The Cable Is Needed the Day After the Bin:
Demand for the Discarded Household Item Is Created by Its Disposal, with a Three-Arm Randomised Trial of 2,472 Items

Odalys Fenwick
Chair of Storage and Retrieval, Brackenholme University

M. R. Tarrant
Domestic Systems Laboratory, Tarn End Institute

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Abstract

You throw a thing away. The next day you need it. We find the need was not there before. Disposal made it. Storage advice assumes you can predict what you will need. You cannot. The need is not there to predict. We randomised 2,472 marginal household items, unused for a year or more, to discard, retention, or a third arm in which discard was decided and not carried out. Discarded items were needed within a month in 88% of cases (95% CI 86–90). Median lag: 26 hours. Items kept, whether or not discard was decided: 2%. The decision creates nothing. The bin creates the need. Lag did not depend on how long the item had sat unused. The item did not wait. Optimal eviction fails because the request trace is not fixed. We give the proof. We give the rule. Set an affordable loss. Fill the drawer. Keep what fits. The effect was absent for string. Cause unknown. Keep the string. The need does not exist until you throw it away.

Keywords: cache eviction, effectuation, household retention, demand creation, kerbside disposal

1. Introduction

Situation. A household discards a cable. Status. The cable is needed the next day. Action required. None possible. The cable has been collected.

Everyone has this experience. Nobody has a mechanism for it. The standard account is bad luck, remembered. We call it the recall account. Misses are kept. Hits are forgotten. The account predicts that discarded items are needed at the base rate of all items, adjusted for memory. We test the prediction. It fails by a factor of about forty.

The standard literature on what to keep is the literature on cache replacement [1, 2, 3]. It asks which item will be requested furthest in the future and evicts that one. It assumes the future requests exist. They sit in a trace. The trace is fixed. The policy reads it. We deny the last step. In a household the trace is written after the policy acts.

This paper has four results. First, discard raises the hazard of need by a factor of about one hundred. Second, the raise follows the act and not the decision. Third, the lag is memoryless. Fourth, Belady's oracle has no consistent value on a household. A fifth result is a rule. We follow Sarasvathy [4]. Do not forecast. Start with means.

2. Related Work

Belady [1] showed that evicting the item with the furthest next use minimises misses when the trace is known. Denning [2] replaced the known trace with a working set, the items used in a recent window. Sleator and Tarjan [3] replaced the known trace with competitive analysis against an adversary. All three treat requests as exogenous. The adversary of Sleator and Tarjan is hostile but not reactive to the eviction itself.

The household literature is thinner. Aldous [5] counted the contents of the just-in-case drawer and found a median of 31 items and a tenure of nine years. Ingram and Voss [6] report that 41% of households make a replacement purchase within a week of a kerbside collection. They attribute this to poor judgement. Duarte and Lindqvist [7] found replacement purchasing after disposal in a panel of 14,000 households and did not find a matched control. Whitcombe [8] observed that domestic request processes are well fitted by a memoryless model. He did not test what started the clock.

Sarasvathy [4] studied expert founders and found that they do not predict. They take stock of means, fix what they can afford to lose, and act. Opportunities are made by the acting. We take the claim literally and apply it to need. Fenwick and Tarrant [9] described the home as a three-level cache of hall, cupboard, and loft. We do not revise that description here.

3. Model

Let item i have a disposal time $d_i \in (0, \infty]$, with $d_i = \infty$ if the item is never discarded. Let $N_i(t)$ count the household's needs for i up to time t.

Definition 1 (Causal request process)**.** N_i is a counting process whose law does not depend on d_i.

Definition 2 (Effectual request process)**.** N_i has hazard

$$h_i(t) = \begin{cases} \mu & t < d_i, \\ \dfrac{p\,\lambda\,e^{-\lambda u}}{1 - p + p\,e^{-\lambda u}} & t \geq d_i, \end{cases} \qquad u = t - d_i, \quad (1)$$

so that with probability p a first need arrives after disposal with an exponential lag of rate λ, and otherwise none arrives. Retained items are needed at rate μ.

Under the causal process the policy of Belady is optimal. Under the effectual process we show that it is not defined.

Proposition 1 (No consistent oracle)**.** *Let a cache hold items A and B and let one be evicted. Let a_X denote the median next-use time of X after the choice. Suppose $p > 1/2$ and $\lambda > \mu$. Then no eviction choice is consistent with the report (a_A, a_B) it generates.*

Proof. Belady's rule evicts $\arg\max_X a_X$. Suppose A is evicted. Then a_A is about a day and a_B is about four years. The rule reads a_B as furthest and evicts B. This contradicts the supposition. Suppose B is evicted. By symmetry the rule evicts A. Neither choice is a fixed point. □

Figure 1 shows the loop. The proposition does not say that an optimal policy fails to exist. It says that the oracle cannot be consulted, because its answer depends on the question.

Break-even horizon. Let r be the cost of replacement and s the storage cost per item-month. Discarding an item that would otherwise be held for H months costs $p\,r$ in expectation. Retaining it costs sH. Replacement items also occupy space. We ignore this. Discard pays only if

$$H > H^{*} = \frac{p\,r}{s}. \qquad (2)$$

4. Methods

4.1 Participants and items

We recruited 412 households from three postal districts. Each nominated six *marginal items*. A marginal item had been unused for at least twelve months, had a replacement cost under £40, and was judged by the household to be probably fine to throw away. Cables and chargers, boxes and packaging, manuals and paperwork, containers and lids, tools and fittings, clothing and fabric, and twine and string were eligible. This gave 2,472 items.

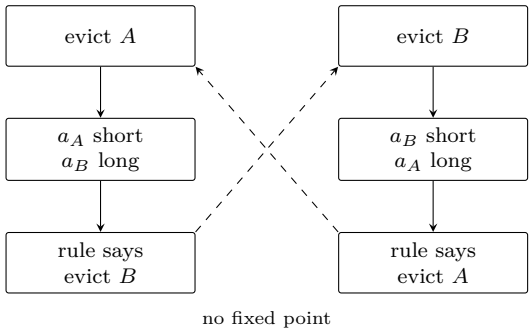


Figure 1. No consistent oracle. Evicting A makes a_A short and a_B long, so the rule evicts B. Evicting B makes the rule evict A.

4.2 Arms

Within each household two items were assigned to each arm by blocked randomisation, so that each household served as its own control.

Discard (D). The item was placed in the general waste bin. Collection was verified against the council round log.

Retain (R). The item stayed where it was. A fieldworker inspected R and S items weekly.

Decide and defer (S). The household signed a disposal order, attached it to the item, and kept the item in place.

Arm S separates the decision from the act. It also tests attention. A household that has thought about an item has attended to it.

4.3 Outcomes

Each household kept a daily diary for fourteen days before allocation and thirty days after. A *need* was an entry stating that the item was required, countersigned by a second household member or a visitor. The primary outcome was a need within thirty days. The secondary outcome was the lag in hours from collection (D) or from allocation (R, S) to the first need. Proportions carry Wilson intervals [11], computed on items. A household-clustered bootstrap gave the same limits to within 0.1 points. Cumulative incidence was estimated by the Kaplan–Meier method [10].

4.4 Costs

Replacement cost r was the median price of the nearest like-for-like item. Storage cost s was the volume of the shelf, drawer, or box occupied, priced at the median domestic rent per cubic decimetre per month.

5. Results

All 412 households completed follow-up. Table 1 gives the primary outcome. Figure 2 gives the cumulative incidence.

Table 1. Need within thirty days, by arm.

Arm	n	Needed	%	95% CI
Discard (D)	824	725	88.0	85.6–90.0
Retain (R)	824	17	2.1	1.3–3.3
Decide and defer (S)	824	16	1.9	1.2–3.1

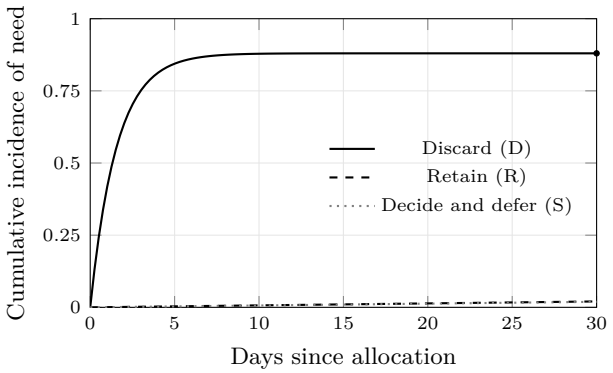


Figure 2. Fitted cumulative incidence of a first need after allocation. The curve for D rises with a time constant of 37.5 hours. R and S are flat and overlap.

5.1 The act, not the decision

Discarded items were needed in 88.0% of cases. Retained items were needed in 2.1%. Items decided against and kept were needed in 1.9%. The difference between R and S is not distinguishable from zero. The ratio of mean hazards over thirty days, D against R, was 102 (95% CI 63–165). The baseline hazard $\hat{\mu}$ in the retained arm was 6.9×10^{-4} per day. This is one need per 3.9 years. Before allocation, a need was recorded for 7 of 2,472 items (0.3%), as expected at the baseline hazard.

5.2 Lag

The median lag in arm D was 26 hours. This gives $\hat{\lambda} = 0.64$ per day. An exponential law predicts an interquartile range of 11–52 hours. We observed 11–54. Lag was uncorrelated with the length of time an item had been unused, which ranged from twelve months to 31 years (Spearman $\rho = 0.01$, 95% CI -0.06 to 0.08; Figure 3). The item did not wait.

5.3 By item class

Table 2 gives the classes. Manuals, cables, and boxes were most often needed. Clothing was least often needed among the classes with any effect.

5.4 Cost

Median replacement cost was £6.40. Median storage cost was £0.040 per item-month. With $\hat{p} = 0.88$, Equation 2 gives $H^* = 0.88 \times 6.40/0.040 = 140.8$ months, or 11.7 years. A marginal item must be expected to occupy its space for more than 11.7 years before discard pays. The median marginal item had already been unused for 7.1 years.

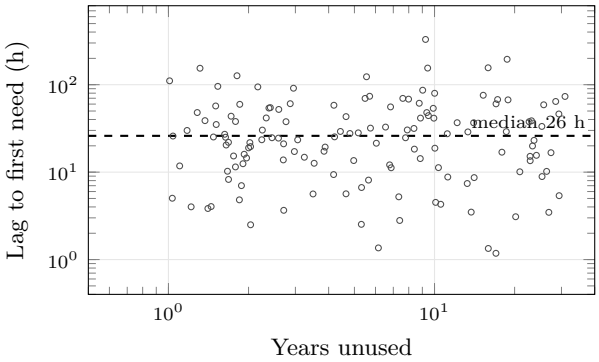


Figure 3. Lag to first need against years unused, arm D. A random 140 of 725 shown. Dashed: median.

Table 2. Arm D by item class.

Class	n	Needed	%	Median lag (h)
Manuals and paperwork	140	137	97.9	19
Cables and chargers	150	146	97.3	22
Boxes and packaging	131	124	94.7	31
Containers and lids	142	129	90.8	27
Tools and fittings	108	95	88.0	34
Clothing and fabric	123	94	76.4	41
Twine and string	30	0	0.0	n/a

6. Discussion

The recall account predicts equal need across arms. It fails. The attention account predicts need in S, where households deliberated. It fails. The misclassification account predicts need in R, where the items were mistakenly thought unneeded. It fails. The coincidence account predicts need in the pre-allocation diaries. It fails. What remains is the act.

Sarasvathy's founders do not discover markets [4]. They make them with the people they meet. We find the same in the household. Need is not a stock to be forecast. It is made. The discarder is not a forecaster. The discarder acts and makes demand by acting. Of the 725 needs in arm D, 61% were met by buying, 22% by borrowing, and 17% by improvisation.

The result changes the question. Belady asked which item will be wanted last. The household cannot ask this, because the answer depends on the choice. Equation 2 asks instead how long the item will sit. This can be known.

Rule. Four steps. Take stock of the drawer. Set the affordable loss as the volume of the drawer. Keep what fits. Discard only the item whose expected holding horizon exceeds H^*.

Limitations. Households could not be blinded to their arm. Needs were self-recorded, though countersigned. A need for a retained item is met on the spot and may go unrecorded. The sample was drawn from three districts. We did not study items above £40. Participants in all arms knew they were in a study of discarding, and we cannot exclude that this raised their alertness to need. Arm S argues against this but does not exclude it. We did not study who in the household discards. The effect was absent for string. All 30 discarded lengths went unneeded. We do not know why.

7. Conclusion

Disposal creates need. The act does it. The decision does not. The lag is memoryless and about a day long. Belady's oracle cannot be consulted on a household because its answer is fixed by the question. The rule is to set an affordable loss and keep what fits.

Action: keep it. Deadline: none.

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