (DI) are as follows:

$$SI = \frac{A + O}{A + O + M + I}$$

$$DI = \frac{M + O}{A + O + I) * (-1)}$$

For example, in number 1 the attribute "Fold" have value of A = 7; O = 1; M = 3; I = 8

Completion:

$$SI = \frac{7 + 1}{7 + 1 + 3 + 8} = 0{,}42$$

Likewise with the Dissatisfaction Index (DI). Example in number 1 of the "Folding" attribute have value of A = 7; O = 1; M = 3; I = 8

Completion:

$$DI = \frac{3 + 1}{(7 + 1 + 3 + 8) * (-1)} = -0{,}21$$

Table 3 shows the results of the Kano Questionnaire analysis.

Table 3 Kano Questionnaire Analysis Results

No.	Attributes	A	O	M	I	R	Q	Total	SI	AT	A+O+M	I+R+Q	Category
1	Fold	7	1	3	8	1	0	20	0.42	-0.21	11	9	A
2	Seating & Backrest	8	2	0	8	1	1	20	0.56	-0.11	10	10	A
3	Wheels	7	2	0	6	5	0	20	0.60	-0.13	9	11	I
4	Handle	4	3	1	11	0	1	20	0.37	-0.21	8	12	I

Based on the results of the Kano category obtained in Table 1, the resulting attributes will be developed with notes: (1) Attractive category attributes can help in increasing consumer or user satisfaction. This feature can increase consumer satisfaction, but consumer satisfaction does not decrease if features from the Attractive category are missing. It is known that this study did not find attributes with categories other than Attractive and Indifferent, (2) the Indifferent category attribute will be ignored because it does not affect customer satisfaction whether the feature is present or absent. Calculation of satisfaction index and dissatisfaction index to determine the position of satisfaction features on the Kano interpretation graph. Based on the Table 3, features that are in the attractive quadrant have a fairly high Satisfaction value between 0.5 and 1, therefore this feature is the main one to be made.

Figure 4 illustrates the position of each of the attributes/features in the level of customer satisfaction. Based on the figure there are 2 attributes in the attractive quadrant, namely, the addition of seats, backrests and the addition of wheels. From these 2 attributes will be used as design development or proposed improvements made.

Concept Selection

To design the Walker with additional seats, backrests and wheels, ergonomic aspects were used to determine the size that suits the dimensions of the human body in general. The design used is according to the manufacturer's standard size without changing the basic size. The attributes for the seat and backrest are made of rubber (ribbon) while the wheels are made of PBT Plastics. Material Description and Quantity can be seen in Table 4. The walker wheel can be seen in Figure 5. Meanwhile, Rear View (A), Front view (B), and Seating and Backrest Size (C) can be seen in Figure 6.

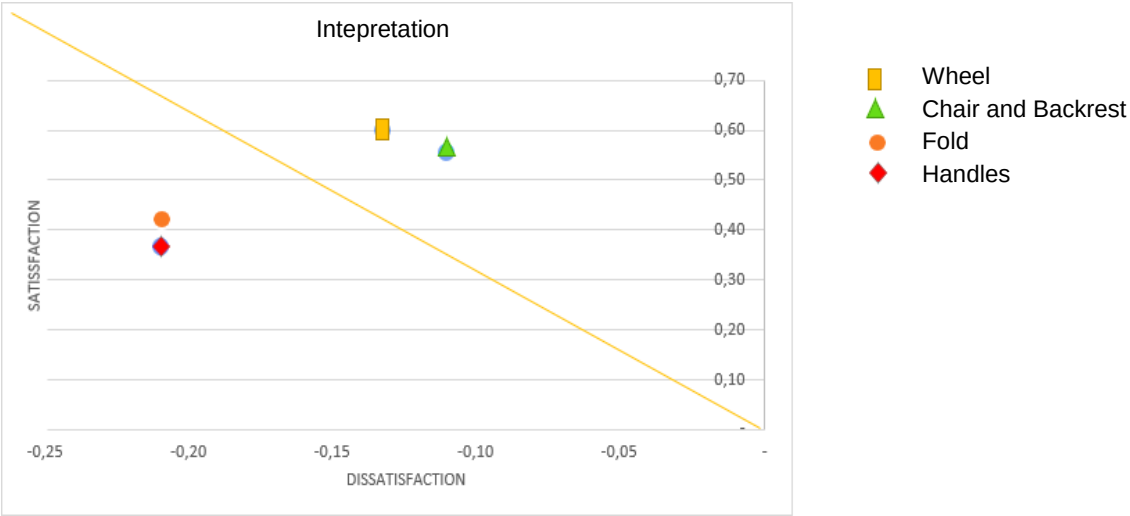


Figure 4 Interpretation Chart.

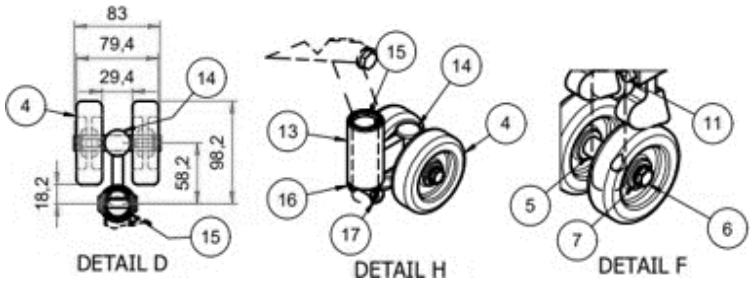
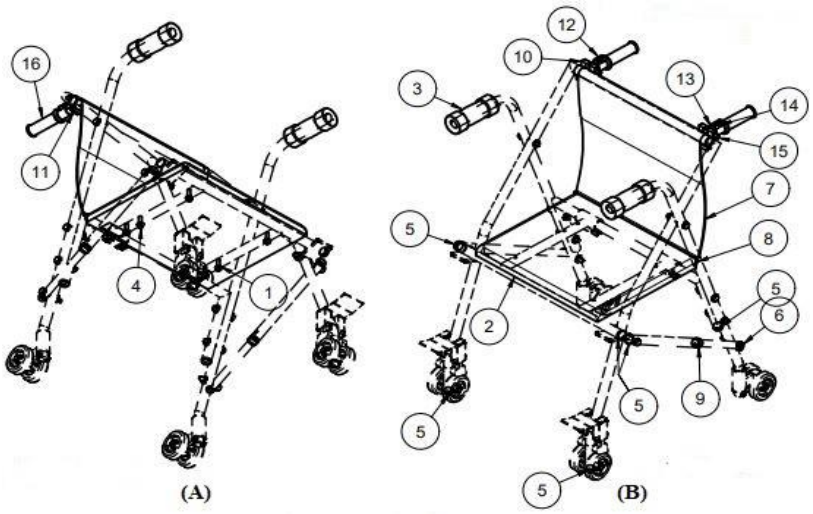


Figure 5 Walker Wheel.



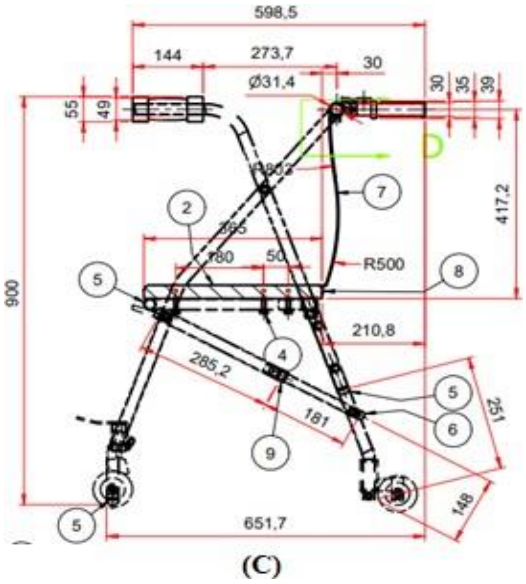


Figure 6 Rear View (A), Front view (B), and Seating and Backrest Size (C)

Table 4 Material Description and Quantity

No.	Materials	Quantity
1	Steel, Mild	6
2	Wood (Walnut)	1
3	Rubber	2
4	Stainless Steel	6
5	Rubber	8
6	Rubber	2
7	Rubber, Silicone	1
8	Rubber, Silicone	1
9	Rubber	2
10	Stainless Steel	2
11	Aluminum 6061	2
12	Stainless Steel	2
13	Stainless Steel	2
14	Stainless Steel, Austenitic	2
15	Stainless Steel, Austenitic	2
16	Rubber, Silicone	2

This research, ergonomics and safety aspects are taken into consideration in determining the parts/ components of the Walker. The safety aspect is very important because the users are elderly or leg injuries so it needs to be considered properly in the field of safety of use. The proposed parts developed have great benefits in terms of safety in Walker. It is hoped that the results of its development can reduce the level of work accidents due to its use. Then, information about products on the market is collected to support decisions regarding product positioning to be developed. The following is the collection of competitor product information in Table 5 of the Walker comparison on the market.

Table 5 Comparison between Walker Products

No.	Previous Researcher	(Ginting & Kokman, 2022)	(Mohite & Bagchi, 2020)	This research
1.	Research Title	Application of Brainstorming Method in Product Design of Sitting Stick (Walker) for the Elderly	Design of Hybrid Rollator cum Walker for Eldery: Review onLiterature	Design of walking andsitting aids for the elderly using the Kanomethod

No.	Previous Researcher	(Ginting & Kokman, 2022)	(Mohite & Bagchi, 2020)	This research
2.	Products Figure 7	Stick (Walker)	Rollators	Walker Redesign
3.	Excellence	1. Product has afoldable stand 2. Rubber materialcoated handle 3. Material made of aluminum	1. Flexible backrestfor comfort, 2. The ergonomic handbrake locks therear wheel for safety 3. Flip-up seat with built-in handle	1. Multifunctional, canbe a wheelchair 2. Ergonomic footbrake can lock thefront wheel when it becomes a safety seat. 3. There is a footrest and double wheels
4.	Disadvan-tages	1. The product mustbe lifted when in use 2. Low mobility 3. There is a chanceof falling	1. Can roll off thepatient, 2. Requires good abdominal strength to maneuver 3. Brake failure may occur	1. Backrest materialmade of thin rubber 2. Brake failure mayoccur 3. Requires power to maneuver

(a) (b) (c)

Figure 7 Three Dimensions, (a) Walkers, (b) Rollators, and (c) Redesigned Walkers.

Based on Table 5 above that the previous researcher (Ginting & Kokman, 2022) with the advantages of the product has a foldable seat, the handle is coated with rubber materialand the material is made of aluminum then the disadvantages of the product must be lifted when used, low mobility, and there is a chance of falling. Meanwhile, researcher (Mohite & Bagchi, 2020) with its products Rollators have the advantage of flexible backrests for comfort, ergonomic hand brakes lock the rear wheels for safety, flip-up seats with built-in handles, in addition there are disadvantages regarding products such as being able to roll away from the patient, requiring good abdominal strength to maneuver and brake failure can occur. Based on previous research, the researcher was inspired to make a redesign to be more multifunctional as a Walker in addition it can also function as a wheelchair. Where when the user is tired of walking using the Walker, the user can rest sitting on the Walker and can be pushed with the help of other people so that it is multifunctional and can become a wheelchair.

4. Conclusion and Suggestion

Based on the results of research on the development of walker design, the concept design of walkers and sitting for the elderly using the canoe method is obtained. The walker design has the addition of a seat, backrest and wheels. The final result obtained is the design of a walker design by combining the concept of a stick (walker) with a reclining chair or wheelchair. So that it makes it easier for users to rest to sit after a long walk without having to look for a place to sit and can be used as a wheelchair with the help of the push force from others. With the addition of these features, it is expected to be able to solve the problem of limitations that exist in walkers so that they can help accommodate elderly activities.

The data obtained and compiled through the development of this Walker design using the Kano Method to produce a Walker that is multifunctional and safe to use, namely by adding a seat, a safebackrest and front-rear wheels that can rotate 360^{o} for the rear and refers to ergonomic design with Ribbon material for seats and backrests while for wheels made of PBT Plastic. From the discussion, it can be concluded that customer satisfaction is used as follows 1) Materials (seat and backrest: rubber, wheels: rubber, frame: steel), (2) Handles are available for push assist or wheelchair opposite direction with handle walker and (3) Collapsible frame for easy storage

Based on the results of the research that has been carried out due to limited knowledge, abilities, and time and there are still many shortcomings in the work on this design, so suggestions from the author are added so that in the future the design can be developed and become better, including the following 1) Addition of electrical control for further technology development, and (2) Remote Control Application Sofware on Smartphone for easy searchthe presence of walkers and emergency alarms.

Reference

Alfadhlani, Y., Meuthia, & Valent, D. F. (2013). Design Improvement of Underarm Crutches for Leg Injury and Disability Patients. *Jurnal Optimasi Sistem Industri*, *12*(2), 400–410. https://doi.org/10.25077/josi.v12.n2.p400-410.2013

Aljabar, M. W. M., & Hasibuan, S. (2021). Performance evaluation of after-sales service partners in the power tools industry. *Jurnal Sistem dan Manajemen Industri*, *5*(2), 105-114. https://doi.org/10.30656/jsmi.v5i2.3985

Arrayan, M., Billa, S., & Dewi, N. S. (2022). Analysis of Risk Factors for Falls in the Elderly at the Posyandu for the Elderly in Kradenan Village. *International Seminar of Community Health and Medical Sciences (ISOCMED)*, *September*, 26–33.

Avikal, S., Singh, R., & Rashmi, R. (2020). QFD and Fuzzy Kano model based approach for classification of aesthetic attributes of SUV car profile. *Journal of Intelligent Manufacturing*, *31*(2), 271–284. https://doi.org/10.1007/s10845-018-1444-5

Dewi, S. K. (2019). Service Quality Assessment using Servqual and Kano Models. *Jurnal Teknik Industri*, *20*(1), 94–104. https://doi.org/10.22219/JTIUMM.Vol20.No1.94-104

Ginting, R., & Kokman, W. (2022). Perancangan Produk Walker with Toilet Lift Menggunakan Metode Brainstorming dan Problem Solving. *National Conference on Industrial Engineering (NCIE) 2022*, *5*(2), 692–696. https://doi.org/10.32734/ee.v5i2.1637

Idiar, & Yunus, M. (2021). Pengembangan Desain Walker Fleksibel Bagi Lansia. *Jurnal Mesin Nusantara*, *4*(1), 1–10. https://doi.org/10.29407/jmn.v4i1.15965

Kamp, S., Spitz, T., Müller, U., & Feller, N. (2022). Ergonomic Engineering of a Mobile Walker. *Applied Human Factors and Ergonomics International Ergonomic*, *19*. https://doi.org/10.54941/ahfe1001266

Kurnia, E. (2017). Factors of walking aids with the risk of falls in the elderly at Posyandu Lansia RW 04 Kelurahan Bangsal Kota Kediri. *JURNAL STIKES RS Baptis Kediri*, *10*(139–147). https://jurnal.stikesbaptis.ac.id/index.php/STIKES/article/view/306

Minister of Health. National Action Plan for Elderly Health 2016-2019. http://hukor.kemkes.go.id. Modok

Mohite, D. D., & Bagchi, S. (2020). Design of Hybrid Rollator cum Walker for Elderly : Review on Literature. *The International Journal of Analytical and Experimental Modal Analysis*, *12*(1), 1108–1111. https://doi.org/10.36909/jer.ICIPPSD.15535

Muktiyono. (2015). Rancangan Kualitas Pelayanan Unit BPPT Enjiniring Dengan Integrasi Servqual, IPA Dan Kano Model Dalam Model QFD. *Operations Excellence: Journal of Applied Industrial Engineering*, *7*(1), 50–63. https://publikasi.mercubuana.ac.id/index.php/oe/article/view/526

Nugraha, S., & Aprillia, Y. T. (2020). Health-Related Quality of Life among the Elderly Living in the Community and Nursing Home. *Jurnal Kesehatan Masyarakat*, *15*(3), 419–425. https://doi.org/10.15294/kemas.v15i3.21282

Priyono, A., & Yulita, A. (2017). Integrating Kano Model and Quality Function Deployment for designing service in hospital front office. *Intangible Capital*, *13*(5), 923–945. https://doi.org/10.3926/ic.1001

Tang, L. L., Chen, S. H., & Lin, C. C. (2020). Integrating fmea and the Kano model to improve the service quality of logistics centers. *Processes*, *9*(1), 1–16. https://doi.org/10.3390/pr9010051

Tarwaka. (2014). *Industrial Ergonomics. Basics of Ergonomics Knowledge and Application at the Task Site*. Harapan Press.

Yang, X., & Li, X. (2020). Design of Intelligent Walking Stick for the Elderly based on User Experience Research. *E3S Web of Conferences*, *179*(02079), 1–6. https://doi.org/10.1051/e3sconf/202017902079

Yoga, P., Laksana, K., Setyanto, R. H., & Herdiman, L. (2021). Redesign walker for children with diplegic cerebral palsy using TRIZ method. *Jurnal Sistem Dan Manajemen Industri*, *5*(1), 8–14. https://doi.org/10.30656/jsmi.v5i1.2855