

## Determinants of Littering: An Experimental Analysis

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Littering, the improper disposal of small quantities of waste, is one of the main causes of environmental degradation. To protect the environment from this degradation, we need to factor out the determinants of littering behaviour. In this study, we conduct a controlled laboratory experiment to examine whether people would avoid littering if the social cost of this behaviour was internalised. Based on the microeconomic theory relating to externality, we test whether penalising littering decreases its level compared to when it is not. The results indicate that when the cost of production of littering is internalised, the level of littering drops.

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*Keywords:* Litter, Externality, Private Cost, Internalisation, Experiment, Baseline Treatment, Cost Treatment

### 1. INTRODUCTION

The careless and improper disposal of small quantities of waste is defined as littering [Geller, *et al.* (1982); Stokols and Altman (1987); Keenan (1996)]. Keep America Beautiful (2009) shows that improper litter disposal poses a threat not only to human, animal, and plant life, but also to man's economic prosperity. Raffoul, *et al.* (2006) show that along with polluting surface and ground water, littering is one of the main causes of transmission of diseases like dengue and leptospirosis. Additionally, littering makes the environment unpleasant, causes vehicle accidents and puts children at risk of cuts and infections in public places like parks and grounds.

Studies show that various factors lead to littering. For example, people litter when they are too lazy to dispose their waste properly [Ojedokun and Balogun (2011)], when they argue that everyone else is doing it [Campbell (2007)] and when there is lack of waste bins nearby [Williams (1997); Keep America Beautiful (2009); Ojedokun and Balogun (2011)]. The findings of other researches also suggest that litter begets litter [Dur and Vollaard (2012)], and that littering persists when the private cost of disposing litter correctly is very high [Torgler, *et al.* (2008)].

Most of the available literature uses field surveys for data collection which makes it difficult if not impossible to isolate the impact of a certain variable of interest without controlling for the other factors. In this study we isolate the impact of the internalisation of the social cost of littering on the level of production of littering by using a controlled laboratory experiment. In a controlled laboratory experiment it is possible for the experimenters to examine the impact of a single factor on littering while controlling for the remaining factors that may influence littering behaviour.

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Our experiment has two treatments: in the Baseline treatment, the participants do not bear the private cost for littering whereas in the second treatment (which we term as the ‘Cost treatment’), each participant bears the private cost for littering. Based on the microeconomic theory regarding externality, we hypothesise that an individual will litter more when littering has no private cost as compared to when there is a private cost associated with littering. This private cost may take various forms such as disapproval by others (social cost), remorse and guilt (conscious cost), jail or doing community service (legal cost), or fines etc. (monetary cost). This study examines the impact of monetary cost only. The rationale is that monetary cost is easier to quantify in comparison to the rest of the private costs. Our study finds that the internalisation of the social cost of littering decreases the level of production of littering. On the other hand, littering is more prevalent when individuals do not bear any private cost for the creation of littering.

The rest of the paper is organised as follows: the next section is devoted to literature review; Section 3 explains the theoretical framework and the hypothesis; Section 4 discusses results, and Section 5 draws the conclusion.

## 2. LITERATURE REVIEW

A volume of studies is available on the issue of littering. Some studies address the question ‘why people litter?’, some examine the factors affecting the amount and frequency of littering, while some discuss ways to improve littering behaviour for a cleaner environment. A complete review of such literature is beyond the scope of the present study; hence we provide a brief review of studies relevant to our research question in the following paragraphs.

Various researchers have explored the role of laziness in littering behaviour. For example, a study conducted in Nigeria shows that littering is an automatic and routine behaviour as it is easy and comfortable [Ojedokun and Balogun (2011)]. Campbell (2007) concludes that many people litter simply because they do not bother to walk up to a waste basket. Likewise, Williams (1997) states that one of the major reasons of littering is indolence.

Dur and Vollaard (2012) test whether litter begets litter and find that littering increases significantly when regular cleaning is not done. Some other studies show that the presence of litter is an incentive for further littering. [Krauss, *et al.* (1978); Reiter and Samuel (1980); Heberlein (1971); Robinson (1976)]. Other contributing factors to littering are age. Research shows that younger people—especially between the ages of 17 and 19—tend to litter more than older people [Beck (2007)]. Moreover, when the personal cost of disposing waste materials correctly is high in terms of time and energy spent, individuals litter more [Torgler, *et al.* (2008)].

Ojedokun and Balogun (2011) further add that low altruism, low self-efficacy, low locus of control, and low self-concept lead to a positive attitude towards littering whereas higher education and awareness lead to a negative attitude towards littering. Arafat, *et al.* (2007) and Al-Khatib, *et al.* (2009) report that socio-cultural factors such as gender, marital status, monthly income, religious convictions, education level, age, and type of residence all have an impact on littering behaviour. Littering is also more frequent in situations when the person is in a hurry, the item is biodegradable, there is a sense that someone else will pick it up, and when the item is not recyclable [Keep America Beautiful (2009)]. Several studies further state that littering practice is often the result of non-availability of a trash basket nearby [Finnie (1973) and Keep America Beautiful (2009)].

The above analysis shows that extensive research is available on littering. However, to our knowledge, there is no study except of Torgler, *et al.* (2008) which evaluates the impact of internalising the social cost of littering. The focus of Torgler, *et al.* (2008) to an extent, is close to our study; yet, their study is based on European Values Survey, (1999-2000) and is much broader in nature. On the other hand, we focus on a single variable and examine whether internalising the social cost of littering decreases the levels of littering. While the subject matter of our question has been discussed extensively in microeconomic theory, little empirical evidence from a controlled laboratory experiment exists.

### 3. THEORETICAL FRAMEWORK AND HYPOTHESIS

The study is based on the concept of negative environmental externalities. Environmental externalities refer to the economic concept of “uncompensated environmental effects of production and consumption that affect consumer utility and enterprise cost outside the market mechanism” [Glossary of Environment Statistics (1997)]. When negative externalities are associated with an economic activity, governments usually intervene in the form of bans, taxes, fines, etc. The purpose of these measures is to act as deterrents and to internalise the negative impact of economic activities on a society. Following the basic assumption that all economic agents are rational and wish to maximise their welfare, it makes intrinsic sense that if there is a monetary cost associated with an action such as inappropriate removal of waste, the economic agents will become wary of what they throw on the ground and endeavour to curtail it in order to capitalise on their earnings.

Based on the idea of negative externality discussed above, the present study examines whether the negative externality of littering can be internalised by associating a cost to the act by imposing a fine on the litterers. The hypothesis of the study is thus: littering is likely to be lower if the private cost of its production is high.

#### 3.1. Experimental Procedure

The experiment consists of two treatments, namely the Baseline treatment and the Cost treatment. The participants of the experiment are undergraduate students belonging to the School of Economics, Quaid-i-Azam University, Islamabad.

The participants of the experiments were selected at random by using the ballot system to decide which semester's students would be asked to sit for which treatment. We wrote down the number of semesters on paper chits and put them in a box.<sup>1</sup> This was

<sup>1</sup>It is pertinent to mention that at the time of the study, three batches were enrolled in the School of Economics (QAU). The first batch students were in their 5th semester while the second and first batch students were in their third and first semester, respectively. Our protocol is between treatments, reason being that we have to collect and count the number of litter pieces produced after students have left the experimental room. Hence, we could not have the within treatment protocol. Additionally, we invited students of different semesters for the two treatments because inviting students of the same semester for both treatments could contaminate the data as students could discuss the experiment with each other during the interval time period. Running both treatments at the same time could solve the issue of running both treatments on the same semester students, however, the constraint of space and number of experimenters did not make that possible.

followed by a blind selection of two chits from the box. Consequently, students of third semester were asked to participate in the Baseline treatment whereas the students of first semester were asked to participate in the Cost treatment (all students were informed beforehand that participation was voluntary). The experiment was conducted in October 2012. The detail of each treatment follows:

### 3.1.1. Baseline Treatment

In the Baseline treatment, there were 40 participants. Each participant was given some coloured sheets with squares drawn on them, 1 pair of scissors and 2 envelopes. One of the envelopes was labelled “Use Me for Squares” and the other was labelled “Use Me for Waste Material”. The instructions required participants to cut as many squares drawn on the coloured sheets as possible within three minutes and put those squares into the envelope labeled “Use Me for Squares”.<sup>2</sup> There was no monetary cost of littering and the monetary compensation to the participants followed the criterion given below:

$$\text{Monetary Reward} = (\text{PKR } 10 * \text{Number of completed squares}) - (\text{PKR } 0 * \text{Number of pieces of litter})$$

Participants were informed that 10 percent (4 out of 40) from among them will be randomly chosen using the ballot system (all participants were seated on numbered chairs) and paid PKR 10 for each completed square at the end of the experiment.<sup>3</sup> The experiment lasted half an hour. The randomly chosen participants were paid cash at the end. The earnings of each of these 4 participants were between PKR 40 to 50. The participants were not paid any show-up fee.

### 3.1.2. Cost Treatment

The second treatment was similar to the Baseline treatment: the only difference was that the instructions clearly mentioned that the monetary compensation to the randomly selected individuals would be deducted if extra pieces of paper were found around them (i.e. if they produced litter). As such, a private cost for littering was introduced in this treatment. The rest of the procedure was the same as in the Baseline treatment but with a different group of students. The compensation to the randomly chosen participants was given based on the following criterion:

$$\text{Monetary Reward} = (\text{PKR } 10 * \text{Number of completed squares}) - (\text{PKR } 5 * \text{Number of pieces of litter})$$

The randomly chosen participants were paid cash at the end of the experiment. The earnings of each of these 4 participants were between PKR 20 to 30.

<sup>2</sup>See Appendix A for the full instructions used in the Baseline treatment and Cost treatment.

<sup>3</sup>Questions inevitably arise concerning the non-seriousness of participants regarding payoffs in this game. However, the procedures employed (paying off in 1 out of 10 subjects) are comparable to other experimental research in this area. For example, in Kagel, *et al.* (1996) subjects participate in 10 bargaining periods against different opponents in an ultimatum game and they are paid conditional on their bargaining outcomes for one period which is selected randomly at the end of the session.

#### 4. RESULTS AND DISCUSSION

For statistical analysis, we report one-tailed Wilcoxon rank-sum test as the data of our study does not come from a population with a normal distribution. The reason to report one tailed Wilcoxon rank-sum test is that we have ex-ante hypothesis about the impact of cost on littering.

Table 1 shows the descriptive statistics across treatments. The table compares the mean, mode, and standard deviation of the number of completed squares, the number of litter pieces inside the waste envelope, and the number of litter pieces outside the waste envelope across treatments. The mean number of squares cut by each individual in the Baseline and Cost treatments is 4.4 and 4.1, respectively. However, the mode remains the same at 0 in both treatments. On the other hand, the mean number of litter pieces inside the waste envelopes in the Baseline and Cost treatments is 1.0 and 2.18, respectively, while the mean number of litter pieces outside the waste envelope in the Baseline and Cost treatments is 7.25 and 4.75, respectively. In addition, there is a sharp drop in the mode from 9 in the Baseline treatment to 0 (zero) in the Cost treatment. It appears that internalisation of cost does decrease the level of litter outside the waste envelope; however, some participants show careless behaviour towards littering even after incorporating the cost. This is evident from the standard deviation of the level of litter outside the waste envelope in the Cost treatment as compared to the Baseline treatment.

Table 1

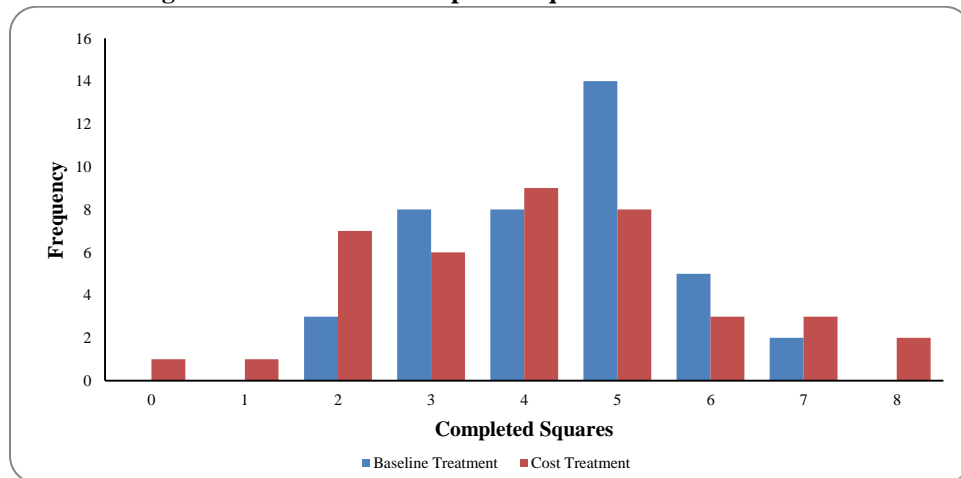
##### *Descriptive Statistics Across Treatments*

	No. of Completed Squares		Litter Pieces Inside Waste Envelop		Litter Pieces Outside Waste Envelope	
	Baseline Treatment	Cost Treatment	Baseline Treatment	Cost Treatment	Baseline treatment	Cost Treatment
Mean	4.4	4.1	1	2.18	7.25	4.75
Mode	5	4	0	0	9	0
Std. Dev.	1.30	1.88	2.60	3.28	4.38	4.45

Although Table 1 shows a summary of the results across treatments, the detailed behaviour of each participant is unobservable. Therefore, we show the frequency distributions of each of the three decisions made by participants in both treatments.

##### 4.1. Distribution of Completed Squares Across Treatments

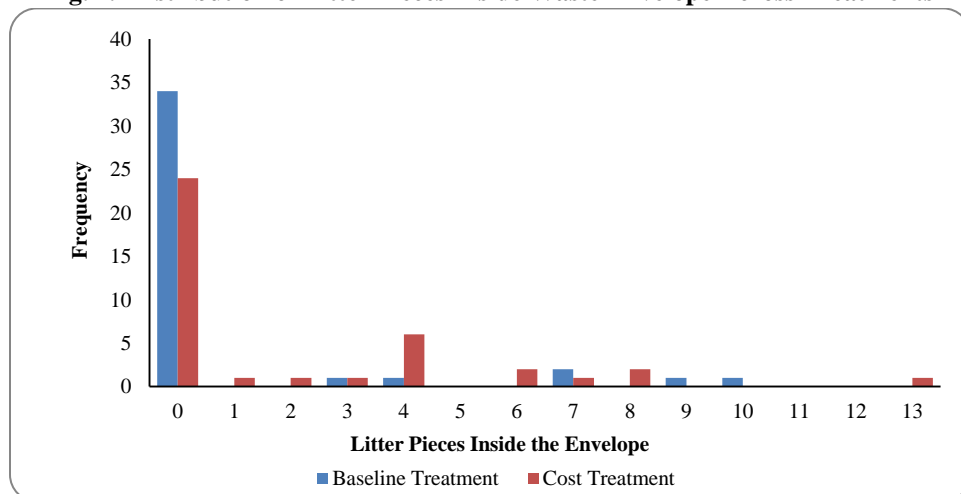
Figure 1 presents the distribution of squares across treatments. Taking the number of squares as independent observations, the Wilcoxon rank-sum test shows that the distribution of the number of squares in the Baseline treatment is not significantly different than the distribution of number of squares in Cost treatment ( $p=0.16$ ). This result shows that internalising the social cost of littering does not significantly affect the efficiency of participants in terms of the production of squares.

**Fig. 1. Distribution of Completed Squares Across Treatments**

#### 4.2. Distribution of Litter Pieces Inside the Waste Envelope Across Treatments

Figure 2 presents the distribution of litter pieces inside the envelopes across the treatments. We can see that the number of participants who did not use the waste envelope at all is higher in the Baseline treatment as compared to the Cost treatment. We also observe that more participants use the waste envelope for litter disposal in the Cost treatment than in the Baseline treatment. The mean number of litter pieces inside waste envelope in the Baseline and Cost treatments is 1.0 and 2.18, respectively.

Taking individual pieces of litter in the waste envelope as independent observations, the Wilcoxon rank-sum test shows that the distribution of proper disposal of litter in the waste envelope in the Cost treatment is significantly higher than the proper disposal of litter in waste envelope in the Baseline treatment ( $p < 0.05$ ). This finding is in line with our hypothesis.

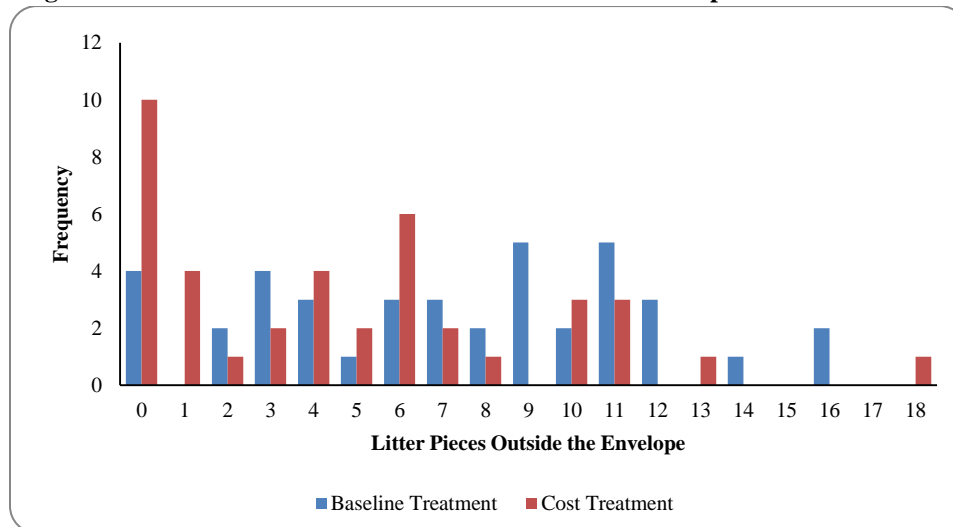
**Fig. 2. Distribution of Litter Pieces Inside Waste Envelope Across Treatments**

This result implies that littering without care is a general behaviour in the Baseline treatment. Conversely, this behaviour is not too common in the Cost treatment as some of the participants are more conscious of their littering behaviour. This shows that internalising private cost does indeed control littering behaviour.

#### 4.3. Distribution of Litter Pieces Outside the Waste Envelope Across Treatments

Figure 3 presents the distribution of litter pieces outside the waste envelope across treatments. We can see that the number of participants who do not produce litter outside the waste envelope is high in the Cost treatment. On the contrary, there is a fair number of participants who littered outside the waste envelope in the Baseline treatment. Taking the number of waste pieces outside the waste envelope as independent observations, the Wilcoxon rank-sum test shows that the distribution of number of waste pieces outside the waste envelope in the Baseline treatment is higher than the distribution of number of waste pieces outside the waste envelope in the Cost treatment ( $p < 0.01$ ). Therefore, this finding is also in line with our hypothesis.

**Fig. 3. Distribution of Litter Pieces Outside the Waste Envelope Across Treatments**



#### 4.4. Total Waste Disposal Across Treatments

Table 2 shows the total number of completed squares, total number of litter pieces inside and outside the waste envelope across treatments. We can see that the total number of litter pieces outside the waste envelope is higher in the Baseline treatment (290 pieces) as compared to the Cost treatment (190 pieces). Wilcoxon Rank-Sum test shows that the sum of the number of litter pieces outside the waste envelope in the Baseline treatment is lower than the number of litter pieces outside the waste envelope in the Cost treatment ( $p < 0.05$ ). It is also worth mentioning that the number of squares is not affected much due to internalisation of the social cost. This shows that the internalisation of social cost make people litter-conscious without compromising their efficiency in the form of the production of squares.

Table 2

*Total Number of Squares, Litter Pieces Inside and Outside  
Waste Envelope Across Treatments*

	Sum of Litter Pieces		
	Sum of Squares	Inside Waste Envelope	Sum of Litter Pieces Outside Waste Envelope
Baseline Treatment	176	40	290
Cost Treatment	164	87	190

## 5. CONCLUSION

This study tests whether internalisation of the social cost of littering decreases the level of littering. We investigate the answer of our research question by conducting a controlled laboratory experiment. In the Baseline treatment, the participants are asked to cut as many squares as possible within a mentioned time in return for a monetary reward with no cost for littering. In the Cost treatment, participants bear monetary cost for littering.

We find that most of the participants in the Baseline treatment did not bother to open the envelope labeled “Use Me for Waste Material”. They littered the area around them. On the other hand, participants in the Cost treatment mostly put the litter pieces in the waste envelope without compromising on the number of squares. The findings support our hypothesis indicating that littering is more frequent and common when the private cost to littering is not internalised as opposed to when there is a penalty for littering.

The results of the study have implications especially in those areas where litter is a significant problem, e.g. academic institutions like the Quaid-i-Azam University, Islamabad. It is suggested that in order to discourage littering behaviour and achieve environmentally favourable outcomes, one step in the right direction would be adequate provision of waste baskets complemented by imposition and implementation of fines on littering. If monetary fines are not possible, then developing a norm among faculty and students to criticise individuals who are littering is also likely to work. In other words, the study also suggests that where formal institutions are weak, activities having negative externality could be curtailed through informal institutions such as social norms and peer effect. Nevertheless, the limitations of the study are that littering behaviour could depend on gender, risk preferences and demographic features, which we did not control for.

There is also scope for further study on the subject matter by addressing it from different perspectives and by refining the experimental model further. A few suggestions towards that goal would be to see how results differ if the size of the waste envelope is increased/decreased, the average age of the control group is altered, the time for the participants for cutting the squares is increased, or the introduction of a heavier fine on the litterers.



## APPENDIX A

### INSTRUCTIONS FOR BASELINE TREATMENT

You are now taking part in an economic experiment. Please do not talk or communicate in any way with other participants during the experiment. Please also remember to turn off your cellphones. Should you have any questions, please raise your hand and one of us will come to assist you. At the end of the experiment one of you will be randomly selected and paid in cash in private for your participation.

Although there are many people participating in today's experiment, everyone is working independently. This means that if you are the one who is randomly selected, your earnings will be based entirely on your decisions—what the others do has no effect on your earning. It is therefore important that you take your time to understand the instructions.

In the experiment you are required to cut as many rectangles drawn on the coloured sheets provided to you as you can within the span of 3 minutes. You will use the scissors provided to you to do this. The time will be measured using the clock in front of you. You will be asked to stop cutting as soon as the three minutes time is over.

At the end of 3 minutes one of you will be selected at random. For this purpose you will write your seat number on a piece of paper and put it in a box. One of the experimenters will randomly pick one number in front of you from that box. If you are the one who is randomly selected in the draw, you will be paid Rs.10 per completed rectangle.

Below are two examples to help you understand the experiment. These examples are not meant as a guide for behaviour in the experiment.

#### Example 1

Assume that you cut 15 rectangles within 3 minutes and at the end of 3 minutes you are the one who is randomly selected in the draw. Your earnings at the end of the experiment will be  $15 \times 10 = \text{Rs.}150$  which will be paid to you in cash in private at the end of the experiment.

#### Example 2

Assume that you cut 15 rectangles within 3 minutes and at the end of 3 minutes you are NOT the one who is randomly selected in the draw. Your earnings at the end of the experiment will be NIL.

If you have any questions, please raise your hand to attract the attention of one of the experimenters. Otherwise, please proceed to answer the questions below. Once you have finished answering the questions, please raise your hand and one of the experimenters will come to check your answer.

#### Control Questions

- (1) If you have completed 6 rectangles by the end of three minutes and your seat number is selected at random, how much will be your earning?

Rs 0

Rs 60

Rs 100

- (2) If you have completed 6 rectangles by the end of three minutes and your seat number is not selected at random, how much will be your earning?

Rs 0

Rs 20

Rs 60

### INSTRUCTIONS FOR COST TREATMENT

You are now taking part in an economic experiment. Please do not talk or communicate in any way with other participants during the experiment. Please also remember to turn off your cellphones. Should you have any questions, please raise your hand and one of us will come to assist you. At the end of the experiment one of you will be randomly selected and paid in cash in private for your participation.

Although there are many people participating in today's experiment, everyone is working independently. This means that if you are the one who is randomly selected, your earnings will be based entirely on your decisions—what the others do has no effect on your earning. It is therefore important that you take your time to understand the instructions.

In the experiment you are required to cut as many rectangles drawn on the coloured sheets provided to you as you can within the span of 3 minutes. You will use the scissors provided to you to do this. The time will be measured using the clock in front of you. You will be asked to stop cutting as soon as the three minutes come to an end.

At the end of 3 minutes one of you will be selected at random. For this purpose you will write your seat number on a piece of paper and put it in a box. One of the experimenters will randomly pick one number in front of you from that box. If you are the one who is randomly selected in the draw, you will be paid Rs.10 per completed rectangle.

However, Rs 5 per piece of extra paper found around you will be deducted from your total earning.

Below are a few examples to help you understand the experiment. These examples are not meant as a guide for behaviour in the experiment.

#### Example 1

Assume that you cut 15 rectangles within 3 minutes and at the end of 3 minutes you are the one who is randomly selected in the draw and you have no pieces of extra paper on your desk or down on the floor. Your earnings at the end of the experiment will be  $15 \times 10 =$  Rs 150 which will be paid to you in cash in private at the end of the experiment.

#### Example 2

Assume that you cut 15 rectangles within 3 minutes and at the end of 3 minutes you are the one who is randomly selected in the draw, but you have 2 pieces of extra paper on your desk or down on the floor. Your earnings at the end of the experiment will be  $15 \times 10 =$  Rs 150  $- (2 \times 5) =$  Rs.140 which will be paid to you in cash in private at the end of the experiment.

Assume that you cut 10 rectangles within 3 minutes and at the end of 3 minutes you are the one who is randomly selected in the draw, but you have 20 pieces of extra paper on your desk or down on the floor. Your earnings at the end of the experiment will be  $10 \cdot 10 = \text{Rs.}100 - (20 \cdot 5) = 0$  and you will not be paid any money.

### Example 4

If you have any questions, please raise your hand to attract the attention of one of the experimenters. Otherwise, please proceed to answer the questions below. Once you have finished answering the questions, please raise your hand and one of the experimenters will come to check your answer.

- (1) If you have completed 6 rectangles by the end of three minutes and no extra piece of paper is found on the desk or down on the floor in front of you; moreover, if your seat number is selected at random, how much will be your earning?  
Rs 0                                  Rs 60                                  Rs 100
- (2) If you have completed 6 rectangles by the end of three minutes and your seat number is selected at random, but 1 piece of extra paper is found on the floor in front of you, how much will be your earning?  
Rs 0                                  Rs 55                                  Rs 60
- (3) If you have completed 6 rectangles by the end of three minutes and your seat number is not selected at random, how much will be your earning?  
Rs 0                                  Rs 20                                  Rs 60

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