# REAL TIME BUS PASSENGER INFORMATION TAKE-UP AND USER PERCEPTIONS OF THE SERVICE

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**Abstract**
Real-time passenger information (RTPI) is now a major element in most public transport systems in the developed world. It has been associated with rail systems for many years and over the last decade or so has also been used increasingly along the bus network. Yet, existing analysis assessing issues such as the socio-economic characteristics of users of RTPI, the devices used to access RTPI information (i.e. mobile phone, home computer, at stops etc.) and the impact of RTPI on perceptions of public transport reliability and ridership, has received only limited attention in the literature with few studies focusing on the bus network in particular. Accordingly, this paper reports on research conducted to assess these issues with respect to the introduction of real-time bus passenger information in Dublin. The methodology employed was quantitative and consisted of 360 questionnaire surveys with bus users undertaken along specific low, medium and high frequency routes during the peak and off-peak period. The results show that RTPI use correlates with socio-economic status. They also show that most users access RTPI at the bus stops but that those accessing the information via mobile devices are from wealthier socio-economic backgrounds. Finally, the introduction of RTPI at stops and via mobile and internet communications has significantly increased passenger perceptions of the reliability of the service.

## Introduction

Buses are essential components of efficient urban public transportation systems which provide a highly flexible mode of transport [1, 2]. In this context, RTPI is becoming increasingly important as an intelligent transport solution that aids with increasing the attractiveness of public transport as an alternative to the private car. RTPI has traditionally been the domain of rail transport over the last two decades or so given the generally better reliability of that mode due to the fact that it operates along its own right of way and therefore tends to be subjected to less uncertainty with regard to unexpected delays and congestion. It is only in the relatively recent past that RTPI technology has improved enough to be deployed relatively inexpensively throughout more expansive bus fleets. Improvements in satellite and associated global positioning system technology and its affordability have allowed this to happen.

In the academic literature, there is quite a depth of research investigating intelligent transport solutions for public transport systems in the form of RTPI. However, to date few studies have focussed on RTPI systems along the bus network. This paper attempts to address this gap by focussing on passenger perceptions of bus-based RTPI along different route frequency categories in Dublin, Ireland. The study also focuses on the socio-economic characteristics of users of RTPI and devices used to access RTPI information (i.e. mobile phone, home computer, at stops etc.).

## Relevant Literature

Harrison et al [3] point out that, very often, it is a combination of measures that serve to increase public transport ridership. In this regard, the move towards RTPI is one that is thought will improve the overall passenger experience particularly in terms of enhancing perceptions of service reliability which should serve, the theory goes, to increase patronage levels. RTPI is thereby often presented as a stepping stone to a more attractive and user friendly service, where long unknown waiting times and associated frustration might be eliminated. Indeed, Caulfield and O'Mahony [4] found that passengers with access to RTPI overestimated their wait time by 9-13% but those without it overestimated it by 24-30%.

Numerous international studies [4, 5, 6] have emphasised the ability of RTPI to increase the attractiveness of bus services. However, a decrease in passenger waiting times appears to be the greatest tangible benefit of RTPI with Cham et al. [7] noting that most of the benefits of RTPI systems might accrue from reductions in wait time and reductions in the

cost of wait time uncertainty. Similarly, Monzon et al [1] argue that RTPI systems have mainly been developed to enhance the ease of use of public transport through both perceived and actual reductions in passenger waiting times thereby increasing overall satisfaction levels. Indeed, Monzon et al [1] and Daskalakis and Stathopoulos [8] assert that improvements to public transport performance are directly related to passenger perceptions of the service, not necessarily objective improvements. Support for this view was found by Zhang et al [9] who showed that although passengers may be waiting at the bus stop for the same amount of time as normal, RTPI has the effect of making passengers believe that the service is more time-efficient.

Monzon et al [1] and Molin and Timmermans [10] suggest that there are numerous benefits from RTPI introduction including less waiting time, passengers have a willingness to pay for an improved service, as well as the positive psychological effects of RTPI on passengers. However, these suggestions have not gone without challenge. Neuherz et al [11] disagrees that passengers will pay a higher price after RTPI introduction and argues that passengers regard travel information as something that is already paid for by transport fares. On the other hand, Lappin [12] states that several studies have come to more or less similar conclusions as Monzon et al [1] and Molin and Timmermans [10]. Politis [13] evaluated the impact of a newly introduced RTPI system in Thessaloniki, Greece. Similar to the results of Lehtonen et al. [14] he found that general satisfaction levels were quite high, over 80% for both the content and the reliability of the information given.

Tang and Thakuriah [15] state that although the RTPI may be implemented to increase numbers taking the bus, in reality it is there to remove any sense of anxiety about whether or not a bus will, in fact, arrive. In the literature, this finding is consistently reinforced. Lehtonen et al. [14], Mishalani et al. [16], Wardman [17], Caulfield and O'Mahony [4], Wolfenden [6], Zhang et al. [9] all point out that RTPI assures passengers that the vehicle has not passed and that they will reach their destination on time. Indeed, research by Caulfield and O'Mahony [4] has shown that prior to RTPI being implemented the vast majority of bus users (80%) indicated that not knowing the arrival time of their bus caused the greatest frustration among users.

Ridership gain is the ultimate goal of any RTPI system. A study undertaken by Infopolis [18] asserts that there have been increases of 5-6% on lines equipped with RTPI in Liverpool and Brussels. Studies undertaken in the US - Transit Watch [19] in Seattle and Transit Tracker [20] in Oregon - found no change in patronage levels at bus stops as a result of RTPI introduction. These results are supported by Tang and Thakuriah [15] and Schweiger [21] with the latter reporting that none of the responsible agencies found an increase in ridership due to the introduction of RTPI. Tang and Thakuriah [15] further reinforce that there are, as of yet, no definitive reports of transit use or mode share increase as a result of RPTI but that higher satisfaction levels and reduced anxieties are common since the introduction of the service. It is common that responsible agencies feel that there may have been an increase in bus patronage, but have no definitive statistics to support that it is a direct result of RTPI [21].

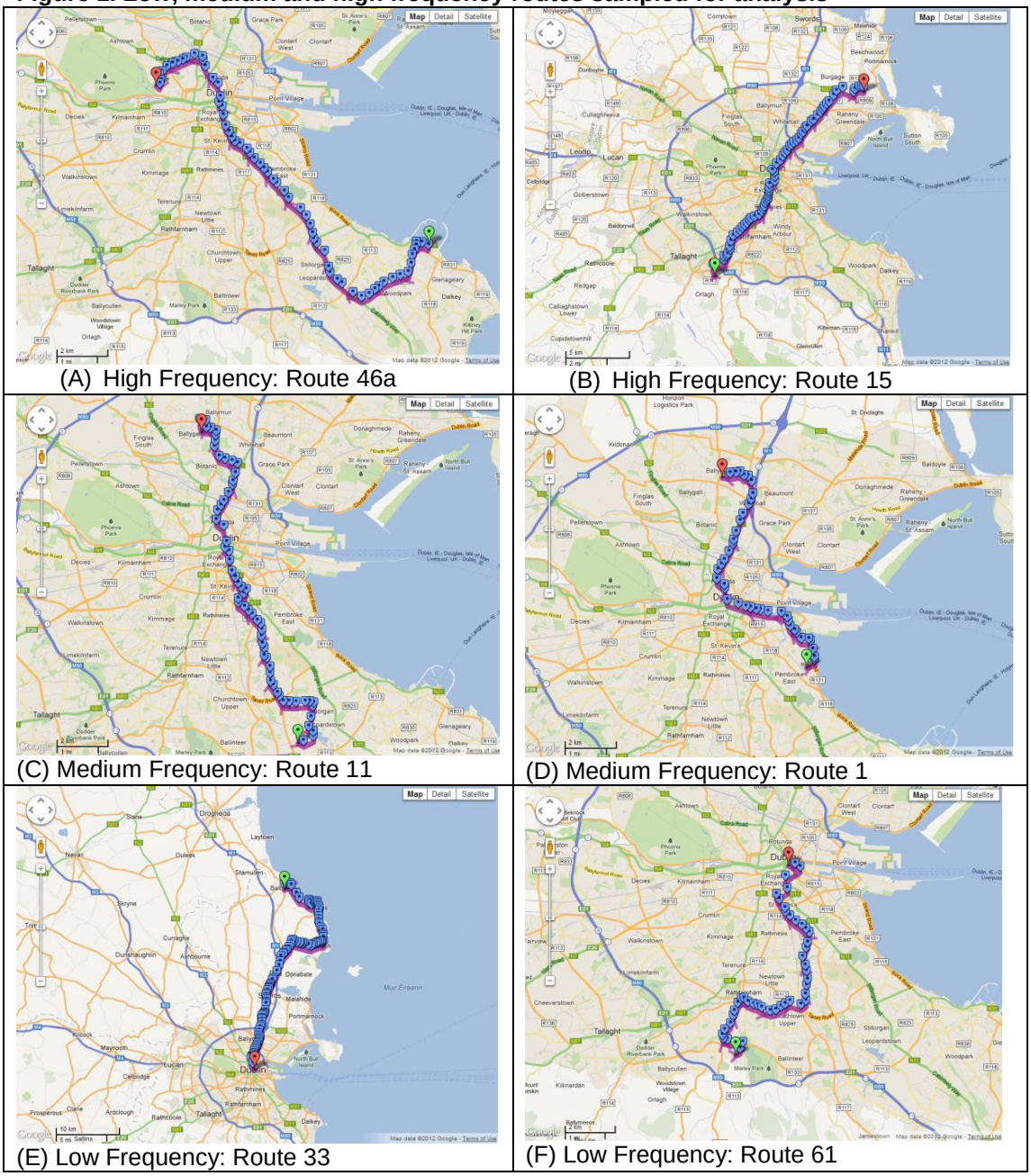
In terms of stated preferences of passengers, Tang et al [15] found 63% of respondents would use transit more if RTPI information was provided on buses and trains. Furthermore, Lehtonen et al. [14], Tang and Thakuriah [15] and Infopolis [18] have illustrated potential ridership increases. The latter reported that 98% of people found RTPI useful and 46% said that they would use the system more as a result of RTPI introduction.

**Methodology**

The overall sampling approach had two components. First, bus routes with different service frequency were chosen based on their categorisation as low, medium or high frequency routes. Specifications for low, medium and high frequency routes were based upon the running headway along each route. High frequency routes were deemed to be routes with headway of 10 minutes or less; medium with headway of 11-20 minutes; and finally low with headway 21 minutes or greater. This is a slight variation on Transport for London's (TfL) categorisations which includes only low and high frequency routes. Second, was the number and choice of routes to be selected. Two routes each that conformed to our categorisation of low, medium and high frequency routes were chosen. A set of criteria was established for selecting the routes: (1) where possible, the routes would traverse the city; (2) they would cover a wide geographic area; and (3) taken together, would traverse areas of varying socio-

economic status. In the case of the low frequency category, routes traversing the city could not be found because no low frequency routes exist that traverse the city. In this case, a separate route each serving the north and south portion of the city was chosen for analysis. The low, medium and high frequency routes chosen for analysis are displayed in Figure 1.

**Figure 1. Low, medium and high frequency routes sampled for analysis**



(A) High Frequency: Route 46a

(B) High Frequency: Route 15

(C) Medium Frequency: Route 11

(D) Medium Frequency: Route 1

(E) Low Frequency: Route 33

(F) Low Frequency: Route 61

For the high frequency routes the 46a and 15 were chosen. These routes not only traverse the city but they also cover a wide geographic area. Moreover, the routes also traverse through areas of contrasting socio-economic characteristics i.e. from affluent to poorer areas of the city. For the medium frequency routes the 11 and the 1 were chosen while 33 and 61 were chosen as the low frequency routes. Although the latter are different to the medium and high frequency routes in that they do not traverse the city, when the routes are combined they do cover a wide geographic area of the city that traverses the city on a north-south axis.

In order to get a representative sample of bus users, it was necessary to distribute a questionnaire survey to Dublin Bus users during peak and off peak periods. Dublin Bus averages c.50000 users a day which constitutes the sampling frame for the research. Data

on the number of daily users for individual bus routes is not publicly available. By selecting a 95% confidence level with a confidence interval of 5.15 requires a sample size of c.360 users using the standard sample size calculation formula. Thus, 60 respondents were sought from each of the six routes amounting to a total of 360 respondents. From each route 30 surveys each were gathered during the peak and off-peak periods. The peak period consisted of the morning and evening peak while the off-peak consisted of the daytime and evening off-peak periods.

Similar to other studies [22], questionnaire surveys were self-administered to route users at various bus stops along individual routes and also on buses operating along the route. The questionnaire surveys had a series of open and closed questions focussing on key issues of interest to the project. The survey had a total of twenty questions focusing on the user background and socio-economic profile, mode and route usage habits, RTPI usage habits, devices used to access RTPI information (i.e. mobile phone, home computer, at stops etc.) and the impact of RTPI on perceptions of public transport reliability and ridership. The data was input into the statistical package SPSS and data analysis was performed therein including chi-square tests to test the association between variables, difference of means tests (t-tests), and also some descriptive analysis.

**Results**

With regard to RTPI use, the results showed that 80.2% of respondents used RTPI along the bus routes while 19.2% did not. Using an independent samples t-test, the results showed that there was a significant difference (p=0.01) in the age profile of those who used the service and those who did not. Table 1 shows that the average age of those using the service is considerably lower than non-users indicating that there may be an age barrier to accessing RTPI information particularly using smartphone applications. Furthermore, in terms of income there no notable difference in use of RTPI across income categories despite the fact that smartphones tend to be quite expensive (see Table 2).

**Table 1. Age profile statistics for RTPI users and non-users**

| | Do you use RTPI? | N | Mean | Std. Deviation | Std. Error Mean |
|---|---|---|---|---|---|
| Age | Yes | 247 | 31.42 | 15.187 | .966 |
| | No | 54 | 38.48 | 19.239 | 2.618 |

**Table 2. Income and RTPI use**

| | | | Income | | | |
|---|---|---|---|---|---|---|
| | | | <10k | 10-30k | 30-50k | 50k+ |
| Do you use RTPI? | Yes | Count | 76 | 81 | 36 | 14 |
| | | % | 84.4% | 83.5% | 83.7% | 87.5% |
| | No | Count | 14 | 16 | 7 | 2 |
| | | % | 15.6% | 16.5% | 16.3% | 12.5% |

It was hypothesised at the outset that there would be a relationship between route frequency category and usage of RTPI. Specifically, we felt that the magnitude of RTPI usage would be higher on low frequency routes and lower at high frequency routes given that the latter are effectively 'turn-up-and-ride' routes which we suspected would, at least somewhat, negate the reliance on RTPI along high frequency routes. Statistical analysis using a chi-square test found no relationship between route frequency and RTPI use (p=0.39). Counter intuitively, the descriptive statistics (Table 3) show that the lowest proportional RTPI use was on the low frequency routes with the highest being on medium frequency routes.

Table 4 shows the platform used to access RTPI information along the different route frequency categorisations. The results show very little difference in how RTPI is accessed across different route frequency categories where trends are more or less similar. Electronic

display at stops is the most popular method along all routes followed by the Dublin Bus mobile phone app and then via internet on a personal computer.

**Table 3. Relationship between route frequency categorisation and RTPI use**

| | | | Do you use RTPI? | |
|---|---|---|---|---|
| | | | Yes | No |
| | Low | Count | 70 | 20 |
| | | % | 77.8% | 22.2% |
| | Medium | Count | 102 | 18 |
| | | % | 85.0% | 15.0% |
| | High | Count | 97 | 23 |
| | | % | 80.8% | 19.2% |

**Table 4. Route frequency categorisation and RTPI access platform**

| | | | On what Device(s)? | | | | |
|---|---|---|---|---|---|---|---|
| | | | Phone ( App) | Phone (Internet) | Computer (Internet) | Phone (Text) | Electronic Display |
| | Low | Count | 18 | 3 | 8 | 2 | 25 |
| | | % | 32.1% | 5.4% | 14.3% | 3.6% | 44.6% |
| | Medium | Count | 25 | 4 | 9 | 5 | 36 |
| | | % | 31.6% | 5.1% | 11.4% | 6.3% | 45.6% |
| | High | Count | 22 | 5 | 8 | 4 | 34 |
| | | % | 30.1% | 6.8% | 11.0% | 5.5% | 46.6% |

Table 5 shows the relationship between route frequency and perceptions of bus reliability since the introduction of RTPI. While the relationship is not statistically significant (p=0.33), it is notable that the lowest proportions of users who feel the bus service is more reliable is along low frequency routes. From a policy perspective, this is the opposite of what we might want or indeed expect. RTPI is particularly useful along low frequency routes because it reduces wait times whereas along 'turn-up-and-ride' high frequency routes it is less important because of generally low wait times. Somewhat counter intuitively then, it seems that in the case of Dublin's system, users find RPTI improves bus reliability to a greater extent along high frequency than where it is need to improve reliability i.e. along low frequency routes. Overall, almost two-thirds (63.2%) of respondents feel that the introduction of RTPI has improved bus reliability.

**Table 5. Route frequency categorisation and perceptions of bus reliability**

| | | | More Reliable | Less Reliable | About the Same |
|---|---|---|---|---|---|
| | Low | Count | 51 | 3 | 36 |
| | | % | 56.7% | 3.3% | 40.0% |
| | Medium | Count | 81 | 2 | 37 |
| | | % | 67.5% | 1.7% | 30.8% |
| | High | Count | 76 | 6 | 37 |
| | | % | 63.9% | 5.0% | 31.1% |

Respondents were asked about the impact of the introduction of RTPI on their use of the bus: specifically, whether they use the bus more or less often or about the same since the introduction of RTPI along their route. The results of a cross tabulation of RTPI users and their response is shown in Table 6. The results of a chi-square test reveal a strong statistically significant relationship between the two variables at the 1% confidence level (p=0.00). Thus, the results show that respondents who use RTPI cite using the bus more often since the introduction of the system. Although it is not definitive, this implies that the introduction of RTPI has increased patronage levels specifically among users who use the RTPI facility. Overall, 29.9% of respondents cite using the bus more often since RTPI introduction which does indicate, albeit tentatively, greater usage levels.

**Table 6. Relationship between RTPI and bus usage frequency**

| | | | Describe use | | | Total |
|---|---|---|---|---|---|---|
| | | | More Often | Less Often | The Same | |
| RTPI Use | Yes | Count | 94 | 7 | 166 | 267 |
| | | Expected Count | 79.8 | 6.5 | 180.7 | 267.0 |
| | No | Count | 4 | 1 | 56 | 61 |
| | | Expected Count | 18.2 | 1.5 | 41.3 | 61.0 |
| Total | | Count | 98 | 8 | 222 | 328 |
| | | Expected Count | 98.0 | 8.0 | 222.0 | 328.0 |

Respondents were also asked whether they considered that the introduction of the RTPI system had made the bus system more or less reliable. As in the previous case, the results (Table 7) are statistically significant (p=0.00) using a chi-square test. For respondents who use RTPI and who think the bus system is more reliable, the observed count considerably exceeds the expected count indicating that there is a tendency for RTPI users to perceive the bus as being more reliable; by way of contrast, less than expected respondents who are not RTPI users perceive the bus service as more reliable. Overall, 63.2% of respondents think the bus service is more reliable since the introduction of RTPI.

Table 8 shows the relationship between bus usage since the introduction of RTPI and perceptions of RTPI reliability. The results of a chi-square test show that the relationship between the two variable is significant at the 10% confidence level (p=0.91). Specifically they show that users who feel that the RTPI service is reliable also cite using the bus more often as a result of the introduction of RTPI. More broadly, 78.0% of respondents consider the RTPI service to be reliable with only 6.6% finding it unreliable.

**Table 7. Relationship between RTPI use and user perceptions of service reliability**

| | | | Bus Reliability | | | Total |
|---|---|---|---|---|---|---|
| | | | More Reliable | Less Reliable | Same | |
| RTPI Use | Yes | Count | 186 | 11 | 72 | 269 |
| | | Expected Count | 170.1 | 9.0 | 89.9 | 269.0 |
| | No | Count | 22 | 0 | 38 | 60 |
| | | Expected Count | 37.9 | 2.0 | 20.1 | 60.0 |
| Total | | Count | 208 | 11 | 110 | 329 |
| | | Expected Count | 208.0 | 11.0 | 110.0 | 329.0 |

**Table 8. Frequency of bus usage perceptions of RTPI reliability**

| | | | RTPI Reliability | | |
|---|---|---|---|---|---|
| | | | Reliable | Neither | Unreliable |
| Bus usage | More Often | Count | 80 | 7 | 8 |
| | | Expected Count | 74.1 | 14.6 | 6.2 |
| | Less Often | Count | 6 | 1 | 1 |
| | | Expected Count | 6.2 | 1.2 | .5 |
| | The Same | Count | 152 | 39 | 11 |
| | | Expected Count | 157.6 | 31.1 | 13.2 |

## Conclusions

The results demonstrate that the introduction of RTPI along the bus network in Dublin has been popular. More than 80% of respondents use RTPI with more than 70% of respondents accessing the information via either electronic display or through the Dublin Bus Smartphone app. Moreover, almost two-thirds of respondents feel that the technology has improved the reliability of the service. This is despite the fact that perceptions of reliability of the technology are lowest where they it is arguably needed most – on low frequency routes.

Interestingly, almost 30% of respondents cite using the bus more often since the introduction of RTPI. In policy terms, this suggests that RTPI may be responsible for increasing patronage levels although more objective statistics would determine this definitively. The results also revealed a statistically significant relationship between RTPI users and patronage levels; effectively, those who use RTPI also use the bus more often since its introduction. Similarly, there is a significant relationship between respondents who use RTPI and those who think the bus system is more reliable since RTPI introduction. In fact, more than 60% of users think the service is more reliable since RTPI introduction - quite an impressive attitudinal change among users.

Taken together, the results show that RTPI usage is high across the bus network. They also show that the technology has considerably improved user perceptions of the bus service in terms of its reliability despite the fact that there has been little real change in service operations.

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