Research Article

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Study and Development of the Process of Converting the Postal Jacket to Deteriorate for Apply to Products

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Abstract

The purpose of this study was to evaluate the conversion of deteriorated postal jacket materials into an applied product. Postal jackets are used by the Thailand Post Co., Ltd, and can be converted into a solid sheet material. In this study, a conceptual framework was used to design a product, enlisting senior experts in materials and production to evaluate 3 design drafts to create a suitable prototype. Descriptive statistics were used to analyze and summarize the obtained data. The results found that an office furniture set design, utilizing the design concept of a flying envelope, a symbol (brand) and a horizon, was deemed a unique decoration for the office of Thailand Post Co., Ltd. This product design had the highest overall suitability ($\bar{X}$ = 4.71, S.D.= 0.21), with user and executive satisfaction rating the designs aesthetics highest ($\bar{X}$ = 4.31, S.D. =0.76), followed by structure, function, and identity, respectively.

Keywords: *Postal jacket, Converted material, Design process*

1. Introduction

In Thailand, sustainable development is sought to improve the well-being of its population. Therefore, the sustainability of natural resources alongside an environmental management strategy are important to prepare the country to be an environmentally friendly low-carbon economy. This is expected to help increase energy efficiency across the transportation sectors, resulting in a reduction of greenhouse gasses. Moreover, it will enable a greater emphasis to be placed on city planning, combining culture, society, and ecology (Office of the National Economics and Social Development Council: 2012-2016).

Plastics are contained in everyday items, for example, plastic water bottles, plastic bags, penholders, clothing, and various types of dresses. Plastics are produced from the organic polymer group in petroleum via polyvinylchloride (PVC), nylon, polyethylene (PE), polystyrene (PS) and polypropylene (PP). Plastics smaller than 5 millimeters (range of 1 nanometer to 5 millimeters) are called micro-plastics, with 15-31% (2 out of 3) originating from synthetic fibers from washed clothes. Micro-plastics can also result from car tires, which can be washed away into various water sources, becoming a major problem in water filtering processes due to their size. Ingestion of plastics by birds (Mallory, 2008; Cadee, 2002) and turtles (Mascarenhas et al., 2004; Bugoni and Krause, 2001; Tomas

and Guitart, 2002) have been well documented, with at least 44% of marine bird species reported to ingest plastics (Rios and Moore, 2007). Micro-plastics, which end up in the ocean, can affect the seafood that humans consume, such as fish, shrimps and crabs. This may not only reduce the availability of seafood for consumption, but also affect human health (True Plookpanya: 2018).

Thailand Post Co., Ltd., is a transportation business, which earns a 27,800 million baht revenue from the postal business group, with a net profit of approximately 4,200 million baht. The Thailand Post logistics and parcel delivery business has a ~50% market share (total market value is 30,000 million baht) and a growth rate of 10 - 20% (THP Journal: 2018). In order to improve the service provided to users, staffing has been increased across distribution areas, resulting in the need for uniforms, or clothing, to enhance the company's image. However, once the clothing has deteriorated they are disposed of by combustion, resulting in the release of small dust particles and toxic gas into the atmosphere. Alternatively, if the clothing ends up in a landfill, or is discarded as waste, it may result in micro-plastic contamination of water sources.

Accordingly, the aim of this study was to convert deteriorated postal jacket materials into a reusable environmentally friendly product to facilitate the reduction of plastic waste in the environment.

2. Objectives

1. To study the process of converting deteriorated postal jacket.
2. To test the quality of materials obtained from the converting deteriorated postal jacket by testing and comparing according to product standards.
3. To design products that use materials from the converting deteriorated postal jacket in production.
4. To evaluate satisfaction of service users and executives affecting products that used materials from deteriorated postal jacket.

3. Methodology

In order to convert a deteriorated postal jacket into an applied product, the researcher used the following methodologies.

3.1 The researcher used purposive sampling.

A group of data providers were used to study the process of converting the deteriorated postal jacket. The data providers included 3 senior material experts, 3 designers who defined the spec. of the jacket for Thailand Post, and a single contractor from a tailoring company.

The group of data providers that were used to design the products from the deteriorated jacket materials, included 2 industrial product design senior experts, and 3 experts in the production of items, or equipment and durable supplies, for Thailand Post Co., Ltd.

A satisfaction survey of service users included the general public, and executives from Thailand Post Co., Ltd., who used postal services (80 persons in total).

3.2 Data sources

The primary data was via interview and observation of the data providers (senior material experts, designers who defined spec. of jacket, and contractor tailoring company).

The secondary was via researched data documents, textbooks and research papers, including various sources from government agencies and online sources, which involved the conversion of deteriorated postal jackets into applied products.

3.3 *Research tools*

An unstructured interview about the process of converting the deteriorated postal jacket, including information about the steps of converting the polyester, and the process of sewing jackets, were conducted with the data providers by taking notes, and recording audio and video.

Testing and comparisons were undertaken in accordance with product standards by using testing values compared with relevant standards.

A feedback survey form for the product design and converted materials during production, including an evaluation form, was used with senior experts in industrial product design and experts in the production of items or equipment and durable supplies at Thailand Post Co., Ltd.

A satisfaction survey of prototyped products from the deteriorated postal jackets, provided to both the general public who used the postal service, and the executives of Thailand Post Co., Ltd., (80 persons in total),

3.4 *Data Analysis*

The researcher used the information obtained from interviews and observations, and used short and long answer descriptive statistical methods, and a summary of information, guidelines and basic information, to divide into categories for data analysis.

In accordance with product standards, testing and comparisons were undertaken using test values and compared with relevant standards. The test results were included in analysis to find suitable guidelines for using the materials from the postal jacket for product design.

The researcher used the statistical data to find suitable guidelines for the materials used in converting the postal jacket during product design. This was combined with the analysis from respondents and the design's conceptual framework to present percentage data alongside mean ($\bar{X}$) and standard deviation (S.D.).

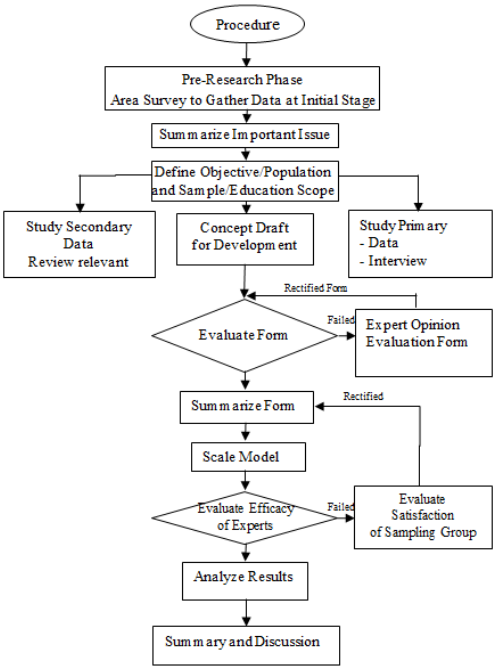

Figure 1: Chart shows the process of studying and developing the converting deteriorated postal jacket for apply to products.
Source: Teerapong Poti (2020)

4. Research Result

The documents and related research, including idea sketches from attending academic seminars, found that the deteriorated postal jacket could be converted into solid sheet material by mechanical thermoforming.

The comparative test results were based on the standard of particleboard, using testing values according to Thai industrial standards.

Figure 2: Shows the process of converting into solid sheet material by mechanical thermoforming
Source: Teerapong Poti (2020)

Table 1 Comparative test results based on standard of particleboard.

Solvents	Testing Features	Standard Level (Not less than)	Test Result	Test result compare with test criteria
Gasoline	Bending Strength	11.5 Newton	10.48 Newton	Failed
	Modulus of elasticity	1,500 Newton	1,281 Newton	Failed
	Tensile stress perpendicular to surface	0.30 Newton	0.65 Newton	Past
	Bond stress of screw - Surface - Edge	 360 Newton 360 Newton	 1,267 Newton 836 Newton	 Past Past
Thinner	Bending Strength	11.5 Newton	9.59 Newton	Failed
	Modulus of elasticity	1,500 Newton	1,276 Newton	Failed
	Tensile stress perpendicular to surface	0.30 Newton	0.60 Newton	Past
	Bond stress of screw - Surface - Edge	 360 Newton 360 Newton	 1,162 Newton 748 Newton	 Past Past

The results of the solid sheet material experiment showed that the material obtained from the experiment had good bending strength and tensile stress perpendicular to the surface, however the bond stress of screw moderately exceeded the standard value. The flexibility and bending strength had properties similar to the standard due to the main composition of the bonding glue, polystyrene (PS). This has strong properties and is not as flexible as it should be in plastic. Nevertheless, the solid sheet material, which was obtained from the experiment, had suitable overall properties, which could be combined with product design.

The selection of materials, which were converted from the deteriorated postal jacket into solid sheet materials for product design using 3D Max and Key Shot, can be summarized as follows:

Figure 3: The experiment to design to produce various products
Source: Teerapong Poti (2020)

The various product styles which were designed using the materials converted from the deteriorated postal jacket, were presented to the material senior expert and postal machinery and equipment manager at Thailand Post Co., Ltd. The senior expert gave the opinion that the deteriorated postal jacket was a controlled material under the regulations of Thailand Post Co., Ltd., and that it should only be designed as equipment and durable articles for use within the business. The researchers designed products to convey various aspirations, including idea sketches using inspiration from the Thailand Post symbol (flying envelope) and horizon, which is a symbol for decoration at the office of Thailand Post Co., Ltd. These symbols could be mixed, applied, and modified, in order to get the shape of furniture for sitting in the waiting hall at the post office. The creative ideas for product design were as follows:

Figure 4: Idea ketch
Source: Teerapong Poti (2020)

Table 2 shows the evaluation results of the product design using materials from the converting deteriorated postal jacket combine with production on style no. 1, according to the opinions of material senior expert and materials and production expert.

Table 2:

No	Evaluation Details	(n = 5)		Comment Level
		$\bar{x}$	S.D	
1.	**Function**			
	1.1 The cushion shape is suitable for use.	5.00	0	Most
	1.2 The chair style makes comfortable when sitting.	4.80	0.45	Most
	1.3 The overall chair shape can be easily cleaned.	4.80	0.45	Most
	1.4 The overall appearance of chair can be moved conveniently and flexibly.	5.00	0	Most
	1.5 The chair style has characteristics and overall size suitable for use.	4.80	0.45	Most
2.	**Safety**			
	2.1 The chair leg structure is safe, no harmful parts for use.	4.80	0.45	Most
	2.2 The anchorage in various structures of chair legs is strong and safe.	4.80	0.45	Most
	2.3 The height of chair is 450 mm. that not be harmful and not be hinder for use.	4.60	0.55	Most
	2.4 The overall chair structure is stable, not easy to fall down.	4.60	0.55	Most
	2.5 Use safe, environmentally friendly materials to build the chair legs structure (Chrome plated steel).	4.80	0.45	Most
3.	**Construction**			
	3.1 The chair legs have a stable and strong structure.	4.80	0.45	Most
	3.2 The chair legs structure can support the weight very well.	4.60	0.55	Most
	3.3 The chair structure was assembled (cushion and chair legs) with stable and strong.	4.80	0.45	Most
	3.4 The materials used to make chair legs (Chrome plated steel) are resistant to the weather inside the post office hall very well.	4.80	0.45	Most
	3.5 The cushion style (400 x 400 mm.) is appropriate, strong and sufficient for use.	4.60	0.55	Most
4.	**Materials**			
	4.1 The materials used to build the chair legs are metal (Chrome plated steel) that is durable, strong enough for use.	4.80	0.45	Most
	4.2 The materials used to build the chair legs are metal (Chrome plated steel) can be easily purchased and is cheap in the market.	4.60	0.89	Most
	4.3 The thickness of cushion is 20 mm. that suitable for use.	4.60	0.55	Most
	4.4 The material used for making cushion (deteriorated postal jacket) is the selection of used recycle materials for maximum benefit.	4.80	0.45	Most
	4.5 The cushion is highly resistant to bond stress of knots, screws or nails very well.	4.80	0.45	Most
5.	**Production**			
	5.1 The chair legs structure has a production process that is simple and not complicated.	4.80	0.45	Most
	5.2 The cushion has a style that can effectively produce in bulk.	4.80	0.45	Most
	5.3 The overall chair legs structure has a production that compatibility with machinery and equipment that are widely used.	4.80	0.45	Most
	5.4 The size of chair legs structure can be produced according to standard size of material that is commercially available in market that without scraps or leaving smallest amount.	4.80	0.45	Most
	5.5 The coating of the chair legs structure with chrome, can be produced in general, without complicated in production.	4.80	0.45	Most
6.	**Maintenance**			
	6.1 The chair legs structure can be easily repaired when damaged.	4.60	0.55	Most
	6.2 When the chair legs structure is damaged, parts or spare parts can be easily found in local.	4.40	0.89	More
	6.3 When the cushion is damaged, parts or spare parts can be easily found in local.	4.40	0.89	More
	6.4 The materials used to make legs (Chromium plated steel) has physical properties that are resistant to rust and easy to maintain.	4.40	0.89	More
	6.5 The cushion is coated with resin that is easy to wipe and clean.	4.40	0.89	More
Total		**4.71**	**0.21**	Most

In Table 2, a total of 3 styles from the converted postal jacket materials were evaluated for product design. It was found that the 1st style was most appropriate ($\acute{x}$ = 4.71, S.D.= 0.21), followed by the 2nd style ($\acute{x}$ = 4.27, S.D.= 0.21) and the 3rd style ($\acute{x}$= 4.05, S.D.= 0.19), respectively. Therefore, the researcher concluded that the 1st style should be used to produce products from the materials of the deteriorated postal jackets.

Figure 5: Shows the product styles that used materials from deteriorated postal jackets.
Source: Teerapong Poti (2020)

A summary of the satisfaction results from service users and executives at Thailand Post Co., Ltd., are shown in Table 3.
Table 3 shows the satisfaction results of 80 service users and executives of Thailand Post Co., Ltd., affecting the products from deteriorated postal jacket.

Table 3:

Evaluation Details	Satisfaction Level		
	$\bar{X}$	S.D.	Satisfaction Level
Aesthetics			
1 The chair shape is beautiful to use.	4.53	0.55	Highly Satisfied
2 The cushion (produced from deteriorated postal jacket) is beautiful.	4.50	0.64	Very Satisfied
3 The chair legs structure is made of suitable and beautiful materials in itself.	4.38	0.77	Very Satisfied
4 The chair style is beautiful and consistent with places.	4.30	0.88	Very Satisfied
5 The chair style is beautiful, modern and attractive.	4.33	0.73	Very Satisfied
Total	4.40	0.71	Very Satisfied
Identity			
6 The overall chair style is beautiful and identity.	4.15	0.74	Very Satisfied
7 The cushion (produced from deteriorated postal jacket) with beautiful and convey using of recycle items that deemed to be organization identity.	4.35	0.77	Very Satisfied
8 The cushion (produced from deteriorated postal jacket) can communicate an organization identity very well	4.15	0.74	Very Satisfied
9 The chair legs style can indicate and convey an organization identity very well.	4.18	0.84	Very Satisfied
10 The overall chair structure is stand out, identity, different from others.	4.28	0.78	Very Satisfied
Total	4.22	0.77	Very Satisfied

Evaluation Details	Satisfaction Level		
	$\bar{X}$	S.D.	Satisfaction Level
Function			
11 The chair shape is suitable to utility space perfectly.	4.38	0.70	Very Satisfied
12 The chair style is suitable to the behavior of service users.	4.25	0.67	Very Satisfied
13 The overall chair shape can be easily cleaned.	4.25	0.90	Very Satisfied
14 There is function in various styles such as communication devices can charge batteries.	4.35	0.86	Very Satisfied
15 Chair cushion (produced from deteriorated postal jacket) with characteristics that can be used properly.	4.28	0.78	Very Satisfied
Total	4.30	0.78	Very Satisfied
Structural			
16 The chair legs structure is safe and without harmful parts.	4.18	0.87	Very Satisfied
17 The overall chair structure is manufactured from suitable materials that safe for use.	4.33	0.69	Very Satisfied
18 The height of chair structure is 450 mm. that is a suitable height, not dangerous and suitable for use.	4.45	0.85	Very Satisfied
19 The chair structure was assembled (cushion and chair legs) with stable and strong.	4.13	0.79	Very Satisfied
20 The adjustable knob is under the chair legs structure, allowing chair to be placed or installed in different level area conveniently.	4.48	0.60	Very Satisfied
Total	4.31	0.76	Very Satisfied

Table 3 shows the overall satisfaction of service users and executives at Thailand Post Co., Ltd. The overall satisfaction level was very satisfied ($\bar{X}$=4.31, S.D.=0.76), with most satisfaction related to aesthetics, followed by structure, function and identity, respectively.

5. Discussion and Conclusion

5.1 Discussion of the study results related to the process of converting the deteriorated postal jackets.

The analysis of the data from relevant documents, including idea sketches from attending academic seminars, found that there were feasible guidelines for converting deteriorated postal jackets into solid sheet materials. Indeed, guidelines were already supported in the research literature. The researcher analyzed the guidelines for a mechanical thermoforming experiment by dividing into hot extrusion and cold extrusion guidelines, respectively. The analysis showed that hot extrusion had more disadvantages (compared with cold extrusion), since the main material in deteriorated postal jackets is polyester, or a group of plastics derived from petrochemical processes, which are not heat resistant. In addition, the hot extrusion reacts to polyester glue that is dissolved causing carbon dioxide to be released into the atmosphere. In comparison, cold extrusion has a lower production cost and can use a mixture of polystyrene (PS) in the bonding process as it is the only plastic that can be dissolved in a solvent. This turns the plastic into liquid without using heat, thus it does not produce smoke and/or dust, and it is easily available on the market.

5.2 Discussion of material performance and comparison with product standards.

The comparative test results based on the standard of particleboard, showed that the standard values of the bending strength and modulus of elasticity, were lower than the specified standards. This was because glue has polystyrene (PS) as its main component, resulting in hard physical characteristics and inflexibility. The results of the tensile stress perpendicular to surface, and the bond stress of the screw, were greater than the nominal standard. Therefore, the solid sheet material has features, which make it hard in a vertical position with the ability to support the bond stress of screws.

5.3 Discussion of the materials used in the product design of converting deteriorated postal jackets for production.

The researcher selected conceptual products for product design, using the materials from the deteriorated postal jackets in production. This was undertaken in accordance with the conceptual framework, namely function, safety, construction, materials, production process and maintenance; and enabled the production of 3 sets of suitable furniture designs (Udomsak Saributha, 2007; Mungpanklang, N. Seviset, S and Eakwutvongsa, S, 2020). The 1st style was selected by the senior design and production experts and was developed and adjusted according to the instructions. For example, using the materials in accordance with the size of the finished material so that it could be sold, or including extra features, such as a charging phone socket or communication device.

5.4 Discussion of consumer satisfaction of the products from the deteriorated postal jacket materials.

The service user and executive satisfaction results, showed that surveyed participants were mainly satisfied by the aesthetics of the product ($\overline{X}$ = 4.40, S.D. = 0.71), followed by the structure ($\overline{X}$ = 4.31, S.D.= 0.76), function ($\overline{X}$ = 4.30, S.D. = 0.78) and identity ($\overline{X}$ = 4.22, S.D. = 0.77). The identity used a style inspired by the symbol of the Thailand Post Co., Ltd., ensuring a consistency similar to the concept of the" Green Coffee Shop" of Starbucks Coffee (Thailand), which developed and used coffee grounds to produce furniture in Starbucks shops.

6. Recommendations

The materials from deteriorated postal jackets can be converted into a form of solid sheet material can be used across many other fields, including 3D round relief, parts in the automotive industry, or in other forms of furniture.

The materials from a deteriorated postal can be converted into carpet, and further developed in combination with the design of various products, such as packaging products, wall paneling for sound absorption, or equipment in household appliances.

The solid sheet materials that were analyzed during testing, found that while hardness was a prominent feature, elasticity was lacking. Therefore, high heat should be avoided when designing products, due to polyester being highly flammable.

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