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Ergonomics and Safety of Manual Bag Sealing

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A variety of seals is used to close bags. Each seal has advantages and disadvantages. For shop assistants sealing bags could be a repetitive physically demanding action. Opening and closing the bags again can cause some discomfort or annoyance for consumers. Besides, it is an activity which can endanger safety, i.e., knives being used in opening, children swallowing the systems of sealing. To prevent these problems a new sealing system was developed.

In this paper the opinion of shop assistants, consumers and experts on several bag sealing systems was studied. It appeared that for sealing plastic bags, adhesive tape with paper is the best out of 4 systems, closely followed by adhesive tape. It is discussed that for the elderly, there is still room for improvement in opening bag seals.

ergonomics safety comfort

1. MANUAL BAG SEALING

Customers continually expect a faster, more efficient and more thorough service at supermarkets [1], but also in other shops where bags are sealed. Manual bag sealing is often used in shops where products are sold that have to be protected for hygienic reasons (meat or bread) or to bundle several smaller products (candy). A variety of seals is used to close these bags. Shop assistants use these seals mainly to close plastic bags, whereas the consumer opens these bags at home and often seals them again. For shop assistants sealing the bags is a repetitive physically demanding action, which takes some time and could cause discomfort, because of the physical load in combination with

the time pressure. Several studies show the negative effects of high frequent movements in combination with force exertion in poor working postures [2, 3]. Opening and closing the bags again can cause some discomfort or annoyance for consumers if they cannot open the bag or when the seal does not close the bag well enough. Besides, it is an activity which can endanger safety, because children could swallow the systems of sealing.

2. DEVELOPMENT

To seal plastic bags several systems are available. However, consumers and shop assistants mention that most of these have disadvantages. Some could be hazardous, because children could swallow

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bag sealing products. Some consist of adhesive tape, which could be difficult to open and some consume much time in bringing the sealing around the plastic bag. Knowing these potential shortcomings, Twin Seal developed a new system of sealing. After various ideas and prototypes it resulted in a system with an adhesive tape, which has a piece of paper at both ends to prevent them from sticking together. The idea is that shop assistants could save time, because a special machine fastens the seals. Consumers could experience more comfort in easy opening the bag and it should be safer, because it is more difficult to swallow by children.

3. USER RESEARCH

To study whether the assumed improvements were also experienced by end-users, an evaluation was set up. A comparative test concerning discomfort,

safety and efficiency of four different seals of plastic bags was performed. This test was done by both shop assistants (for sealing) and consumers (for opening and sealing again). The tested seals were (Figure 1) (a) a paper or plastic covered ironware, (b) a metal clip, (c) adhesive tape and (d) the new adhesive tape with a piece of paper in between.

Systems c and d are always used in combination with a tape-machine (Figure 2). Therefore, in this test these two sealings were tested in combination with the tape-machines.

The research questions are:

1. Which system do shop assistants prefer?
2. Which system do consumers prefer?
3. How do the different kinds of systems score on safety?
4. What is the final evaluation?

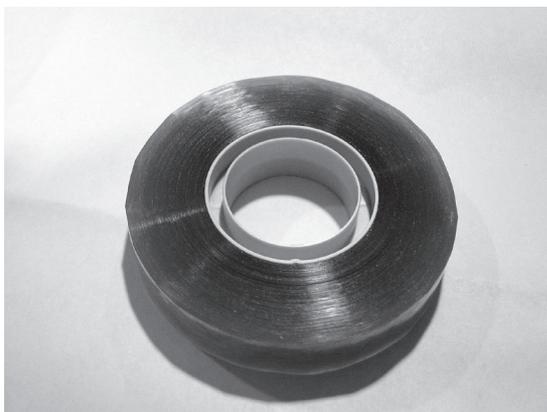
(a)



(b)



(c)



(d)



Figure 1. The four different seals compared in the test: (a) a paper or plastic covered ironware, (b) a metal clip, (c) adhesive tape and (d) new adhesive tape with a piece of paper in between.

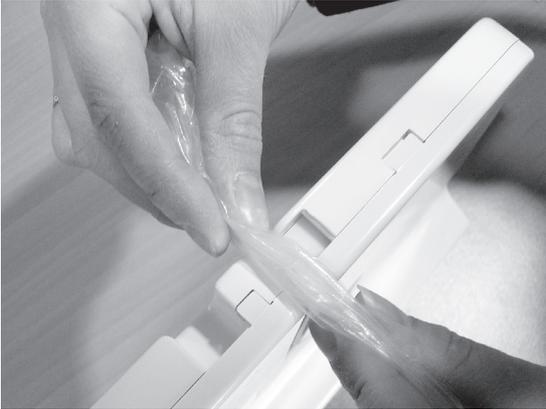


Figure 2. Example of a tape-machine often used to seal bags with adhesive tape.

4. METHODS

Twenty shop assistants (16–50 years old, average age 31.5 years), 24 consumers (8–85 years old, average age 40.3 years) and 5 experts on ergonomics and safety participated in the study. The shop assistants evaluated the sealing of the bags, the consumers evaluated the opening and sealing, and the experts evaluated the safety and also the user-friendliness and physical load. The shop assistants were employees of a bread and meat products department who have to seal many bags daily. Three groups of consumers were selected: 8 youngsters (age 8–19, average 13 years), 8 adults (age 26–51, average 34.4 years) and 8 seniors (age 57–85, average 73.4 years age). Every participant evaluated the four seals. To answer the four research questions the study consisted of four activities:

1. During the sealing done by the shop assistants, the time of sealing five bags one after the other was measured. The time started the moment the first bag was picked up and ended when the fifth bag was laid down. The average time for every seal was measured and tested with a *t* test for paired comparison ($p < .05$). Video recordings were made. The experts evaluated these recordings. After using all systems, every participant was asked to complete a questionnaire with questions about efficiency, safety and the experienced comfort and discomfort.
2. The opening of the bags was tested by 24 consumers. The consumers were selected

at sports fields (youngsters), among family and friends (adults) and in a residence for the elderly (seniors). The subjects were informed that TNO, an independent research organisation, wanted to know which of the four sealing system was preferable. After opening five bags of each type of sealing system every participant was interviewed with questions regarding discomfort, physical load and user-friendliness. Some subjects were also recorded on tape to be used in the expert session.

The video recordings were analysed in the expert session. The experts also sealed with the four systems. Their opinions on safety, physical load and productivity were based on the video and their own experience. The expert panel consisted of five experts (two industrial designers, one movement scientist, one ergonomics expert and one product safety expert).

3. The issue of safety was studied based on the observations and video recordings as well as in an expert panel. Also, additional information was gathered by mind mapping on what and who could be found in the neighbourhood of the bag sealing products. In the questionnaires for the consumers and shop assistants the subjects had to give a rating for the safety per system.
4. For the food industry it could be of help if a total evaluation was available to know which system was best. Therefore, all consumers and shop assistants were asked which element was most important: safety, user-friendliness, quality or work pace. The expert panel made a total judgement over all systems, having all the data available. A table was made with ++ (*very good*), + (*good*), = (*neutral*), - (*bad*), -- (*very bad*) with all separate evaluations and a total expert judgement.

5. RESULTS

5.1. Sealing by Shop Assistants

Regarding comfort, the average score of the shop assistants was higher for the usual adhesive tape and the adhesive tape with paper than for the other two systems. Regarding its use, the majority of the

shop assistants called the ordinary adhesive tape and the adhesive tape with paper *very easy* to use, whereas the plastic covered iron and the clip were *very difficult* or *difficult* to use (Figure 3).

The physical workload estimated by the experts on basis of the video recording was *lowest* for the tape-and-paper system and the tape system. The tape system was *somewhat better* because less force was needed to push the bag downwards. Both other systems had a *higher* physical load, because various repetitive handlings were needed.

The recorded sealing time for adhesive tape and adhesive tape with paper was significantly lower (Figure 4; *t*-test paired comparison, $p < .05$) than for the other two systems.

5.2. Opening by Consumers

Fair and *good* use in opening was found in the paper- or plastic-covered ironware and in the metal clip for all ages (Figure 5). Youngsters and adult consumers also rated the adhesive tape with a

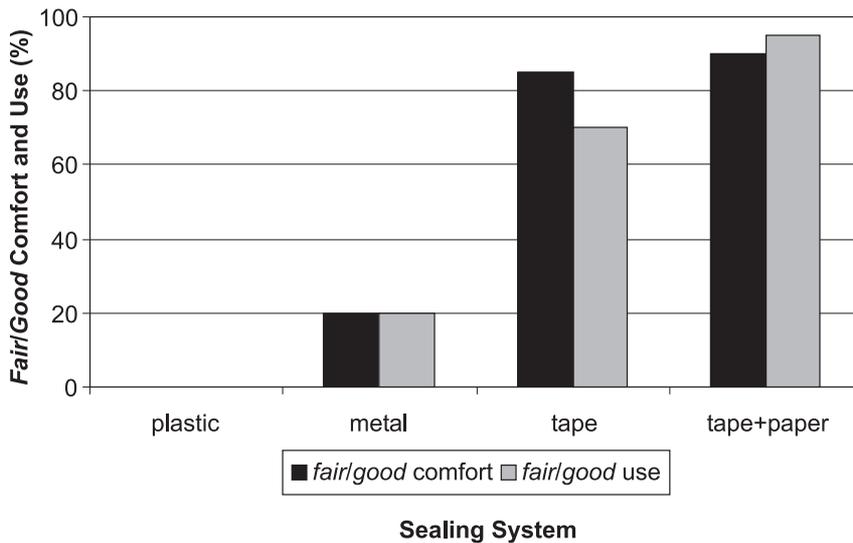


Figure 3. Percentage of the 20 shop assistants rating the comfort and use of the four bag sealing systems *fair* or *good*. A 5-point scale was used (*bad, moderate, neutral, fair, good*).

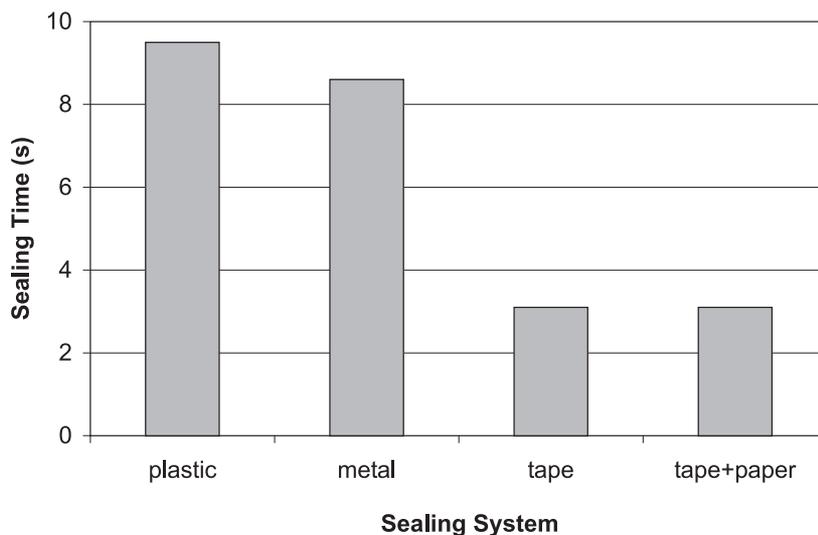


Figure 4. The recorded sealing time for the four types of sealing systems averaged over 20 shop assistants each sealing five bags (100 recordings per tape).

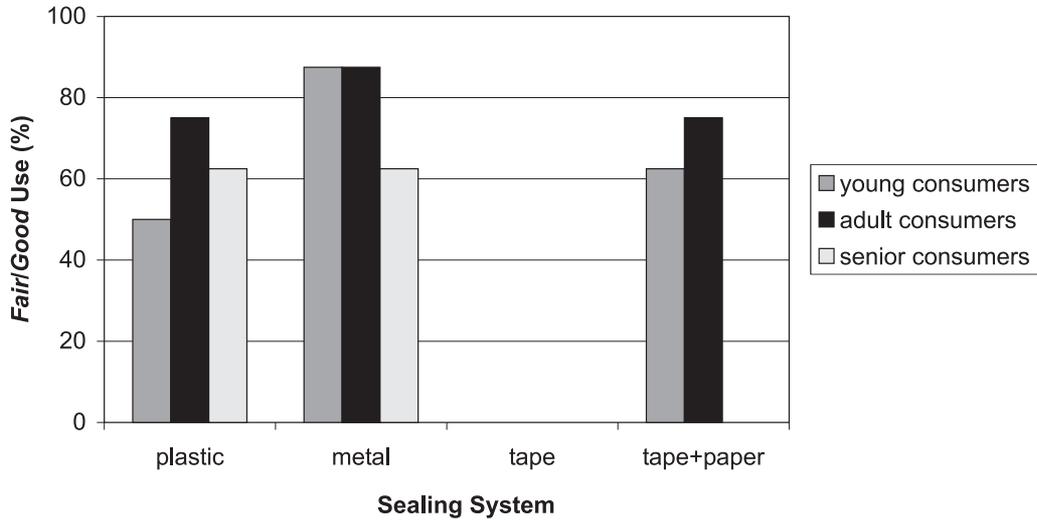


Figure 5. The opinion of consumers on the opening of plastic bags sealed with the four systems. The percentage of consumers (youngsters, middle-aged, elderly) defining the system as fair or good is given for the four systems.

piece of paper in between *fair* or *good*. No groups appreciated the use of the adhesive tape system in opening bags.

Regarding comfort a comparable result was found (Figure 5). *Fair* and *good* comfort in opening was found in the paper- or plastic-covered ironware and in the metal clip for all ages. Youngsters and adult consumers also rated the adhesive tape with a piece of paper in between *fair* or *good*. The comfort of the adhesive tape system was *low* or *neutral* in opening bags by all groups. Seniors rated the comfort *relatively low* for all systems.

When we asked the preference of the groups, seniors preferred the metal clip (56%) (although the seniors did not experience any seal as comfortable). Adults appreciated the adhesive tape with paper (50%) and youngsters preferred the adhesive tape with paper as well (46%). Seniors mentioned problems with opening the adhesive tape with paper, because this action required muscle strength and fine coordination.

5.3. Safety

The experts’ opinion was that safety was an important item and mentioned risks of the different seals. One of the aspects was that a loose plastic-covered iron or clip could fall or slide to an area where children could find it. A child could put it into the mouth and swallow it. The experts also mentioned the danger that a small part of the clip

might break off, which could also be swallowed. For both the ordinary adhesive tape and the adhesive tape with paper this risk was smaller.

Other risks, which were mentioned by the experts, were that you could possibly prick or cut yourself on the sharp edges of the plastic-covered iron or the clip. Shop assistants could hurt their hands at the sides of the machines which produced an adhesive tape seal. This was confirmed by shop assistants who said that they sometimes cut their fingers on the metal clip or pricked on the plastic covered iron. Six out of 9 shop assistants that regularly worked with the metal clip mentioned cutting injuries in the fingers and 2 in the hand. Two out of 13 shop assistants that worked regularly with tape mentioned hand injuries and 1 mentioned finger injuries.

Both the expert panel and the consumers mentioned the possibility of getting injured by using a knife, fork or scissors to open both adhesive tape seals. This risk was higher in the adhesive tape without paper, because the chance that a consumer would use a scissor or knife was higher. Figure 6 presents the total score for safety of the four seals given by the shop assistants and the consumers.

The adhesive tape with paper was evaluated as the safest by the expert panel. This was somewhat different from the score by users. In Figure 6 the total score for the safety of the four seal systems was given by the shop assistants and the

consumers. In fact all systems were evaluated safe enough. In Figure 7 shots of the video recording are shown that were used in the expert session.

5.4. Overall Score

Most (59.3%) shop assistants preferred adhesive tape with paper (Figure 8). Looking at the results of the consumers the scores are less evident. Their preferences differed and showed an equal division. Approximately 30% preferred the plastic-covered iron, clip and adhesive tape with paper (respectively 34.6, 30.8 and 30.8%). If a division is made between the three ages it is clear

that seniors prefer the metal clip and the young and adult groups prefer the tape-and-paper followed by the plastic clip.

In Table 1 the judgements of shop assistants, consumers and the expert panel are summarized. The table with the total score has some arbitrary elements. However, the expert panel agreed on the scores. Because of positive scores on safety, physical load, comfort/use and the high speed mentioned by shop assistants the tape-and-paper system was evaluated as the best, which means that this development is successful.

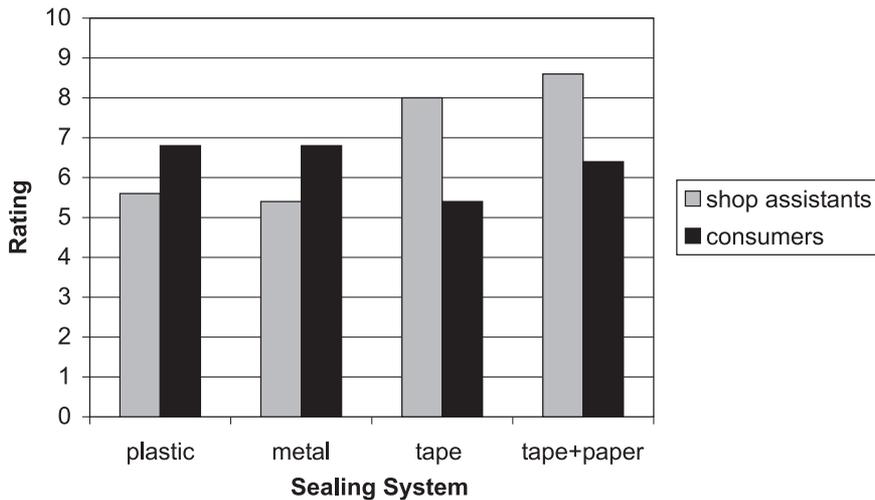


Figure 6. Rating on a scale from 1 to 10 given by the 24 consumers and 20 shop assistants regarding the safety of the different systems (0—unsafe, 10—extremely safe).



Figure 7. Shots of the video recordings used by the expert panel.

TABLE 1. Summary of the Scores for the Four Sealing Systems

Sealing System	Shop Assistant			Consumer		Expert		
	Speed	Safety	Comfort/Use	Speed	Comfort/Use	Physical Load	Safety	Total Score
plastic	-	+/-	-	+	+	--	-	-
metal	-	-	-	+	+	-	-	-
tape	++	++	+	--	--	++	-	+/-
tape + paper	++	++	+	+/-	+/-	+	+	++

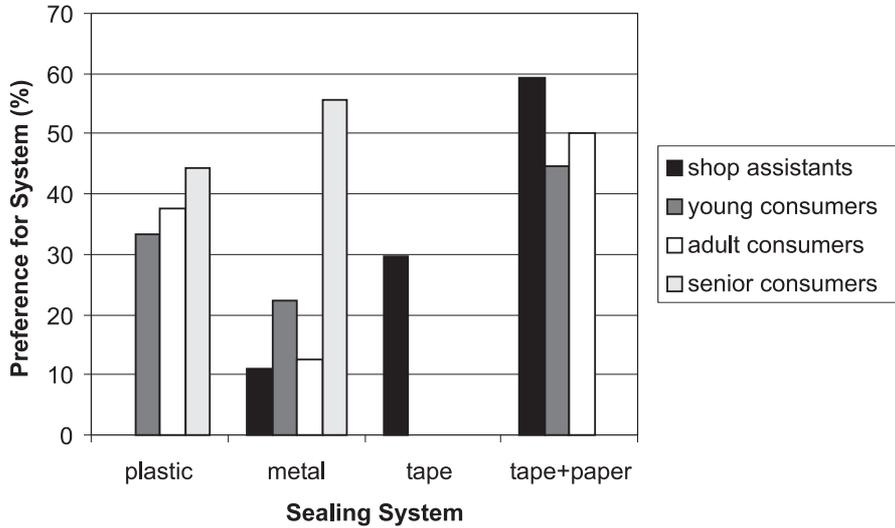


Figure 8. Percentage of the consumers and shop assistants that chose the sealing system as the most preferred sealing. Notes. The total percentage is higher than 100%, because almost half of the subjects mentioned two preferences.

6. CONCLUSION

A simple activity of sealing could play a role in prevention of musculoskeletal injuries or hazardous situations. A new system was developed and rated positive regarding comfort by most end-users and can certainly be seen as an improvement. So, the new system should be promoted. However, further instruction to end-users is needed regarding safety and, if possible, innovations should be found making unsealing easy for everyone, including seniors.

Based on this study the following conclusions are drawn:

- For sealing plastic bags adhesive tape with paper is the best out of the four systems, closely followed by adhesive tape. Both seals score well as far as speed and safety are concerned. Also regarding comfort these two seals are the best. Consumers prefer the system of the adhesive tape with paper and it is evaluated safer by the experts. The physical load of sealing with adhesive tape is evaluated more positively than sealing with adhesive tape with paper.
- The consumers think that the plastic-covered iron and the clip open fastest and they think these are the easiest ones to use. Consumers prefer plastic-covered ironware, clip and adhesive tape with paper above the adhesive tape. Youngsters and adults prefer adhesive

tape with paper. For seniors there is no seal available, which is in their opinion easy and comfortable in its use. Safety is evaluated better for sealing of adhesive tape with paper.

- According to shop assistants the sealing of bags with both systems with adhesive tape is the easiest and fastest. However, consumers mention that the seal without paper is the most difficult to open. Besides they also mention the difficulty to reseal the bags after opening. In short, there is still no seal which is experienced to be comfortable by all shop assistants and all consumers.
- If we had to recommend a seal it would be the seal of adhesive tape with paper. This is because sealing plastic bags is a daily intensive activity for shop assistants.

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