Relationship between Ethics, Economics and Politics with special application to Transportation Engineering using utility theory

Dr. Chandrasekhar Putcha, Fellow, ASCE
Professor
Department of Civil and Environmental Engineering
CSUF Outstanding Professor AY 2006-07
California State University, Fullerton
Fullerton, CA 92834

Lakshimi Lavanya Bandaru
Formerly Graduate Student Assistant
Department of Civil and Environmental Engineering
California State University, Fullerton
Fullerton, CA 92834

Dr. Hakob Avetisyan
Associate Professor
Department of Civil and Environmental Engineering
CSUF Outstanding Professor AY 2006-07
California State University, Fullerton
Fullerton, CA 92834

Abstract- This paper deals mainly with establishing a relationship between three parameters, namely, Ethics, Economics, and Politics using the concept of utility theory. It also shows application of utility theory to Transportation Engineering. Ethics is generally connected to virtue, good social behavior etc. Economics in general deals with profit maximization. Politics, as is well-known deals with a political climate in any given country directly relating to the leaders of that country. In a general sense, one can see the relation between these three variables. This is because the economic policies that are followed by any country will depend on the party in power and the political leaders. Therein comes the concept of ethics whether policies followed deal only with the sole objective of profit maximization with no consideration of ethics or they are based on some kind of ethical values. In particular, this paper will study in detail the two opposite philosophies proposed by Galbraith (1991) and Drucker (1993). Galindo and Cuevas (2008) state that four basic principles shape the fundamental and ethical criteria in economic behavior. These are 1. Ethics deals with "values". 2. These values must be widely established in society. 3. Economic behavior must pursue an individual interest. 4. At the same time, the economic behavior must pursue a common interest. While the principles 1 and 2 are more of philosophical nature and so this paper will not focus on these. It is the principles 3 and 4 that this paper will concentrate. While Drucker seems to advocate principle 3, Galbraith advocates principle 4. However, the work reported by Galbraith seems to indicate that he supports a welfare state while the work of Drucker indicates that he supports the importance of the third sector i.e. non-governmental organizations, charity organizations etc. Nevertheless, the point remains is that some kind of efficiency criteria should be developed to reduce social inequalities. It is this part that this paper will focus on after going through in detail the two opposing theories of Galbraith and Drucker. At the end of the paper, application of utility theory is illustrated to Transportation Engineering.

1. Introduction

Looking from the global perspective, the fields of Ethics, Economics, and Politics are quite diverse and different from each other. But, if one looks closely, the principles of ethics are embedded in the decision one makes in economics (an example of choosing ethical stocks) and Politics (choosing an ethical candidate in any election including Presidential election). Apart from this qualitative statement, the intent of this paper is to see if they can be related in a quantitative manner. In that process, the approaches of Galbraith (1991) and Drucker (1993) will also be discussed. After an extensive literature review and extensive critical thinking, the authors feel that one parameter that ties all these three variables, namely – Ethics, Economics, and Politics is a utility. Before a detailed discussion of utility (including the basic definition) is presented in this paper, how this concept of utility will be used to connect the three variables mentioned above will be discussed. Utility values will be calculated for a choice of decisions in the field of economics/finance (choosing of variously available stocks based on ethical values). Similarly, utility values will be calculated for various available choices of contenders in Presidential elections based on ethical values). In other words, the point that is being made in this paper is that choice of an alternative (among various available ones) can be easily based on utility values. This is because the

desirability of an alternative, in general, may depend on many attributes. These could be financial, social etc. It could also be as rudimentary as pleasure. So, the utility is defined as a true measure of value to the decision maker (Ang & Tang, 2007). Based on this an alternative with highest utility value is chosen. At the end of this paper, the utility theory is applied to transportation engineering problem.

2. Methodology

1. List all the possible alternative events are listed. If there are four, then there will be E_1 to E_4.

2. Establish the preference order based on the actual physical event in the field (in this paper, it will be either economics/finance or Politics) and ethical values.

3. The utility values of extreme events are set as follows:

$u(E_1) = 0.0$

$u(E_4) = 1.0$

4. The utilities for other intermediate events, where the user is indifferent is calculated from

5. $u(B) = p\, u(E_1) + (1-p)\, u(E_4)$ (1)

where, as stated earlier, E_1 and E_4 are extreme events. p is the probability associated with the event.

6. Make a decision among all the alternatives based on the utility values.

It should be pointed out that, it is not always necessary that the utilities of the extreme events are always set to 1 and zero. They can be set an intermediate value based on the actual event and ethical consideration.

After applying the principles of utility theory to the fields of Politics and Economics, it is applied to Transportation Engineering field.

3. Examples

Two examples are considered here. One example is in the field of Economics and the other is in the field of Politics. We are interconnecting ethics with the various fields. We are trying to analyze the connection between the ethical values and economics and ow ethics is related to politics. To explain that further, we have used the Elementary Concepts of Utility Theory.

3.1 Economics

The following 4 stocks are considered for the present study from the fields of Health, Medical, Technology, and Research.

Using the methodology explained in Sec. 2, the utility values are given in Table 1.

Table 1: Utility values for various Mutual Funds

S. No.	Event		Utility Function
1.	E_1 - Prudential Jennison Health Sciences Fund	Low Ethics and Low Yield	0
2.	E_2 - Global Life Sciences Fund	High Ethics and Low Yield	0.3
3.	E_3- T. Rowe Price Health Sciences Fund	Low Ethics and High Yield	0.6
4.	E_4- Vanguard Health Care Index Fund	High Ethics and High Yield	1

It should be pointed out here that Galbraith 1991), who supports a welfare state, whereas, Drucker (1993) supports a welfare state. Hence these philosophies will influence the user the stocks consistent with their philosophy.

The economic philosophies advocated by Galbraith (1991) and Drucker (1993) do come into picture when the use picks the stocks based on ethical consideration. If a user picks stocks like E_1, E_2, or E_3, it implies belief in the economic philosophies of Galbraith (1991). On the other hand, if the user picks stocks like E_3, it implies the belief in the economic philosophies of Drucker (1993). For this example, user should pick either Vanguard Health Care Index Fund or T. Rowe Price Health Sciences Fund based on highest utility values.

3.2 Politics (2016 American Presidential elections)

Here, the four events deal with the popularity polls and the respective ethical standards of the four candidates of 2016 American Presidential elections, namely, Donald Trump, Hillary Clinton, Gary Johnson and Bernie Sanders. Each of the candidates is considered as an individual event and each event has its respective utility value. The utility function value has been calculated utility theory.

Table 2:Utility values for various Presidential Candidates

S. No.	Events		Utility Function
1.	E_1- Gary Johnson	Low Ethics and Low Popularity	0
2.	E_2- Bernie Sanders	High Ethics and Low Popularity	0.4
3.	E_3-Donald Trump	Low Ethics and High Popularity	0.8
4.	E_4-Hilary Clinton	High Ethics and High Popularity	1

It is important to state here that the economic philosophies advocated by Galbraith (1991) and Drucker (1993) play an inherent but active role when the voter votes for the candidates based on ethical consideration. If a voter decides to vote for Gary Johnson (E_1), or Bernie Sanders (E_2) or Hillary Clinton (E_4), it implies belief in the economic philosophies of Galbraith (1991). On the other hand, if the voter decides to vote for Donald Trump (E_3), it shows the voters belief in the economic philosophies of Drucker (1993). For this example, the voters should choose Hillary Clinton based on the utility value followed by Donald Trump based on utility values.

4. Justification for probabilities and utility function values

The utility function value has been calculated using the elementary concepts of utility theory. The utility theory requires us to consider two extreme conditions and with their obvious values being available, the values for the other two events will have to be predicted and calculated. The probability values with which the above utility function values have been calculated were obtained through extensive research and reading. Several journals and articles have been referred to obtain the approximate values and then calculate the utility function values. These are given under Bibliography section after the References section.

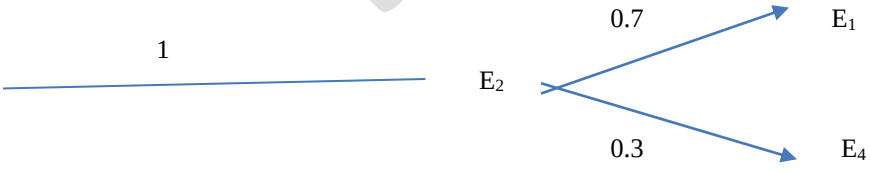
4.1. Explanation for the values in table 1

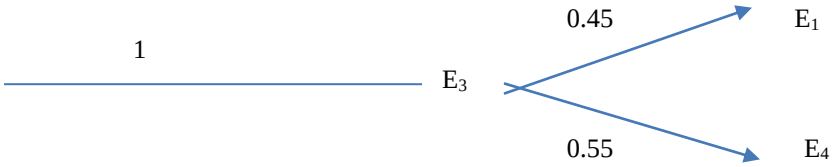
1. E1 - Prudential Jennison Health Sciences Fund — Low Ethics and Low Yield
2. E2 - Global Life Sciences Fund — High Ethics and Low Yield
3. E3- T. Rowe Price Health Sciences Fund — Low Ethics and High Yield
4. E4- Vanguard Health Care Index Fund — High Ethics and High Yield

The preference order: $E_1 < E_2 < E_3 < E_4$

4

$u(E_1) = 0.0$ $u(E_4) = 1.0$



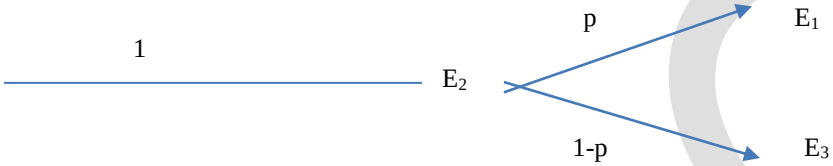


$u(E_2) = 0.7(E_1) + 0.3\ (E_4) = 0.3$

$u(E_3) = 0.45(E_1) + 0.55\ (E_4) = 0.55$

To cross check these utility assignments the decision Maker will be asked for the value of p. As there is only a 50% chance that the predicted and calculated values could be correct. Therefore, we consider the value of p to be 0.5.

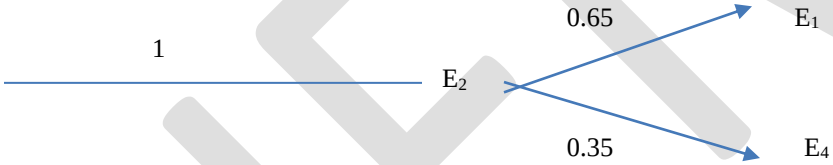
The value of p = 0.5



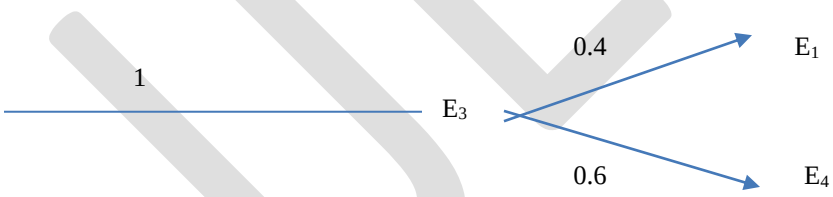
$u(E_2) = 0.5u(E_1) + 0.5u\ (E_3)$
$= 0.5*0 + 0.5*0.55$
$= 0.28$

The values of $u(E_2)$ obtained earlier and now are very similar. Hence, this proves that there is no inconsistency. The values will have to be reevaluated just to re confirm.

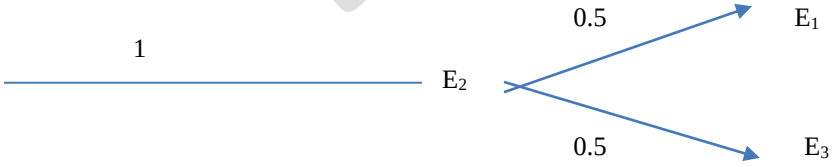
1.



2.



3.



$u(E_2) = 0.35$ $u(E_3) = 0.6$

Substituting it in the new $u(E_2) = 0+0.5(0.6) = 0.3$

This is similar to the earlier $u(E_2)$.

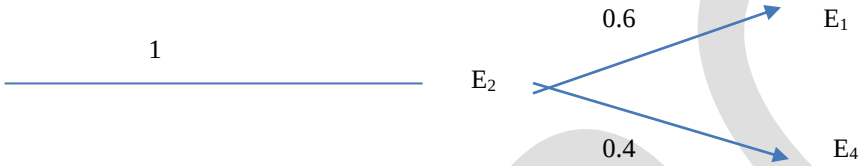
4.2. Explanation for the values in table 2

The following events have been considered:

1. E_1- Gary Johnson Low Ethics and Low Popularity
2. E_2- Bernie Sanders High Ethics and Low Popularity
3. E_3-Donald Trump Low Ethics and High Popularity
4. E_4-Hilary Clinton High Ethics and High Popularity

The preference order: $E_1 < E_2 < E_3 < E_4$

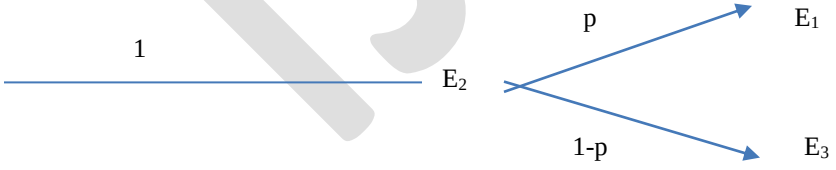
$u(E_1) = 0.0$ $u(E_4) = 1.0$



$u(E_2) = 0.6(E_1) + 0.4 (E_4) = 0.4$

$u(E_3) = 0.2 (E_1) + 0.8 (E_4) = 0.8$

To cross check these utility assignments the decision Maker will be asked for the value of p. As there is only a 50% chance that the predicted and calculated values could be correct. Therefore, we consider the value of p to be 0.5.

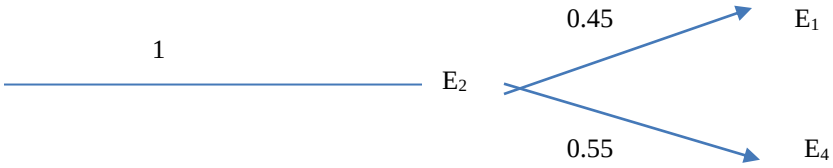


The value of p = 0.5

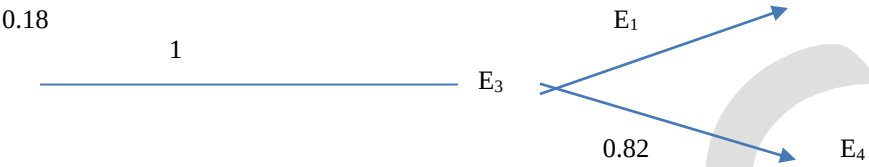
$u(E_2) = 0.5u(E_1) + 0.5u (E_3)$
$= 0.5*0 + 0.5*0.8$
$= 0.4$

The values of u(E_2) obtained earlier and now are very similar. Hence, this proves that there is no inconsistency. The values will have to be reevaluated just to be double sure.

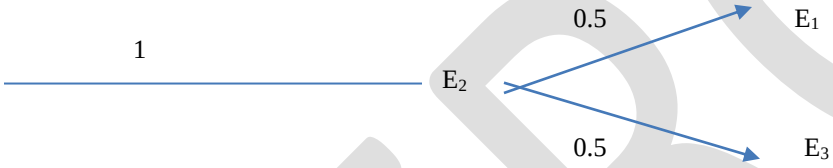
1.



2.



3.



u(E_2) = 0.55 u(E_3) = 0.82

Substituting it in the new u(E_2) = 0+0.5(0.82) = 0.41

This is similar to the earlier u(E_2).

As stated above a decision has to be made as to the best alternative among the four events listed below:

5. Application of utility theory to Transportation Engineering

Proceeding along the same lines as explained earlier in this paper, these concepts are applied to a Transportation Engineering problem where a choice has to be made between two events, both dealing with renting of equipment for construction purposes (Sloboda et al., 2017). Here is the description of the events:

1. E1 represents the event of renting low level equipment for a long period (2-3 weeks)
2. E2 represents the event of renting upgraded equipment for a short period (1-2 weeks)

The duration and the associated costs are shown in Table 1 below. It should be noted that the duration and costs are both random variables. These are assumed to have Gaussian distribution based on the information in the literature (Ang & Tag, 2007).

We are considering certain ratios for the cost and duration. The cost is considered as per $\$10^5$ and the duration is in weeks. As per E1 we are considering two types of basic equipment for the same work that costs us about $\$10^5$ for a duration of 3 weeks and another type of basic equipment that costs us about $\$3*10^5$ for a duration of two weeks. As per E2 we are considering two types of upgraded

equipment for the same work that costs us about $\$2*10^5$ for a duration of 2 weeks and another type of upgraded equipment that costs us about $\$4*10^5$ for a duration of one week. Our major objective is to find the best equipment type considering the major parameters cost and time and to deliver with highest quality.

Table 1: Information regarding the equipment rented for the two events.

E1- REPRESENTS BASIC EQUIPMENT

Cost	Duration
3	2
1	3

E2-REPRESENTS UPGRADED EQUIPMENT

Cost	Duration
4	1
2	2

Table 2 below helps with the decision analysis using multi attribute utility approach for both kinds of equipment's for the same work considering different durations. This process simplifies the method to find a solution for multi attribute problems. Utility function considering the probability of a certain event happening. Through thorough research it has been predicted that the probability of time taken for upgraded equipment to complete the work in 3 weeks is 0.2 or 20%. Whereas the probability of the same equipment to complete the work in 2 weeks is 0.8 or 80%. When we look at basic equipment the probabilities vary or change. that the probability of time taken for upgraded equipment to complete the work in 1 weeks is 0.5 or 50%. Whereas the probability of the same equipment to complete the work, in 2 weeks the probability is 0.5 or 50%.

Table 2 Utility factors of the events

E1 : BASIC EQUIPMENT

(Cost,Duration)		
	0.2	(1,3)
	0.8	(3,2)

E2 : UPGRADED EQUIPMENT

(Cost,Duration)		
	0.5	(2,2)
	0.5	(4,1)

Table 2 Utility factors of the events

The density functions for the duration and cost for both events E_1 and E_2 are shown in Fig. 1 below. The graph represents the costs and durations for upgraded equipment and basic equipment for events A and B. It depicts how the duration of the job varies with the cost of the equipment.

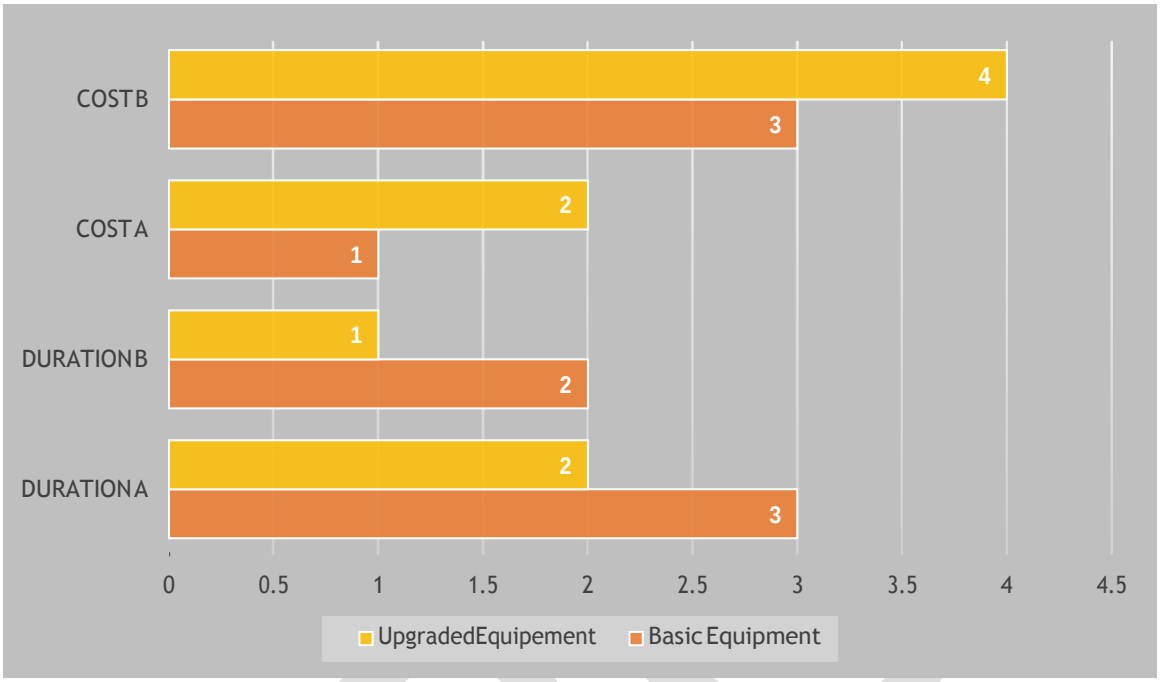
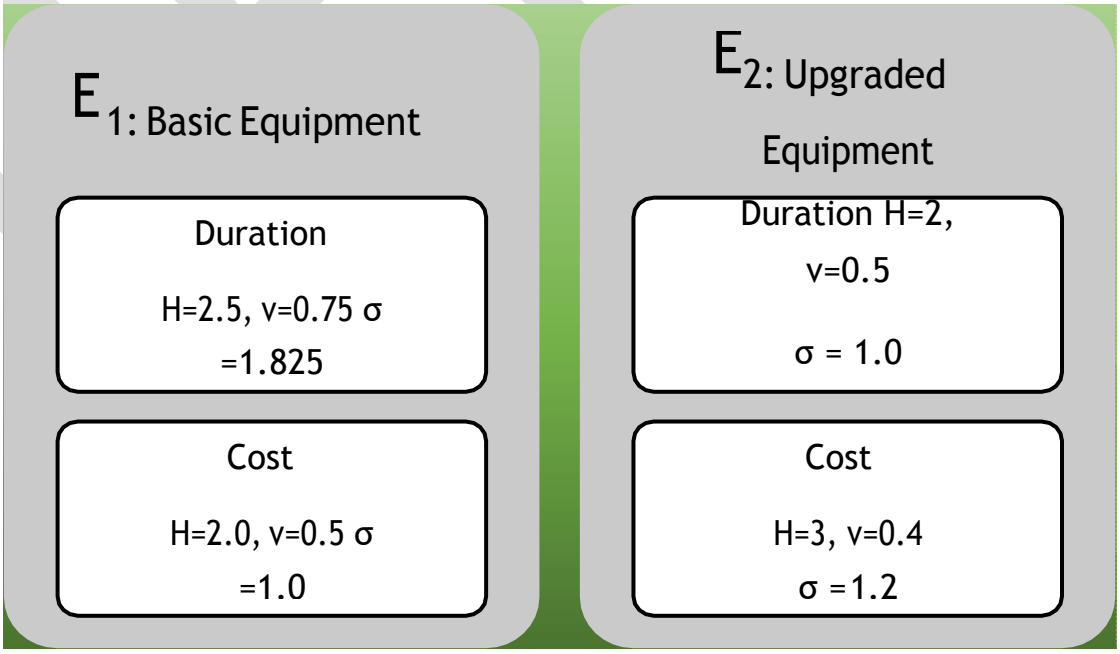


Figure 1 Graphical information for duration and cost of equipment.

We need certain parameter to analyze the best option with respect to time, cost and quality of work. And through thorough research the parameters required for a multi attribute decision are listed below for the two kinds of equipment's we are considering.

Figure 2 Parameters required for the events.



With the help of values in table 2 we have derived the values below.

Assuming u (1,3) =1 and u (2,3) =0 Check
u(x,t) = u(1,3)

= 0.24(1,2) + 0.84(3,3)

As the marginal utility function ranges between 0 to 1, the most desirable cost is $1(10^5)$ and the least desirable cost is $4(10^5)$. We are calculating U_X with the help of the equation below. Hence:

Ux(x) = Ux(x) * 0.5/0.25.....(2)

As the marginal utility function ranges between 0 to 1, the most desirable duration is 1 and the least desirable cost is 3. Hence

Ut(t) = Ut(t) * 0.5/0.25.....(3)

The cost and duration for each of the alternatives are derived using the above equations as they are statically independent.

This implies:
Ux(x) = -x * 0.5/0.25 Ux(x) = -2x
Hence

$U_X(1) = -2$ $U_X(4) = -8$

Applying Linear Transformation

Ux(x) = a+b*Ux(x).....(4)

For the condition to be satisfied: $U_X(1) \equiv a+b(-2)=1$

$U_X(4) \equiv a+b(-8)=0$

Solving the above equations we get a=4/3 b=1/6

Which implies

Ux(x)= 4/3 - x/6.....(5) (or)

Ut(t) ≡ a+b(t).....(6) $U_t(1) = a+b \equiv 1$
$U_t(3)= a+3b \equiv 0$

Solving the above equations we get a=3/2 b=-1/2 Which implies

Ut(t)=3/2 – t/2.....(7)

$U_X(1) = 4/3 – 1/6= 1.16 \approx 1$ $U_X(4) = 4/3 - 4/6= 0.66 \approx 0.5$

$U_t(1) = -1.99+2.63= 0.64$ $U_t(3) = -1.99+7089= 5.9$

(or)
$U_t(1)= 3/2 – 1/2= 1$

$U_t(3)= 3/2 – 3/2= 0$

U(x,t) = 0.2 Ux(x)+0.54 Ut(t)+0.3Ux(x)Ut(t).....(8)

=0.2[4/3 - x/6]+0.5[3/2 - t/2]+0.3(4/3 - x/6)(3/2 - t/2) =0.266 - 0.033x + 0.75 - 0.25t+0.3[12/6 - 2t - x/4 - xt/12] =1.016 - 0.033x + 0.25t + 0.6- 0.6t- 0.075x - 0.025xt
= 1.616 - 0.108x + 0.85t - 0.025xt

The expected utility of not renting additional equipment (alt E_1) can be determined as below:

E(U1) = $\int\int_{-\infty}^{\infty} U(x, t)$ **f^{1}x, T(x,t)dxdt.....(9)**

= $\int\int$**(1.616 - 0.108 + 085t - 0.025xt) f^{1}x(x) f^{1}t(t) dxdt.....(10)**

Integrating term by term

E(U1) = 1.616 - 0.108μx1 + 0.85 (μt1+σt1) - 0.025μx1(μt1+σt1).....(11)

=1.616-0.108(2)+0.85(2.5+1.825)-0.025(2)(2.5+1.825) =1.616 - 0.216+ 3.878- 0.216
=5.062

Integrating the other alternative

E(U2)= 1.616 - 0.108μx2+ 0.85(μt2+σt2)- 0.025μx2(μt2+σt2).....(12)

= 1.616 - 0.108(3)+ 0.85(3)-0.025(3)(3) = 1.616 - 0.324+2.55 - 0.225

=3.616

E(U1)>E(U2)

Hence Basic equipment should be rented.

6. Discussion of Results and Conclusions

The concepts of utility theory have been applied in an innovative way to the problems in the areas of Economics and Political Science integrating ethics into each of the fields with ethics as key basis in the initial portion of this paper. It has been shown that rational decisions can easily be made using utility values.

In the later part, the utility theory has been successfully used to choose the best alternative among the available ones in a construction industry. Using the information regarding basic equipment and upgraded equipment with the help of utility function and multi attribute utility approach it has been analyzed that it is better to rent basic equipment for a longer duration rather than renting upgraded equipment for a shorter duration.

7. Conclusions

All in all, this paper illustrates the application of the tool of utility theory to Economics and Politics and also Transportation Engineering. The fields of Economics and Political Science have been connected in an innovative manner through ethics by using the concepts of utility theory. It has been shown that utility theory helps a person in making decisions in many disciplines.

REFERENCES:

Ang, A.H-S., Tang, W.H (2007). Probability Concepts in Engineering Planning and Design, Volume II- Decision, Risk, and Reliability. John Wiley & Sons.

Ang, A.H-S and Tang, W.H. (1984). **Probability Concepts in Engineering Planning and Design,** Volume II Decision, Risk and Reliability

Drucker, P.F. (1993). **Post-capitalist society.** Butterworth Heinman: Oxford

Galindo, M-A and Cuevas, J.G. (2008), The Role of Ethics in Economics and Management: Galbraith – Drucker approaches, **Int. Adv Econ Res.**

Galbraith, J.K. (1991). **The affluent society**. Peguin:London

Sloboda, B., Putcha, C.S. and Bandaru, L.L. (2017), "Relationship between Ethics, Economics and Politics)", presented at Association for Integrity and Responsible Leadership in Economics and Associated Professions (AIRLEAP), Saint Charles, Missouri, October 13-14.