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The Validity of the Reduction of Disposable Plastic Checkout Bags in Japan

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ABSTRACT

This study examined the effect of reducing disposable plastic checkout bags used in supermarkets, convenience stores, and so on in Japan. Considering that even when these checkout bags are abolished, alternative waste bags should be newly produced, because these checkout bags have been reused as household waste bags so far, and the corresponding amount of oil is still necessary to produce them, the amount of oil saved by this bag reduction was found to be 0.2 L/person/year at most. Further, it was demonstrated that the necessity to purchase substitute bags may increase the household and financial burden on consumers.

Keywords: Disposable; Plastic Bag; Reduction; Oil-Saving

1. Introduction

Recently, with the increased public interest in environmental issues, existing social approaches are being reconsidered. Among them, the reduction of the use of disposable plastic checkout bags (hereinafter shortened to checkout bags) has been rapidly promoted in Japan as an eco-friendly activity each person can easily perform [1]. The basic idea is that the continuous use of non-decomposable plastic bags is not beneficial to society, and conventional campaigns have solely focused on cutting checkout bag use to reduce the amount of waste. But, fundamental actual effects accompanying this movement have not been fully examined.

Under such circumstances, this study examined the effect of checkout bag reduction by performing statistical calculations and case studies to determine its validity.

The study also examined the effect of actively using checkout bags, and compared it with that of reducing their use to confirm the necessity of checkout bag reduction with a view to proposing how to appropriately use checkout bags in our modern society.

While diverse types of bag are available nowadays, in this study, checkout bags were defined as follows: "free polyethylene bags with handles provided according to the size of purchase in retail grocery stores, such as supermarkets, which tend to be non-transparent and white". They are made of polyethylene film, a polyolefin material, and there are 2 types of polyethylene: high-density polyethylene (HDPE); and low-density polyethylene (LDPE). Currently, the former is mainly used due to its strength. These folding bags are easily carried, and, being water-proof, reused for diverse purposes in daily life, such as waste and garbage bags.

Checkout bags with handles were originally developed by Nakayama Seitaikako Co., Ltd. in 1972, and were rapidly popularized all over the country, excluding square envelopes (traditional retail brown paper bags) from the market.

During the same period, the Hokkaido Consumers Association founded in 1961 launched a campaign proposing consumers to bring their own shopping bags, which is regarded as the first "My Bag Campaign" in the country; the problem with discarded checkout bags may have been recognized long before their development. Although the campaign initially aimed to save natural resources by reducing the consumption of checkout bags, its effect on waste reduction was focused on more closely when an organization named the National Conference for Promoting Waste Reduction (renamed "The Zero Waste Partnership Conference" in July 2002) promoted the campaign on a nationwide basis in 1995. In addition to such goals, the campaign currently aims to reduce emissions of $\mathbf{CO_2}$ as the leading cause of global warming and the ecological impact.

In the study, the checkout bag reduction campaign was defined as "My Bag Campaign", namely, "proposing consumers' bringing their own shopping bags ("my bags") to avoid the use of free checkout bags provided in supermarkets".

2. Verification of the Validity of Checkout Bag Reduction

In general, as previously mentioned, the checkout bag reduction campaign is positively recognized in society; however, it has not been widely popularized as expected. As the recent rapidly increased use of blue light-emitting diodes shows, genuinely beneficial ideas and objects tend to be naturally disseminated. In this respect, the passive promotion of checkout bag reduction may be explained by the elusiveness of its effect. Or, conversely, the convenience of shopping using free checkout bags and their reuse as household waste bags may have been highlighted more strongly.

Based on such an idea, the study aimed to clarify the actual effect of checkout bag reduction. For the trial estimation of the oil-saving effect, the weight of one checkout bag of average size and number of daily checkout bags used per person were initially calculated.

2.1. Weight of One Checkout Bag

According to data [2] the Japan Chain Stores Association reported to several organizations, including the Central Environmental Council, the most common size of checkout bags currently used is large (400 × 500 mm), and the mean thickness is 0.018 mm. Further, considering that 2 films are needed to produce one checkout bag, and estimating the specific weight of raw material to be 0.95 g/cm^3, the weight of one checkout bag can be calculated as follows:

$$0.018\times 400\times 500\ \text{mm}\times 2 \times \text{specific weight } 0.95\ \text{g/cm}^3 = 6 \quad (1)$$

However, the formula (1) solely indicates the weight of one simple bag without handles. As checkout bags with handles used in supermarkets are not rectangular, but U-shaped in the upper part, the value obtained with this formula includes the extra weight, and, consequently, is incorrect. A more accurate value may be obtained with the following formula:

$$\text{Weight of one checkout bag} = \text{thickness} \times(\text{width}\times\text{length}-\text{surplus area})\times 2\times \text{specific weight} \quad (2)$$

To verify the reliability of this value, the weight of 10 different types of checkout bag was measured (**Table 1**). Among these bags, the mean weight of the 3 most common types (E-G) was 6.86 g; this was similar to the value obtained with the formula (2), 6.91 g. The difference between the large (H-J) and small (A-D) types was greater with formula (2), as the thickness is directly proportional to the size.

In short, based on calculating using the valid formula (2), the mean weight of one average checkout bag is approximately 6.9 g.

2.2. Daily Checkout Bag Use Per Person

The amount of checkout bags available (domestic production + imports) was initially calculated. According to a website of the Japan Polyolefin Film Industry Trade Association [3], the volume of domestic production of polyethylene bags in 2010 was 100,071 t, and that of imported ones was 480,100 t. Checkout bags for supermarkets accounted for 52% of the total domestic production volume; nearly half. If this rate is also applicable to imported checkout bags, their volume in 2010 may be estimated to be half of 480,100 t, thus, 249,652 t. Being consistent with the association's report that checkout

Table 1. Measurement and calculation of the dimensions and weight of checkout bags.

Type	Wi* mm	Le* mm	Wi* of surplus area mm	Le* of surplus area mm	Weight (measured) (g)	Weight (calculated) (g)	Error (g)
A	318	438	122	112	3.943	4.296	0.35
B	430	500	145	120	5.499	6.758	1.26
C	430	527	196	150	5.545	6.745	1.2
D	448	490	201	141	6.214	6.538	0.32
E	430	530	192	135	6.769	6.908	0.14
F	430	530	192	135	6.85	6.908	0.06
G	430	530	192	135	6.95	6.908	0.04
H	467	610	230	154	10.3	8.531	1.77
I	584	664	274	165	14.5	11.716	2.79
J	612	674	320	193	20.22	11.995	8.23

*Wi and Le means Width and Length, respectively.

bags accounted for half of all imported polyethylene bags in 1993 and 2002, such an estimate may be regarded as reliable. Therefore, the total amount of checkout bags available in the country in 2010 was calculated as follows: 100,071 + 249,652 = 349,723 t.

Subsequently, the total annual checkout bag use was calculated, estimating the mean weight of one average checkout bag to be 6.9 g, as follows: 349,723 t/6.9 g = 50,700,000,000 pieces.

In line with this, the daily checkout bag use per person in 2010 may be calculated as follows: 50,700,000,000 pieces/total population in 2010 (127,500,000)/365 days = 1.1 pieces.

Based on this calculation, the entire Japanese population, including children, may be regarded as consuming 1.1 checkout bags/person/day, and the study was developed using this value.

2.3. The Amount of Checkout Bags Reused as Household

Checkout bags brought back home are reused for diverse purposes. In a questionnaire survey conducted by Nakano in 2002, the most common answer to the question "What do you reuse checkout bags for?" was "As kitchen garbage bags", accounting for more than 80% of all answers, followed by "room trash bags" accounting for nearly 80%. In contrast, those who discarded checkout bags without reusing them comprised a low rate of 0.8% [4]. The results of this survey indicate that checkout bags are mainly reused as waste bags, simultaneously suggesting that, if checkout bag use is entirely cut, it would be impossible to reuse them as waste bags, and, consequently, substitutes would be needed.

Based on this idea, the annual consumption of household waste bags was estimated, as follows: The volume of daily waste generation per person was initially calculated, and, subsequently, the number of household waste bags required a year by estimating the volume of waste discarded in each bag.

In the Survey on the Disposal of General Waste conducted by the Ministry of the Environment in 2009 (The Ministry of the Environment, 2009), the volume of daily waste generation per person in Japan was 994 g (based on its website) [5]; however, as there are various types of waste, this value may not directly indicate the volume of household waste we usually discard in waste bags (**Figure 1**).

In line with this, the calculation should be limited to kitchen garbage and packaging waste. **Table 2** created by the Ministry of Internal Affairs and Communications (MIC) shows the estimated proportion of such waste to the total volume of household waste:

The proportion of the total of kitchen garbage, packaging waste, and others in 2004 as the most recent data in

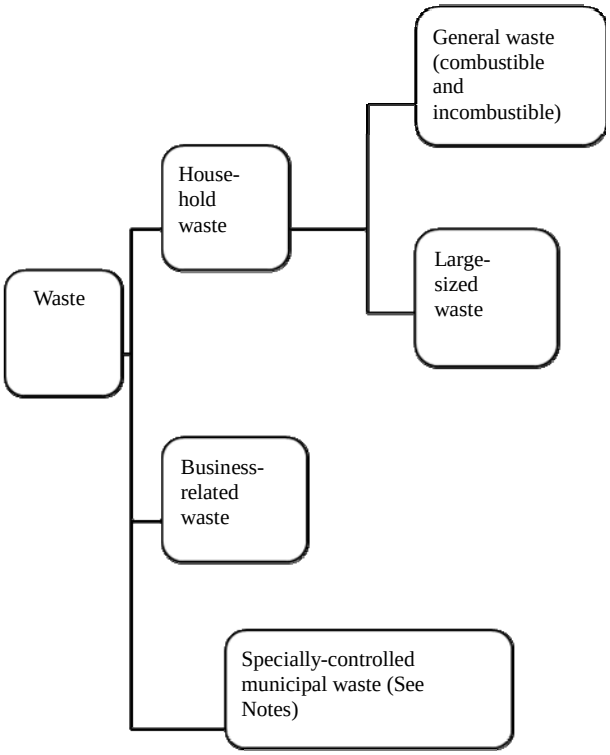

Figure 1. Classification of waste. Notes: Figure 1 shows the management of 18 types of industrial waste, including cinders, sludge, waste oil, waste acid, waste alkali, waste plastics, paper scrap, wood scrap, textile scrap, animal and plant remains, rubber scrap, metal scrap, glass scrap, ceramic scrap, slag, rubble, annual manure and carcasses, and dust.

Table 2. Time-dependent changes in the volume of household waste by composition estimated by the MIC on a dry-weight basis (from the MIC's website) (Unit: 10,000 t, %).

Classification Year	1999	2000	2001	2002	2003	2004
Kitchen garbage	1,19	1,23	1,25	1,19	1,13	1,07
Proportion	36.6	37.8	37.1	35.5	33.6	32.4
Packaging waste	789	806	800	811	813	803
Proportion	24.3	24.7	23.8	24.3	24.2	24.2
Newspapers and magazines	757	790	849	869	889	860
Proportion	23.3	24.2	25.3	26	26.4	26
Other	509	435	466	477	531	576
Proportion	15.7	13.3	13.9	14.3	15.8	17.4
Total household waste	3,24	3,27	3,36	3,34	3,37	3,31
Proportion	100	100	100	100	100	100

Notes: 1) **Table 2** was created by the MIC based on the Survey on the Disposal of General Waste and Survey of Packaging Waste Management conducted by the Ministry of the Environment; 2) Large-sized and recyclable waste was excluded. 3) Values indicate the proportion to the total volume of household waste.

Table 2 was 74.0% (excluding paper waste, such as newspapers and magazines, as they tend to be discarded without waste bags). According to the previously mentioned survey conducted by the Ministry of the Environment, the weight of household waste accounts for approximately 64% of the total waste weight. Based on these findings, the volume of daily waste generation per person may be calculated as follows: 994 g/person/day × 0.64 × 0.74 = 471 g/person/day.

Based on this calculation, it is likely that approximately 530 g/person/day of waste is generated and discarded in waste bags.

Further, in 4 surveys examining combustible waste managed in several waste transfer stations in Kumagaya City, Saitama Prefecture during the period from November to December 2004, the mean weight of one large-sized waste bag was 2215 g [6]. According to another survey conducted in Osaka City, the median number of checkout bags observed inside each of 19 large-sized waste bags was 4.2 [7]. Considering that these checkout bags were reused as household waste bags, the volume of household waste in one checkout bag was calculated, as follows: 2215 g/4.2 = 527 g/bag.

Unexpectedly, this value was identical to that of daily waste generation per person; therefore, the annual consumption of household waste bags per person may be estimated to be 365 pieces, and the total annual consumption of household waste bags was calculated as follows: 365 × total population in 2010 (127,500,000) = 46,500,000,000 bags.

2.4. Oil-Saving Effects

According to the trial estimation of the Japan Polyolefin Film Industry Trade Association [8], the total amount of oil needed to produce one checkout bag is 18.3 ml, comprising 11.5 ml converted into a solid substance as a checkout bag, and 6.8 ml converted into CO_2 during the manufacturing process. This value was obtained by converting the amount of energy needed to produce one checkout bag into that of oil.

As previously estimated, the number of daily checkout bags used per person in Japan was 1.1, and that of daily consumption of household waste bags was approximately 1. Assuming that similar amounts of oil are needed to produce one checkout and household waste bags, the amount of oil saved by checkout bag reduction may be estimated to be 77,000 KL, as shown in **Table 3**:

The annual amount of oil saved per person was estimated to be 0.67 L. Further, the proportion of the total amount of oil saved by checkout bag reduction to the domestic oil consumption in 2005 of approximately 280,000,000 KL (based on a website of the Agency for Natural Resources and Energy) was not greater than 0.031%. Although opinions may be divided over whether this is significant, as two thirds of checkout bags are imported, the oil-saving effect of reducing domestic checkout bags is likely to be less than 0.22 L. In addition, this estimate did not include the amount of oil needed during the manufacturing process; therefore, the actual balance may be even smaller.

Based on this calculation, the oil-saving effect of checkout bag reduction may be slight.

3. Economic Effects of Checkout Bag Reduction—Costs of Checkout Bags

The annual cost of checkout bags was initially calculated. As shown in **Table 3**, the annual amount of oil saved by checkout bag reduction was estimated to be approximately 928,000 KL (18.3 × 50,700,000,000); this value is equivalent to approximately 5,840,000 barrels.

Based on this estimation, a simple calculation of the cost price of checkout bags was performed. The price of oil per barrel in recent two years was around 90 dollars, and one dollar was equivalent to approximately 80 yen on June 11, 2012 (Nikkei Network) [9,10]; therefore, estimating the price of oil per barrel to be 7200 yen, the annual cost of checkout bags may be calculated as follows: 7200 yen × 5,840,000 barrels = 42,000,000,000 yen.

The important point is that this cost may finally be charged to consumers; although checkout bags are free, it costs to produce them, and consumers pay such a cost included in the price of other articles. In line, the annual cost of checkout bags per person was calculated as follows: 42,000,000,000 yen/127,500,000 (Japanese population) = 330 yen.

Subsequently, the annual cost of substitute household waste bags needed when checkout bags are entirely cut was estimated. The prices of various types of polyethylene bag of average size (W400 × L500 mm) available in the community where the authors live were investigated. Based on the results of this investigation, the annual cost of substitutes was calculated, as shown in **Table 4**:

Table 3. Annual amount of oil savings.

	Per person	Total population
Amount of oil saved by checkout bag reduction	18.3 ml × 1.1 bags × 365 days = 7.35 L	18.3 ml × 50,700,000,000 bags = 927,800 KL
Oil needed to produce substitutes	18.3 ml × 1 bag × 365 days = 6.68 L	18.3 ml × 46,500,000,000 bags = 851,000 KL
Balance	0.67 L	77,000 KL

Table 4. Household waste bags available in Uji City, Kyoto.

Dimensions (mm × mm)	Thickness (mm)	Number of bags (pieces)	Price (including tax) (yen)	Price per piece (yen/piece)	Annual cost (yen/year)
450 × 500	0.015	10	123	12.3	4490
500 × 600	0.015	20	105	5.25	1916
400 × 600	0.015	25	105	4.2	1533

Based on this calculation, the annual cost of checkout bags may be estimated to be approximately 330 yen, and that of substitute household waste bags to be at least 1533 yen; as the former solely represents the cost price, it may be not appropriate to compare it with the market price, but the latter is more than six-fold of the former. This finding suggests that, if checkout bags currently available at a cost of 330 yen are entirely cut, it may be necessary for consumers to bear several-fold costs for substitutes. Such a finding simultaneously emphasizes the advantage of checkout bag use from the consumers' viewpoint.

To sum up, checkout bag reduction may not be economically valid; rather, it may result in an increased financial burden on consumers.

4. Conclusion

As previously discussed, the effect of checkout bag reduction may not be significant. Particularly, from an economic aspect, such a campaign may have a negative impact on consumers. On the other hand, the appropriate use of checkout bags may be more beneficial to both consumers and the environment than their reduction.

In addition, checkout bag reduction inevitably involves the problem of necessary substitutes. Considering that checkout bags are currently reused for diverse household purposes, this study examined the necessity of substitutes, limiting them to household waste bags; however, if checkout bags are entirely cut, a significantly negative effect may be expected. In contrast, if such bags with multiple functions are actively reused for a broader range of purposes, further products may be spared.

At municipal waste transfer stations, oil is used to incinerate kitchen garbage, and highly combustible checkout bags included in waste are regarded as an auxiliary material for the incineration; such reuse of checkout bags, in addition to that as household waste bags, may consequently lead to the more appropriate use of oil.

In conclusion, checkout bag reduction under the current circumstances may not be valid; although it may be significant in terms of superficial benefits, such as reducing the unnecessary use of checkout bags, it may be inappropriate to promote their reduction even from a long-term viewpoint. Up to the present, checkout bag use has been promoted in consideration of their potential as substitutes with multiple functions for a wide range of products; therefore, for the benefit of both people and the environment, it may be more appropriate to make full use of such functions by actively using them.

Needless to say, reuse is far better than recycling requiring energy; in line with this, reusing a checkout bag at least once as a waste bag may be a more effective environmental measure than recycling PET bottles.

REFERENCES

[1] "Plastic Bag Reduction," Accessed 8 June 2012. http://plasticbags.planetark.org/

[2] "Grappling with a Measure for Global Warming in Chain-Store Business," Accessed 8 June 2012. http://www.env.go.jo/council/06earth/y060-65/mat04.pdf

[3] "Annual Variation of Imported Volume of Polyethylene Bags 2006-2010," Accessed 8 June 2012. http://www.pof.or.jp/data/data/PEBag-y1.pdf

[4] K. Nakano, "The 25th Debate Agora 5," Accessed 11 June 2012. http://www13.big.or.jp/~yokayama/Agora/rejifu.doc

[5] Ministry of the Environment, "Survey of the Disposal of General Waste 2009," Accessed 11 June 2012. http;//www.env.go.jp/recycle/waste_tech/ippan/h21/data/env_press.pdf

[6] M. Motoki, "Research on the Life-System Wastes at Kumagaya-City, Saitama," Accessed 11 June 2012. http://www.geo.ris.ac.jp/~orc/happyou/pdf/p2-07.pdf

[7] K. Funaki, "Rejibukuro no Kankyoukeizaiseisaku (Japanese)," Recycle Bunka-Sha, Tokyo, 2006, pp. 46-47.

[8] K. Funaki, "Rejibukuro no Kankyoukeizaiseisaku (Japanese)," Recycle Bunka-Sha, Tokyo, 2006, pp. 28-29.

[9] Nikkei.com, Accessed 11 June 2012. http://nikkei.com/e/fr/freetop.aspx

[10] "Transition of Crude Oil Price (WTI)," Accessed 11 June 2012. http://ecodb.net/pcp/imf_usd_poiluti.html#index02

