

# Design and Fabrication of an Ergonomic Trolley Bag

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## ABSTRACT

The plastic bag is a non-rigid container made of petroleum and natural gas. This project aims to design and fabricate an ergonomic trolley bag. From review of different types of bags for storage applications from 1852-2014, it was revealed that no work is reported on shopping bags using multi-functional features. It is ergonomics, adjustable volume, made by green material.

**Keywords:** foldable, user friendly, selection of material, biodegradable, ergonomic

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## INTRODUCTION

The plastic bag is a non-rigid container made of petroleum and natural gas, which are nonrenewable substantial ("Should Plastic Bags Be Bygones?" 2011). It is low cost, light weight, high strength, and water resistance. Most retailers provide free plastic bags to consumers to hold their purchases from shop to car and home. Some of the plastic bags will reuse for garbage, but most of the plastic bag is only used once. It has been estimated that up to 1 trillion plastic bags are used worldwide each year, nearly 2 million each minutes (Larsen 2014; Sampford and Leader 2010). Waste generated by plastic bags not only affect the environment, it also affects the marine ecology. Sea animal mistaken eat the plastic bag for food cause death.

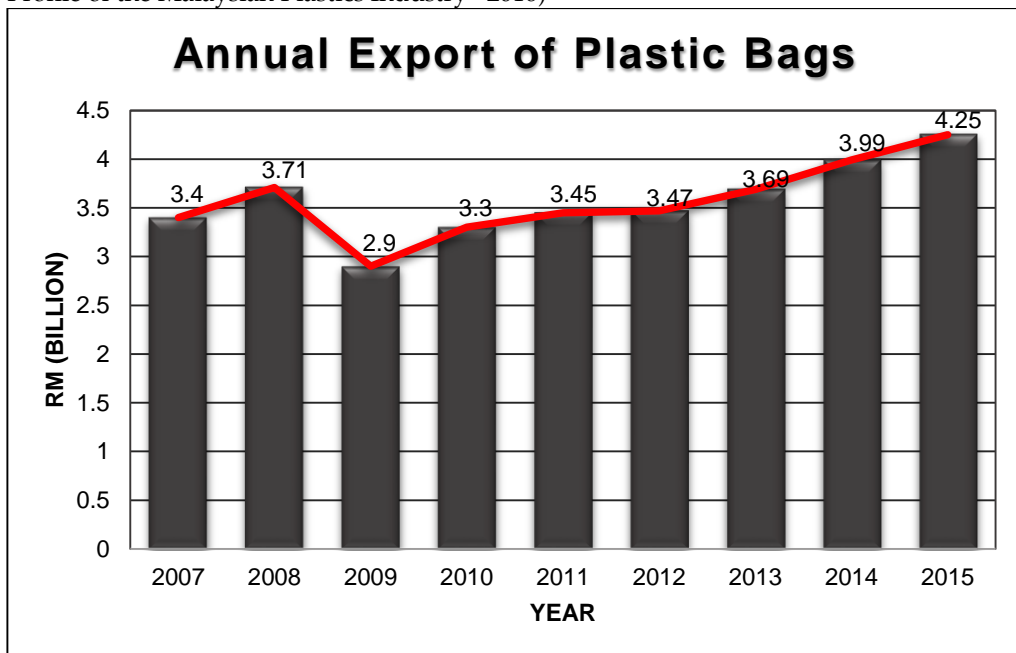
In addition, green bag is a reusable shopping bag made from cotton, it is also known as recycle bag which can reuse many times. It is an alternative to single-use paper or plastic bags. Reusable shopping bags are a kind of carrier bags, which are available for sale in supermarkets and apparel shops. If reusable shopping bag are not washed on a regular basis, there will be a build-up of bacterial, mold, yeast, and Coliforms if they contact with food could be a potential health hazard (Van Leeuwen 2013). Most of the plastic bag is only used once. A study commissioned by the United Kingdom Environment Agency in 2005 found that the average cotton bag is used only 51 times before being thrown away (Martin 2011). In some cases, reusable bags need to be used at least 131 times before they are better for the environment than single-use plastic bags (Quentin 2014).

According to State Education, Higher Education, Science and Technology, Green Technology, and Innovation chairman, Datuk Md Yunos Husin, the state government will impose the ruling in all shopping malls and supermarkets. From 1<sup>st</sup> January 2016, consumer have to bring along their own shopping bag or the cash counters will supply them with biodegradable bags made of plant-based materials to reduce wastage (MURALI 2015).

Figure 1 shown annual export of plastic bags in Malaysia for pass nine years. According to Malaysian Plastic Manufactures Association department of statistic, can see that number of plastic export are increasing annually since the year 2009 to 2015. This also can conclude as the number of plastic bags used are increasing every year. At year 2008, several countries have banned the use of plastic bags or levied a tax on them. The ban of plastic bag used with a little success with 20 to 30% drop of plastic bags export ("High Usage Of Plastic Bags" 2009).

This work is a dedicated review of the different types of bags used for storage applications. The review is based on year 1852 – 2014 focusing on various bags used and their key features such as 'foldable', 'user friendly', 'selection of material', 'biodegradable', and 'ergonomic'.

**Figure 1:** Graph showing amount of plastic bags usage over the pass 9 year ("Current Profile of the Malaysian Plastics Industry" 2016)



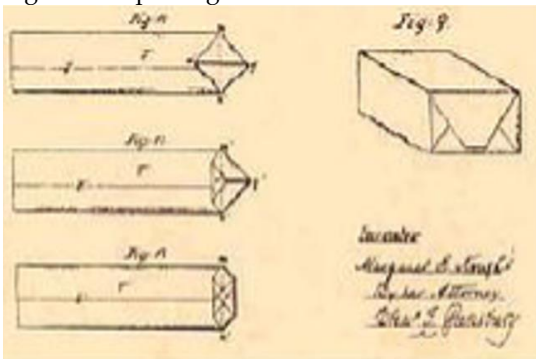
## REVIEW OF DIFFERENT TYPES OF BAGS FOR STORAGE APPLICATIONS

### Paper bags

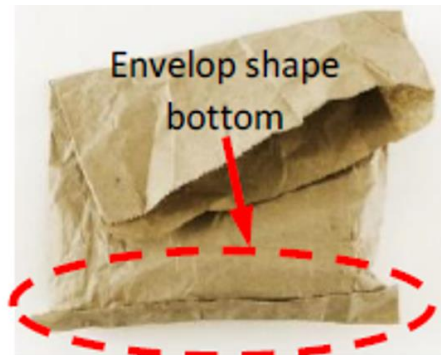
The first paper bag is patented by Francis Wolle (CHIPBRUCE 2015) (Aidan O'Connor 2010) in 1852. It is an envelope shape bag, which is limited in durability and interior space. This is clearly shown in Figure 2(a). In 1870's Margaret Knight (CHIPBRUCE 2015) (Aidan O'Connor 2010) improve the bag to square bottom paper bag, which is increasing the

interior space of the bag. This is clearly shown in Figure 2(b). In 1883, Charles Stilwell (CHIPBRUCE 2015) (Aidan O'Connor 2010) improved the bag with pleated sides for easier folding shown in Figure 2(c). In addition, the advantages of this bag is it is eco-friendly and recyclable. However, the disadvantages of the bag are it only used for storing dry item because paper are not waterproof and not washable material, besides that, this paper bag has no handle to carry the bag. This is clearly shows in figure 2(c).

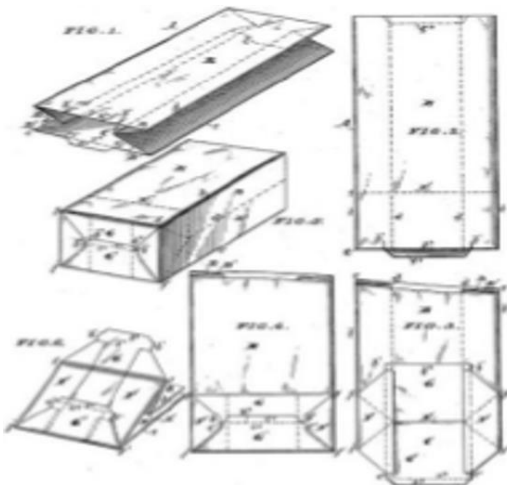
Figure 1: Paper bag



(a) Francis Wolle's paper bag design



(b) Margaret Knight's Paper bag



(c) Charles Stilwell's paper bag



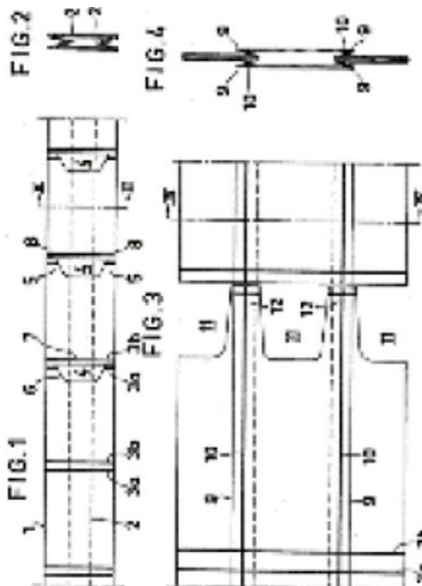
**Plastic bags**

The first plastic bag was invented by a Swedish engineer, Sten Gustaf Thulin (Martyn Lewis 2015) in early 1960's. It is a simple, low cost, resistance to water and high load carrying capacity bag. The advantages of this bag is it has handle to hold the bag. However, it is not washable and not eco-friendly to the environment because it is made of plastic. In addition, the handle of the plastic bag has no ergonomic concept of handle. This is clearly shown in Figure 3(a). When carrying heavy load item can cause painful at hand palm. Figure 3(b) shown the patent design of plastic bag.

Figure 2: Plastic Bag  
 Handle does not without ergonomic concept.



(a) Plastic bag with handle



(b) Patent of plastic bag (Sten Gustaf 1965)

**Sealing type plastic bags**

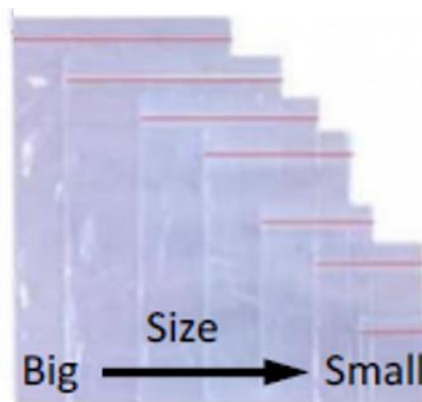
This plastic bag with sealing tape to store food are designed by Edholm and Ullenius (S Edholm and L Ullenius 2011). It's made of polyethylene plastic. It come in attracted colour and it is washable and can be reuse many times since it can be re-sealed by the sealing tape show at Figure 4(a). It is very convenient to use since it has the sealing type mechanism. This prevents moisture from entering the bag if it's packed with food, thereby making food last longer (Cook 1975), when food products are vacuum packed, there is no oxygen in contact with it. Once it's open, the food gets oxidized because of the oxygen in the air. This causes the food to spoil quickly. Besides, the bag comes in various dimensions for convenience of buyers. This clearly shows in Figure 4(b). The transparent design let user easy to recognize thing store inside the bag. In addition, this bag also use of store medications. However, after reuse the bag after a period of time, the bag will break at the side.

Figure 3: Sealing bags  
 Sealing tape can easily seal

food inside plastic bag



(a) Plastic bag with sealing tape



(b) Different size of sealing bags

## Carry bag

FRAKTA is a large carrier bag design by Hagberg (Hagberg and Hagberg 2011). It is made of 100% polypropylene and polypropylene plastic. The maximum load capacity is about 25kg. The advantages of this bag are cheap and it's easy to keep clean and take little space to store because it is washable and can be folded into a smaller size. This bag have two different length handle to carry the bag, it easily carries by hand or carry with the shoulder. This clearly shows in figure 5(b). However, Figure 5(a) shown the product does not incorporate the concept of ergonomics since the handle of the bag does not have the contour of an actual human hand.

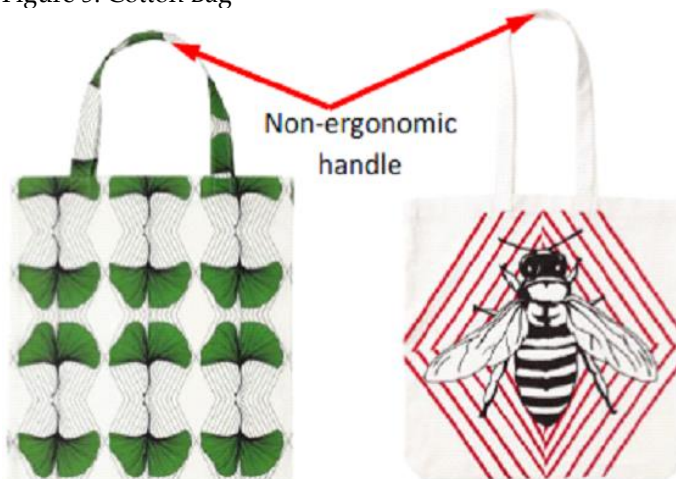
Figure 4: Large carry bag



## Cotton bag

ANVÄNDBAR is a carry bag design by Falvey and Stevenson (Falvey and Stevenson 2011). It made if 100% cotton.

Figure 5: Cotton Bag



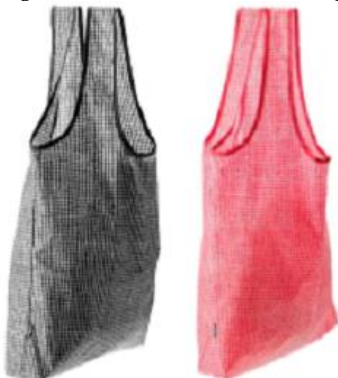
From the design it can be seen that the bag looks much more attractive with the colour and design on the outer surface of the bag as compared with the previous design. Mainly to make the bag look much more attractive. The bag comes in different colour and design. In addition, cotton is a type of material where it is fully washable. If the bag has any stain or

after a certain period of time, the bag becomes dirty, it can be washed by hand or wash by washing machine. The advantage of this bag is recyclable because cotton is sustainable sources. However, the handle of the bag does not incorporate the concept of ergonomics since the handle of the bag does not have the contour of an actual human hand. This is clearly shown in Figure 6.

### Carrier bag

KNALLA carrier bag are design by Hanna Dalrot (Hanna Dalrot 2011). It's made from 100% polyester. It comes in attractive colour that show in Figure 7(a). Besides that, the advantages of this carry bag are easy to keep on hand since it can fold to small size and keep in a coat pocket or handbag show in Figure 7(b). In addition, the extra wide handle are comfortable to carry in both hand and over shoulder. This clearly shows in Figure 7(c). Furthermore, this bag are waterproof and washable, after using a period of time, the bag become dirty, it can clean by machine wash. However, the disadvantages of this bag are it does not have a zip to close, this may cause a small item came out from the bag when the bag is placed on the table. The handle of the bag does not incorporate the concept of ergonomics since it is made of the same material, it can cause hand pain when holding the bag by hand shown in Figure 7(c).

Figure 6: KNALLA Carrier Bag



(a) Carrier bag with different colour



(b) Carrier bag when folded



(c) Carry bag in holding position



## Lunch bag

This lunch bag are design by Anna Efverlund (Anna Efverlund 2011). The fabric is made of 100% polyester and coating is made of 100% polyethylene. It comes in many attractive colour. Food can store in the bag seen the bag has a flat base, making the food hard to spill in the bag during handling of the bag. Figure 8(c) shown food organized in the bag. The advantages of this bag are it has a flat base to make food hard to spill out, it is waterproof and washable, can be folded when not in use and large volume. This clearly shows in Figure 8(a) and Figure 8(b). The disadvantages of this bag is the handle of the bag not ergonomic and it has a lot of camber when been washed in the washing machine.

Figure 8: Lunch bag



## Estring bags

Estring bags is a reusable cotton bags create by the Australian creator ("Reusable Cotton Bags - Green- Cotton String Bag-Short Handle – E String Bags" 2006) for regular trips to shop. It is made of 100% cotton and capacity stretch is up to 14kg. The advantage of this bag is the load caring capacity is high and it's made of eco-friendly material. It can wash by washing machine when it became dirty after a period of time used. The disadvantages of this bag don't have any privacy because the thing that bring can be seen throw, and the handle of the bag are not ergonomic. This is clearly shown in Figure 9.

Figure 9: Estring cotton bag



### Natural Bamboo Basket

It is a type of storage basket made of 100% bamboo (natural bamboo laundry basket picnic cesta fruit baskets kitchen storage Vegetable cestas gift cesto de roupa organizer, n.d.). Which are eco-friendly with the environment. Biodegradable, made of totally waste agriculture product, which is bamboo. It is rigid and cannot fold to a smaller size. The handle are not ergonomic. The basket has no cover to cover the food. This clearly shows in Figure 10(a). It is a traditional way to carry goods or use as give or souvenir. In Malaysia, bamboo craft is a traditional way to build the product. For example, bamboo furniture, bamboo music instrument, bamboo shoe and bamboo tableware. This clearly shows in Figure 10(b). In Nigeria, bamboo also use for construction, paper making, textile, pharmaceutical and household item (Atanda 2015).

Figure 10: bamboo craft in traditional way





## Rattan Basket

The basket are create by Sweden designer in year 2012 (BRANÄS 2012). The base material is made of rattan and the frame made of solid pine and solid acacia. It is 100% renewable material. It is easy to pull out and lift as the basket has handle. Each basket is woven by hand and the slight colour variations are a natural part of rattan and enhance the individual look of your basket make the basket unique. This clearly shows in Figure 11. Disadvantages of this basket, is it is rigid. Rattan are generally lightweight and durable. The flexible and long stems of great strength, it is a primary material used to provide structural support in construction and furniture. Once split, rattan also used for weaving baskets or sleeping mats and furniture. In temperate climates, rattan is suitable to use for outdoor furniture(Meijaard et al. 2014).

Figure 11: Rattan basket



## Steel Basket

This basket are design by Wiebke Braasch (Wiebke Braasch 2014) in year 2014. The basket made of steel with powder coating and handle made of birch veneer. It comes to attracting colour, it also easy to access and get overview of the item inside basket. In addition, it has tiltable handle that can move left and right and move the handle to the side at store position, this makes easy access the staff in basket. The colour and handle are different colour to easy to identify the handle and the basket. This is clearly shown in figure 12.

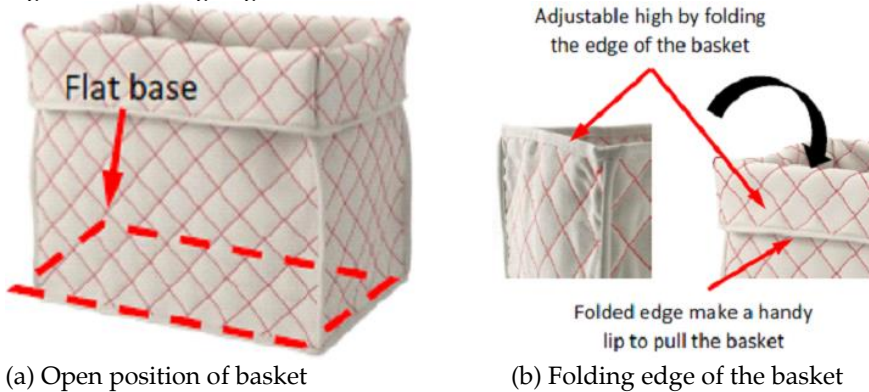
Figure 12: Steel basket with tiltable handle



**Polyester Basket**

It is a storage basket made of 100% polyester (SKUBBARE Basket 2011). It comes attractive colour, white colour basket outlook make the user feel clean and easy to see when it has any stain or dirt on the surface of the basket. The advantages of this basket are easy to keep clean and fresh as it can be machine washed. Figure 13(a) shown the square flat base of the basket make the basket can place in the cabinet. The high of the basket can be adjusted by folding the edge of the basket, the folded edge also make a handy lip to pull the basket. This clearly shows in Figure 13(b). It seems on inside or outside, so the user can choose the side they want to face inside or outside of the basket. It also suitable to store small item or clothes.

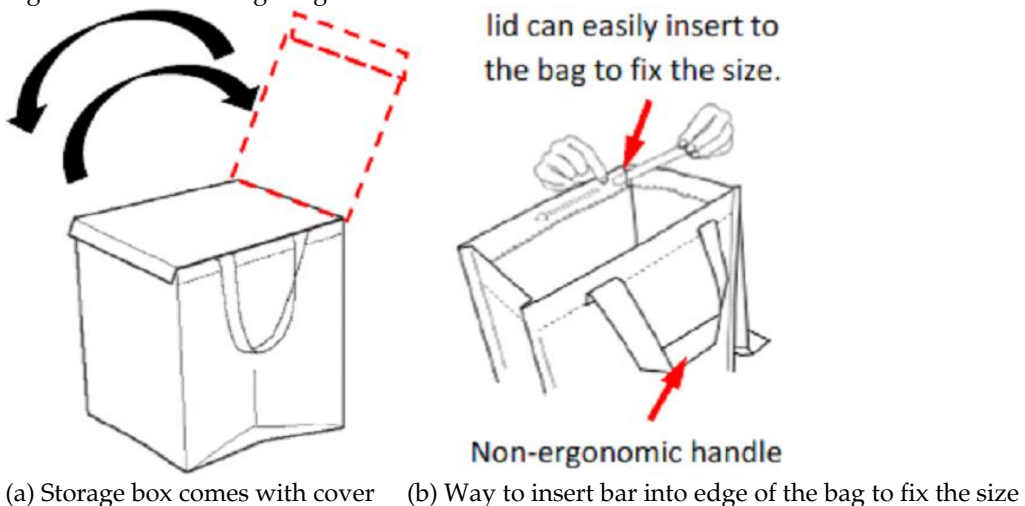
Figure 13: Folding edge of the basket



**Waster Storage Bag**

It is a waste storage bag made of plastic design at year 2014 (DIMPA 2014). It made of plastic and it's suitable for waste glass, metal, plastic, and newspaper. Figure 14(a) shown the tiltable lid on the bag hides what inside the bag. At the top of the bag with removable bar that fix the size of the bag. With the handle on the sides, the bag is easy to carry from one place to another place.

Figure 14: Waste storage bag





(c) Storage bag with different volume

However, it does not have the contour of actual human hand. This clearly shows in Figure 14(b). Figure 14(c) shown the label outside the bag, it helps user recognize the item inside the bag when the cover of the bag is closed, the waste storage bag also comes in different volumes. The disadvantages bag this bag is it made of plastic which is not eco-friendly material.

#### Laundry bag with stand

This laundry bag is made of EVA plastic, 100% polyester for edge fabric, 100% polypropylene for string, steel for the rack (JÄLL Laundry bag with stand 2011), and load capacity are 8kg. The advantages of this bag are it can be folded up, which makes the laundry bag simple to carry and put away. It can easily carry by handle together with the stand. The bar cover with bag separate force equally when carry. This causes the bag not easy to break and less hand pain when the bag is fully filled with laundry. This clearly shows in Figure 15. The disadvantage of this bag is the outlook design of the bag not attractive and it has no wheel at the below of the stand. It needs to use extra energy to carry with one hand when full load.

Figure 15: Laundry bag with stand

Handle with bar



(a) Open position of laundry bag



(b) Close position of laundry bag

## Shopping Bag on Wheels

A shopping bag on wheels designed by Maris Vinka (Maria Vinka 2013) in the year 2013. The fabric is made of 100% polyester, the frame made of steel, handle made of BS plastic, wheel made of polypropylene plastic, and maximum load capacity is about 20kg. Figure 16(a) shown it come in a lot of attractive colour. The advantages of this bag are the handle of the bag are adjustable to two different lengths and lock it in place, it can keep short when not in use and it incorporates the concept of ergonomics since the handle has contour of actual human hand. The wheel of the bag help user saves energy when carries the bag. It has also come with a lid to cover the item purchasing. This clearly shows in Figure 16(b). In addition, the shopping bag and cart are easy to store since they can fold flat. It has also come with detachable pocket and key hook to keep wallet and key, it helps users to find wallet and key easily. It can remove when no need the extra pocket. This clearly shows in Figure 16(c).

Figure 16: Shopping bag with ergonomic handle and wheel help to move the bag



(a) Adjustable ergonomic handle      (b) Different colour and design



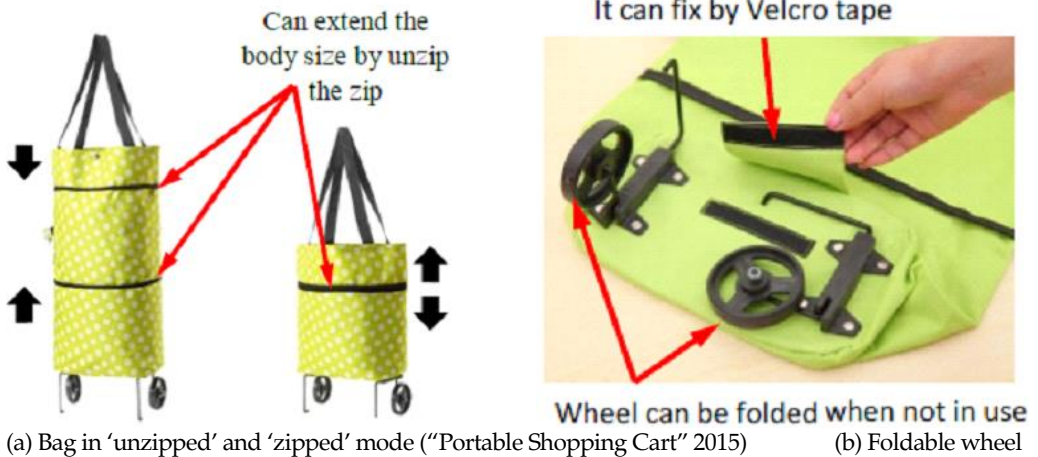
(c) Detachable pocket and hook to keep wallet and key

## Portable shopping cart

This shopping bag is made of Oxford cloth ("Portable Shopping Cart" 2015) and load capacity is 25kg. It come in a lot of attractive colour and elongation in size by unzip the zip at the outer of the body bag. This is clearly shown in figure 17(a). The bottom of bag with wheel design to reduce energy carry when full load. The bag can fold flat and store and the wheel also can be folded when not in use, and it can be fixed by Velcro tape. This

clearly shows in Figure 17(b). It is waterproof and can keep clean by washing or wipe by wet cloth. The handle of the bag, let the user carry by hand easily or carry on shoulder. However, it does not incorporate the concept of ergonomics since the handle has no contour of actual human hand.

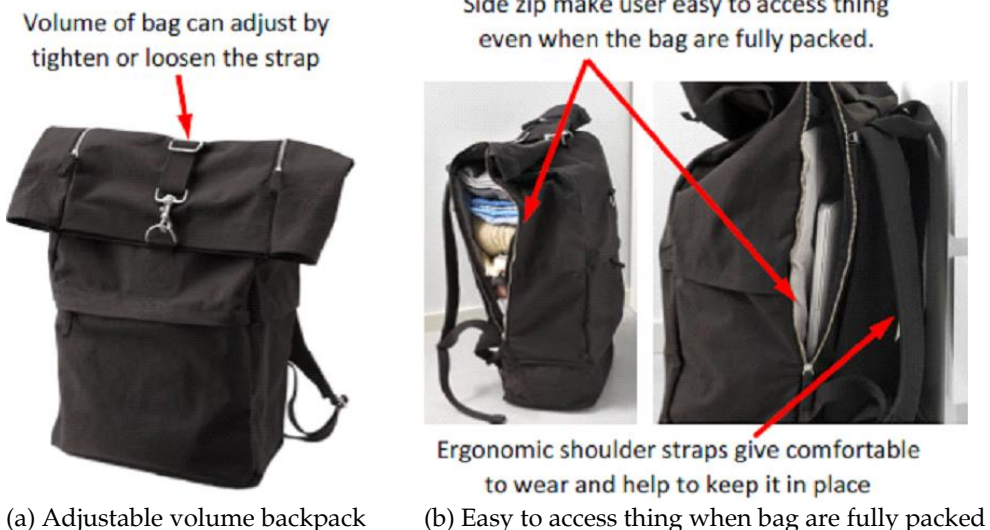
Figure 17: Portable shopping cart



**Backpacks**

This backpack is made of 100% polyester and filling with polyethylene foam and EVA foam. The bottom part of backpack made of synthetic rubber and zipper are made of brass and 100% polyester (FÖRENKLA 2011). The volume of the bag can easily adjust by tighten or loosen the strap, which is held in 2 D-ring. In addition, the backpack has a handy outer compartment so that user easy to keep key, mobile phone or wallet or other anything else need to close in hand. This clearly shows in figure 18(a). Side opening makes it easy to access items, even when the backpack is fully packed. Adjustable padded and ergonomic shoulder straps give comfortable to wear and help to keep it in place show in figure 18(b).

Figure 18: Adjustable volume by tighten or loosen the trap of the bag



After a period of time used, if the bag have any stain or dirt on the surface of the bag, it can easily clean by hand wash. The bottom part of the bag has a zip and it can store shoe. This bag is suitable for travel.

### Travel Bag

Jacob Durham and Jon Richards (Jon Richards and Jacon Durham 2014) established this travel bag in year 2014. It's made of 100% waterproof tarpaulin material. Figure 19 shown it has three ways to carry the bag, which are vertical position, horizontal position, and use as backpack. The advantages of this bag are it has a vacuum bag with waterproof and air tight function. This added feature help user packs all and save space in the bag. It has also come in laundry bag, the laundry bag was designed to fit perfectly inside the door of the shoe compartment of travel bag, laundry bag can expand and hang on the door knob to easily toss a dirty shirt. When the trip is over, it will fit back into your travel bag perfectly and keep your dirty clothes separate and organized. At the top of the bag with water bottle pocket lined with waterproof material keep other thing belonging dry in case of leaking. Large volume capacity suitable use for 3-7 day trip.

Figure 19: The bag are carry by multi position



### Grab Bag

This grocery grab shopping bag is made of nylon and non-woven fabric ("Grab Bag" 2015). The load capacity of the bag is 18kg. It has 2 different types of bag, without insulated layer and with insulated layer. The advantage of this bag are it have an ergonomic concept design, which is clipped to hold the bag to the shopping cart that show in figure 20(a). In addition, it has a large carrying capacity and it is waterproof and washable. The bag can easily fold flat and store when not in use. It has insulated layer to keep food fresh. However, the product does not incorporate the concept of ergonomics since the handle does not have the contour of an actual human hand show in figure 20(b).

Figure 20: Clip of the bag can grip the shopping cart to fix the bag



(a) Shopping bags with clip



(b) Shopping bags with insulated layer

**Foldable Shopping Trolley Bags**

This foldable shopping bag is made of waterproof PVC and nylon (“Foldable Shopping Trolley Bags” 2015). Its use for carry and storage purpose. It comes in few attracted colour and incorporate the concept of ergonomics since the handle with to live up the bag as shown in figure 21(a). Besides that, the extendable side fixes all sizes of the shopping cart, it also have clip to hold the bag with shopping cart. This clearly shows in figure 21(b). The disadvantages of this bag are it does not have lid to cover the bag, the item inside the bag will easy to get out from the bag when put the bag in car time move back to home.

Figure 21: Handle with bar to life up the bag



(a) Shopping bag with ergonomic handle



(b) The clip of the shopping bags used to fix the bag at shopping cart

## Trolley bags

The Irish creator, Paul Doyle [33] established trolley bags in the year 2010. Trolley bags are a system of 4 reusable bags with 4 different sizes. It is made of non-woven material and the load carrying capacity per bag is about 15kg. It comes in a lot of attractive colours. However, the product does not incorporate the concept of ergonomics since the handle is made of the same material and does not have the contour of an actual human hand. Besides that, the handle bar of the bags is too long which is seen as an obstacle when it is mounted on the shopping cart. This is clearly shown in Figure 22(c). It easily stores by rolling it up to close a position that shows in Figure 22(a). It also can join and separate the bag one by one by using Velcro tape show in Figure 22(b). The advantages of this bag are it has four different bags to separate item purchasing. It is waterproof and washable.

Figure 22: Trolley Bag



(a) Store position of Trolley Bags (b) Each bag can easily join and separate by Velcro tape

**Long handle bars with no  
'self locking' mechanism**



(c) Open position of trolley bags inside shopping cart



## SUMMARY OF LITERATURE SURVEY

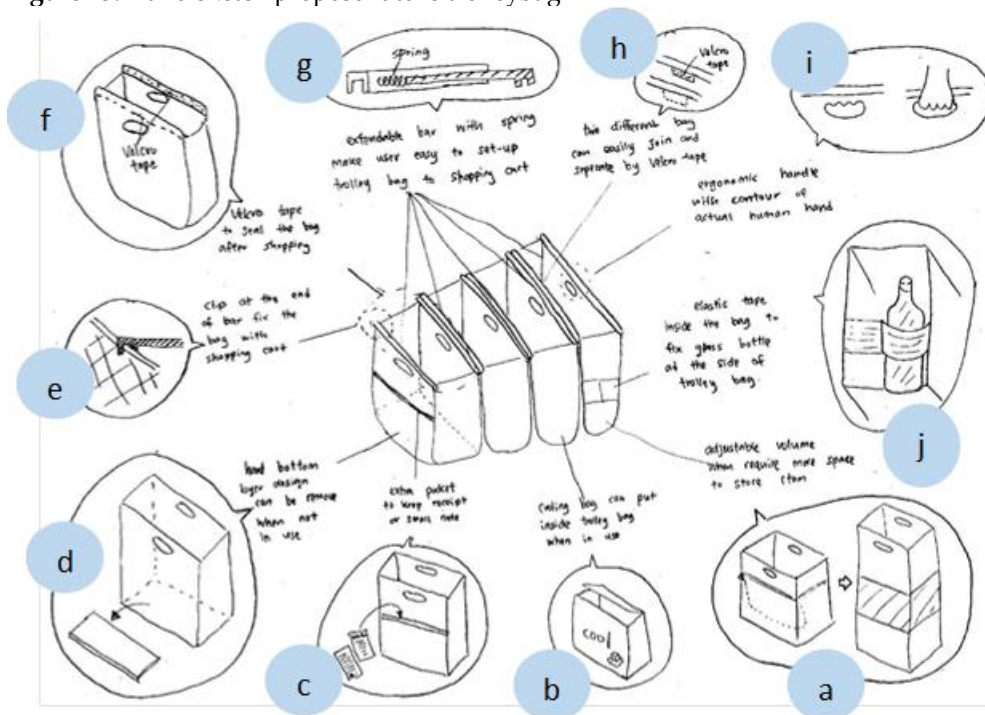
Literature review has been done from year 1852 to year 2014 for instant, a few important points can be highlighted on the design of shopping bags. They are followed:

- Paper bag and plastic bag are most general bag that using in 1960's until present time (Aidan O'Connor 2010; Martyn Lewis 2015). This two type of shopping bag is normally 'free of charge' when purchasing goods at any store. Most of the paper bag is considered as single use shopping bag and it is not suitable to hold wet item such as food or liquid, it becomes impossible to reuse after use for the wet item. Furthermore, plastic are not eco-friendly to the environment, when the plastic bag disposes to the water system, they will finally end up into the sea. When they are in the sea, sea animal like sea turtle view this submerge plastic bag like jelly fish. Hence, they accidentally eat them, when they eat them, it causes major harm to them because the plastic is petroleum base produce, hence it is toxic when consume. This will cause death to the sea animal (Schuyler et al. 2016).
- Washable and cheap material, it can reuse for many times. However, the handle of the bag does not incorporate the concept of ergonomics since the handle is made of the same material and does not have the contour of an actual human hand. Using non-ergonomic handle can cause Carpal tunnel syndrome (Angerpointner 1984). This is a painful condition of the hand and wrists caused by pressure on the median nerve, which runs from the shoulder down the arm to the hands. In addition, carpal tunnel syndrome include numbness, tingling and weakness in the hands. In advanced cases, carpal tunnel syndrome can make common activities impossible, such as holding a frying pan, folding laundry or lifting an infant.
- Traditional way to craft which are made of bamboo and rattan. It is made of 100% renewable material, washable and easy to clean. The handle are fixed shape, which are more suitable for the human hand to carry. However, the basket is rigid, it required space to store it when not in use.
- Shopping bag with wheel does not require a lot of energy to carry. The handle with contour of actual human hand and it is user-friendly since it is adjustable by volume. When not in use, the shopping bag are foldable to smaller size for easy storage.
- Multi-function back pack can store a lot of things inside a bag and comfortable handle design.
- Shopping bag with clip that can put in the shopping cart, there are made of non-woven fabric and nylon. Which are washable and easy to clean. They are perfectly fit into shopping cart. It comes in four bags, user can easily separate item purchasing into different categories.

In summary, the patent of the shopping bag is improved from 1960's. Now days, most of the shopping bag are washable and easy to clean. Some of the shopping bags are adjustable volume depend on their purchase. The handle of the shopping also include the ergonomic design with the contour of actual human hand. It is also design chip to fix shopping bag inside the shopping cart.

## FUTURE OF TROLLEY BAGS

Figure 23: Hand sketch propose future trolleybag



After review of previous bag design, in future shopping bag design will combine few previous design and some additional idea. Figure 23 shown hand sketch future trolley bag. There are few features of proposed future trolley bags. The trolley bag can separate into 3 to 4 bags, the item purchasing can separate by following category. For example, vegetable, soap, cloth, and field rations. Soap and food should not put together to prevent the smell of the soap mix with food.

- Adjustable volume: When the user uses trolley bag at the larger shopping cart or requires an extra place to store item, it can simply unzip the zip at the middle of the bag and extend the bag. The bag will become longer bag.
- Cooling bag: Cooling bag can easily put in the trolley bag to keep food fresh.
- Extra pocket: Extra pocket outside of the trolley bag can keep receipts or small note.
- Hard bottom design: The bottom of the bag are design in having removable hard board. The plate is to make sure that the item is stable while lifting the bag. (The item such as bottles or canned food can be easily placed in a stack). The board also can be removed if it does not required by the user.
- Clip at the end of the bar: The trolley bag comes with a clip and cylinder bar on the top to hold the bag at shopping cart to make sure it does not move freely.
- Velcro tape to seal the bag: Velcro tape along the bag at the top of each trolley bag help seal the trolley bag after purchasing. It can prevent when shopping bag place in a car. The bag drop and the item came out of the bag.
- Cylinder bar with spring: The cylinder bar with spring are adjustable length to fix most shopping carts in Malaysia. User can easily clip the trolley bags at one side of the

shopping cart and pull the bar and clip it at another side of the shopping cart the fix the bag in the shopping cart. This spring bar design help user to easily set up the shopping bags in the shopping cart.

- Velcro tape to join two different bag: Each of the bags can be separate and join easily by Velcro tape. For example, the Velcro tape helps hold the bag side by side when shopping, it can separate when take out the bags from the shopping cart.
- Silicon handle: Silicon handle are soft and comfortable for holding. The handle of the bag are placed under the bar with the contour of the human hand. When user lifting up the bag with the cylinder bar to prevent Carpal Tunnel Symptom.
- Elastic tape: The inner side of the bag having an elastic band to hold glass bottle firmly.

Lastly, the bag can be easily kept from rolling it around the cylinder bar. The cylinder bar and hard board at the bottom can be removed and the bag can wash by machine. The bag made of cotton canvas fabric with one layer of wax to get waterproof purpose. The hard bottom layer and cylinder bar made of biodegradable plastic.

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