

Mask design to prevent foggy glasses and difficulty breathing

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ABSTRACT

The present of the pandemic has given to a new habit that we call the new normal. One of the habits we hear most often is wearing a mask. Ironically, the use of masks creates new problems for certain populations, for example, glasses users and people with respiratory problems. Eyeglass users complain of the effect of fog on the glasses when wearing a mask, sufferers of respiratory problems complain of shortness of breath when wearing a mask. To find the design solution, the researches employed the data analysis method and experiments (trials) on the appropriate shape, structure, and material of the mask. The results of this design succeeded in presenting the expected design solutions, namely preventing the effects of eyeglasses fog, reducing the effects of tightness when wearing a mask, a display that supports appearance, and fulfill the WHO mask criteria. It presented in four basic color variants.

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1. INTRODUCTION

The coronavirus 2019 (COVID-19), which first appeared in Wuhan, China at the end of 2019, has spread throughout the world [1]. The first case in Indonesia occurred in March, 2020 [2]. COVID-19 is known to be a respiratory tract infection caused by the transmission of the SARS COV-2 virus through the membranes of human organs, namely the eyes, nose and mouth [3], [4]. Experts agree that this transmission can be prevented by closing the access to transmission which is applied in several ways, namely: the use of personal protective equipment such as face coverings or masks [5]–[9] other prevention is done by keeping a distance of at least 1-2 meters with consideration of the effect of the droplet spray can reach that far [10], [11] and wash your hands with soap [12]. These things are the basis for the creation of several new habits during the pandemic which we call the 3M jargon, namely: wearing masks, keeping your distance, and washing your hands [13].

In particular, the use of masks as a new habit has an effect on the activities of certain populations [14]. People with a history of respiratory problems [15], [16] the elderly [17], [18] and those who wear glasses are the population that has felt the significant impact of this new habit. People with this respiratory disorder admit that wearing a mask makes them feel even more breathless. Similarly, eyeglass wearers admit that wearing a mask can cause more vapor to form on their glasses causing interference with their field of vision when moving [19].

Several mask manufacturers try to answer this challenge; they make various types of masks that have been equipped with airflow valves, air filter systems, and mask materials that facilitate airflow for users, such as scuba masks. Ironically, the solution received a rebuttal from the world health organization (WHO).

Does not recommend the use of valve masks or the like because they are claimed to reduce the effectiveness of preventing transmission of the corona virus through droplet splashes [20].

Likewise with the problem of wearing glasses, some have overcome them by using contact lenses, some have replaced glasses with anti-fog glasses, used anti-foam spray on glasses, applied liquid soap on glasses [21]–[23]. Mask manufacturers have tried to answer the challenge by presenting a mask that is claimed to be an anti-fog mask. For example, masks with spatial designs (3D), half face shield masks, and masks with a buffer in the nose area [24].

However, there are things to note, looking at existing product solutions such as contact lenses, not all eyeglass users are comfortable using contact lenses [25] so this option is not an alternative to be studied further. The alternative of replacing anti-fog eyeglass lenses [21] which tend to cost three times the price of regular lenses, is considered too heavy for the general public. Likewise, the design solutions for masks related to the fog effect of glasses, the solutions offered have not fully answered the challenges faced by eyeglass users, for example from the design aspect of the mask straps that are stacked on top of the glasses handle, thereby reducing the comfort of wearing glasses. In designing a product as a design solution, a designer needs to pay attention to the novelty value of a product [26] so that the author brings up what distinguishes the author's design from the previous design solution, namely a design that combines four aspects at once, namely the function of preventing the effect of fog on glasses, reducing shortness of breath on the user, providing a form that can support appearance (fashionable) and pay attention to recommendations from the WHO in preventing COVID-19 [20].

This seemingly simple problem, but for eyeglass users is an important thing, considering that the use of glasses for nearsighted people (myopia, hypermetropia, or both) has become part of their daily life. Without glasses, their daily activities will be disrupted, this can have an impact on their quality of life [19] so that by answering the problems caused by using this mask, they can restore their quality of life as before [27]. Given the importance of answering these problems for those population groups, a product that can answer these challenges is needed. The design of special masks as the beginning of this problem can be the closest alternative solution to overcome these problems. An important aspect that needs to be considered regarding this mask is the requirement for masks that are in accordance with WHO standards.

2. RESEARCH METHOD

This study employed a qualitative method. This qualitative research aims to find the best design solution for the problems raised in the background, namely by observing similar products (study of previous design) [24], [28]–[30] black-box sketches, data analysis and evaluation, then concept generation, trials (experiments), prototype and final design. In detail, this research process is described through two process schemes, namely the design process scheme in Figure 1 and the production process scheme in Figure 2.

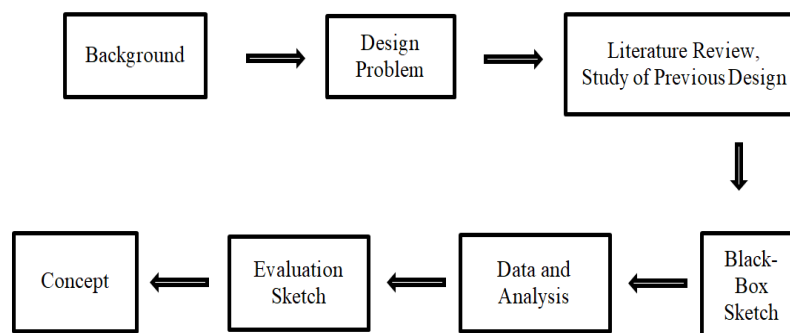


Figure 1. Schematic of the design process

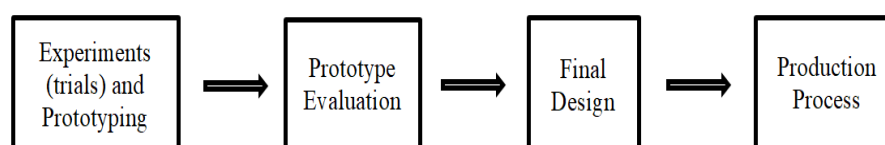


Figure 2. Schematic of production process

2.1. Schematic of the design process

The Figure 1 is a schematic of the process flow for designing this product. Starting from the background that has been explained in the initial paragraphs of the introduction. Then the design problem is explained in the last three paragraphs of the introduction. Literature review and study of previous designs are steps that contain the process of finding library references that support this product design solution as well as studying similar products that have also tried to answer the problems raised. The next step is black-box sketch. In the design process, there is one method called black-box. This method allows the researcher to pour out all his/her thoughts about the product being designed [31]. This step is outlined in the form of a sketch. Here the author attaches some sketches in Figure 3 that have been made through this step.



Figure 3. Black-box sketches

Furthermore, author performs data collection and analysis related to things that support or do not support the details of the designed product. For example, mask patterns, mask frames, mask straps, materials, and so on (details will be described in point 2.3 data and analysis). Then, the results of the analysis become the basis for evaluating the sketch which will later become the reference for the concepts made in this design.

2.2. Schematic of production process

The Figure 2 is a schematic of the process flow of producing and evaluating this product. Base on the concept that was created in the previous scheme, the concept was re-tested through experimentation and making the design prototype, considering that this process is not one-way so that the experimental step of this prototype is also contained in the data and analysis. The experimental results of the prototype are then evaluated (prototype evaluation). The results of this evaluation then produce the final design. The next step is the product production process. After the product is produced, this product is also tested on individuals to provide a response to use, but this step will then be placed in the discussion section of this paper.

2.3. Data and analysis

Mask pattern the 3D mask pattern is a mask pattern that presents a 3D shape after sewing. This 3D shape produces a spatial structure that adapts to the three-dimensional structure of the face [32], [33]. This space also provides a place for air circulation that is formed from the distance between the mask cloth and the surface of the mouth and nose. This space is one of the advantages of 3D masks so that they can prevent tightness when it used. With these considerations, the author tries to test and modify the development of the mask pattern as shown in Figure 4. Figure 5 presents in detail the standard size of the mask [34] according to the pattern that has been selected. Considering the comfort aspect raised in the form of preventing the effect of fog on glasses users, the following is presented in Table 1 the analysis and evaluation of the previous design alternatives that try to answer these challenges.

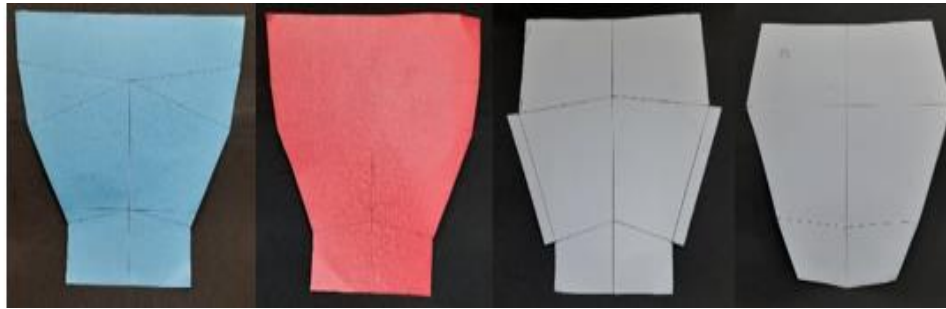


Figure 4. Trial and pattern modification

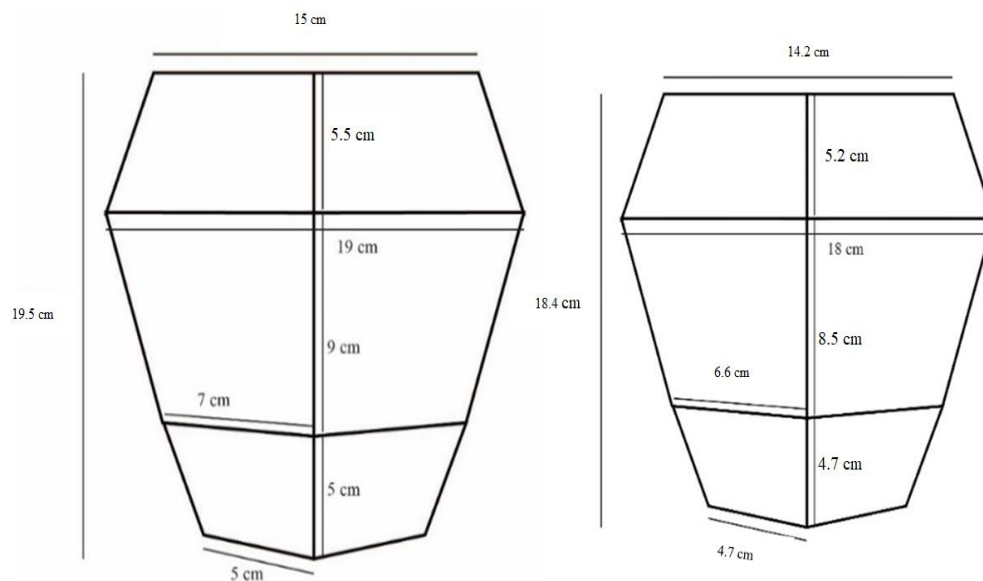


Figure 5. The size of the selected mask pattern and alternative sizes (women) [35]

Table 1. Analysis of alternative design solutions for anti-fog effects on masks

Alternative design	Cutton material	Anti-fog solution	Protection effectiveness	Total
Valve mask	3	2	0	5
3D mask	3	3	3	9
Mask with nose bridge	3	3	2	8
Mask with extra space	3	3	3	9

Note: 0: bad, 1: quite, 2: good, 3: best

Based on the assessment of the design alternatives in Table 1, the highest points were obtained, namely the 3D mask design and the mask with additional space. Considering that masks with additional (extra) space require additional components that create many folds that have the potential to become a source of virus transmission, the authors prefer an alternative 3D design to prevent the effect of condensation on the glasses as shown in Figure 6.

2.4. Mask frame

The next point related to the comfort aspect of the mask is to prevent suffocation in users with respiratory problems. This means that users without respiratory problems can feel short of breath when wearing a mask, so of course users with respiratory problems will have more problems when using a mask. After making various observations on the components that cause shortness of breath [36] when using a mask [37] the authors found that this was because the distance between the inner fabric of the mask which was too close to the nostrils and mouth became an obstacle to the ventilation process (human inspiration-expiration) when breathing. The illustration is shown in Figure 7.



Figure 6. Prototyping the mask pattern

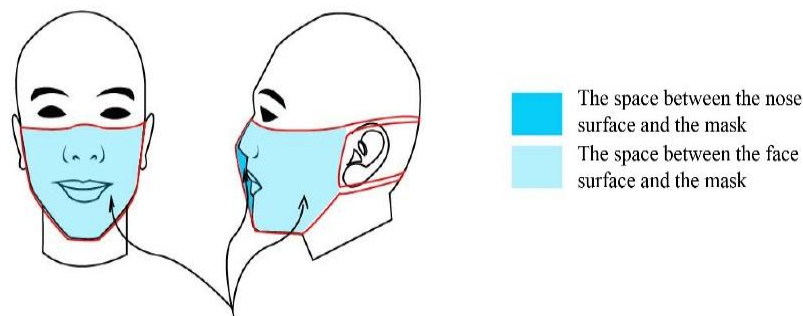


Figure 7. The area of space between the mask and the surface of the face

The dark blue area represents the space formed by the distance between the inner mask surface and the nose-mouth. The existence of this area is a solution to preventing congestion when wearing a mask. The following in Table 2 is an analysis of alternative design solutions that become a reference. With these considerations, the consideration of procuring an adjustable frame in the mid-mask area as an adjustable nose support is an evaluation of the design.

Table 2. Analysis of alternative design of anti-suffocation solutions on masks

Alternative design	Cutton material	Anti-breathless solution	Protection effectiveness	Total
Valve mask	3	3	0	6
3D mask	3	2	3	8
Mask with nose bridge	3	3	2	8
Mask with extra space	3	1	3	7

Note: 0: bad, 1: quite, 2: good, 3: best

2.5. Mask strap

The next thing to pay attention to is the robustness of the position of the mask to the user, given that the head consists of the face, skull, and neck area, the ideal position of the mask strap is in an area with minimal movement so as to avoid using the strap in the neck area. This strengthens the choice of strap design (the upper part) in the form of a head loop, considering the area traversed on this strap (the skull) is a static area (no joints) as shown in Figure 8. Another consideration is the component of the lower strap of the mask that functions as a chin support which is the most active part on the surface of the face which when opened dynamically pulls the upper part of the mask downwards so that the mask easily sags, with these considerations the authors designed the lower strap as a support chin on the mask.

2.6. Mask color

Every object or product must have a color. The application of color to this product chooses neutral colors (black) and primary colors (red, blue, yellow). The choice of black color has a consideration that the nature of this color is neutral and does not easily look dirty, this is important because the mask is located on the face so that it will affect the user's confidence. The selection of primary colors, such as red, blue, and yellow, took into account that these colors are unisex so that they do not specialize in the gender of the user considering that the target users are male and female.

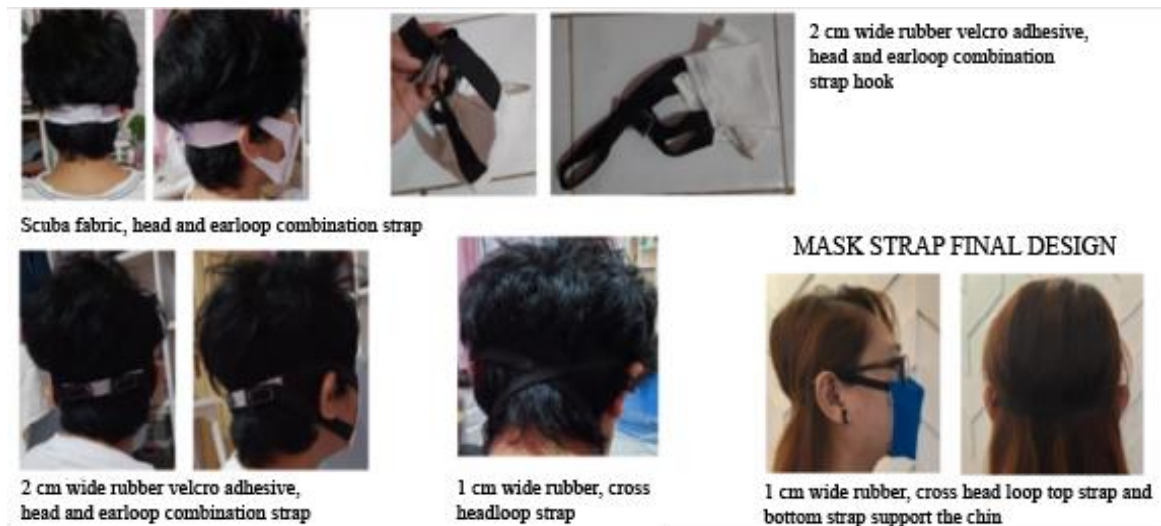


Figure 8. Trial and analysis of material and shape of the mask strap

2.7. Mask material

An ideal combination of materials for non-medical masks: an inner layer made of a hydrophilic material (e.g. cotton or cotton blends), a hydrophobic middle layer made of a synthetic nonwoven material such as polypropylene, and an outer layer made of a hydrophobic material such as polyester [38], polypropylene or a mixture of both so as to limit contamination from outside that penetrates into the nose and mouth of the wearer [39]–[41]. Figure 9 is an illustration of the fabric lining and the combination of materials recommended by WHO [20].

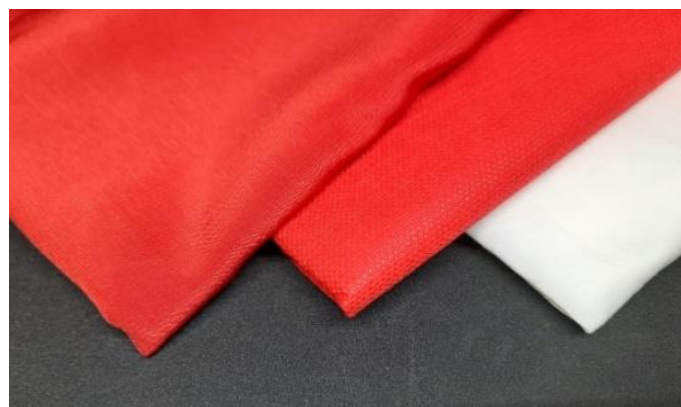


Figure 9. Mask layer: polyester, spunbond, and Japanese cotton (left to right)

2.8. Connection system

The connection system on a cloth mask that has a mask strap component is also an elastic rubber cloth is by the sewing method. Considering that the elastic structure of the rubber is not resistant to heating, this mask is not recommended for a connection system in the form of heating or a press system.

2.9. Maintenance

The cotton fiber structure of the cotton fabric makes it even stronger when wet. Other types of fabrics do not have this advantage, so we can wash cotton products without worrying about them getting damaged quickly. Cotton also has good resistance to high temperatures, so you can iron cotton products without worrying about damaging their shape and softness. The rigid, water-resistant structure of the spunbound fabric adapts to washing. Likewise, the polyester structure is easy to clean without ironing, making it easier to maintain this reusable mask.

Considering that there is a rubber component of the mask strap and buffer wire inside, it is not recommended to wash this mask using a machine because it can damage the elastic mask strap and wire structure, so hand washing is recommended in maintaining the cleanliness of this mask. This mask is recommended to be washed every day after using it for a maximum of eight hours according to WHO recommendations [20].

3. RESULTS AND DISCUSSION

3.1. Concept of shape and size

The shape of the mask used is in the form of 3D because this shape is the most suitable form for the design problem raised, namely preventing the effect of fog and reducing the effect of tightness on the user. The size of the mask consists of the length, height and thickness of the mask body and the length of the strap. The height of the mask pattern is 19.5 cm, the width of the mask pattern is 19 cm and a minimum thickness of 0.3 cm with an estimated layer thickness of each fabric of 0.1 cm according to WHO requirements, which consists of three layers of fabric. The length of the upper strap is 40-45 cm which can be adjusted so that it allows the user to adjust the comfort of its use in half the circumference of the head and the length of the lower strap is 12 cm so that it can support the lower jaw (chin).

3.2. Concept of material

The material used in this mask consists of the materials that make up the mask, namely three layers of cloth material on the body of the mask, elastic material on the mask strap, and buffer wire material on the inner layer. The choice of three layers of fabric is according to their respective properties, namely absorbing water (inner layer) and retaining water (middle and outer layers). The material for the mask strap is elastic because it makes it easier to adjust the mask strap. The buffer wire material was chosen because it functions as a buffer so that the structure of the mask can be sturdy, making it easier for users to breathe.

3.3. Concept of connection system

The connection system used is the sewing technique because the main material of this mask is three-layer cloth and the other material that is connected is an elastic rubber material so that the sewing technique is the best choice for the connection system. This connection system avoids the use of press and heating techniques because of the elastic properties of the material which can be damaged or reduced in flexibility due to heating.

3.4. Concept of color

The colors used in this mask are the basic colors (red, yellow and blue), and the neutral color (black), because these colors minimize confusion in identifying their use. The colors used avoid flashy impressions because considering their use in areas of the face that not everyone wants to look flashy.

3.5. Concept of structure

The structure of the mask used is in the form of a buffer that is placed on the inside of the mask so that the shape of the mask can be maintained properly attached to the face area. The structure of the mask that has this buffer is to prevent the mask from sliding down when used when the user is driving (motorcycle) or actively moving on the face area when talking which causes the mask to sag.

3.6. Concept of maintenance

This mask is a reusable mask because the material is a three-layer cloth which allows it to be washed. Masks are not recommended to be washed by machine, considering the elastic material that loosens more easily after washing by machine, so hand washing is recommended.

3.7. Final design

Figure 10 is the final design which is an illustration of the concepts that have been described previously. The display of the product that has been made is shown in Figure 11. This Figure presents the appearance of the product from various points of view to provide a detailed picture of the shape of the product.

3.8. Discussion

The final design that has been produced is then tested on several people to assess the effectiveness of its use according to the design problems raised. The following is a comparison of the use of similar products to assess whether or not fog is formed when used in Figures 12 and 13 and difficulty breathing when used in Figure 14.

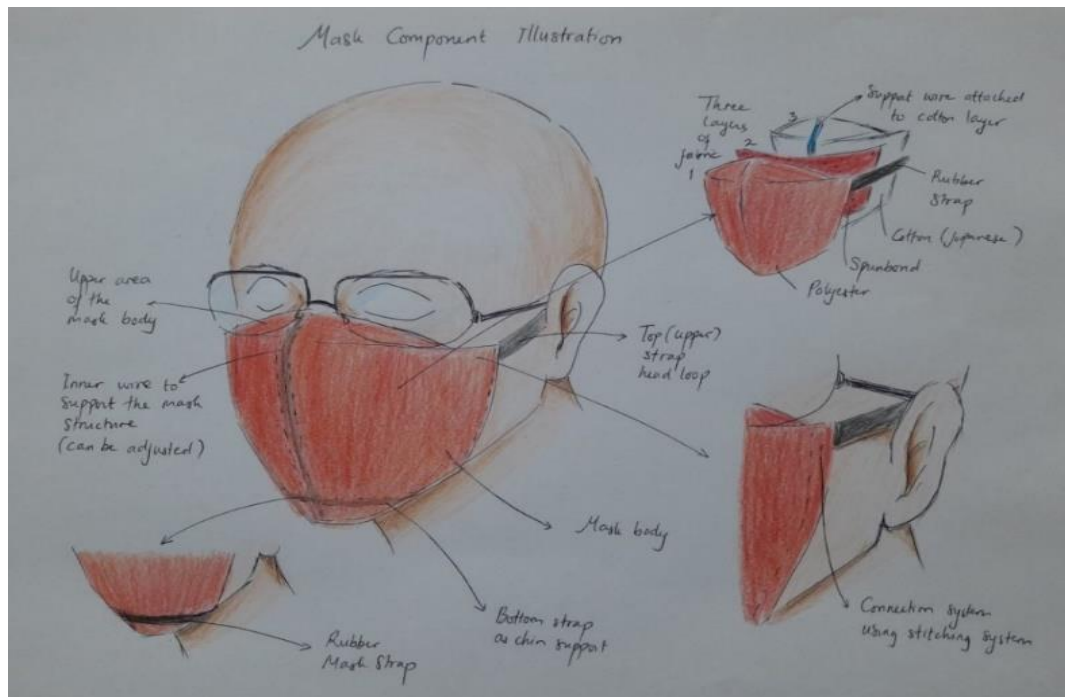


Figure 10. Component illustration of the final design

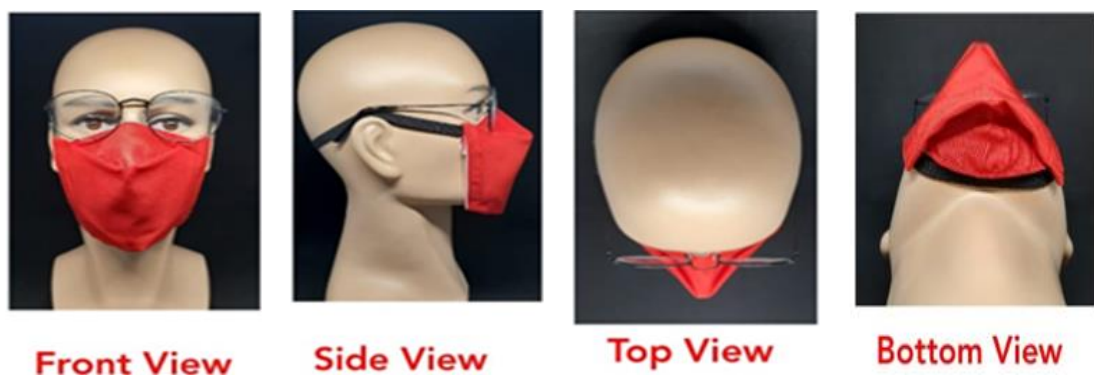


Figure 11. Display mask



Figure 12. Trial of a similar type of mask that foggy when used



Figure 13. Trial of the final design mask does not fog up when used



Figure 14. Trial difficulty breathing while wearing the final design mask

There are some responses of users who have wear the mask:

Ms. D, “The masks used are quite comfortable, the appearance is also fashionable. However, for women with long hair, the hairdo becomes damaged when you have to insert the mask through this type of mask strap (head loop).”

Ms. A, “The color of the mask is bright, but a bit loose on my jaw. Maybe because my jaw is small. It is advisable to make a more varied size.”

This design initially only used one general type of pattern with a standard adult male head size so that user input about the loose of lower jaw part gave rise to alternative design size patterns for female users as shown in Figure 5.

4. CONCLUSION

As the authors explained on the background and problems, that this design aimed to solve problems caused by a new habit that was present during the pandemic, namely the use of masks. The use of these masks has given to new habits that have an impact on the quality of life of certain populations, such as glasses users and people with respiratory problems. Their problem, namely the effect of fog on the glasses and the feeling of shortness of breath when breathing, are the main things that the author tries to solve through this design. The solution to this problem comes through the process of collecting data in the form of references to similar masks. The study discovered design solutions that prevent the effect of fog on glasses and reduce shortness of breath in users with respiratory disorders. However, considering that this design is a new design concept, clinical and mass testing are needed to assess the level of effectiveness for wide users.




REFERENCES

- [1] WHO, “Pneumonia of unknown cause-China,” China, 2020. [Online]. Available: <https://www.who.int/emergencies/disease-outbreak-news/item/2020-DON229> (accessed Aug. 31, 2021).
- [2] WHO, “WHO COVID-19 preparedness and response progress report - 1 February to 30 June 2020,” 2020. [Online]. Available: <https://www.who.int/publications/m/item/who-covid-19-preparedness-and-response-progress-report---1-february-to-30-june-2020> (accessed Aug. 31, 2021).
- [3] M. Gamerra, E. de Corso, and E. Cantone, “COVID-19: the crucial role of the nose,” *Brazilian Journal of Otorhinolaryngology*, vol. 87, no. 1, pp. 118–119, Jan. 2021, doi: 10.1016/j.bjorl.2020.08.001.
- [4] J. S. Kutter, M. I. Spronken, P. L. Fraaij, R. A. M. Fouchier, and S. Herfst, “Transmission routes of respiratory viruses among humans,” *Current Opinion in Virology*, vol. 28, pp. 142–151, Feb. 2018, doi: 10.1016/j.coviro.2018.01.001.
- [5] B. Nina, “Still confused about masks? here’s the science behind how face masks prevent coronavirus,” *Patient Care*, vol. 26, 2020.
- [6] Y. Li *et al.*, “Face masks to prevent transmission of COVID-19: A systematic review and meta-analysis,” *American Journal of Infection Control*, vol. 49, no. 7, pp. 900–906, Jul. 2021, doi: 10.1016/j.ajic.2020.12.007.
- [7] M. Liang *et al.*, “Efficacy of face mask in preventing respiratory virus transmission: A systematic review and meta-analysis,” *Travel Medicine and Infectious Disease*, vol. 36, p. 101751, Jul. 2020, doi: 10.1016/j.tmaid.2020.101751.
- [8] W. Lyu and G. L. Wehby, “Community use of face masks and COVID-19 : evidence from a natural experiment of state mandates in the US,” *Health Affairs*, vol. 39, no. 8, pp. 1419–1425, Aug. 2020, doi: 10.1377/hlthaff.2020.00818.
- [9] M. Abboah-Offei, Y. Salifu, B. Adewale, J. Bayuo, R. Ofosu-Poku, and E. B. A. Opare-Lokko, “A rapid review of the use of face mask in preventing the spread of COVID-19,” *International Journal of Nursing Studies Advances*, vol. 3, p. 100013, Nov. 2021, doi: 10.1016/j.ijnsa.2020.100013.
- [10] P. Anfinrud, V. Stadnytskyi, C. E. Bax, and A. Bax, “Visualizing speech-generated oral fluid droplets with laser light scattering,” *New England Journal of Medicine*, vol. 382, no. 21, pp. 2061–2063, May 2020, doi: 10.1056/NEJMc2007800.
- [11] D. R. Hess, “The mask for noninvasive ventilation: principles of design and effects on aerosol delivery,” *Journal of Aerosol Medicine*, vol. 20, no. s1, pp. S85–S99, Jun. 2007, doi: 10.1089/jam.2007.0574.
- [12] A. Przekwas and Z. Chen, “Washing hands and the face may reduce COVID-19 infection,” *Medical Hypotheses*, vol. 144, p. 110261, Nov. 2020, doi: 10.1016/j.mehy.2020.110261.
- [13] A. D. Fakhira, A. S. Pawitra, K. C. Diyanah, E. A. Wikurendra, I. Nagy, and N. S. M. Abdeljawad, “Awareness of doing 3m (wearing mask, physical distancing, washing hands) during pandemic era in rural and urban families,” *Jurnal Kesehatan Lingkungan*, vol. 13, no. 2, pp. 94–101, Apr. 2021, doi: 10.20473/jkl.v13i2.2021.94-101.
- [14] K. Kisielinski *et al.*, “Is a mask that covers the mouth and nose free from undesirable side effects in everyday use and free of




- potential hazards?," *International Journal of Environmental Research and Public Health*, vol. 18, no. 8, p. 4344, Apr. 2021, doi: 10.3390/ijerph18084344.
- [15] J.B. Soriano *et al.*, "Face masks, respiratory patients and COVID-19," *European Respiratory Journal*, 2020, doi : 10.1183/13993003.03325-2020.
 - [16] S.Y. Kyung *et al.*, "Risks of N95 face mask use in subjects with COPD," *Respiratory Care*, vol. 65, no. 5, pp. 658-664, doi: 10.4187/respcare.06713.
 - [17] M. C. Howard, "The relations between age, face mask perceptions and face mask wearing," *Journal of Public Health*, Feb. 2021, doi: 10.1093/pubmed/fdab018.
 - [18] M. J. Johnson *et al.*, "Breathlessness in elderly adults during the last year of life sufficient to restrict activity: prevalence, pattern, and associated factors," *Journal of the American Geriatrics Society*, vol. 64, no. 1, pp. 73–80, Jan. 2016, doi: 10.1111/jgs.13865.
 - [19] J. F. Dankert and M. S. Virk, "Mask-related glasses fogging: a predisposing mechanism of falls during the covid-19 pandemic," *Case Reports in Orthopedics*, vol. 2021, pp. 1–5, Aug. 2021, doi: 10.1155/2021/5600216.
 - [20] W. H. O. Others, "Dvice on the use of masks in the context of COVID-19: interim guidance, 5 June 2020," 2020. [Online]. Available: <https://apps.who.int/iris/handle/10665/332293> (accessed Aug. 31, 2021).
 - [21] P. Agarwal and D. Sharma, "How to prevent fogging of spectacle glasses when wearing a face mask," *Indian Journal of Surgery*, vol. 83, no. 6, pp. 1609–1610, Dec. 2021, doi: 10.1007/s12262-021-02729-x.
 - [22] S. S. Malik and S. S. Malik, "A simple method to prevent spectacle lenses misting up on wearing a face mask," *The Annals of The Royal College of Surgeons of England*, vol. 93, no. 2, p. 168, Mar. 2011, doi: 10.1308/rcsann.2011.93.2.168b.
 - [23] A. Bhardwaj, C. Sharma, and B. Rajan M, "Simple solutions for the fogging of spectacles when wearing surgical masks," *Journal of the American Academy of Dermatology*, vol. 85, no. 4, pp. e237–e238, Oct. 2021, doi: 10.1016/j.jaad.2020.08.041.
 - [24] F.-L. Chao, "Face mask designs following novel Coronavirus," *Journal of Public Health Research*, vol. 9, no. 1, Jun. 2020, doi: 10.4081/jphr.2020.1770.
 - [25] C. Martinez-Perez *et al.*, "Influence of face masks on the use of contact lenses," *International Journal of Environmental Research and Public Health*, vol. 18, no. 14, p. 7407, Jul. 2021, doi: 10.3390/ijerph18147407.
 - [26] H. Soedarwanto, "Vitruvius Theory vs sir henry wotton's theory in product design (In Indonesia: Teori vitruvius vs teori sir henry wotton dalam desain produk)," *Narada*, vol. 5, no. 2, pp. 17-25, 2018.
 - [27] D. Altschul *et al.*, "Face covering adherence is positively associated with better mental health and wellbeing: a longitudinal analysis of the CovidLife surveys," *Wellcome Open Research*, vol. 6, no. 62, pp. 1-17, 2021.
 - [28] L. Donaldson, "Improved face mask design helps fight COVID-19," *Materials Today*, vol. 42, p. 6, Jan. 2021, doi: 10.1016/j.mattod.2020.10.018.
 - [29] W. Lee, X. Yang, D. Jung, S. Park, H. Kim, and H. You, "Ergonomic evaluation of pilot oxygen mask designs," *Applied Ergonomics*, vol. 67, pp. 133–141, Feb. 2018, doi: 10.1016/j.apergo.2017.10.003.
 - [30] S. D. Ozturk, "Rethinking the black box in architecture design studio," *SAGE Journals*, pp. 1-13, 2020, doi : 10.1177/2158244020927408.
 - [31] S.D. Ozturk, "Rethinking the black box in architecture design studio," *SAGE Journals*, pp. 1-13, 2020, doi : 10.1177/2158244020927408.
 - [32] M. Panero, Julius and Zelnik, *Human dimension and interior space: a source book of design reference standards*. Watson-Guptill, 1979.
 - [33] D. M. Caretti, L. Blaney, and K. Ghosh, "A human factors model for mask designers," *Ergonomics in Design: The Quarterly of Human Factors Applications*, vol. 8, no. 2, pp. 16–21, Apr. 2000, doi: 10.1177/106480460000800204.
 - [34] C. E. Clauser, *Anthropometry of air force women*. Aerospace Medical Research Laboratory, Aerospace Medical Division, 1972.
 - [35] A. Hutchinson, N. Barclay-Kling, K. Galvin, and M. J. Johnson, "Living with breathlessness: a systematic literature review and qualitative synthesis," *European Respiratory Journal*, vol. 51, no. 2, p. 1701477, Feb. 2018, doi: 10.1183/13993003.01477-2017.
 - [36] H. P. Lee and D. Y. Wang, "Objective assessment of increase in breathing resistance of n95 respirators on human subjects," *The Annals of Occupational Hygiene*, vol. 55, no. 8, pp. 917-21, Sep. 2011, doi: 10.1093/annhyg/mer065.
 - [37] Sylvia N., D. Pradipta, "Review of polyester on jersey bicycle," *NARADA Journal of Art and Design, Mercu Buana University*, vol. 8, no. 1, 2021.
 - [38] A. Konda, A. Prakash, G. A. Moss, M. Schmoldt, G. D. Grant, and S. Guha, "Aerosol filtration efficiency of common fabrics used in respiratory cloth masks," *ACS Nano*, vol. 14, no. 5, pp. 6339–6347, May 2020, doi: 10.1021/acsnano.0c03252.
 - [39] S.-A. Lee, D.-C. Hwang, H.-Y. Li, C.-F. Tsai, C.-W. Chen, and J.-K. Chen, "Particle size-selective assessment of protection of european standard FFP respirators and surgical masks against particles- tested with human subjects," *Journal of Healthcare Engineering*, vol. 2016, pp. 1–12, 2016, doi: 10.1155/2016/8572493.
 - [40] K. O'Dowd *et al.*, "Face masks and respirators in the fight against the COVID-19 pandemic: a review of current materials, advances and future perspectives," *Materials*, vol. 13, no. 15, p. 3363, Jul. 2020, doi: 10.3390/ma13153363.
 - [41] Institute of Medicine, *Reusability of facemasks during an influenza pandemic: facing the flu.*, Washington, D.C.: National Academies Press, 2006.

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