A FACTORIAL ANALYSIS EXPERIMENTATION OF INAPPROPRIATE WASTE DISPOSAL

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ABSTRACT

This paper presents a statistical approach to estimating the effects of psychological factors on humans due to inappropriate waste disposal in the environment. Factorial experimental analysis is combined with the concepts of transition matrix and steady state conditions. An adequate understanding into the statistical quantification of the waste disposal concept would aid policy makers in effective decision making and the proper control of environment. The feasibility of developing statistical parameters for assessing the waste disposal concept is confirmed. The work shows the novelty of the approach.

Key words: Factorial analysis, statistical approach, decision making, waste disposal, psychological factors

INTRODUCTION

This work is approached by studying the experimental analysis of the factors that influence inappropriate waste disposal by a combination of two or more levels. The individual and joint effects of several variables and combination of values of levels are studied and analysed as representing different treatments. The application of this analysis is to ascertain that the waste disposal information collected for each individual under experimentation is influenced by the variation of the conditions under which each experiment is carried out (Jain *et al.*, 1981; Hamer 2003; Berkhout, 1991). The markovian principle is augmented into the framework. The probabilistic nature of the markovian waste disposal methodology suggests that experiments which are the activities (trials), which produce one or more of the possible outcome as a result of experimental design, is as importants as sampling since it is a part of the total design of the experiment. The experiment carried out in this study is to prove the claim since those individuals react to wastes that are detrimental to their health. This analysis aims at disease prevention (Romualdo *et al.*, 2002.). An important feature of the analysis is the use of hypothesis to test the claims made in the body of the work. By excluding factors such as ignorance and poverty and the like, it is assumed that human instincts direct him to follow measures that would help in correcting situations that would prevent diseases. The application of experimental design consists of several phases before obtaining meaningful results. These phases are applied to the problem of inappropriately disposed waste through which meaningful results are obtained (Graham *et al.*, 2003; Sangodoyin and Ipadeola, 2000). Several studies have been conducted on waste disposal with beneficial results for the waste disposal community (Attrill and Gibb, 2003a,b; Bridle and Kirkpatrick, 2003; Sangodoyin and Olorunfemi, 1996; Calijuri *et al.*, 2004). A number of these beneficial studies are as follows. In a study by Chattopadhyay *et al.* (1995), the effect of air pollution on the physical and mental health of human adult subjects was investigated. The areas that were analysed were industrial, commercial and residential regions. These areas were selected following criteria given by National Environment Engineering Research Institute. Subjects were selected randomly and matched in sex, education, occupation, marital status, family type, etc. Migrated subjects were not included. It was of utmost importance that subjects investigated were free from any neurological deficient. The following

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tests were conducted for each subject's session: psychological and physiological measures, involving STAI, stressful life events, Cornell medical index, personality questionnaire, basal skin conductance. The inclusion on data and information recorded revealed that residents of the industrial area were highly affected in terms of physical and mental health. The reports from these subjects were throat and eye irritation, respiratory problems, tension and anxiety much more than the inhabitants of the residential area. Inhabitants of commercial areas were found to be somewhere between these conditions. In this work, following the same layout of procedures, information on the probabilities of experience of these states can be obtained. Obtaining steady state probabilities indicates a level of certainty, which can be obtained depending on information from sessions like the one mentioned above. It is into these aspects that researchers investigating further on this matter have been provided with a basic approach. Giving them a better understanding of the problems, causes, effects, and enabling them make better-informed decisions. This information is also useful for the organising of documentaries, seminars and generally increasing the scientific knowledge base. Another study describes the Biomass production of 17 popular clones in a short-rotation coppice culture on a waste disposal site and its relation to soil characteristics (Laureysens *et al*., 2004a,b). An experimental field plantation with 10,000 cutting ha^{-1} was established on a former waste disposal site. A randomised block design was used with three replicate plots (9m x 11.5m). At the end of the establishment year, all plants were cut back to a height of 5cm to create a coppice culture. At the end of the fourth year after coppicing, diameters of all living and dead shoots were measured, and biomass production was estimated with an allometric power equation. A composite soil sample was taken for all plots, and pH, organic matter, water content, bulk density, content of nutrients, minerals and heavy metals were determined. Highest production was found for P. trichocarps x P deltoids hybrids Hazendans and Hoogroist, P. trichocarpa clones Fritz Pauley, Columbia River and Trichobel, and native P. nigraclone Wilterson with mean annual biomass production ranging between 8.0 and 11.4 mg/ha per year. Lowest performance was observed for P. trichocarpa x P. deltoids hybrid Boelare, P. deltoids x P. trichocarpa hybrids IBW1, IBW2 and IBW3 and P. deltoids X P. nigra hybrids Gaver and Gibecq with a mean annual biomass production ranging between 2.8 and 4.7 Mgha-1. Mean dead biomass accounted for less than 2% of total standing biomass for all clones, some clones exhibited a uniform production across replicates, implying low susceptibility of soil heterogeneity, other clones showed a high inter-replicate variation. Ojeda-Benítez and Beraud-Lozano (2003) carried out further investigations of waste disposal. They noted that cities in Mexico as other cities around the world, face the serious problem of environmental pollution, caused mainly, by the inadequate and inefficient final disposal of their generated solid and liquid waste. An analysis of one stage of the municipal solid waste (MSW) cycle in Mexico is given in this paper, presenting the result of research in four cities. Four case studies where the sanitary landfill and the uncontrolled dump, with varying degrees of management, are used as the final disposal of municipal solid waste are presented.

MATERIALS AND METHODS

Experimental design

In this paper, experiments are planned so that known sources of variability in the values of factorial measurement for inappropriate waste disposal are deliberately varied in such a way that their variability can be eliminated from the estimate of chance variation. One way to accomplish this is to repeat the experiment in several blocks where these variables are held fixed in each box but vary from block to block (considering the level of variation for each of the other variables).

Out of the ten factors, those that are likely to be relatively more detrimental to the subjects' health are:

– Reduction of appetite: A
– Impedes breathing: E
– Urge to throw up: G
– High temperature: B

So usually we expect a higher percentage values for these values since the larger values will indicate that the information from the data is influenced by the fact of the claim individuals react to waste that is more detrimental to their health.

In other words probabilistic data is dependent on the human instinct to protect him from diseases which come as a result of the effects that are much more hazardous to their system. This analysis will be carried out considering all the ten conceptualised factors of effects of inappropriate waste disposal. Therefore factors C, D, F, H, I, J will have relatively smaller percentages in the attainment of their steady state probabilities.

Procedures objectives

There must be an objective to test: the claim that subjects react more to detrimental or hazardous effects resulting from waste as compared with other factors involved in the effects of inappropriate waste disposal.

Response variable

Probability data was measured through questionnaires which were distributed to family members, colleagues at work, friends, and data obtained from medical resources etc.

Sessions

Individual (subject) comes to the analysts who examine him. This is to observe the number of times the individual responds to any of the factors (effects) or a particular set of factors (questionnaire is prepared to this effect).

Analysing the data

To analyse the data from various sources, they are subjected to hypothesis testing, the objective is to test whether there is a significant difference between those factors that are much more detrimental to their (subject's) health and those that are not so detrimental. Before we proceed we shall have to understand some basic principles, certainly the conditions in which the experiments would be carried out are not identical considering the various contributory factors to data recorded. A definition of the subject matter at this point introduces some new concepts and issues. Psychology is the science of objective and subjective measures or the science of behaviour and mental processes, therefore some pertinent issues that are associated with psychology includes:

Neuroscience

This is physiological psychology, which studies how the body and brain create emotions, memories, and sensory experiences.

Psychodynamic

This is how behaviour springs from unconscious drives and conflicts (biological)

Social

This relates to thinking about influence and relating to one another in a mental stable manner, which could result in rational or irrational decisions or actions.

Socio-cultural

This can be regarded as environmental factor, studying how behaviour and thinking vary across situation and cultures. In this analysis we shall be considering three out of these four factors.

Multi Factorial Experiments

To begin we must define some terminologies.

Experiment

An individual/subject in a waste environment exhibiting any of the psychology effects of inappropriate waste disposal.

Treatments

Values attached to the four factors or issues of psychology. There would be a, b and c. The experimental condition in replicate.

Replicate

The process of repeating the entire procedure i.e. a.b.c. Experimental conditions a total of r times, randomising the order of applying the conditions in each repetition (Table 1).

Table 1: Factors and levels

Factor	Levels
a Physiological	Normal, (N) Negative (Ng), Positive (p), Mild (M)
b Environmental	Favourable (F), Unfavourable (U_f)
c Mental	Rational (R), Irrational (I)

Factor a has 4 levels (N, Ng, P, M)
Factor b has 2 levels (F and U_F)
Factor c has 2 levels (R and I)

Define X has psychological effects that are more detrimental to health, of which A, E, G and B falls under, messing or implying that these would usually have higher percentages model equation for a 3-

factor experiment is

$$y_{ijkl} = \mu + \alpha_i + \beta_j + \gamma_k + (\alpha\beta)_{ij} + (\alpha\gamma)_{ik} + (\beta\gamma)_{jk} + (\alpha\beta\gamma)_{ijk} + \rho_i + \varepsilon_{ijkl}$$

For $i = 1,2, \ldots, a$
$j = 1,2, \ldots, b$
$k = 1,2, \ldots, c$
$l = 1,2, \ldots, d$

Assumptions

– Sum of the main effects (α's, β's, γ's) as well as sum of replication effects is equal to zero.

– Sum of two-way1'2'1 interaction effects summed on either subscript is zero for any values of the other subscripts.

– Sum of three way interaction effects summed on any one of the subscripts is zero for any values of the other two subscripts.

– The ε_{ijkl} are values of independent random variables having zero means and common variance σ^2.

Main effects

Definitions of terms

These are the three factors mentioned that are now subdivided into various levels with a having 3 levels then b and c having 2 each.

Two-way interaction

Involves combination of two factors, for instance if α_i is the effect of ith level of factor a and β_j is the effect of the jth level on factor b, therefore $(\alpha\beta)ij$ is the interaction of the joint effect of the ith level of factor a on the jth level of factor b.

Three-way interaction

It involves combination of three factors if α_i is the effect of ith level of factor a and β_j is the effect of the jth level on factor b and γ_k is the kth level of factor c, then $(\alpha\beta\gamma)_{ijk}$ is the interaction or joint effect of the ith level of factor a and the jth level of factor b and the kth level of factor c.

All the other terms of the model equation for the three factor experiments are as follows:

μ is the grand mean

γ_k is the effect of kth level of factor c

σ^2 is the common variance of the experiments

$\varepsilon ijkl$ is the value of independent variables with zero means.

Analysis of factorial experimentation proceeds with using the formulae:

Sum of Squares for Analysis of Variance

$$SST = \sum_{i=1}^{a}\sum_{j=1}^{b} y_{ij}^2 - c \quad \text{(total sum of squares)}$$

$$SS\,(Tr) = \sum_{i=1}^{a} T_{io}^2 - c \quad \text{(treatment sum of squares)}$$

$$SS\,(Bl) = \sum_{j=1}^{b} T_{oj}^2 - c \quad \text{(block sum of square)}$$

$$C = \frac{T_{oo}^2}{ab} \quad \text{(connection term)}$$

$$SSE = SST - SS(Tr) - SS(Bl) \quad \text{(error sum of squares)}$$

$$F_{TR} = \frac{SS(Tr) \div (a-1)}{SSE \div (a-1)(b-1)} \quad \text{(F ratio for treatments)}$$

$$F_{Bl} = \frac{SS(Bl) \div (b-1)}{SSE \div (a-1)(b-1)} \quad \text{(F ratio for blocks)}$$

Hypothesis testing

Introductory notes on hypotheses testing

The concept behind test of hypotheses is based on the need to decide whether a statement concerning a parameter or a set of parameters is true or false. It is to ascertain the truth in a claim. Usually experiments would be involved, data is recorded, standards are maintained, and decisions are made based on the results obtained. In testing a statistical hypothesis H, Table 2 gives a summary.

Table 2: Test of hypothesis

Test	Accept H	Reject H
H is true	Correct decision	Type I error
H is false	Type II error	Correct decision

If hypothesis H is true and accepted or false and rejected, the decision is in either case correct. If hypothesis H is true but rejected, it is in error. If h is false but accepted, it is in error. The first error is called a Type I error and probability of committing it is α. The second is Type II error and probability of committing it is β.

The term null hypothesis is used for any hypothesis set up primarily to see whether it can be rejected.

The term significance test is used when the test is based on checking the difference error ($\overline{X}$ - the difference between the estimate and the quantity it is supposed to estimate) is too large to be reasonably attributed to chance.

Steps to follow for hypotheses testing

Formulation of a simple null hypothesis and an appropriate alternative hypothesis which is accepted when the null hypothesis must be rejected:

Specification of the probability of Type I error which is called the level of significance, usually set at $\alpha = 0.05$ or $\alpha = 0.01$. This value of probability of Type I error should not be too small.

- Based on the sampling distribution of an appropriate statistics, we construct a criterion for testing the null hypothesis against the given alternative.
- Calculations from the data the value of the statistics on which the decision is to be based.
- Decisions on whether to reject the null hypothesis, whether to accept it or whether to reserve judgement.

Benefits of hypothesis testing on the analysis of the psychological effects of inappropriate waste disposal

The results from the hypothesis testing section of the factorial experimentation, from which decisions are made which helps the environmentalist on which factors should be considered as a major contributory factor influencing the behaviours which are exhibited in the light of psychological effects of inappropriate waste disposal. Knowing such an information helps the analyst to decide the areas which need to be addressed in the proposing of remedies for the sanitisation and the remedy towards disease prevention.

Relevance of hypothesis testing

The probability of steady state is dependent on the different conditions of the subject in (Table 3).

Table 3: Steady state values (showing the effects of inappropriate waste disposal)

S/No.	a	b	c	Rep 1	Rep 2	Total
1	No	F	R	12.96	14.20	27.16
2	No	F	I	11.03	11.82	22.85
3	No	U_F	R	7.13	9.96	17.09
4	No	U_F	I	6.92	7.23	14.15
5	M	F	R	11.42	10.10	21.52
6	M	F	I	14.10	13.19	27.29
7	M	U_F	R	8.89	12.70	21.59
8	M	U_F	I	7.59	9.36	16.95
9	Ng	F	R	10.65	11.27	21.92
10	Ng	F	I	9.49	8.30	17.79
11	Ng	U_F	R	10.86	7.86	18.72
12	Ng	U_F	I	6.85	10.42	17.27
13	P	F	R	9.87	9.35	19.22
14	P	F	I	10.88	11.88	22.76
15	P	U_F	R	9.90	14.43	24.32
16	P	U_F	I	8.83	9.15	17.98
a. b. c factorial experimentation			Total	157.37	171.21	328.58

4 x 2 x 2 = 16 complete factorial experimentations

From experience, simple logic or observations from the individuals that are familiar with the phenomenon, it can be stated that particular factors resulting from the effects of psychological effects of inappropriate waste disposal are expressed more often than some other factors. This obviously is a claim that draws attention to the need for hypothesis testing. The claim might even be from the analysts or environmentalist or the researcher.

As it might have been observed hypothesis testing concept applies equally to topics concerning relationships among several variables.

RESULTS

The following results are obtained from the computation carried out in this study.

$$\text{Correction factor, } C = \frac{(328.58)^2}{32} = 3373.9005$$

SST=

$$\begin{bmatrix} (12.96)^2+(11.03)^2+(7.13)^2+(6.92)^2+(11.42)^2+ \\ (14.1)^2+(8.89)^2+(7.59)^2+(10.65)^2+(9.49)^2+ \\ (10.86)^2+(6.85)^2+(9.87)^2+(10.88)^2+(9.9)^2+ \\ (8.83)^2+(14.20)^2+(11.82)^2+(9.96)^2+(7.23)^2+ \\ (10.10)^2+(13.19)^2+(12.70)^2+(9.36)^2+(11.27)^2+ \\ (8.30)^2+(7.86)^2+(10.42)^2+(9.35)^2+(11.88)^2+ \\ (14.42)^2+(9.15)^2 \end{bmatrix} -$$

33.739005= 3518.5146 – 3373.9005 = 144.6141

$$SS(Tr) = \frac{1}{2}\begin{bmatrix} (27.16)^2+(22.85)^2+(17.09)^2+(14.15)^2+ \\ (21.52)^2+(27.29)^2+(21.59)^2+(16.95)^2+ \\ (21.92)^2+(17.79)^2+(18.27)^2+(17.27)^2+ \\ (19.22)^2+(22.76)^2+(24.32)^2+(17.98)^2 \end{bmatrix}$$

$$= \frac{6961.1944}{2} - 3373.9005 = 3480.5972 - 3373.9005$$

= 106.6967

$$SSR = \frac{1}{16}\left[(157.37)^2+(171.21)^2\right] - 3373.9 =$$

3379.886 – 3373.9 = 5.9863

SSE = 144.6141 – 106.6967 – 5.9863 = 31.9311

Tables 5 and 6 show the measurments at different levels.

Table 4: Total of measurements at levels F and U_F

b

	F	U_F	
No	50.01	31.24	81.25
M	48.81	38.54	87.35
Mg	39.71	35.99	75.70
P	41.98	42.30	84.28
	180.51	148.07	328.58

Table 5: Total of measurements at levels R and I

c

	R	I	
No	50.01	31.24	81.25
M	48.81	38.54	87.35
Mg	39.71	35.99	75.70
P	41.98	42.30	84.28
	171.54	157.04	328.58

The degrees of freedom for each sum of squares are 31, 15, 1 and 15, respectively. Table 6 show the totals of all measurements obtained at the respective levels of the two variables.

Table 6: Summarised levels, (F and U_F) Vs (R and I)

	F	U_F	
R	50.01	31.24	171.54
I	48.81	38.54	157.04
C	180.51	148.07	328.58

To calculate the treatment sum of squares, we calculate, $\frac{1}{r.c}\sum_{i=1}^{a}\sum_{j=1}^{b} T_{ijoo}^2 - c$

Recall that:

Table 7: Summary of treatments

a	b	c	d
4	2	2	2

$$\frac{1}{4}\begin{bmatrix} (50.01)^2+(31.24)^2+(48.81)^2+(38.54)^2+ \\ (39.71)^2+(35.99)^2+(41.98)^2+(42.3)^2 \end{bmatrix} -$$

3373.9005=3442.1150 – 3373.9005 = 68.2145

$$SS_a = \frac{1}{bcr}\sum_{i=1}^{a} T_{iooo}^2 - c$$

$$= \frac{1}{8}\left[(81.25)^2+(87.35)^2+(75.70)^2+84.28\right] - 3373.9005$$

= 9.2487

$$SS_b = \frac{1}{acr}\sum_{j=1}^{b} T_{ojoo}^2 - c$$

$$= \frac{1}{16}\left[(180.51)^2+(148.07)^2\right] - 3373.9005 = 32.8861$$

SS(ab) = 68.2145 – 9.2487 – 32.8861 = 26.0797

For the second Table,

$$\frac{1}{rb}\sum_{i=1}^{a}\sum_{k=1}^{c} T_{ioko}^2 - c = \frac{1}{4}\begin{bmatrix} (44.25)^2+(43.11)^2+(40.64)^2+ \\ (43.54)^2+(37.00)^2+(44.24)^2+ \\ (35.06)^2+(40.74)^2 \end{bmatrix}$$

– 3373.9005= 3394.7572 – 3373.9005 = 20.8507

$$SSc = \frac{1}{abr}\sum_{k=1}^{c} T_{ooko}^2 - c$$

$$\frac{1}{16}\left[(171.54)^2+(157.04)^2\right]-3373.9005=3380.4708-$$

$337.9005 = 6.5703$

$$SSa = \frac{1}{bcr}\sum_{i=1}^{a} T_{iooo}^2 - c = 9.2487$$

SSac = 20.8507 – 9.2487 – 6.5703 =5.0317

For the third Table,

$$\frac{1}{r.a}\sum^{c}\sum^{b} T_{ojko}^2 - c \quad \frac{1}{8}\begin{bmatrix}(89.82)^2+(81.72)^2+\\(90.69)^2+(66.35)^2\end{bmatrix}-3373.9005$$

= 3421.5987 – 3373.9005 = 47.6982

SSc = 6.5703; SSb = 32.8861;

SScb = 47.6982 – 6.5703 – 32.8861 = 8.2418

The Three Way Interaction Sum of Sum

$SS_{abc} = SS(Tr) - SS_a - SS_b - SS_c - SS_{ab} - SS_{ac} - SS_{bc}$

= 106.6967 – 9.2487 – 32.8861 – 6.5703 – 26.0797 – 5.0317

– 8.2418 = 18.6384

Table 8 shows the results of statistical tests.

Table 8: Complete analysis of variance for the experimental effects of inappropriate waste disposal

Source of Variation	Degrees of Freedom	Sum of Squares	Mean Square	F
Replicates	1	5.9863	5.9863	2.81
Main effects				
a	3	9.2487	3.0829	1.45
b	1	32.8861	32.8861	15.45
c	1	6.5703	6.5703	3.09
Two factor interactions:				
ab	3	26.0797	8.6932	4.08
ac	3	5.0317	1.6772	0.79
bc	1	8.2418	8.2418	3.87
Three factor interactions:				
abc	3	18.6384	6.2128	2.92
Error	15	31.9311	2.1287	
Total	31	144.6141	4.6649	

Hypothesis

In comparing the subject's response (percentage high and percentage not high) to four different factors, then we decide whether the proportion of those with high percentages out of the ten factors remain constant. In other words, when we judge whether there is a significant difference in the effects of these four factors on the two categories of psychological effects of inappropriate waste disposal i.e. X and Y, we are therefore testing whether these two binomial populations have the same parameter P.

X has P_1 and Y has P_2

We are interested in testing the null hypothesis

$$P_1 = P_2$$

Against the alternative hypothesis that these proportions of X and proportion of Y are not all equal.

Level of significance I: $\alpha = 0.01$

Level of significance II: $\alpha = 0.05$

Criterion: Reject the null hypothesis if: F > Z, the value of $Z_{0.01}$ and $Z_{0.05}$ for 1:16 and 3:16 degrees of freedom for all the effects i.e. for replications reject the null hypothesis if F > 8.53, the value $F_{0.01}$ for (r.1) and (abc-1) (r-1) degrees of freedom i.e. 1 and 16 d.o.f.

For main effects 'a' reject the null hypothesis if F > 5.29, the value of $F_{0.01}$ for a-1 and (abc-1) (r-1) degrees of freedom i.e. 3 and 16 d.o.f. For main effect b, reject the null hypothesis if F > 8.53, the value of $F_{0.01}$ for (b-1) and (abc-1) (r-1) degrees of freedom i.e. 1 and 16 d.o.f. For main effect c, reject the null hypothesis if F > 8.53, the value of $F_{0.01}$ for (c-1) and (abc-1) (r-1) degrees of freedom i.e. 1 and 16 d.o.f.

For interaction 'ac', reject the null hypothesis if F > 5.29, the value of $F_{0.01}$ for (a-1) (c-1) and (abc-

1) (r-1) degrees of freedom i.e. 3 and 16 d.o.f. For interaction ab, reject the null hypothesis if F > 5.29, the value of $F_{0.01}$ for (a-1) (b-1) and (abc-1) (r-1) degrees of freedom i.e. 3 and 16 d.o.f. For interaction bc, reject the null hypothesis of F > 8.53, the value of $F_{0.01}$ for (b-1) (c-1) and (abc-1) (r-1) degrees of freedom i.e. 1 and 16 d.o.f. For interaction abc, reject the null hypothesis of F > 5.29, the value of $F_{0.01}$ for (a-1) (b-1) (c-1) and (abc-1) (r-1) degree i.e. 3 and 16 d.o.f.

From the Tables for $F_{0.01}$ when v_1 = numerator and v_2 is the denominator.

$$\frac{v_1}{v_2} = \frac{1}{16} = 8.53$$

$$\frac{3}{16} = 5.29$$

Checking the values for $F_{0.05}$ significance test.

From the Tables for $F_{0.05}$, we obtain:

$$\frac{1}{16} = 4.49 \text{ and } \frac{3}{16} = 3.24$$

DISCUSSION

From the results obtained, using the factorial experimentation analysis, it was discovered that:

At the $F_{0.01}$ level of significance:

- for replications the null hypothesis is accepted
- for main effect ‘a’, the null hypothesis is accepted
- for main effect ‘b’ the null hypothesis is rejected
- for main effect ‘c’, the null hypothesis is accepted
- for the two way interaction ‘ac’, the null hypothesis is accepted
- for the two way interaction ‘ab’, the null hypothesis is accepted
- for the two way interaction ‘bc’, the null hypothesis is accepted
- for the three way interaction ‘abc’, the null hypothesis is accepted

At the $F_{0.05}$ level of significance:

- for replications the null hypothesis is accepted
- for main effect ‘a’, the null hypothesis is accepted
- for main effect ‘b’, the null hypothesis is rejected
- for main effect ‘c’, the null hypothesis is accepted
- for the two way interaction ‘ac’, the null hypothesis is accepted
- for the two way interaction ‘ab’, the null hypothesis is rejected
- for the two way interaction ‘bc’, the null hypothesis is accepted
- for the three way interaction ‘abc’, the null hypothesis is accepted

From the results above, we conclude that the test for replication is not significant at either level (0.01 or 0.05).

- The test for the factor ‘a’ is not significant at any of the levels
- The test for the factor ‘b’ is significant at the $F_{0.01}$ level but not at the $F_{0.05}$ level.
- The main factor ‘c’ is not significant at any level

For the two way interactions:

- ‘ac’ is not significant at either level
- ‘ab’ is significant at the 0.05 level but not at the 0.01 level
- ‘bc’ is not significant at either level

For three way interaction:

- ‘abc’ is not significant at either level

Table 9 shows the factorial experimentation analysis.

Table 9: Factorial experimentation analysis

Factors	Null hypothesis	Significance	Levels
A	A	N	0.01
	A	N	0.05
B	R	P	0.01
	R	P	0.05
C	A	N	0.01
	A	N	0.05
Ab	A	N	0.01
	R	P	0.05
Ac	A	N	0.01
	A	N	0.05
bc	A	N	0.01
	A	N	0.05
abc	A	N	0.01
	A	N	0.05
replication	A	N	0.01
	A	N	0.05

A: Accepted R: Rejected
N: Negative P: Positive

We conclude from this analysis that variations in ‘b’, which represents environmental factors, affect the psychological effects/responses of waste disposal while variations in ‘a’, which represents physiological factors, and ‘c’, the mental factors, do not. This might be as a result of the simulated values, using random number selection between specified ranges) and there are no interaction except at the ‘ab’ interaction with 0.05 level of significance. All the other sources of variation apart from ‘b’ and ‘ab’ (0.05) have data that does not refute the hypothesis that under the stated conditions, the steady state values of X and Y have the same proportions. The non availability of specific values for the levels of each factor is not helpful in this situation of investigating the magnitudes of the effects. In a case where appropriate values can be obtained for the factor that has an effect then a graph of factor against the main effect would be plotted to observe the magnitude of effect. This is an area, which can be studied under the waste problem.

Factorial experimentation is an important scientific test carried out across a wide range of disciplines in order to test the statistical strength of a set of data during model testing and validation. In this work we applied this traditional age-long statistical concept to simulated data on the psychological effect of inappropriate waste disposal. Based on the Markovian waste disposal methodology proposed, we formulated hypothesis that compare subjects responses (percentage high and percentage not high) to four different factors. As a follow up, we decide whether the proportion with high percentages out of the ten factors remain constant. In other words, we judge whether there is a significant difference in the effects of these four factors on the two categories of psychological effect of inappropriate waste disposal. From the results obtained, the factorial experimentation reveals that at $F_{0.01}$ and $F_{0.05}$ levels of significance: (i) the test for the factor ‘a’ is not significant at any of the levels, (ii) the test for the factor ‘b’ is significant at the $f_{0.01}$ level but not at the $f_{0.05}$ level, (iii) the main factor ‘c’ is not significant at any level. However, for the two ways interactions (i) ‘a’ is not significant at either level, (ii) ‘ab’ is significant at the 0.05 level but not at the 0.01 level, and ‘bc’ is not significant at either level. For the three way interactions, ‘abc’ is not significant at either level. Future statistical test of the framework of the inappropriate waste disposal methodology is possible in a variety of ways. A follow on study is the adequate computerisation of the statistical process. Software could be developed that easily test the statistical strength of data in the face of a large data pole. Obviously, computing such data with manual efforts may be tedious, uninteresting, and subject to human errors that may not easily be traced. As such having a computerise software we avoid or minimise these problems.

Development on waste disposal research has reached a level of quantitative experimentation such that interdisciplinary collaboration is expected among experts. Thus, environmentalists, mathematicians, statisticians, engineers and biomedical experts may pull resources together in order to extend the fountain of knowledge in waste disposal theory and practical applications. Hopefully, these efforts will stimulate interesting research results that may gradually grow into a specialised area where researchers and students may invest huge resources for profiting.

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