Design and Development of a Carry-On Bag to Support Women in Work-and-Travel Activities

Suchada Rianmora[1], Thorfan Netkueakun[2], and Nutthamon Samorhom[3]
[1,2,3]School of Manufacturing Systems and Mechanical Engineering
Sirindhorn International Institute of Technology, Thammasat University
Pathumthani, Thailand
E-mail: suchada@siit.tu.ac.th[1], thorfan.net@gmail.com[2], nutthamon.sam@gmail.com[3]

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***Abstract*—Design under constraints can be accomplished properly with the assistance of Product Design and Development (PDD). Presented in this study is the development of durability, flexibility, and accessible briefcase-style bag for work-and-travel activity. Target customers are set as women who, mostly, require some details that lead the designers to comprehend some hidden issues. Providing enough space and a strong body to store many stuffs, and preserving items in good condition are the key considerations. A solid-based baggage cover can provide a shock-absorption structure, and its size must not exceed - 40cm x 20cm x 25cm. The weight of the bag plus stuff is determined around 4 kg, which is the key parameter for Finite Element Analysis (FEA). Force distribution around the bag is simulated for safety purposes; when a 1000 N of the external force (or impact force) delivers a shock or high impact in a relatively short period of time on the front/back area of the bag, the developed bag still in a usable condition; no crack found. Polycarbonate (PC) - Acrylonitrile Butadiene Styrene, or ABS plastic material is applied to the main body of the bag. All analyzed results can be applied as the key guidelines for the manufacturers or customers to assist work-and-travel activity with happiness.**

***Index Terms*—Design and Development, Carry-on Bag, Finite Element Analysis, Conceptual Design, Usefulness of Products.**

I. Introduction

Over the past three years, during the COVID-19 pandemic, people have made the decision to pay less attention to going out for doing some activities, and some have stayed at home almost all the time where online foods and products are the choice and key tool for supporting their basic needs [1]-[5]. However, some might feel not comfortable living like that as a twenty-four-seven platform. Besides, as the stay-at-home lifestyle is prolonged in many parts of the country, people are getting more about experiencing worry, unease, or nervousness; typically, about an imminent event or something with an uncertain outcome. For instance, if people live in an area where nonessential travel is advised against, it would not be a good idea to drive to an outdoor space. A great way to release these stresses and problems, outdoor activities are the choice to get a change of environment. Since, at this particular moment, people are facing on-and-off services in the middle of the coronavirus pandemic, not all outdoor activities are allowed to do as a full option/version. Some outdoor activities are not engaged right now; luckily, some are safe, which can help give people a much-needed mental reset. Traveling is a good choice and is recommended as one of the popular activities to do. For supporting this activity, proposed in this study is about how to provide an easy-to-access product with durability plus flexibility where a "carry-on bag" is applied as the case study.

Since, "Quality of life" can be expressed as an individual's perception of their position in life in the context of the culture and value systems in which they live and in relation to their goals, expectations, standards, and concerns. For supporting this issue, current, many researchers have tried to provide specific concepts and approaches for supporting the COVID-19 pandemic to enhance the quality of life of people in various fields; fundamental needs, logistics, medical services and facilities, traveling issues, automotive, and transportation [8]-[11]. When the day-to-day of our lives is already super-stressful, people have tried to find ways for reducing stress by doing outside activities where traveling and visiting nature experienced can greater decrease stress than those who perform either indoor activities or who watch nature programming on visual reality platforms for the same amount of time. From the obtained results, someone who is depressed may have mood swings, changing environment can make their mood improve more. These have led to the proposed approach to introduce an alternative design of a carry-on bag, which can support users who would like

to perform tasks while traveling where the conditions or the item(s) inside can be preserved as the original conditions.

II. Research Background

In order to extract and reveal the blind spot of business, gender is the most powerful determinant of how to see everything in the world – different viewpoint, different gender. With this keyword – "gender", it is more significant than age, income, ethnicity, or geography. Recently, for creating and developing a new design of the product, a design team has started with launching a set of questionnaires to both men and women (target) customers [12], even if some products are emphasized to sell to men such as clothes, shoes, socks, shaving, or sportswear. Since women have a multiplier effect. They are multiple markets in one. Because women serve as primary caregivers for children and the elderly in virtually every society in the world, women buy on behalf of the people who live in their households, as well as for extended family (such as older parents and in-laws) and friends.

A. The Status of Women in Society

There are 1.4 million more women who are licensed to drive than men. Women also tend to purchase more new cars than used ones, with 62% of new cars in the country being purchased by women [13]. Women influence 7 trillion dollars of spending annually and influence 83% of all consumer spending [14]. From this viewpoint, it can convey and imply the trend of work-and-travel platforms in women that is growing up day by day. Moreover, as a growing number of women are buying cars, it is now crucial for entrepreneurs to create facilities or special items to support women's needs to work with a smile while traveling. In Thailand in some areas like downtown – metropolitan areas, people have spent more time traveling on the road because of traffic jams. Some minor activities are raised and performed during that situation. The situation is better when people drive on a clear road at night. There is a steady stream of oncoming traffic. However, the national speed limit applies. Thus, daytime activity is taken into consideration as the reference for creating a drafted design of a product proposed in this study.

B. Concerning the Issue When Women Keep Stuff in Bags

The target group of customers, in this study, is considered "the female of age group ranging 15-64 years", since this range is the main consumer of the handbags market [15]. In general, women can express their feelings with a clearer view than men; some hidden issues can be revealed such as the key considerations of the desired product that should provide durability, reliability, safety, and affordability characteristics. Whereas, from the men's viewpoints, they are more drawn to interior layout, exterior styling, technology, and ruggedness. Women define a successful transaction as getting the exact product they want, while men are more about negotiating the best deal [16]-[17].

Normally, the lady keeps the cosmetic in a bag (purse), and a small container at home that provides stability at room temperature is required and it is considered as one of the basic needs of women. This requirement is, also, imprinted as perception where the case or container required for containing sensitive stuff inside needs to provide some functions and space like this case.

Illustrated in Fig. 1 [18] is an example of a cosmetic box that is available in the market and it contains many slots plus functions such as light-dimming brightness application attached to the mirror or compact size of the drawers. The style of this product type, which is about the combination between a round-shaped structure and easy-to-use characteristics of the product, is mainly constructed based on the knowledge and skills to enable customers to feel relaxed and at ease, confident, and assured that their expectations will be met - even better when exceeded.

Fig.1. The main components of the cosmetic box [18]

However, in the real life and situation of working women, women, sometimes, forget and put their makeup sets in the wrong place such as a car or high-temperature weather environment, which is a nightmare for the lady.

Comparing among various types of cosmetic items (e.g., lipstick, blush, foundation, face powder, eye shadow eyeliner, and mascara) that women need to own, "lipstick" is the winner, since its concepts are about "available anywhere, anytime, and to anyone". However, it is reported that the structure and chemical properties are considered the most sensitive product [19]-[23].

For supporting the design stage of this proposed study to design a carry-on bag for supporting work-and-travel activity, the lipstick plus its characters (i.e., both physical and chemical terms) are studied and reviewed as the key component with the assumption that if the lipstick can maintain its shape and property

under the provided conditions inside the developed carry-on bag, the other products can be preserved their original conditions.

C. Key Factors to Make Customers Feel Comfortable

The design team had found the bright direction to create the criteria and constraints of the space (room) with compartments inside the bag, materials used for making and covering a whole bag, and the main structure like bag skeleton for supporting force applied during traveling. However, some hidden issues such as customer feelings and requirements for the bag are needed to be revealed in a systematic way. Sometimes, the target customers do not want to answer long and too much texts questionnaires since, in their perception, doing this for unknown people like a self-administered survey wastes their time. This style of the questionnaire is designed explicitly to be completed by a respondent without an interviewer's assistance (or bias). Self-administered surveys are widely used for collecting quantitative research data. From the known-to-known platform, one of the most common types of self-administered surveys is mail-in questionnaires. Online questionnaires sent out to respondents via email invitations are another example of a self-administered survey. Apart from paper and online forms, self-administered surveys also come in the form of oral tests [24].

However, currently, even if a digital platform and an easy-to-access application have become famous and necessary for better living, with this digital platform, some drawbacks are indicated via distorted details and wrong instructions since "copy-and-paste" style can make a new document file in second from an unknown group of people. They just start to consider which social media channels of whom contain many followers and have become famous influencers. Then, the illegal groups tried to copy the identity of those people to be theirs by using personal information, pictures, a product of interest, or an address for selling prod-up products to innocent target customers. The forbidden websites or social media platforms do not exist in terms of registration by known persons. After they receive money from bank transactions, they are gone and leave the recent social platform(s), then they have started a new account with a new name of another famous influencer [25]-[26].

D. Reasons and Factors Influence Women to Purchase

Recently, the majority of marketing victim who has decided to purchase product(s) from illegal websites are women [27]-[29]. To understand more about some hidden issues plus the reasons why they have made a decision like those recorded data, the key factors are taken into consideration.

Factor 1: Reliability, Empathy, and Trust

Once the customers know that the design team or manufacturers are interested in meeting their needs rather than selling a product, their comfort level will increase. The following statements are the key tools that will support the design team and manufacturers to meet customer satisfaction.

1) Taking time to find out what customers really need and want by considering facial expressions or ways to answer questions is the priority to do. Next, show them how the design team can meet those desires. This kind of respect engenders comfort and trust – this can link to the reliability of the product and business.

2) The manufacturers must consider are about "acknowledge and respect diversity", since women are as diverse a group as they come. Moreover, during the 21st century, women are strong and independent when compared to historical times. Modern women enjoy having their strength, even after marriage and having children. Having strength is socially accepted now because a woman is doing things for herself as well as others, like working and or furthering their education while raising children. They can do many things and almost everything they want to do.

3) A woman's strength is very important to her because that is part of what self-confidence is built upon. This leads to many strong women achieving goals and accomplishing dreams only to create new ones that reach even higher. Many women during this century are strong in the fact that they are an entrepreneur/workers as well as a mother, wives, daughters, and sisters/aunts, among many other titles/roles. The products launched to this target group should contain "durability, flexibility, and safety function".

4) Historically, women were not socially accepted in the ways that they are now. The best example is the fact that women can serve in any military branch, political office, or even any business capacity. Thus, these can reveal the trend of products that should be provided with "boyish" which is a style that blends masculine and feminine trends, and it is considered as a younger look and more casual than a "mannish one". For "Mannish style", is quite similar to the "boyish style"; however, the "Mannish style" is a masculine (i.e., having qualities or an appearance traditionally associated with men or boys) focused fashion most often worn by women with a professional look. It features masculine items and oversized items and is meant to accentuate femininity with masculine clothing.

In summary, when companies or manufacturers understand the background and respect the roles or titles of women in a systematic way, and in return, they will appreciate the respect and the way to afford them. This might show the good and bright future that they will choose a brand, service, or product made by those manufacturers who can maximize customer loyalty with a smile.

Factor 2: Classic Requirements from Women's Viewpoint

This factor is considered as a classic set of data that are about the tool for supporting the design and development of a new product. The marketing and sales strategies for women consumers are also included in this topic where the "secret" to why women buy and why they do not. Listed things to keep in mind when marketing and selling to women are [30]-[33]:

1) Women are considered the world's most powerful consumers, and their impact on the economy is growing every year.

2) Around 70-80% of all consumer purchasing is driven by women, through a combination of their buying power and influence. Influence means that even when a woman is not paying for supporting herself, she usually acts as the influencer behind someone else's purchase.

3) The concept of "shades of pink or everything about pink", sometimes, is not the right choice for setting as the key strategy. When a product is offered in only one color, and that color is pink, it conveys a limited message to the target customers who are assumed as women or a smaller group compared to providing varied ranges and shades of color. Not all women do like the pink item(s). Versatile with flexible products can increase the selling volume.

4) Service is a key tool and identifier for making customer retention. Since women tend to change their minds at critical moments such as seeing bad service occurred to other customers who are purchasing the same item from the same manufacturers or service provider, they decide to quit and leave immediately. Since they have higher expectations for customer service. Thus, when manufacturers decide to elevate the experience for women, this means that they have been trying to elevate it for everyone with the same standard.

5) Prices tell about the quality, according to an e-commerce study, consumers often fall for prices and miss out on other facts. This usually gives a bad experience to the customers. We all must have heard the saying "Good things come at a good price". Thus, if we see a good collection of outfits at a very low price then there is a chance that the quality will be degraded.

6) Women are getting married at older ages, and women (and men) are having fewer children than in previous generations. This implies that they have more potential to buy something without concerning much about financial stress.

In summary, the key point results obtained from this section are about creating a bag to support work-and-travel activity; four classic requirements from women's viewpoints are addressed: *durability, flexibility, safety, easy-to-access, and attractive details.*

III. Research Concept

In order to create a conceptual design and platform of a new product, the key considerations are "*durability, flexibility, and easy-to-access concepts*" where the concept of Product Design and Development (PDD) is applied. PDD consists of five main stages concept development, system-level design, detailed design, testing and refinement, and production ramp-up, as shown in Fig. 2.

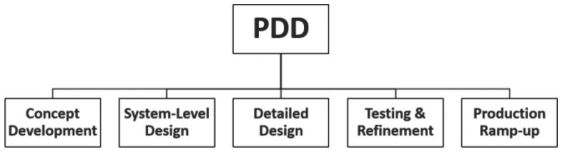


Fig. 2. Five phases of PDD for creating a new product

A. Concept Development Stage

For supporting the design team to create a drafted model of a carry-on bag, the combination of water-proof cooler food storage (thermo-bag style) (Fig. 3) and a briefcase-design platform with a small size is applied as the reference model (Fig. 4). Besides, in order to accomplish creating a drafted design of a new bag, the concept called "3Fs – Form, Fit, and Function" is applied. Moreover, after identifying the drafted ideas about the direction to go for creating a carry-on bag, the proper number of respondents who are the target customers, the classic method that is sample size analysis is discussed.

Fig. 3. Waterproof-cooler food storage (thermo-bag style) for supporting outdoor activity with insulated pouch accessories item [34]

Fig. 4. Small compact 4-wheeled briefcases with 3.231-kg weight [35]

- *Form/Fit/Function-Guidelines for A New Design*

The form is expressed the physical characteristic or looking of the future product expected to be made

by a design team. The proper references (i.e., the existing products available in the real market) are raised and extracted into main components.

For the waterproof-cooler food storage illustrated in Fig. 3, the outer surface of the main body is made from EVA material plus Oxford cloth, which can support waterproof characteristics and provide lightweight, and stylish. However, the cushion material is not found in this bag. Carrying a digital device or tablet with this bag style is not a choice.

For the small compact 4-wheeled briefs, the design and function provided can match the work-and-travel platform since some digital gadgets and devices can be properly supported compared to the previous style – soft thermo-bag design. However, the weight of the 4-wheeled briefcase, which is made from poly-carbonate and polyester materials, is the main concern – that women might feel worried about it.

Moreover, for supporting traveling activity via airline channels, the size of the bag is the main concern. Carry-on baggage allowance can vary according to the airline, the cabin class customers are traveling in, and even the size of the aircraft. As a general guide, carry-on baggage should have a maximum length of 22 in (56 cm), a width of 18 in (45 cm), and a depth of 10 in (25 cm) [36]. Illustrated in Fig. 5 is an example of baggage restrictions announced by airlines [37]. For the hand baggage, all customers are permitted to carry one piece of hand luggage and one small item (handbag/ laptop) on board. Hand luggage must not exceed 56cm x 45cm x 25cm, and the small item must be no bigger than 40cm x 30cm x 15cm. Both items can weigh up to 23 kg each.

This information is conveyed to the customers to avoid paying for fees, if the hand baggage exceeds the limit, it will be checked into the hold. This can be added to the customer's checked baggage allowance. However, if it exceeds this, the customer will be charged the airport's excess baggage fees [37].

Fig. 5. Baggage restrictions [37]

- *Sample Size Analysis*

The sample size is the number of completed responses the survey receives. The sample size of this research represents part of the group of the people or target population. This research focuses on work-and-travel supportive bags where conducting the surveys of women's favorite activities with the assistance of a statistically significant sample size can help to find out what issues are a greater concern [38]. In general, considering customer perceptions and behaviors from their experiences cannot obtain the exact direction of answers – biases are found. The biases are mentioned as beliefs, which are not initiated by known facts about someone or about a particular group of individuals [39]. For surveying the favorite activities performed by women, the measures of satisfaction level can be expressed as facial emotions or mood-and-tone during the conversation; however, when an online-questionnaire platform has become a vital technology and popular, the total time spent answering question set is taken into consideration as a tool for measuring and showing a willingness to work on the assigned task. When the respondents submit the question set with too fast or too slow, these imply about lack of concentration or consciousness to perform the task. Besides, this can imply consciousness which is a function of mind, understanding, reasons, emotion, and instinct interacting with memory. The conscious ability can be improved by gaining more information in memory through learning and experiencing new things. Thus, the proper way to inform the target customers before answering questionnaires is to provide "a storytelling of carry-on bag" to them in concise words - 5 to 7 sentences. For providing a whole frame of research to motivate their concentration. They will then use their intellect to override their emotions following the contents provided. Thus, they can focus on the task at hand. Whereas less key information is provided as the preface details, a lack of concentration occurs. Age, culture, place to live, educational background, carrier, and salary are the basic demographic variables that are included in the surveys [40].

The researchers have studied the perceptions and behaviors of people who live in the capital city (i.e., the Bangkok metropolitan region) and the survey questions were constructed to assess how people feel about favorite activities. The researchers did not have much information on the subject to begin with, so assumed that half of the respondents decide to travel and bring assigned task to do at that moment; this gave us maximum variability - Equation (1) is applied [41], [42]:

Equation 1:

$$\left(\frac{(Z)^2 \, x \, p \, x \, q}{(e)^2}\right) = n, \qquad (1)$$

where

e is the desired level of precision (the margin of error, or confidence interval)

p is the estimated proportion of the population that has the attribute in question

q is *1-p.*

Therefore, in this study, $p = 0.5$ indicates 95% confidence, and at least 5%—plus or minus—precision. A 95% confidence level gave Z values of 1.96, per the normal tables, giving

$$\left(\frac{(1.96)^2 \, x \, 0.5 \, x \, 0.5}{(0.05)^2}\right)$$

From the calculated value, it was found that a random sample of 385 respondents in the target population was enough to give the confidence levels needed. In practice, around 500 online-link of questionnaires were distributed to the target customers. At this initial stage of the concept development phase, 400 respondents returned their answers; these obtained data were extracted and translated into a conceptual model of the carry-on bag – 3D CAD model. Besides, the key points, which are used as the supportive information plus reasons to select the proper materials used for creating a carry-on bag, are "the monthly income" (Table I), and "the favorite activity" (Table II) of the target customers. The resulted presented in Table I presented that the first and second groups of the monthly income are considered as the major group of the target customers where the range of salary is around 35,000 - 100,000 THB (1058.14 - 3023.16 USD). This implies some key points that they can support work-and-travel platform with less stress comparing to the average salary in Thailand, which is 24,500 THB (734 USD) [43].

TABLE I
MONTHLY INCOME OF THE RESPONDENTS

Monthly Salary		No. of Respondents (400)	(%)
(THB)	(USD*)		
< 15,000	453.47	36	9
15,001 - 25,000	453.50 - 755.79	56	14
25,001 - 35,000	755.82 - 1058.11	68	17
35,001 - 50,000	1058.14 - 1511.58	108	27
50,001 - 100,000	1511.61 - 3023.16	104	26
> 100,000	> 3023.16	28	7

* Foreign Exchange Rates as of 19 January 2023 - Exchange Rate = 33.078 THB/US Dollar [43]

From Table II, the first four activities that women would like to do when they have free time are listed as *Traditional Shopping, Travelling, Communication with Family & Friends,* and *Outdoor Exercise*, respectively. These can show the bright direction for the design team to go and continue the task – since "Traveling" is counted as one of the popular things women like to do.

TABLE II
MONTHLY ACTIVITIES OF THE RESPONDENTS

Favorite Activities	No. of Respondents (400)	(%)
Traditional Shopping	67	16.75
Travelling	63	15.75
Communication with Family & Friends	59	14.75
Outdoor Exercise	46	11.5
Cooking	43	10
Housecleaning	40	10
Online Shopping	23	5.75
Religious Activities	16	4
Indoor Exercise	15	3.75
Singing	13	3.25
Embroidery	6	1.5
Gardening/Planting	4	1
Language Learning	2	0.5
Musical Activities	1	0.25
Watching TV/Movies	1	0.25
Working	1	0.25
Art Activities	0	0

Two alternative design concepts as shown in Fig.6 and Fig. 7 are taken into consideration where their designs are suitable for carrying many types of stuffs and they are quite popular as the favorite styles that women want to use in daily life – as everyday bag.

For **"Design A"** (Fig. 6) – this bag contains waterproof-insulated material and a gusset on the bottom area with a trapezoidal prism-shaped design of a main body.

For **"Design B"** (Fig. 7) – this bag provides a solid structure of the main frame, which is similar to the concept of a briefcase and hand baggage style with a small size. Handle with finger grooves is provided; however, this fixed finger grooves structure might make the users feel not comfortable and hurt during grabbing after a while, since the space between a concave-up (curve) is not a universal design that is available for all sizes of fingers and hands – not for everyone. Thus, it would be better to provide the straight-line design of the handle as a universal design concept, all sizes of fingers and hands can be supported.

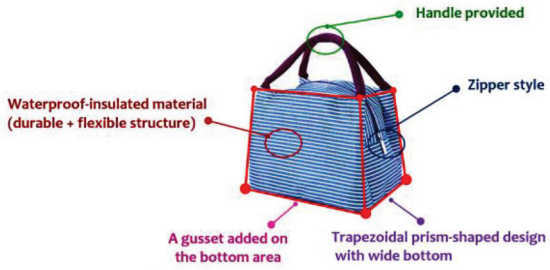


Fig. 6. Main components of the carry-on bag – *Design A*

Fig. 7. Main components of the carry-on bag – *Design B*

For **"Design C"** (Fig. 8 to Fig. 10) – this style has been introduced as the original design of a carry-on bag that provides the solid structure of the main frame, which is similar to the concept of briefcase and hand baggage style with a small size (Design B). For the handle, since the fixed finger grooves structure as present in Design B might make the users feel not comfortable during grabbing after a while, since the space between a concave-up (curve) is not a universal design that is available for all sizes of fingers and hands – not for everyone. Thus, it would be better to provide a straight-line or arched trunk handle for the briefcase bag; this illustrates more on universal design concept where the various scales of palms, hands, and fingers hands can be supported.

Fig. 8. Original design of "Design C" – carry-on bag inspired from classic briefcase baggage – Design B, (left) Isometric view, (right) Transparent display of isometric view

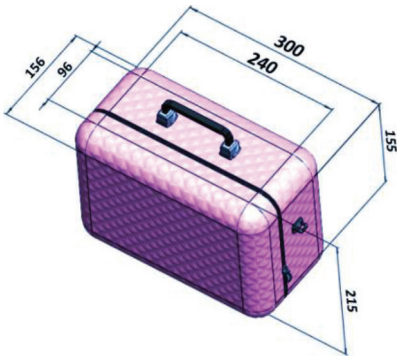


Fig. 9. Original design of "Design C" – isometric view with dimension

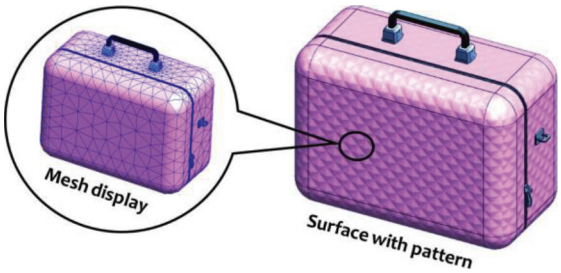


Fig. 10. Design C – printed pattern provided on the body's surface; mesh model showing smooth surface without texture

Recently, in 2021, the *"Keep It Cool" Smart Bag by the Internet of Things (IoT) for better living with the alternative design* proposed by Rianmora and Seng [44] was introduced (Fig. 11). The key concept of this reference is about presenting "a smart bag" that can support the people to keep the sensitive cosmetic products in a good condition for traveling to another province/place where the temperature inside the bag can be adjusted, and controlled the temperature and humidity conditions inside the bag easily and properly via a smartphone application. Besides, applying this will not damage and destroy the physical or chemical properties of the products compared to the traditional insulated bags. This research mentioned that the "internet of thing – IoT can make the world and life easier with simple settings and convenient functions applied while requiring less effort and investment cost.

Fig. 11. "Smart bag" prototype propsed by S. Rainmora, and S. Seng [44]

Since from the key points mentioned earlier, which are the solid-profile structure like briefcase bag, the minimal design of handle, the zipper closure platform, and the air ventilation unit with small fan for keeping items inside back with preserving the original condition, the proposed design (**Design - D**) contains these key points to create the conceptual model as shown in Fig. 12 and 13. The optional function – air ventilation with automatic fan unit, is added to the original style of briefcase-like platform – ***Design C***.

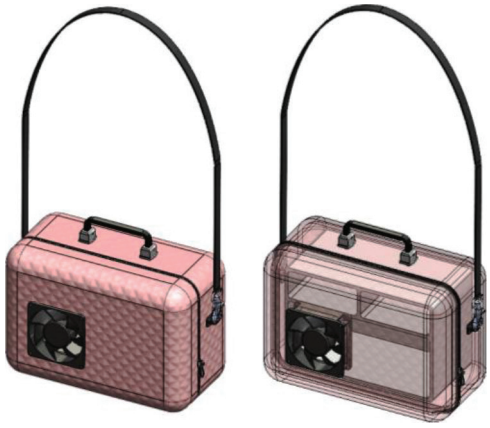


Fig. 12. Main components of the carry-on bag – Design D, (left) Isometric view, (right) Transparent display of isometric view

However, in the recent research (Rianmora and Seng [44]), the force distribution or weight of the items stored inside plus the bag itself have not been mentioned in details. This would be a bright direction to study more on the issue of load applied and design the mainframe (body) of the briefcase-like bag. Therefore, these have led to the proposed research where the design and development of a briefcase-like bag with air ventilation unit (i.e., small fan attached to the frontal area of the bag) has been studied and simulated by using Finite Element Analysis – FEA, which will be discussed in Section D – Testing and refinement stage.

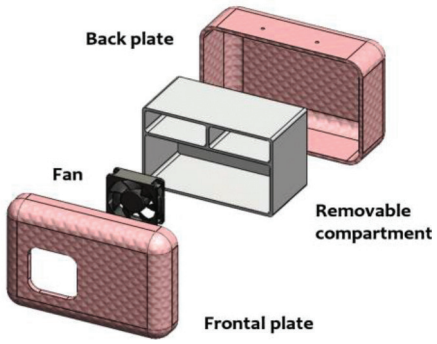


Fig. 13. Revealing the body components of the carry-on bag – Design D

B. System-Level Design Stage

This sub-section is required for classifying the carry-on bag of Design D into main components and sub-components. In general, there are many components to a bag depending on the its style and configuration. In general, there are three key elements that apply to most bags, which are body and compartment, closure and opening, and strap and handle.

• *Body and Compartment*

Body size is considered around 40 x 30 x 15 (unit in cm) with zipper (or other with easy-to-access style) – the users can access it whenever they want, and clasp locker, which is a commonly used device for binding together two edges of fabric or other flexible material. A gusset can be added and applied as a bracket strengthening an angle of a bag structure. It is like a panel, either triangular or diamond in shape, that is inserted into a garment or flexible material to help shape and reinforce key points. A bag might have feet on their flat bottoms to protect the bag if it stands on the ground. Besides, the materials used for the bag (both exterior and interior) can be guided by both function and style. Materials used are also critical to the relative sustainability of a handbag.

Keys: Function and form are both determining factors in this design decision. If a bag is meant to hold a computer, it might not be round; however, bags with unique shapes can be great ways to express style of the designer. For the bottom area of bag, if the bag needs to hold more, or stand up on its own, the bag might have a boxed bottom plus studs or feet or have a gusset on the bottom (and usually the sides).

Guidelines: In this study, material used for this area is waterproof-like fabric or polymer. To make bag durable for supporting work-and-travel platform, some high-tech plastics are recommended: polyethylene, ABS, and polycarbonate, which are lightweight and durable. ABS is lighter, but polycarbonate is more durable. The most durable, but also the heaviest, is aluminum [45]. Moreover, the interior and exterior pockets add to the functionality, and change the look of the bag.

• *Closure and Opening*

This element is the most important part of a bag, since a bag opening must provide good function to secure belongings, makes access easier or harder depending on customer's needs. Moreover, the design and pattern of this element have direct effect on the physical look of a bag. However, closure options for bags are limitless – drawstrings, carpet bag hardware, snaps, magnets, turnbuckles, or zippers.

Keys: A zipper can support easy-to-use and access by users; however, sometimes, it will not stick together. Either the head has been broken, and the teeth are

misaligned, some of the zipper stitching has slipped, causing the teeth to be misaligned, or the head and pull tab have broken or warped, causing the teeth to malign when the users pull the tab of the zipper. A larger size zipper will fail just as quickly as a smaller one. Zippers can be an indication of the overall quality of the bag. A YKK zipper is widely believed in the industry to be the most reliable zipper on the market [46].

Guidelines: In this study, for keeping stuffs safely inside bag where easy-to-access concept is applied. For the traditional zipper style, it is very useful and recommended for applying to make bags where the lock function is added. Zippers come in two types: chain, and coil. A chain zipper contains two sets of interlocking teeth, usually made of metal. It is better and stronger than a coil one, which slides on two parallel coils usually made of polyester. The key benefit of chain zippers is shown through being much more difficult to break into than coil zippers, which can be pulled apart with a ballpoint pen and reclosed.

- *Strap and Handle*

This is considered a critical element of a bag since it determines how users carry the handbag, and how much users can (or should) carry. The weight of the bag and its contents (items inside) are supported, by the body, wherever the strap/handle makes contact. The load can be made comfortable by how it is carried (e.g., in the hand, over one shoulder, across the body, or around the waist).

Keys: The specific characteristics of the strap and handle are described in the following statements:

1) *Strap Width:* For the wider straps, they can distribute larger loads better than narrower ones of the same material and pattern. Under a heavy load, the wider strap can be more comfortable. The key design depends upon the size of the bags, the small bags do not have the loading of laptops or heavy items or cross-body bags. Thus, straps can be narrow and delicate, while remaining comfortable and good feeling.

2) *Strap Length:* The key consideration of length design is dictated primarily by function during using where the style and pattern (adjustable padded shoulder strap with swivel snap hooks).

Guidelines: Material types for straps can imply the strength and comfort of a bag since some textiles need to be doubled (or more) over and stitched for giving enough strength to the strap, while material like leather or webbing is strong enough to be used as a single layer strap - high stiffness value. Styles of the strap can be defined as:

1) *Adjustable strap:* making it easy to change the length as needed is the key point that adds convenience and flexibility.

2) *Removable strap:* it can be attached in different ways, allow crossbody bags to be easily converted into belt bags, shoulder bags, or even backpacks.

3) *Fixed strap:* it is mounted directly into the handbag itself (it is not attached with hardware). This can be a striking design feature, and can give peace of mind with added security and fewer connections. However, this type of strap needs to be sized correctly for best fit.

For *Handle:* it might be the main way and be often applied for carrying a small handbag. They can also be striking design elements when they are made from a contrasting material (e.g., wood, acrylic, polymer, or metal).

After extracting the key considerations and guidelines of all key elements that apply to most bags, the researchers have tried to list and assigned the main components of the bag – for both styles (Fig. 6 and Fig. 7) for supporting the "detailed design stage" where the proper specific characteristics on the new design of carry-on bag can be assigned quickly without trial-and-error.

Summary: The main frame and function of the carry-on bag are constructed according to "Design D". Three key elements are classified as body, closure/open, and handle. The details of each are explained in the following statements.

Body: Trapezoidal-prism shaped (i.e., pyramid-like platform) plus round-corner design with the a wide bottom are applied. A removable compartment is provided inside the bag for providing flexibility to the users. The waterproof material is applied on the solid structure where the bag can stand by itself without a gusset.

Closure and open: A chain zipper type with a ring for attaching straps is applied.

Handle: Round-and-thick style is applied where the curve of the handle will be provided with ergonomics consideration.

C. Detailed Design Stage

In order to identify the specific details of a bag product that can be applied for carrying stuff, the key considerations are raised first via two issues; *what are the common items (or popular items) inside a woman's bag, and how to find the weight of bag after putting items inside.* Some everyday items are required by women, which are mentioned in many articles from easy-to-access online resources (Table III). These items are (mostly) carried in women's purses as products they would like to work into their daily routine [47]-[80]. However, carrying these items can cause some pains around the forearm and shoulder-bone or muscle between the shoulder and the elbow.

For identifying the force applied to the bag, the researchers have tried to find the key factors and issues, which have a direct effect on the bag during carrying every day. One of the factors is "the stuff/ items inside the bag". Thus, lists of popular items stored inside women's bags are presented in Table III. All 31 items were listed and researched from various sources: both online (articles posted on the websites) [81]-[87], and offline (direct interviewed data) platforms. After identifying the handbag essentials that every modern woman carries in her purse, the total weight of items inside the bag is around "3,200 g (or 3.2 kg)". This is amazing information found from this research, and it can imply that women must carry loads of two main sources: bag (itself-200 to 500 g), and stuff inside the bag. Illustrated in Table V are the FEA results obtained from the SolidWorks application. The areas affected by the load distribution are shown as the front and back areas plus the handle portion.

For **Design A**, since this design is provided with waterproof-insulated material (fabric) and a water-resistant bottom-folding tote bag, the weight is around 99-115 g.

For **Design B**, the design is provided with a solid structure with zippers and finger-grooves handle like a small briefcase where the weight is around 1 kg.

For **Design D** (Fig. 12), the design contains the main body, removable compartment (as partitions inside the bag-interior design), universal-design handle (straight-line handle), and strap. Besides, air ventilation with a small fan is applied according to the controlling system proposed by Rianmora and Seng (2021).

Illustrated in Fig.14 are the body components of the developed design of the carry-on bag – Design D. This model will be used in FEA simulation for studying force/load distribution applied around the front, back, top, and bottom areas of the bag.

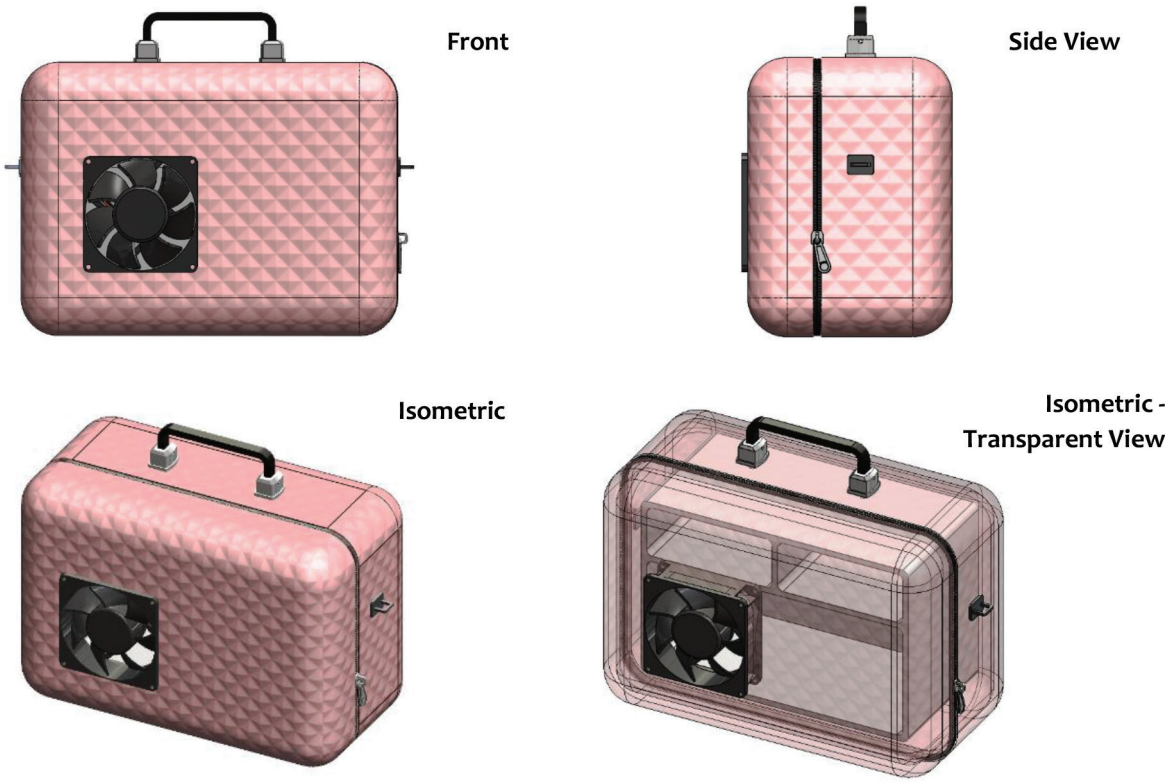


Fig. 14: Four views of the carry-on bag – Design D

D. Testing and Refinement Stage

To minimize the risk of pain in the shoulder and arm that is often due to muscle, tendon, or ligament damage from holding and carrying a load all the time or every day. These have led to the next sub-section which is about the study of loads, which are from the bag itself and the stuff carried. For studying the effect of loads carried on the shoulders [88]-[90], the researchers have tried to extract the weight of each item and combine all to be the reference for the design of load contribution activity – "testing and refinement" by the application of Finite Element Analysis (FEA) method [91]-[96].

The key reason for applying FEA in this design study is to determine the amount of external force-impact force, which is a force that delivers a shock or high impact in a relatively short period of time. It occurs when two entities collide, and this collision is the result of any object falling onto, or slamming into, the developed bag.

TABLE III
HANDBAG ESSENTIALS EVERY MODERN WOMAN CARRY IN HER PURSE

No.	Item	Weight (unit in "g")	Source
1	Battery case or portable cellphone charger/ Portable Charger	125-620	[47]
2	Tablet	460-470	[48]
3	Earphones or air pods	38.3	[49]
4	Diary / notebook / notepad	190	[50]
5	Mobile phone	130-200	[51]
6	Nail file	13	[52]
7	Wallet (Leather)	28.35-85.05	[53]
8	Hand cream (100 mL)	86- 90	[54]
9	Hand sanitizer	190	[55]
10	Mask (Extra Masks)	12.5 g/pc	[56]
11	Lipsticks, lip gloss, or lip balm	2.5-4.3 (Avg. 3.4)	[57]
12	Sunscreen (88 ml)	85.05	[58]
13	Face moisturizer (50 mL)	96.4	[59]
14	Handkerchief/Tissues: wet wipes (small pack – 25 wipes)	160	[60]
15	A period (a sanitary) pad	4.7-14.1	[61]
16	Zippered pouches	40.5	[62]
17	Reusable Bag (HDPE)	5.5 g/pc	[63]
18	Breath freshener/ Mint or any chewing gum	240	[64]
19	Aromatherapy pulse point oil/ Travel-size perfume bottle (88 mL)/ Deodorant	85.05	[65]
20	Hair stuff: hair brush, scrunchies, rubber bands, hair bands, clips, or clutches	5- 8	[66]
21	Sleek compact mirror – (48 x 48 x 6 inches)	109	[67]
22	Makeup Kit (travel-sized set)	80	[68]
23	A Pen (1 g[69]) & Paper (one A4 paper- 5 g[70])	6	[69] , [70]
	Medication	0.5-2.4 g/pc	[71]
24	Blister packs (10 pills/pack) (unit-dose packaging for pharmaceutical tablets)	3 g/10 pills/pack (0.3 g/dose)	[72]
25	Plasters (50 g – 60 pcs.)	0.83 g/pc	[73]
26	Sunglasses or Reading glasses (40 g[74]) and its case (47 g[75])	87-90	[74] , [75]
27	Business cards / Cardholder	30	[76]
28	A Key	7	[77]
29	Safety pins	0.1 g/pc	[78]
30	Foldable umbrella	120	[79]
31	Candy/ Chocolates/ Snack Bar	28	[80]

The key components, which are required as the inputs for the simulation, are the *type of material used for each element (component) of the bag*, the direction of load applied on the bag, and the type of motion applied. Moreover, the setting of commands applied in the simulation are the same; except for the fixed geometry, force, and mesh size, which will be changed according to the area of interest. Table IV is the type of material that is used for making each component of a carry-on bag; these are assigned according to the experiences of the design team and exerts who are now working on a similar type of business. Each type of material is then used for identifying "Young's modulus (E)" value [92],[93].

Young's modulus (E) is a property of the material that tells about how easily it can stretch and deform and is defined as the ratio of tensile stress (σ) to tensile strain (ε). The stress is the amount of force applied per unit area ($\sigma = F/A$) and strain is extension per unit length ($\varepsilon = dl/l$) [92],[93].

TABLE IV
TYPE OF MATERIAL REQUIRED FOR MAKING EACH ELEMENT OF A CARRY-ON BAG

No.	Part	Material	Young's Modulus (MPa)*
1	Outer Shell	ABS PC	2410
2	Handle	ABS PC	2410
3	Handle Hook	Aluminum 1060 Alloy	69000
4	Side-Hook	Stainless Steel	200000
5	Interior Compartment	Low-Density Polyethylene (LDPE)	172
6	Strap	Rubber	6.1
7	Swivel Strap Hook	Stainless Steel	200000

Source: * Young's Modulus of each material is the default value provided in SolidWorks [91].

For *Finite Element Analysis* (FEA), four areas of interest are studied (Table V) where the simulation with commands was performed in the *SOLIDWORKS* program - to identify the von Mises stress of each area. The *static / stress* is selected to calculate displacements, reaction forces, stresses, strains, and factors of safety distribution of the model. Using this simulation can support the design team to avoid failure or crack due to high stresses where four failure criteria are considered. The simulation process can be done by setting the following steps: *Part > Connections > Fixture > External Load > Mesh > Run.*

Steps required: the *SolidWorks* simulation is used for all areas where the external load of 1000 N is applied to the *handle* and to the *front*, *back, left,* and *right sides of the model*.

Firstly, setting proper material for each part of the bag in "*Part Property Manager*" is performed when all materials used for this design are provided in the library of software (Table IV).

Secondly, "*Connections Property Manager*" is done by setting "*Component Interactions and Local Interactions*". The *Component interaction* is used to specify the interaction conditions that control the action of the selected components during simulation while "*Local interaction*" is used to define interactions between sets of geometric entities of solids, shells, and beams. In addition, *Local interactions* settings override component-level interactions.

Thirdly, the *Fixture Property Manager* is used to define displacements on vertices, edges, or faces of the model. The *Reference Geometry, On Cylindrical Face,* and *Fixed Geometry* commands are used to assign value, and location is dependent upon the area of interest.

Fourthly, the *Distributed Mess, Gravity,* and *Force* commands in the *External Loads Property Manager* are used in the simulation. The *Distributed mess* of 4 kg is assigned at the inner bottom area of the interior compartment and acts as the weight of the handbag essential in the purse. In this case, the distributed mass plus the weight of the stuff inside the bag (from Table III) are applied. At the center of the model, the *gravity force* is applied. Moreover, the *force* assigned to each area is depended upon the area of interest.

Fifthly, in the *Mesh application*, the *blended curvature-based mesh* is used with a mesh size of 35 mm.

Finally, the program starts to simulate the conditions assigned where the time spent for simulation depends upon the mesh size, no. of interesting areas, and size of the virtual model. In this study, the range of time indicated around 30 minutes to 1 hour for each simulating process.

During the analysis of the Finite Element (FE) part, it was assumed that the objects inside the bag were fixed to each other, which established the contact conditions among them. A total of 152,661 elements were used in the analysis.

Results: for the handle, the results showed that the maximum von Mises occurred on the strap is 5.641 MPa. In the second area, the front and the back sides of the outer shell, the maximum von Mises occurred in these areas is 1.741 MPa. In the third area, the left and right side of the outer shell, the maximum von Mises occurred in these areas is 3.933 MPa.

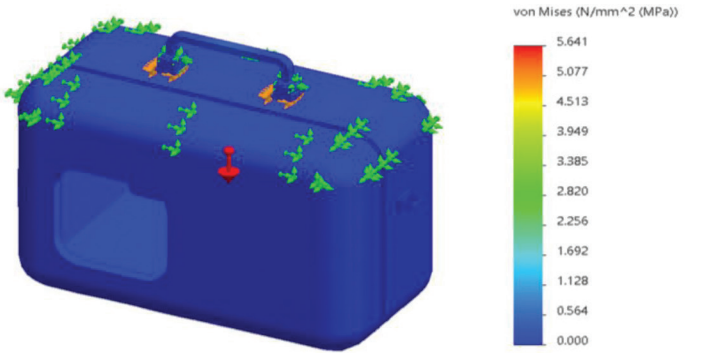
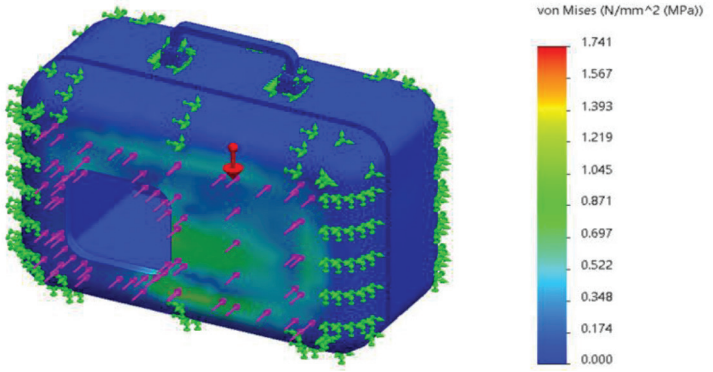
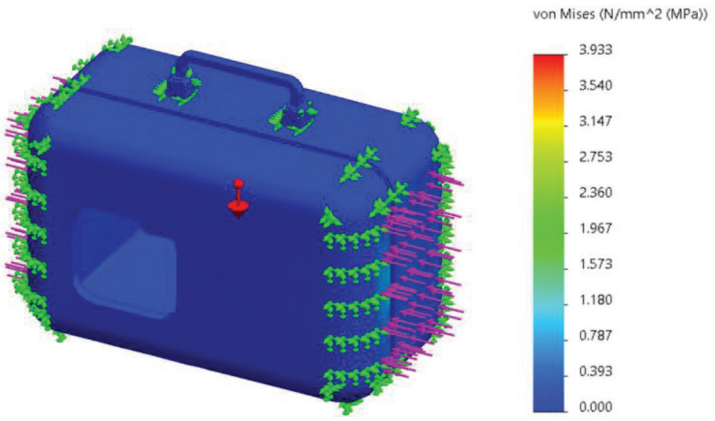
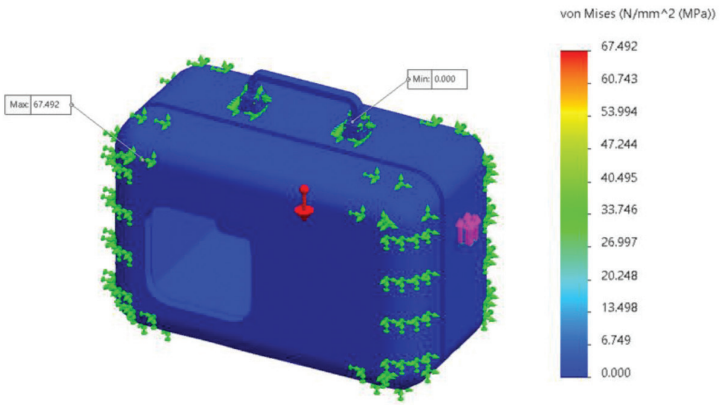
Discussion: The Finite Element (FE) part of the analysis has some limitations that should be noted, including:

1. Although the strap was made of rubber, a "linear elastic" behavior in the analysis was assumed. This may not accurately reflect the material's true behavior.

2. The design team did not perform a convergence test to ensure the accuracy of our results.

3. The analysis was conducted under static conditions, while the 1000-N load we used was an assumption of an "impact load". To accurately simulate an impact load, a dynamic explicit analysis should be performed".

TABLE V
FEA SIMULATION ON "DESIGN - D" OF THE PROPOSED DESIGN

Area of Interest	External Force (N)	Max von Mises (MPA)	Result
Handle	1000	5.641	
Front And Back Sides of The Outer Shell	1000	1.741	
Left and Right Sides of The Outer Shell	1000	3.933	
Side Hook	100	67.492	

In conclusion: from the three areas where the same material is applied: (Poly Carbonate/Acrylonitrile Butadiene Styrene - PC/ABS), the maximum von Mises occurs is not exceed the yield strength or Young's modulus of the ABS PC which means that these areas will not break with the load of 100 kg or 1000 N. For the last area, *the side hook*, the results showed that the maximum von Mises occurs is around 67.492 MPa, which does not exceed the yield strength or Young's modulus of the stainless steel, which means that these areas will not break with the load of 10 kg or 100 N

E. Production Ramp-up Stage

In order to support the platform of the start-up companies who ramp up once they leave the prototype stage and begin regular production for the market, essentially, ramp-up implies bringing the company's capacity utilization close to maximum.

The key concept of this stage: Considering "the right person, the right place, and the right time" is applied. A sudden increase in resource requirement is known as ramp-up. Simply saying that the resource manager identifies and allocates the appropriate resources to fulfill the resource requests. Ramp-up occurs during the "execution" stage when additional resources are needed to complete different tasks.

Background: After obtaining the guidelines for designing a 3D virtual model of a carry-on bag, some specific elements; body structure, handle, and closure functions are suggested in detail where easy-to-maintain functions are raised; applying water-proof-polymer surface cover can make water or rain roll off the surface immediately, and safety condition relating to force (load) distribution on the bag during carrying and traveling.

Guidelines: In practice, the calculation about the "usefulness of products" can be used for supporting "two stages" of PDD; *concept development* – to identify and select one proper design from two or more alternative ones, and *production ramp-up* – to recheck and verify about the decision made by a design team whether that decision is correct and follows a good pattern of the design stage. Like in this study, two references of bags are compared and checked the trend of the selected design can match the target customers.

Limitations: However, in research, the physical prototype (a real manufactured part) has not been created yet, only graphical shapes via artworks and 3D CAD models are applied. The alternative designs (i.e., Design A and Design B) are considered to use as the reference prototype – the design team must make a decision on which one is the best or the most suitable one. Applying the "usefulness of products" method can see which component(s) of the product(s) should be considered and selected to be modified and used as the reference(s) for a new design and development [97].

How to do: Usefulness can be defined as an effective concept, which describes an item or new technology for helping someone to do something with appropriateness and socially valuable. The actual use of a product is the key consideration for the "Usefulness (U)" calculation [98]. In order to apply Table VI to select the importance level of the product, the concept of "needs" by "Maslow's Hierarchy of Needs" [99] is asked for supporting the design team to select the suitable value; however, making a decision by a group of people is quite suggestive. The potential members with skills or experiences in that product are required to suggest and discuss this issue in a systematic way. In this study, bags or containers used for storing stuff are considered as basic and safety needs according to as shown in Fig.15. Thus, from the importance level (Table VI), bags can be considered as "Very High" level where the main benefits can be implied about supporting essential for daily activities, and compulsory daily activities.

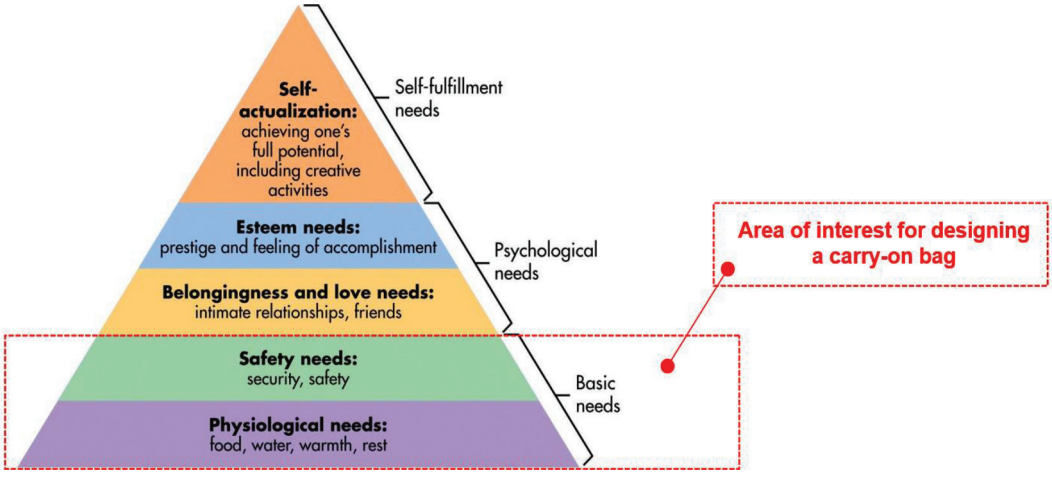


Fig. 15. Maslow's Hierarchy of Needs [99]

The key components of "usefulness of products" can be expressed as:

1) Important Level

The "importance of use" can be described as the impact of a product on people or users' lives. The product, which has more impact on society, should have a higher value of usefulness. The level of importance of products depends on how much a product has an impact on user life. Some items are essential to human life, but some are not. Five levels of importance of use have been identified (Table VI).

TABLE VI
LEVEL OF IMPORTANCE OF PRODUCTS [99]

Code	Points on a Scale of 5	Level of Importance	Type of Importance	Product Examples
A	5 (>4.0 - 5.0)	Extreme	• Life-saving drugs, life support systems • Patient life support system • Medical equipment, medicine	Mechanical ventilator or Equipment, Defibrillator, Heart/Lung bypass machine (Oxygen Cylinder, Pacemakers)
B	4 (>3.0 - 4.0)	Very high	• Essential for daily activities • Compulsory daily activities	Water, Taking food, Using restroom, Vehicles, Bags, or Containers to carry stuff safely
C	3 (>2.0 - 3.0)	High	• Accommodation • Social communication • Banking transactions	House, Clothes, Internet, Computer, Smartphone, EDC Machine, Pen, Belt, Spectacles, Shoes
D	2 (>1.0 - 2.0)	Medium	• Household appliances • Machines for daily needs	Air-conditioning system, refrigerator, Washing machine
E	1 (0.0 - 1.0)	Low	• Recreation activities • Entertainment systems • Recreation systems	Television, Comics, Books, Computer games, Bowling, Go-carting

From Table VI, the level of importance of products can be modified and adapted due to the current situation and conditions required by the people who are living in the society in that period. Since new technologies have the potential to change and elevate the human condition – the quality plus standard of life. Ways to modify the importance of products are mentioned as considering how technology or invention applied for creating some products becomes more important and necessary for living compared to the results or performance of itself in the past, that thing is referred to and considered as "high level". For example, "Internet and banking transactions". In the past, banking transactions – as online applications, can only be done and executed only at the local branch service area of the bank compared to the present where customers can perform banking transactions such as transferring money, paying bills and especially, card-less cash withdrawal that can be done in seconds by using mobile banking application on a smartphone with internet connection.

2) Popularity of Use

The key consideration of this "popularity of use" is how often people prefer to use a product launched by a company named "A", compared to others (a product from a company named "B"), which is counted in a similar group. If a product from "A" company has often been used by many people, that product from "A" company should be considered more useful and popular than another (product from "B" company) that is used by fewer people. It defines as the rate of popularity within a certain time.

However, the concept of "product differentiation" is required for supporting the analysis of "popularity of use", since "product differentiation" is the process of identifying and communicating the unique qualities of a brand compared to its competitors. Currently, some open sources of digital forums and comments can easily convey wording data speedily. This has a direct effect on the reason why people prefer brands as compared to products. Since customers require comfort, happiness, and satisfaction in their lives, and they get it in part through the products they purchase. If the brands they use consistently deliver or provide a positive experience, customers form an opinion that the brand is trustworthy, which gives them peace of mind when buying.

In summary, the key factors that customers choose one brand of a product instead of a different brand of the same product are *service quality, customer experience, brand awareness, association,* and *brand perceived quality*.

3) Usage Duration

"Usage duration" is one of the key factors, which have a direct effect on "product usefulness". Simply saying that a product of "A" company has been used for a long period, and this is longer than a same product of a different brand (i.e., from "B" company). This situation can be considered more useful compared with others. In practice, the usage duration can be considered in units of "hour per day".

4) Assessing Product Usefulness

Equation 2:

Usefulness (U) = Important level (L) × Popularity of use (R) × Usage frequency (F) × Usage duration (D)

The unit should be the same for all factors in the equation such as day, month, or year. For a seasonal product such as a sweater or swimsuit, product demand changes significantly over a seasonal period, then a large unit of time such as a year should be considered. For products that demand does not fluctuate over the period, any unit of time can be selected for the calculation.

Case A: Usefulness Calculation for "Design A: Waterproof-Insulated Storage with Oxford cloth"

Based on customer feedback, it was found that some customers prefer to use other items or materials instead of small-scale bags. However, for carrying fresh fruits, foods, or beverages that require more space, the waterproof-insulated style shown in Fig. 16 was developed. This style, which is similar to Design A, is considered as one of the alternative containers for carrying items during the day. The importance of "Design A" was rated as 3.7, indicating that it is still a popular choice among customers due to its affordable price.

The time spent for carrying or holding this bag style is "around 4 hours". From the customers' experiences (228 out of 400-57%), they said that it is not comfortable for carrying this bag, even if it is a lightweight bag, since when "electronic devices or digital gadgets" are contained inside, there is no supportive element provided. They decided to use it like the on-and-off pattern-it is not a "continuous usage" type. The rate of use is identified as 4 hours per day or 24 hours (4/24).

Calculation of Design A: Waterproof-insulated storage with Oxford cloth

Importance of use (L): **Very high (Code B) = 3.7/5 (3.7 scale from the maximum - 5 scales)**

Rate of popularity for use (R): **278/400** (ratio of number of target users who have experience with the waterproof-insulated storage/total number of people who could potentially use it)

Rate of use (F × D): **3/24** (ratio of number of hours of use/total number of hours in a day)

Therefore, applying *Eq. 2* can determine the *Usefulness (U) of Design A:*

Usefulness (U) = Important level (L) × Popularity of use (R) × Usage frequency (F) × Usage duration (D) ***Eq.2***

= (3.7/5) × (228/400) × (4/24)

= **0.0703**

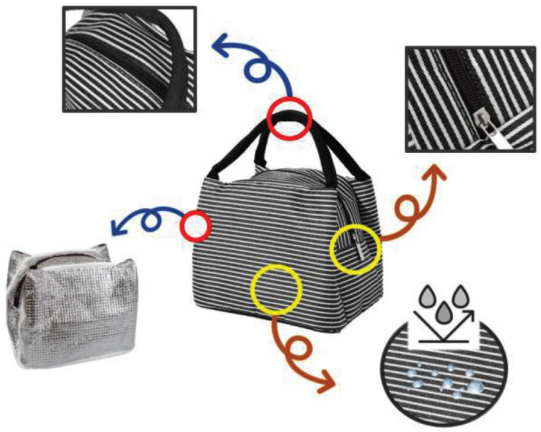


Fig. 16. Key considerations from customer perceptions on waterproof-insulated storage with Oxford cloth

Case B: Usefulness calculation for "Design B: Small briefcase-like style with strap"

For considering the assessing the usefulness of Design B: a "small briefcase-like style with strap" (Fig. 17), from the customer's viewpoint, this style can preserve and protect some stuff inside rather than using soft fabric or synthetic material as seen in Design A, even if the weight of the solid structure is higher than Design A. Besides, with the structured plastic handle that is curved ergonomically fits the balm during holding or carrying, this style is choice and easy to grab while traveling during rush hour. Therefore "4.0" is selected as the point for representing the important level of Design B. From the customers' experiences (172 out of 400-43%) –the price of Design B was higher than Design A's. This implied less selling volume for Design B compared to Design A. Moreover, time spent using this type of cane was considered around 3 hours per day or 24 hours (6/24), even if the weight is the main concern, the customers decided to apply and use this style almost all-day during working–some digital gadgets required for work can be properly carried and saved in this briefcase-like bag.

Calculation of Design B: A Small briefcase-like style with a strap

Importance of use (L): **Very high (Code B) = 4/5 (4 scales from the maximum- 5 scales)**

Rate of popularity for use (R): **172/400** (ratio of number of target users who have experiences with the simple walking cane/total number of people who could potentially use it)

Rate of use (F × D): **6/24** (ratio of number of hours of use/total number of hours in a day)

Therefore, applying *Eq. 2* can determine *Usefulness (U) of Design A:*

Usefulness (U) = Important level (L) × Popularity of use (R) × Usage frequency (F) × Usage duration (D) ***Eq.2***

= (4/5) × (172/400) × (6/24)
= **0.086**

Fig. 17. Key considerations from customer perceptions on small briefcase handbags

Discussion – Assessment of the Usefulness of a Product

After calculating the value of usefulness of two different styles – waterproof-insulated bag and small briefcase bag, the discussion activity has been raised where four main areas are taken into consideration.

Analysis of selecting value: for distinguishing among very similar products with the same range of level of importance, in this study, the importance level of a bag/container/storage is "Very high" or 4 (>3.0 - 4.0) scale – since this type of product is necessary for carrying, storing, or keeping some important stuffs for everyday life. Assigning intermediate points to the "level of importance" could be beneficial. Even if, there is a higher popularity and easy-to-use involved in applying "Design A – waterproof-insulated bag with a lightweight design that a briefcase-style – Design B. However, with the foldable material characteristic presented in Design A, users feel so worried about carrying electronic or digital items inside – since there are no supportive layers like a shock absorber provided. Thus, the importance level of Design A (3.7 from 5) should be less than the of Design B (4 from 5).

From customer perceptions, the bag, which contains a solid structure plus a zipper-locking system with a lightweight body, can produce the stuff inside safely and it is suitable for traveling. With proper sections or compartments provided inside the bag, some items are organized and easy to access and find a thing. Besides, shock-absorber material is provided, the users can bring digital gadgets or tablet everywhere they want and they can enjoy a work-and-travel platform.

However, the weight of a briefcase-style bag even the small one is around 1 kg. The users might feel fatigued carrying during the day.

Suggestions: however, this method could also be based on user preferences and the perspective of a design team. Using various methods such as user surveys or research articles – data analysis or optimization can support the way to make a decision.

Findings: for the conclusion of this phase, the researchers could obtain the guideline about assessing the ratio of the usefulness of these products as the usefulness of "Design A" (a waterproof-insulated bag): usefulness of "Design B" (A small briefcase bag) = 1: 1.22. This value can be applied to the trend of selling volume when the manufacturers would like to start creating or developing a new product. This can support the assumptions raised by a design team about the choice or reference bag that might fit to the customer's requirements. In this study, a briefcase-style bag with a small size is the proper choice, and its characteristics are interesting to be developed for supporting more activities in various conditions of the situation.

IV. Conclusion

In order to provide a proper design structure, Product Design and Development (PDD) with the assistance of finite element analysis (FEA) are applied. At the initial stage of this study, the customer perceptions and the market survey of a bag that is popular for women were considered and the obtained results could support the researchers for making the analysis of the market for a particular bag, which includes the investigation into customer feelings,expectations, and requirements. The durability, flexibility, universal design concept, easy-to-access, and easy-to-use function are the key points extracted from target customers. *For the conceptual design stage*, the researchers first started to reveal the hidden issues of the bag structures of waterproof-insulated and briefcase bags where a high percentage of usage (found from waterproof-insulated bags) may be inappropriate since only the price is the key to purchasing decisions.

For *assessment of the usefulness of a product*, distinguishing among very similar products with the same level of importance can be identified and studied by using the "usefulness (U)" formula. The guideline of this calculation can convey information about "identifying which design should be selected?" or "checking the reference style of the bag selected by designers is proper enough for supporting the design and development stage". However, the scale of importance of a product ranging from 0 to 5 will be assigned by the judgment of the researchers; that is quite subjective. Using various methods such as user surveys or research articles can support the way to make decisions. For *material selection and final design obtained*, "durable, flexible, portable, and

waterproof concepts are required as the key consideration. Therefore, ABS PC, Aluminum 1060 Alloy, Stainless Steel, Low-Density Polyethylene (LDPE), Rubber, and Stainless Steel are applied. The virtual model of the bag is provided with air ventilation (FAN) to maintain the original condition of the stuff inside the bag. The load-distribution simulation (FEA) is applied to that 3D model where the critical part was shown through the corner-slot area of the fan since it was not the flat surface for a whole frontal plate.

V. Contribution

Some designs of the bag can provide and serve as a decorated platform where the fashion accessory such as a colorful handle, strap, protective case (covering coat), or extraordinary handle-curve design is introduced. For self-defense purposes, the durability, stability, and force distributed on the front and back areas plus the handle of the bag are the key considerations, the applications of FEA can be used to support the ways to identify the proper material used. Moreover, the strength of structures of equal cross-sectional area loaded in tension is independent of the shape of the cross-section. The "tensile stress" is the key consideration where it is the stress state caused by an applied load that tends to elongate the material along the axis of the applied load, in other words, the stress caused by pulling the material.

VI. Recommendation

In order to develop a new design for work-and-travel bags based on customer needs, the conceptual design of the product should concern with dimension, shape, size, and material usage for the manufacturing process. Those factors have a strong positive correlation with the weight of the product. The Finite Element Analysis (FEA) technique has been applied in this study to determine the suitable material for a bag. However, the results obtained from this study are applied and suitable for being as one of the main guidelines and considerations for the manufacturers or customers to select the proper design and material for making a "fancy bag" with the simple-and-minimal design concept.

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Conflict of Interest

The authors of this publication declare there is no conflict of interest.

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Suchada Rianmora is a lecturer in School of Manufacturing Systems and Mechanical Engineering, Sirindhorn International Institute of Technology, Thammasat University, Thailand. She received her D. Eng from Asian Institute of Technology, Thailand. Her research interests are reverse engineering, rapid prototyping, design and development, and manufacturing processes.

Thorfan Netkueakun received her Bachelor of Technology in Industrial Engineering Program from School of Manufacturing Systems and Mechanical Engineering, Sirindhorn International Institute of Technology, Thammasat University, Thailand. Nowadays, is a full time Master degree student in Logistics Supply Chain System Engineering at the same school. Her research interests are product design and development, and manufacturing processes, supply chain and marketing strategy.

Nutthamon Samorhom is a received her Bachelor of Technology in Industrial Engineering Program from from School of Manufacturing Systems and Mechanical Engineering, Sirindhorn International Institute of Technology, Thammasat University, Thailand. Currently, she is research assistant. Her research interests are reverse engineering, rapid prototyping, manufacturing process design, and instrument process and control.