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THE POTENTIAL IMPACTS OF *LUAS* ON TRAVEL BEHAVIOUR

Hazael Brown[i]
Dr., Independent Researcher

Abstract:
The Irish government is determined to provide a better and efficient transport service for everyone, no matter where they live. It is recognised that the impacts of transportation and its travel behaviour on the environment is crucial. One way to try and control road traffic growth in Dublin is through the introduction of a new light rail system called LUAS. Predicting the impacts of this system on travel behaviour is complicated, in particular given the lack of experience of this type of mode in Ireland. It is important to emphasize that the people's modal choices of whether to use or not to use any of these modes of transportation (bus, car, bike, train and LUAS), is an important factor in determining and predicting travel behaviour. In this research, a method borrowed from social psychology called Theory of Planned Behaviour is used to examine the people's modal choices, travel decisions, changes in travel behaviour and also, predicting their travel behaviour.

Keywords: Irish transportation, potential impacts, LUAS, transport problem, travel behaviour

1. Introduction

The government is determined to reduce traffic congestion and pollution through the introduction of the light rail transit system called LUAS. In this research, the studies show how the behavioural theories such as The Theory of Planned can be used to examine, how modal choices are made and how it impacts on the people's decision making process, with a view to predict accurately the modal choices and travel behaviour the people will make when using the LUAS in future. The LUAS system can potentially impact on Land use, Travel demand, Traffic and Travel behaviour. This

[i] Correspondence: email hzaelb@gmail.com

research will only focus on travel behaviour. The Theory of Planned Behaviour is a method borrowed from social psychology and was used to examine the intention of the people's decision making processes in relation to using the LUAS. This Theory of Planned Behaviour was also used to examine the impacts of LUAS on travel behaviour.

In summary, the objectives of this research were to:

- Find out what people's beliefs would be for LUAS.
- Discover how these beliefs would determine their attitudes, subjective norms and perceptions of behavioural control.
- Show how these factors could affect people's decisions to use LUAS and the associated changes to people's travel behaviour.
- Examine whether people's beliefs, attitudes, subjective norms and perceived behavioural control could play a role in predicting their use of LUAS.

2. Travel Behaviour Forecasting Studies.

In the past, there has been widespread evidence for discrepancies between the forecasts of patronage on the new urban public transport systems and the actual patronage. For example, in the forecasts for Manchester Metrolink and Sheffield Supertram systems, there were errors in the predictions in the number of people using the systems due to incorrect representation of supply conditions at the time of opening**.**

2.1 The Forecasting studies of Sheffield Supertram.

The Sheffield Supertram was opened in 1994 with a population of 500,000 and unemployment levels of 12.5%. The system cost £240.6 million. The studies of the Supertram were carried out by MVA consultancy and WS Atkins. The forecast of patronage of the system was predicted as 22 million passengers per year, but only resulted in 6.3 million passengers per year. There were more non-work trips than expected. Also, it was predicted that 14.9 million trips would transfer from bus to Supertram, but the actual transfer amount was 1.2 million trips. Furthermore, it was predicted that 0.8 million trips would shift from car to Supertram, but the actual shift was 1.2 million trips.

2.2 The Forecasting studies of Manchester Metrolink

The Manchester Metrolink studies were carried out by Oscar Faber in 1992 and the system cost £140 million. The actual annual patronage was 12.4 million, but the forecast of patronage of the system was predicted as 11.4 million. The number of trips to the city centre on two lines of the Metrolink was lower than expected. The Bury line trips were 23% lower than expected for some stations. Also, the Altrincham line to the city centre

was between 12% and 14% lower than expected for some stations. The off-peak patronage of the system was much higher than expected.

In these cases, the forecasting studies pointed out that there were problems with the assumptions made about the behavioral responses of potential users to the new public transport systems.

3. The Psychological Method: The Theory of Planned Behaviour

For this reason, the researcher will examine the potential impacts of the new LUAS system on the travel behaviour of the people in Dublin using a method borrowed from social psychology called the Theory of Planned Behaviour. The Theory of Planned Behaviour according to (Icek Ajze, 1985 and 1987), states that human action is guided by three kinds of considerations: behavioural beliefs, normative beliefs and control beliefs. Furthermore, all behaviour is determined by intention to carry it out. Intention is a function of three factors:

- attitude toward the behaviour,
- subjective norm; and
- perceived behavioural control.

The combination of these three lead to the formation of behavioural intention. Attitudes, perceptions of what other people think and perceptions of how easy an action is to carry out, determines whether someone will choose to carry out the given behaviour. The illustration of the components of the Theory of Planned Behaviour is shown in Figure 1 below:

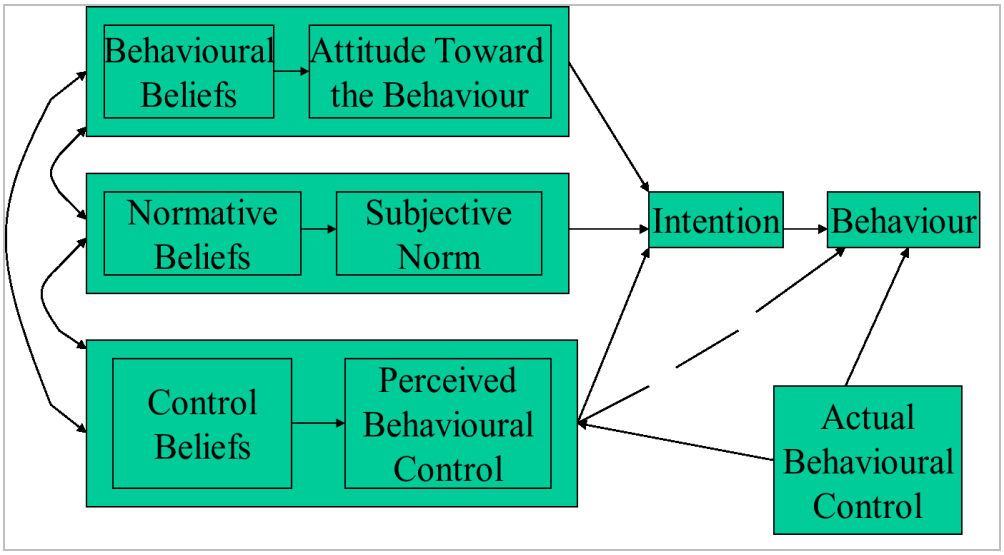

Figure 1: The Theory of Planned Behaviour

Source: Icek Ajzen 2002

3.1 The Application of the Theory of Planned Behaviour

Let's look at the three factors that involve in decision making by applying Theory of Planned Behaviour.

A. Attitude

- Behavioural beliefs
- Outcome evaluations

I believe that using the light rail transit system called LUAS will save time when I go to work.

3 2 1 0 -1 -2 -3

3 = Agree strongly, -3 = Disagree strongly

Saving of time when I go to work is:

3 2 1 0 -1 -2 -3

3 = Very important, -3 = Very unimportant

$$\mathbf{A = \Sigma\ (BB * OE)}$$

Where,

A - Attitude

BB - Behavioural beliefs

OE - Outcome evaluation

B. Subjective norms

- Normative beliefs
- Motivation to comply

My family thinks that I should use LUAS for all trips, because it will reduce traffic congestions in Dublin.

3 2 1 0 -1 -2 -3

3 = Agree strongly, -3 = Disagree strongly

In generally, do you want to do what the family wants?

3 2 1 0 -1 -2 -3

3 = Agree strongly, -3 = Disagree strongly

$$\mathbf{SN = \Sigma\ NB * MC}$$

Where,

SN - Subjective norm

NB - Normative belief

MC - Motivation to comply

C. Perceived Behavioural control

- Control beliefs
- Perceived facilitation effect

When I have a lot to carry walking is

3 2 1 0 -1 -2 -3

3 = Very easy, -3 = Very difficult

I have a lot to carry

3 2 1 0 -1 -2 -3

3 = Always, -3 = Never

PBC = Σ CB * PFE

Where,

PBC - Perceived behavioural control

CB - Control belief

PFE - Perceived facilitation effect

Therefore, in order to use and apply the Theory of Planned Behavior in decision making, it is important to identify the beliefs, attitudes, subjective norms and perceived behavioural control of potential LUAS users.

4. The LUAS Routes

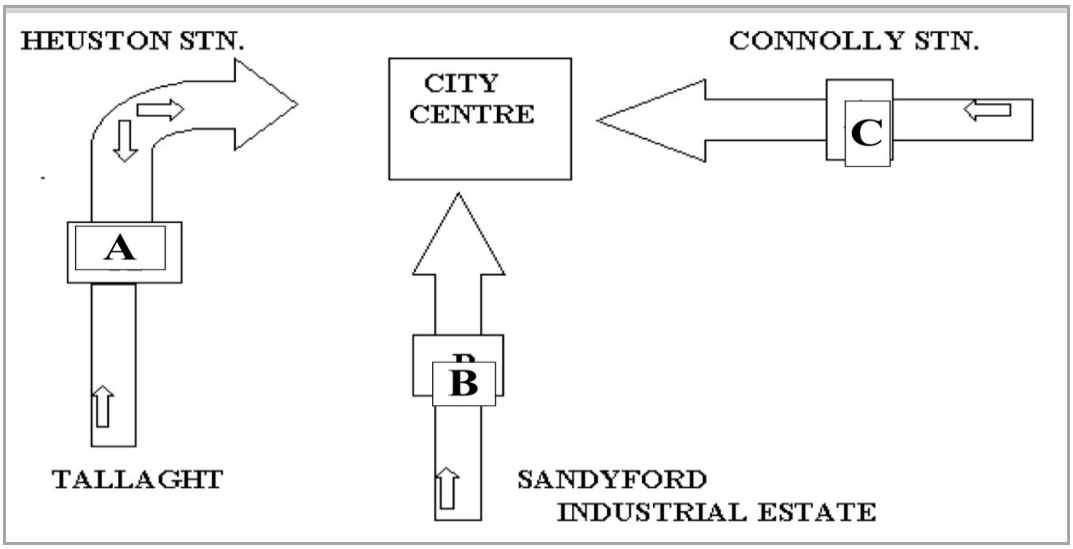

Figure 2: Sketch diagram of LUAS Lines A, B and C

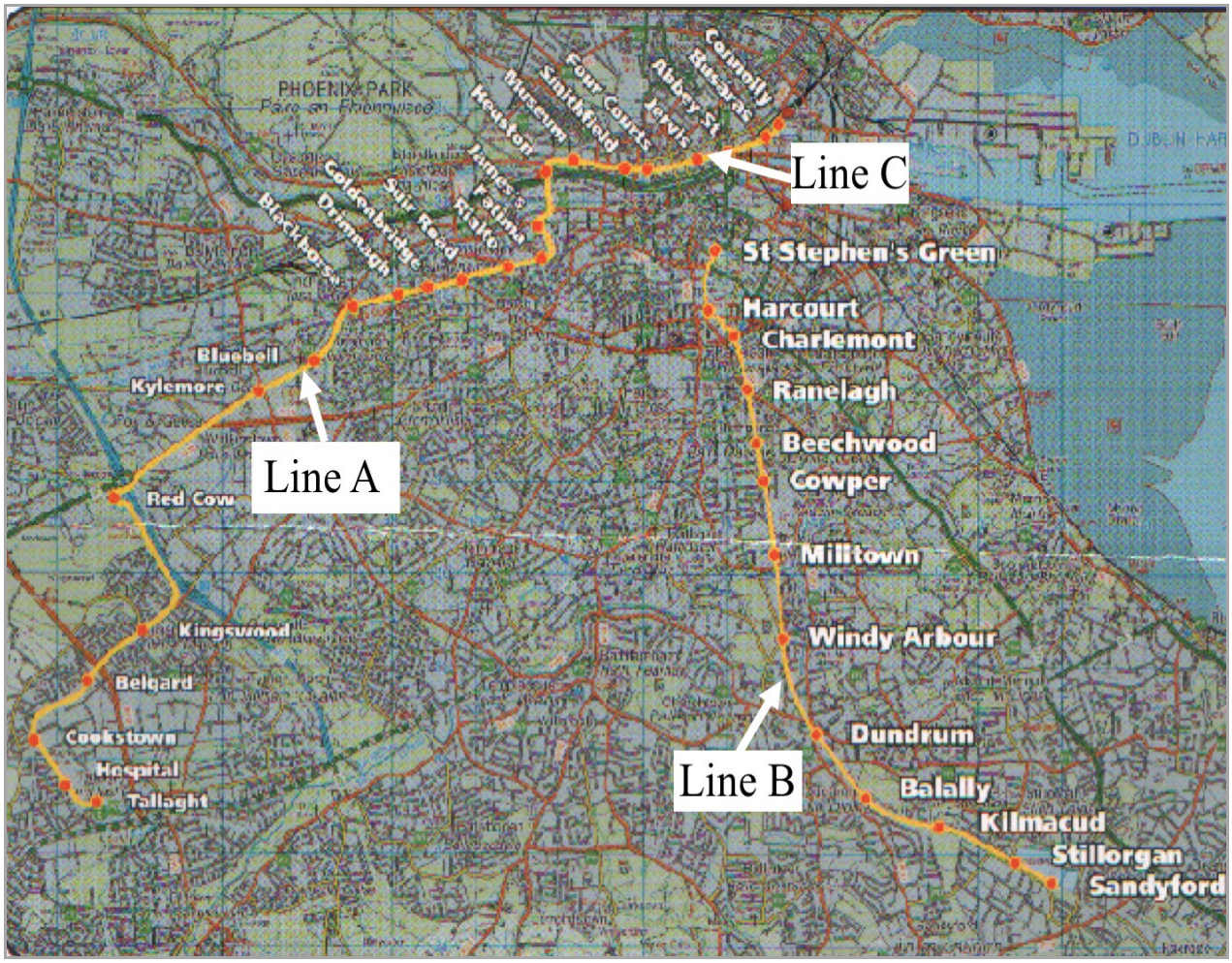

Figure 3: Map of LUAS Lines A, B and C

5. The Survey Studies

The studies survey of potential LUAS users in Dublin was carried out through the use of questionnaires and interviews, 12 months prior to its opening. Also, six months after LUAS systems were opened, follow-up studies were conducted to find out how many of those who filled the questionnaires and interviewees had used the LUAS systems.

The questionnaire was designed to measure:

- The intention of the respondents to use LUAS on their commuter trips.
- People's attitudes to using LUAS on commuter trips.
- People's subjective norms regarding using LUAS on commuter trips.
- People have perceived behavioural control regarding using LUAS on commuter trips.

6. The Results of the Findings

Then, the results of the findings of the questionnaires and interviews in Dublin survey, were presented in tables below.

Table 1: Behavioural, Normative and Control Beliefs Score Between -3 to +3

I believe in using LUAS on my work trip:	**Group**		
	A	**B**	**C**
Will improve personal safety.	1.2	-0.8	0.2
Will decrease my chances of being involved in an accidence.	1.2	-0.6	1.3
Will save me money.	1.4	-0.9	-0.3
Will save me time.	1.8	-1.3	0.5
Will reduce traffic congestion.	1.7	0.2	0.8
Will be more comfortable.	1.8	-1.0	0.9
Will improve the environment.	2.1	0.3	1.3
My family think that it's good for me to use the LUAS and I will listen to their advice.	0.8	-1.0	1.5
Dublin Transportation Office (DTO) has issued publicity urging me to use the LUAS, but I am not impressed by this publicity and it does not influence my choice.	1.6	0.9	0.4
My friend thinks it's a good idea for me to use the LUAS and I will listen to their advice.	1.2	-0.7	0.3
I belief that it would be a good idea to use the LUAS to travel to word if:			
I was in a hurry.	1.6	-0.9	1.1
I was travelling in heavy traffic.	1.8	-0.7	0.5
I live near the LUAS.	2.4	0.5	1.8
I work near LUAS.	2.3	1.2	1.8

From Table 1 above, the respondents gave a score between -3 to +3, which reflects their behavioural, normative and control belief scores.

The hypothesis of the study is that the intention a person to use the LUAS is directly dependent to his or her attitude, subjective norm and perceived behavioural control. According to (Long 1997), Ordinal Regression Analysis should be used when the dependent variable is ordinal. Table 2 below shows the original scores and the new scores for the ordinal regression analysis.

Table 2: Scores used in the ordinal regression analysis

Original score for attitude, subjective norm, perceived behavioural control and intention	New scores for ordinal regression analysis
-3	-2
-2	-1
-1	-1
0	0
1	1
2	1
3	2

Table 3 below shows the average scores of intention, attitude, subjective norms and perceived behavioural control for the respondents in group A, B and C.

Table 3: Scores for the components of the TPB in the study

Component	Group A (those likely intended to use LUAS)	Group B (those unlikely intended to use LUAS)	Group C (those not decided to use LUAS)
Intention to use LUAS	2.1	-2.6	0.0
Attitude to using LUAS	2.3	-1.5	0.1
Subjective norm	1.5	-1.4	0.1
Perceived behavioural control	1.4	-2.5	0.1

7. The Regression model and Logistic Regression Model

Let, **Si** be a dependent variable that depends on a set of explanatory variables **xi** according to a model as shown in Equation 8.1

$$\mathbf{Si} = \alpha + \beta \mathbf{x}_i + \varepsilon_i \qquad \text{(Equation 8.1)}$$

Where,
Si - dependent variable (latent variable)
$\mathbf{x}_i$ - independent variable
ε_i - stochastic error
α and β - are use as parameters in regression equation.
$\mathbf{T_1....T}_{j-1}$ - This is the set of thresholds that is use to transform Si into the observed variable y according to the equation below:

$$y = J \text{ if } Si < T_{j-1} \quad \text{(Equation 8.2)}$$

In the situation that is under analysis in this paper, there are three independent variables, so the equation becomes:

$$Y = \alpha + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 \quad \text{(Equation 8.3)}$$

Where,
Y = Dependent variable. That is, the person's intention to use LUAS.
X_1, X_2 **and** X_3 = Independent variables. These are the attitude scores, the subjective scores and perceived behavioural control scores.
β_1, β_2 **and** β_3 = Regression coefficients.

In logistic regression, the Logit transformation of the linear regression model were performed. That is, conversion of Y to P (probability), so as to obtain outcomes of the dependent variable probabilities. The above equation 8.3, can rewritten as:

$$Y = \log (P/1-P) = \alpha + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 \quad \text{(Equation 8.4)}$$

The estimated multiple logistics model:

$$\log(P/1-P) = \alpha + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 \quad \text{(Equation 8.5)}$$

Where,
log - Natural logarithm (natural log)

$$P/1-P = \text{Odds ratio} \quad \text{(Equation 8.6)}$$

Odds ratio - ratio between the probability intentions of one group to people likely to use the LUAS, to the probability intentions of the other group of people unlikely to use the LUAS.

$$P = \text{Odds}/1+\text{Odds} \quad \text{(Equation 8.7)}$$

Where,
P - probability intention of likely to use the LUAS;
1-P - probability intention of unlikely to use the LUAS.

Therefore, from equation 8.5 above, by taking natural log from both sides of the equation and doing some algebra, the expression above can be rewritten as:

$$P = 1 / (1 + e^{-y}) = e^{y} / (1 + e^{y}) \quad \text{(Equation 8.8)}$$

$$1-P = (1 - e^{y}) / (1 + e^{y}) = 1 / (1 + e^{y}) \quad \text{(Equation 8.9)}$$

Where,

e^{y} = exponential function or exp(·)

$y = \alpha + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3$

The Logistic regression line have the best fit for the sample data. As the probability intentions of potential LUAS users likely to use the LUAS increases, the probability acentotically closer to one (1), Also, as the probability intentions of LUAS users predicted unlikely to use the LUAS decreases, the probability acentotically closer to zero (0). In this model, the probability ranges from zero (0) to one (1) and the Log Odds ranges from minus infinity to plus infinity. Thereby, producing a reseanable forcasting tools that could be used to predict the impacts of LUAS on travel behaviour.

8. The Conclusion and Recommendations

In conclusion, from the Theory of Planned Behaviour, we were able to understand the followings:

- How travel related factors such as time, comfort, safety etc could play a role when choosing a mode,
- How attitudes and social norms have an impact on people's travel choices
- The impact that constraints (perception of behavioural control) have on the people's travel behaviour and how these impact on their travel decisions.

So, some recommendations can be made as to how to promote and patronize LUAS thereby bringing about change in travel behaviour. For the campaign message to be effective, the message should address the identified problems and the negative beliefs of the potential users, so as to change them and improve the impacts of LUAS.

In conclusion, the Theory of Planned Behaviour is an important tool that can be used to understand and explain modal choices, travel decisions, changes in travel behaviour and predicting travel behaviour of potential LUAS users. The LUAS system is a dynamic traffic mode and it will generate more trips.

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