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# Exploratory study on usability and product emotion testing of mechanic prosthetic hand usage

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## ABSTRACT

Metic Hand testing is known as a more economical and widespread in Indonesian society than bionic hand. The rapid development of mechanic prosthetic hand only focuses their function during the prototype test, without considering the usability and user emotion. The need of ergonomics, safe and aesthetic product are as important as the function. Therefore, this research aims to test usability of the mechanic prosthetic hand using the therapy equlpment for hand disorder evaluation and product emotion measurement tools (PrEmo). Daily tasks were assigned to one respondent to determine their usability, while thirty-five respondents were tested to determine the product emotion. The product usability performance criteria based on the International Organization for Standardization (ISO) was explored using ISO 9241-11, which consists of efficiency, effectiveness, and satisfaction criteria. In addition, the usefulness, satisfaction, and ease of use and PrEmo tool questionnaires were used to determine the respondents' subjective pleasure and usefulness. Usability Levels are known to be in excellent and good status. It captures special feeling from respondents when used has some disadvantages that need to be corrected. The results of the emotional assessment provide inputs from the respondents were in the form of products shape, stiffness, texture and skin-like color.

**Keywords:** mechanic hand; usability; testing; emotion; product

## 1. INTRODUCTION

The population of people with disabilities continues to increase every year in Indonesia (Badan Pusat Statistik, 2016, 2020, 2024). This makes the process of creating products in the health sector strive to adapt to user needs. Persons with difficulty using/moving hands/fingers account for 1.31% of the total population with disabilities. According to the Survey on the Need for Social Assistance Programs for People with Disabilities, accidents conflicts, and disasters are some factors that cause an individual to become disabled (Adioetomo et al., 2014).

People with hand disabilities will find it difficult to perform activities such as grasping objects, disrupting other essential body function (Parry et al., 2019). Hence, an effective prosthetic hand as a replacement is very important because it can be used to support daily activities. One of the main supporting functions of a prosthetic hand is the grip pattern because it is the basic foundation possessed by people as living beings is to hold objects irrespective of their size (Light et al., 2002). Objects around the environment have various shapes, such as triangles, oval, thin, and lateral, with carrying energy needed to lift them. Therefore, activities that represent handholding patterns in supporting daily activities for prosthetic hands are urgently needed. According to preliminary studies, the absence of assistive device in the form of a prosthetic hand makes it difficult for people to grip object. Preliminary studies have been performed by Susanto et al. (2018) and Susanto et al. (2019) to two previous version of prosthetic products (bionic and anthropomorphic hand). The studies were involved the similar respondents with this study (one respondents). The results concluded identification of some difficulties on daily activity caused by hand amputee including grip object. Some problems when use the product including slippery material, lack of power grip as well as the anthropometric of products that effect on difficulty in grasp activity were also considered (Susanto et al., 2018; Susanto et al., 2019).

Law No. 8 of 2016 article 12 states that one of the rights to health for people with disabilities is obtaining health aids and obtaining protection in health research and development, including people as subjects. Mobility aids are tools in the form of modifications that make it easier for someone to carry out their daily activities.

The development of mobility aids, especially prosthetic hands, in Indonesia is limited due to the high cost of research and manufacture. The existing technology is in the form of bionic and body-powered hands, commonly known as mechanical devices. A microprocessor operates a myoelectric prosthetic hand, and motorized machine with electromyography signals used to assist its movement. In contrast to the myoelectric hand, the body-powered (Metic) operated on a plastic cable/thread/rope system, is usually passed by the amputee's shoulder and controlled by abduction movements on the body's scapula (Salem et al., 2013). The significant difference between these products lies in the purpose of the grip function and the price sold to consumers because the materials used are quite different. Both prosthetic hands have been developed at the Center for Biomechanics, Biomaterials, Biomechatronics and Biosignal (CBIOM3S) laboratory, Diponegoro University. CBIOM3S produced several bionic hands, namely the Asto and Bimo (Susanto et al., 2018; Susanto et al., 2019). According to Susanto Medic Hand testing is more economical and widespread in Indonesian society (Susanto et al., 2018; Susanto et al., 2019).

The previous evaluation's drawback is that it only focused on testing the usability level of the product without involving its emotions in evaluating the developed product. The desire to always innovate high-end products by prosthetic hand designers in the CBIOM3S laboratory leads to the consideration of aesthetic aspects, such as color, type of material, and shape to ensure negative emotions are not generated when used by people with disabilities. The best goal in emotional product assessment is the ability to produce a new design through the combination and assessment of the two prosthetic hand designs.

The development of the Metic Hand for people with disabilities needs the creation of safe, comfortable, and appropriate products. Therefore, it is necessary to test and evaluate product usability against the needs of users or people (Rubin & Chisnell, 2008). A usability evaluation aims to assess how far the product can meet consumer needs while identifying the deficiencies to make adequate improvements. Some studies related development and evaluation in prosthetic hand can be found (Tavakoli et al., 2017; Kashef, et al., 2020; Starke et al., 2022). Previous studies focused on function mechanism and technical performance critera (Isern-Kebschull et al., 2020; Kashef et al., 2020), a single EMG channel and a multi-modal sensor system embedded in the hand for object perception and autonomous grasp execution (Tavakoli et al., 2017; Starke et al., 2022). This study explores the prosthetic hand evaluation based on usability testing to provide user perception related product usage.

Additionally, the external appearance, such as the design of the prosthetic hand, can also evoke an emotional response from the user because it affects their confidence level. Gonzales studied a psycho-physiological assessment of a prosthetic hand sensory feedback system based on an auditory display (Gonzalez et al., 2012), while other studies discuss in wider area such as quality of life (Núñez et al., 2015), mixed reality social (Greenberg & Spitaletta, 2020), written emotional measurement (Gallagher & MacLachlan, 2002), satisfaction (Gupta et al., 2001), prosthesis evaluation quality to identify the quality of life (Legro et al., 1998) as well as effectivess aspect (Verheul et al., 2020). In evaluating product emotions, questionnaires were distributed to new respondents, involving people with disabilities and the general society, using the product measurement emotion product tool known as PrEmo Tool software. This tool was used because it contains a graphic image that can represent each person's emotions. PrEmo as a product emotion assessment tool, was also chosen due to its ability to simultaneously provide real-time facial expressions, which prevented users from being confused about their feelings during usage. The emotional assessment feedback by respondents also provides suggestions for improving the product design. This is in accordance with Jordan's research regarding the need for evaluation tests in wearability and positive affective experience assessment after the most basic needs, such as product functions, are met (Jordan, 2000). Therefore, this research aims to measure the usability level of Metic hand products in people with hand disabilities, to determine its emotional assessment, the problems with the product, and the factors influencing the level of usability for further suggestions.

## 2. MATERIALS AND METHODS

### 2.1 Product specification

In its operating system, Metic Hand has specifications, as shown in Table 1.

**Table 1.** Metic hand specifications

| Specifications | Metic hand |
|---|---|
| Material body | Poly lactid acid (PLA) |
| Material linkage | Flexible PLA |
| Driving force material | Goal braid fishing line size 0.37 mm |
| Grip mode | Grasp |
| Hand weight | 150 gr |
| Price | Rp 1.000.000 – Rp 2.000.000 (around US $80–160) |

### 2.2 Research variables

The data collection model for usability testing is the exploratory or formative method in accordance with (Rubin & Chisnell, 2008), which specifically focuses on products that are at the preliminary stages of being defined and designed. The variables in questionnaire of usability testing were generated from ISO-9241-11 similar with the previous research (Susanto et al., 2018; Susanto et al., 2019). The USE questionnaire is adopted from Lund (2001), while PrEmo is adopted from Desmet (2004).

The variables involved in usability evaluation can be identified and classified into several groups, namely:

1. Independent variables

The independent variables in this study are the twenty-four activities consisting of six activities of moving abstract objects and eighteen tasks of daily activities using PINTERE box.

2. Dependent variable

The dependent variable is the level of usability performance criteria based on ISO 9241-11, namely efficiency (duration of time for completing activities), effectiveness (number of errors generated) and satisfaction (USE questionnaire).

The level of effectiveness can also be determined from the grasping the hands pattern using the calculation of linear index factor (LIF) and weighted LIF in the study (Burgerhof et al., 2017). The score of the factor index value of the holding pattern in the hand is first calculated using the calculation formula (Equation 1). The result is then multiplied by the number of holding patterns in the hands given to all existing activities and then added up to divided by the total number of holding patterns in the hands to produce the weighted LIF or the total effectiveness value of Metic Hand as shown Equation (2).

$$\mathrm{LIF} = \frac{1}{k}\sum_{j=1}^{k}\left(\frac{8 \cdot n_j - t_j}{7 \cdot n_j}\right) \cdot 100 \quad (1)$$

$$\text{Weighted LIF} = \frac{1}{25}(3 \cdot \mathrm{LIF_{Spherical}} + 3 \cdot \mathrm{LIF_{Tripod}} + 6 \cdot \mathrm{LIF_{Power}} + 5 \cdot \mathrm{LIF_{Lateral}} + 5 \cdot \mathrm{LIF_{Tip}} + 3 \cdot \mathrm{LIF_{Extension}} \quad (2)$$

Usability level is determined based on its value and status (Vatankhah et al., 2014). The level of effectiveness of the hand can be shown in the pattern of holding the hand. This percentage is obtained from the calculation between the average time of testing and SHAP normative time data. The types of holding patterns in each activity is shown in Table 2.

**Table 2.** Holding pattern in SHAP activities and the PINTERE test tool

| Activity name | Grasping pattern type |
|---|---|
| Moving a triangle or tripod object | Tripod |
| Moving a ball | Spherical |
| Moving a tube | Power |
| Moving a lateral object | Lateral |
| Moving a tip or thin object | Tip |
| Moving an extension object | Extension |
| Flipping a paper | Extension |
| Removing and putting of shirt buttons | Tripod and tip |
| Pick up coins | Tip |
| Simulated food cutting (plasticine) | Tripod and power |
| Pouring water from the teapot into the glass | Lateral |
| Pouring water from a cardboard into a glass | Spherical |
| Lifting a light object (cylinders) | Power |
| Lifting a heavy object (cylinders) | Power |
| Rotating a screw | Power |
| Opening/closing the zip | Lateral and tip |
| Opening a bottle cap | Spherical |
| Rotating a key | Lateral and tip |
| Lifting a tray | Lateral and extension |
| Opening the door with handle | Power |
| Spraying water | Power |
| Clamping the cloth on the hanger | Tip and power |
| Mashing the plasticine | Power |
| Moving an egg | Spherical |

This is followed by product evaluation to determine its emotional assessment through the distribution of questionnaires from the user's point of view, giving an emotional response using the prEmo Tool software method. The independent variables in evaluating product emotions are based on the types given to respondents, while the dependent is based on the positive and negative emotions. This study's control variable comprises people with and without disabilities. The study was focused on the assessment of usability testing and product emotion. It excludes the relationship between independent and dependent variable.

## 2.3 Respondents

The respondent in usability testing was a 54 years old amputee male who had previous experience in testing prosthetic hands and fulfilled the letter of consent. Sample was selected based on the continuity of the research. Since the respondent was involved in the previous study, it is easier to perform the research procedure. The sampling technique is purposive sampling. The respondent is determined based on previous study (Susanto et al., 2018; Susanto et al., 2019). There was limitation of the respondent number as well, since the use of prosthetic hand needs custom design and size of hand socket based on the kind of respondent disability. Therefore, it is decided to use only one respondent in this preliminary study.

Twenty-five respondents as the evaluator of product emotion using PrEmo were taken into account. As explained by Nielsen (2012), the number of the respondents related human factors issue is varied from 5 until 20 respondents, so it was decided 25 respondents were performed the product emotion evaluation.

### 2.4 Research procedure

The usability testing mechanism used in this study is data capturing, a technique that focuses on obtaining empirical data such as interviews, video recordings, questionnaires and recording responses to activities carried out during research (Nalurita et al., 2015).

The research instruments in usability testing are as follows:

1. The PINTERE box (theraPy equipment for hand disorder evaluation PINTERE box is a tool used to complete activities for usability testing. It comprises 20 activities adapted from the SHAP kit (Burgerhof et al., 2017). Apart from that, there are also 4 activities that are characteristic of everyday Indonesian people.
2. Stopwatch to determine the duration of time respondents can complete each activity.
3. Camera to record the data collection process and support the results analysis.

The activity has completed a minimum of 5 times until it was successful (Susanto et al., 2019). After repeating the activity given, the USE questionnaire was used to determine the level of satisfaction associated with using a prosthetic hand in completing this type of activity. The moderator wrote small notes regarding things that happened while the respondent was trying to complete the activity, such as obstacles, complaints, limitations, and important factors associated with the incident diaries.

In addition, product evaluation was also carried out through an emotional assessment of Metic Hand products by twenty-five using the PrEmo tool (Desmet, 2004). The criteria for respondents are people between the ages of 18 to 30 years, who can read and write, with and without disabilities. The assessment is based on the results of a score from 0-4 using the PrEmo version 2 method.

## 3. RESULTS AND DISCUSSION

It is found that the Metic Hand cannot perform eight activities including (1) pick up coins, (2) simulated food (plasticine), (3) rotating a key, (4) opening/closing the zip, (5) rotating a screw, (6) spraying water, (7) clamping the cloth on the hanger, and (8) mashing the plasticine. Therefore, the independent variables only consider sixteen other activities.

### 3.1 Efficiency

Efficiency can be seen from measuring the time respondents need to carry out an activity from start to finish. the total average efficiency value is 23% for prosthetic hands, such as myoelectric or Bimo hand with one sample of respondents, the total average efficiency value is 23% for prosthetic hands, such as myoelectric or Bimo hand with one sample of respondents (Susanto et al., 2019). Another study (Susanto et al., 2018) also produced an average total efficiency value of 23%, which had been given four activity tests for two sample respondents on a myoelectric hand-type prosthetic called the Asto Hand. The function of the hand and the value of good efficiency depends on the grip speed of the prosthetic hand, where the faster the users reach their goals, the more efficiently the prosthetic hand is used. A study by Kyberd (2011) stated that the type of prosthetic hand control still has a greater impact on functional performance using SHAP than hand speed. The significant difference lies in the type of prosthetic hand controller owned by Metic Hand, and Bimo and Asto. Metic Hand uses a cable system and is controlled by abduction movements on the rest of the disabled hand or scapula of the body, while those owned by Bimo and Asto Hand use a microprocessor controlled by myoelectric signals. Therefore, the type of controller in mechanical hands, the Metic Hand, has a lower efficiency value than bionic/myoelectric hands.

In collecting Metic Hand time data, the smallest efficiency value produces fluctuating line graphs shown in the activity of moving triangles and lateral objects by 2% and 4%. The highest efficiency value is the activity of pouring water from a pitcher into a glass, which is 38%, followed by pouring water from a carton into a glass, which is 28%, resulting in a horizontal line graph.

### 3.2 Effectiveness

Direct observations were made when the task was given to the respondent to determine the level of effectiveness, which is carried out by analyzing the level of success when respondents carry out the activities. The success of Metic Hand in carrying out 20 activities is 75%, which were determined by taking coins, cutting food with a knife, turning the key, opening/closing zippers, and inserting screws. Similarly, previous research (Susanto et al., 2019) succeeded in carrying out 75% of the 20 total SHAP activities provided in their research on Bimo Hand. Unlike the Metic Hand, the five activities that cannot be conducted by the Bimo Hand are lifting lateral objects, moving trays, opening/closing zippers, turning screws and cutting food with a knife. The differences in activities that cannot be carried out are not absolute compared to differences in samples, test equipment, and research objects in previous studies.

The level of effectiveness of the hand can be shown in the pattern of holding the hand, with the percentage obtained from the calculation between the average time of testing and SHAP normative time data. The calculation of effectiveness based on the weight of holding patterns in the hands is shown in Table 3.

Burgerhof et al. (2017) supports the analysis of the level of effectiveness of prosthetic hands, stating that activities will be more successful in achieving goals or targets, each holding pattern in the hand has a good value. Metic Hand has the largest index of 39.40% for spherical holding patterns, indicating that functional performance is more effective in these activities, such as moving a ball, opening a bottle cap, and pouring water from a cardboard pack into a glass. The smallest index on the Metic Hand lies in the pattern of holding the tripod and tip-type hands, namely 0%, and 1.79%. This value supports activities Metic Hand cannot carry out, which contains the principles of the tripod and tip-holding patterns. Previous research (Susanto et al., 2019) showed that the largest and smallest index of the prosthetic hand for the spherical and lateral types is 34.21% and 18.16%, respectively. When compared, the two hands have good effect in the grip pattern, with the holding process used as the standard of artificial hand design for applications in the prosthetic field (Weir, et al., 2001). The types of grasping patterns in the literature consist of a tip, palmar, lateral, hook, spherical, and cylindrical prehensions. The standard pattern of holding on a prosthetic hand is also strengthened by an analysis of prehensile patterns, which have been classified into the grasp taxonomy with a total of 33 patterns where one of the references is SHAP (Feix et al., 2016).

**Table 3.** LIF and weighted LIF score results

| Grasping pattern type | LIF | Weighted LIF |
|---|---|---|
| Spherical | 39.40% | 13.32% |
| Tripod | 0.00% | |
| Power | 23.29% | |
| Lateral | 22.49% | |
| Tip | 1.79% | |
| Extension | 37.90% | |

### 3.3 Satisfaction

The percentage of satisfaction based on the USE questionnaire shows that respondents gave good marks when using the Metic Hand to complete the activity given, with activities value above 80%. Metic Hand has a satisfaction percentage value of 93.88%, which differs from Bimo Hand and Asto Hand at values of 68.03% and 57.55%, respectively. Based on this value, Metic Hand is in an excellent or special status and is highly regarded by its users compared to Bimo, and Asto, which are in good and moderate statuses (Susanto et al., 2019). This is due to users' ease of learning and utilization based on the abilities and types of controllers in each hand studied. In previous research, the Asto and Bimo Hand experiments' control system was not good enough. For instance, during testing, both experiments did not immediately work according to what the respondent instructed, and the product's relaxation signal had a slow response. Meanwhile, the Metic Hand, using cable threads with the rest of the body as a hand mover, made it easier for respondents to carry out activities without obstacles. Respondents who feel the ease of use when completing activities using the product are some of the factors underlying this assessment. This is the reason for the difference in the value of the level of satisfaction between the current and previous research.

### 3.4 Usability level

The recapitulation of the data generated from the questionnaire is shown in Table 4. It represents the level of satisfaction of respondents in using Metic Hand (ISO, 1998). Respondents felt it was quite easy to learn how to use Metic Hand without written instructions. In addition, they also feel proud and helped by its presence, with their left hand used to support more productive activities. The smallest value given by respondents is found in the learnability criteria, which are still included in the category, at 88.84%.

**Table 4.** Questionnaire recapitulation USE

| Questionnaire parameter points USE | Average (%) |
|---|---|
| Usefullness | 90.51 |
| Ease of use | 89.45 |
| Learnability | 88.84 |
| Satisfaction | 93.88 |
| Overall average total | 90.67 |

This assessment was given because the respondent did not feel the benefits of the Metic Hand in completing several activities, such as those still requiring many adjustments to the position and method of use to complete the given activity. In addition, the respondent had difficulty holding small objects. They expended considerable effort to get the Metic Hand in the maximum gripping position, which provided the pressure to hold small objects such as a tripod or triangle.

Based on the results of interviews with respondents, it was found that some of the problems experienced by respondents included the large gloves on the Metic hand, the lack of ability to form an angle of the wrist, to the difficulty of holding precise or small objects.

In addition, the assessment recapitulation results found that the average final rating of the respondents was 90.67%. Adjusting these results to the Usability Level showed Excellent status. with superior or special responses to product use. This contrasts previous research, stating that Bimo and Asto Hand have usability values based on the USE questionnaire, 66.18% (GOOD) and 73.2% (GOOD), and are good enough to be used.

### 3.5 Product emotion

Respondents from the emotional assessment were both men and women, totaling 25 respondents with their description shown in Table 5. There are 14 emotions resulting from the distribution of questionnaires to respondents with and without disabilities, as shown in Figure 1. The Metic Hand has almost the same line pattern where more respondents towards product appearance generate positive emotion scores. This graph also shows that the respondents experienced positive and negative emotions, often mixed emotions (Yogasara & Lestari, 2008). The Metic Hand has the highest and lowest negative emotional response at 0.96 and 0.48.

**Table 5.** Respondents characteristics

| Characteristics of respondents | | Total |
|---|---|---|
| Gender | Male | 19 |
| | Female | 6 |
| Age | 20–40 years | 19 |
| | 40–60 years | 6 |
| Point of view | Hand with disabilities | 9 |
| | Non-disabled people | 16 |

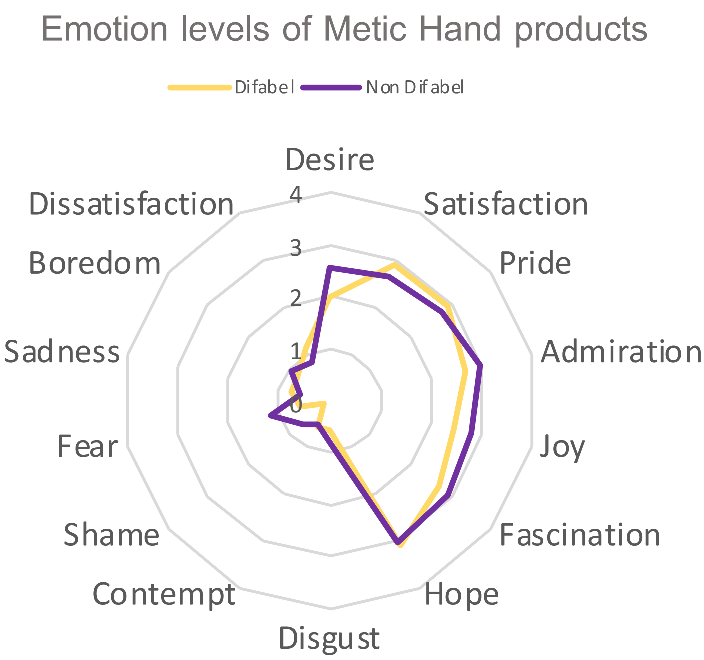


**Figure 1.** Metic Hand product emotions

On the one hand, the highest positive emotional response to the Metic Hand was found in the hope emotion at 3.04, and the lowest is desire at 2.36. According to Shin and Wang's, the emotional response was obtained from the respondents' assessment of product aesthetics, divided into product shape, texture, and color categories (Shin & Wang, 2015). The respondents' opinions also accompany this analysis during the interviews. The factors underlining the emergence of positive and negative emotions about the Metic Hand by respondents are its simple shape, complex texture, which still represents the shape of the original hand in general due to wearing gloves, and the bright color when seen by the respondent.

Emotional scores are classified into two types, namely, from the point of view of respondents with and without disabilities. Respondents with disabilities caused by accidents and congenital disabilities all have knowledge and experience with artificial/prosthetic hands, especially cosmetic types. A prosthetic hand functions as a cosmetic and a functional tool. Cosmetic-type prosthetic hands have a shape that looks like a real hand with a passive function (Weir et al., 2001). In contrast, some non-disabled respondents only knew about prosthetic hands without recognizing the existence of functional aids such as Metic Hand.

The resulting negative emotions are seen in the emotion of fear because the durability of the product design looks unqualified, which makes them worry about possible future damage. In addition, fear is generated because of worry about the side effects of prosthetic devices, such as causing injury and trauma of losing a body part caused by an accident. Refusal to use a prosthetic assistive device at the start of its use is common among people with disabilities. This is because the prosthetic hand is not considered a natural part of the body for the respondents. The adjustment period for its usage, which is still small, is also a factor of rejection in accepting prosthetic types of assistive devices because respondents need adaptations to determine the amount of effort needed to balance the weight and the body when fitted with prosthetic aids (Zbinden et al., 2022). In Metic Hand, colors that do not resemble real hands generally reduce the acceptance of prosthetic hands as substitutes.

The emotion of fear felt by people with disabilities is also caused by visible joints in the hands that look insecure or prone to breaking. This is supported by the bolts that are still clearly visible on the Metic Hand's surface and the colors and shapes resembling toys, thereby increasing the score of fear to 1.187.

The resulting positive emotions spread over all types of positive emotions, namely desire, satisfaction, pride, admiration, joy, interest, and good wishes, from the perspective of people with and without disabilities. This is because product segmentation leads people with disabilities to increase their daily productivity and function, which is very useful as a tool to replace a hand. The emotion of pride refers to the status of a product which is the work of the nation's children capable of creating prosthetic hands to move and increase the wearer's productivity compared to cosmetic types of hands. Most respondents with disabilities have used prosthetic hands of the cosmesis type that only function as a substitute for passive hands. Those owned by the majority of respondents were only used once as displays for formal activities such as weddings. The emotion of desire arises because the respondent hopes to have the prosthetic hand evaluate the Metic's hand. Emotions of awe are also generated by people with disabilities because there are no competitors in Indonesia. From a non-disabled perspective, respondents also scored highly on positive emotions toward the product, with the biggest assigned to admiration. This is because the respondents only know the product's basic function, which is only to benefit other people, especially those with disabilities.

Figure 1 shows that emotions are felt by people who have different views, such as those with and without disabilities. Differences in feelings of desire, satisfaction, pride, awe, hope, fear, and sadness are caused by non-disabled people who think those with disabilities who use prosthetic hands look competent and are a little cold to their environment. According to people with disabilities who use bionic prosthetic hands are stereotyped as competent and those with good intentions hence they have a sense of awe and pride. In addition, people with disabilities who use bionic prosthetic hands are also stereotyped as having bad intentions in their environment despite being competent, thereby causing envy and jealousy. The difference in feelings of joy and humiliation is caused by people with disabilities who think that when they use prosthetic hands, society envisions them as very competent.

There are differences in feelings of desire, admiration, pleasure, interest, disgust, shame, fear, and dissatisfaction associated with users of Metic Hand. Differences in feelings of desire, admiration, pleasure, interest, disgust, embarrassment, and fear are experienced by non-disabled people who think those with disabilities who use prosthetic hands have little competence and have cold attitudes towards their environment. The difference in dissatisfaction is caused by people with disabilities who think using prosthetic hands makes them incompetent. This is proportional to the greater the negative emotions generated, the higher the stereotype associated with incompetency and coldness towards the environment.

It is important to note the stereotype factor in the combination of competency levels and attitudes toward the environment. A study reported that respondents considered people with disabilities who use prosthetic hands as those with high competence levels and similar to the disabled (Meyer & Asbrock, 2018). Respondents also would not consider prosthetic hand users to be more competent than able-bodied individuals.

Based on the results of the data analysis shown in Figure 1, the seven positive emotions produce a larger dominant value than the other negative emotions, which is indicated by lines on the outer radius. Furthermore, the emotional value generated from the point of view of the disabled and abled people has relatively the same value. It can be concluded that people with and without disabilities have the same emotional view of the Metic Hand design. Table 6 describes the respective scores of positive and negative emotions from the perspective of persons with disabilities and non-disabled persons.

**Table 6.** Emotional scores

| **Emotion** | **Metic hand** | |
|---|---|---|
| | **DP** | **NDP** |
| Positive emotion score average | 2.67 | 2.81 |
| Negative emotion score average | 0.63 | 0.79 |

DP : disabled persons; NDP : non-disabled persons

There are positive emotions generated by Metic Hand, namely the durability that looks stronger, assisted by the use of gloves in carrying out activities because it makes it easier to hold small objects. However, in reality, the gloves are not according to the size of the hand. Based on the opinions and interviews of respondents, the color of the gloves, which is different from the Metic Hand, reduces the aesthetic value due to variation, such as red and black, which are chosen in the overall design, thereby representing a type of dissatisfaction emotion. This is reinforced by respondents who prefer neutral colors that are close to skin color and do not have bright ones.

## 3.6 Incident diaries and recommendations

Incident Diaries are a form of investigation of the respondent's experience record of a product. Table 7 shows a recap of incident diaries data based on observations by respondents, designers, and observers for activities on the PINTERE tool. Table 8 shows a recap of incident diaries data based on observations by respondents, designers, and observers for the activities to be conducted.

The hand design does not need to be re-coated with hand coatings or other supporting layers. Therefore, the materials used for the entire hand are of the same type and color but still produce a good gripping function. Most respondents prefer neutral colors such as black and gray, equated with skin color, namely brown, for Indonesian people. Futuristic designs can provide opportunities for the Metic Hand to develop contemporary designs (Clement et al., 2011), such as the shape of the hand surface, which is not too flat and is made slightly more convex on the upper hand, thereby reducing negative emotional value. The design principles of paying attention to detail and clean design are also expected to provide suggestions for improvements to these two products. This is because people's demand is not only limited to product durability and function but a sophisticated and up-to-date appearance, which is a major aspect of product design.

Product levels also need to pay attention to details, such as the right shape and color selection, as well as the product design, which must be integrated and still produce a coordinated mode of operation for product functions. This can be shown in the goal braid fishing line in several parts of the Metic Hand. Therefore, a clean design must be considered for small components to be invisible to the naked eye while maintaining the natural functional factors, such as water and unstable temperatures.

**Table 7.** Incident diary of failed activity

| No | Activities | Information | Improvement suggestions |
|---|---|---|---|
| 1 | Pick up coins | - The small surface of the object makes it difficult for the Metic Hand to lift the coin.<br>- There is a gap between the fingers on the index and thumb.<br>- Metic Hand is functioned using gloves, hence there are obstacles to the layers due to inappropriate or prolonged usage.<br>- Metic Hand only has 1 mode, namely holding. | - The wide angle of the thumb opening is enlarged to ensure the tips of the thumb and forefinger meet.<br>- Metic Hand requires gloves with a thin thickness and according to the size of the original |
| 2 | Simulated cutting food (plasticine) | - The compressive strength of Metic Hand is small, hence it is unable to cut food (plasticine)<br>- Metic Hand only has 1 mode, namely holding. | - The Metic Hand size is extended above the elbow, longer than the previous size to get greater pressure relief |
| 3 | Rotating key | - There is a gap between the fingers on the index and thumb.<br>- Metic Hand only has 1 mode, namely holding. | - The wide angle of the thumb opening is enlarged to ensure the tips of the thumb and forefinger meet. |
| 4 | Opening/closing the zip | - There is a gap between the fingers on the index and thumb.<br>- Metic Hand is functioned using gloves, hence there are obstacles to the layers that are inappropriate or too long.<br>- Metic Hand only has 1 mode, namely holding. | - The wide angle of the thumb opening is enlarged, to ensure the tips of the thumb and forefinger meet.<br>- Metic Hand requires gloves with a thin thickness and according to the size of the original |
| 5 | Rotating screw | - The compressive strength of Matic Honda is small, hence it can't turn the screw.<br>- Metric Hand only has 1 mode, namely holding. | - The Metic Hand size is extended above the elbow, longer than the previous size, to get greater pressure relief |
| 6 | Spraying water | - Metic Hand's compressive strength is small, therefore, it cannot spray water.<br>- Metic Hand only has 1 mode, namely holding.<br>- Water spray generally requires a wide hand opening to grip the handle. | - The wide angle of the thumb opening is enlarged, to ensure the tips of the thumb and forefinger meet.<br>- The Metic Hand size is extended above the elbow, longer than the previous size, to obtain greater pressure relief |
| 7 | Clamping the cloth on the hanger | - Metic Hand's compressive strength is small, hence it is unable to clamp the clamp.<br>- There is a gap between the fingers on the index and thumb.<br>- Metric Hand only has 1 mode, namely holding. | - Metic Hand's compressive strength is small, which makes it unable to clamp<br>- There is a gap between the fingers on the index and thumb<br>- Metic Hand only has 1 mode, namely holding |
| 8 | Mashing the plasticine | - Metic Hand only has 1 mode, namely holding. | - The wide angle of the thumb opening is enlarged, hence the tips and forefinger can meet. |

**Table 8.** Incident diary of success activities

| No | Activity | Evidence | Improvement suggestion |
|---|---|---|---|
| 1 | Moving a ball | - Achievable | – |
| 2 | Moving a triangle or tripod | - Achievable<br>- Improper size of Motor Hand gloves | Changes type of gloves |
| 3 | Moving a tube | - Achievable | – |
| 4 | Moving a lateral object | - Achievable<br>- The wrist on Matic Honda cannot be moved, hence the process of moving lateral objects must be done from the side or rotated 90 degrees, and the respondent's position must be standing | - Added design to Matic Honda to move the wrist |
| 5 | Moving a tip object | - Achievable | – |
| 6 | Moving an extension object | - Achievable | – |
| 7 | Removing various types of shirt buttons | - Achievable, inappropriate size of Motor Hand gloves<br>- Matic Hand only has 1 mode, namely holding | - Changes type of gloves<br>- A longer distance is given between buttons |
| 8 | Flipping the paper | - Achievable, respondents found it difficult to turn the paper because the wrist could not be moved hence the process of turning the paper was carried out from left to right. To turn a page in a book towards the respondent's position, a semi-squatting or standing table that is high enough to place the paper is required | - Added design to Matic Honda to move the wrist |

**Table 8.** Incident diary of success activities (continued)

| No | Activity | Evidence | Improvement suggestion |
|---|---|---|---|
| 9 | Opening the bottle cap | - Achievable, with the help of the right hand that moves the bottom of the bottle | – |
| 10 | Pouring water from the teapot into the glass | - Achievable, with a diameter of a teapot handle that is wide enough to make it easier for the hand to hold a teapot and can represent it in general | – |
| 11 | Pouring water from the cardboard into the glass | - Achievable | – |
| 12 | Lifting a heavy object (cylinders) | - Achievable, Slippery gloves are prone to falling objects (cylinders).<br>- Required assistance from the ring to the little finger for adaptation to lifting cylindrical objects | - Regular practice is required<br>- Changes type of gloves |
| 13 | Lifting a light object (cylinders) | - Achievable, Slippery gloves are capable of falling into cylindrical objects. It takes help from the ring finger to the little finger for adaptation to lifting cylindrical objects | - Regular practice is required<br>- Changes type of gloves |
| 14 | Lifting tray | - Achievable, slippery gloves are prone to falling objects (cylinders). It takes help from the ring finger to the little finger for adaptation to lifting cylindrical objects | - Added design to Matic Honda to move the wrist |
| 15 | Opening doors with handles | - Achievable | – |
| 16 | Bring eggs | - Respondents find it difficult to provide balanced pressure to carry eggs. In addition, the slippery surface of the egg often escapes from one's grip. | - Regular practice is required.<br>- Changes type of gloves |

## 4. CONCLUSION

In conclusion, based on ISO 9241-11, the results of measuring the usability level of Metic Hand products for people with disabilities are in good status. The product's emotional assessment results of Metic Hand using the PrEmo tool showed that the product's average emotional response was mixed emotions, with the positive value higher than the negative. Furthermore, there are several problems and suggestions for improving Metic Hand products from a usability perspective. When viewed from the emotional side of the product, suggestions and input for improvements are shown in the futuristic design with details.

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