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WIRELESS INTERNET ON TRAINS: THE IMPACTS ON THE PERFORMANCE OF BUSINESS TRAVELLERS

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July 2005

Word count: 152 (abstract) + 6098 (text) + 1250 (5 figure/tables) = 7500 words

Submitted for Presentation and Publication Review to Transportation Research Board,

85th Annual Meeting
January 2006
Washington, DC

ABSTRACT

Wireless Internet Service (WIS) is finding increasing implementation in The Netherlands via several markets. Recently, the idea has emerged of providing WIS through public transport services. The impacts of WIS on train-travellers, particularly on business travellers, are, however, currently unknown. This paper describes a study which examines these impacts. Respondents were surveyed, in particular, to find out how WIS might affect their travel and work performance. Respondents were also questioned about their willingness to pay for WIS and their preferred WIS characteristics. In general, respondents were positive about WIS and were willing to spend an average of €3.17 per trip for its use. Furthermore, they considered data security as the most important WIS feature. Hence, it can be concluded that WIS deserves to be implemented in train services for business travellers as a means to enhance their travel and work performance during travelling.

Key words: rail, WIS, business travellers, public transport

1. INTRODUCTION

In The Netherlands, there is wide and growing concern about the social and economic costs of road congestion. An important group affected by traffic delays is formed by business travellers. Business travellers are defined as travellers who spend a substantial amount of their working time at front-office activities, e.g. consultants, sales executives, field technicians, advisors and so on (1). As the time for business travellers is usually valued on a relatively high scale (2), traffic delays resulting in travel-time losses induce higher costs than those encountered by other travellers. Moreover, it leads to business appointments being delayed and negative impacts on work productivity. Some policy makers and employers try to minimise these negative effects by encouraging business travellers to use public transport, in particular, the train. Likewise, teleworking is promoted to increase employees' productivity and reduce the business travel-time losses related to road congestion (3). Teleworking takes place when information and communication technology (ICT) is applied to allow working at a distance from the location where the work would conventionally have been done (4).

Nowadays, Wireless Internet Service (WIS) is expanding as a result of the rapid evolution of wireless technologies. WIS is attractive because it combines the advantages of both broadband and mobility. Such advantages imply "anywhere anytime" availability, which means that employees can be connected to the network or access business information from any location at any time. As a result, the need to physically travel back to the office can be minimised. In Europe, the number of people travelling for business is rising. For instance, 67% of professional workers in Europe are away from their work area for more than 20% of their time (5). For this group, WIS would supply the essential requirements.

The above trends have encouraged researches and developments of WIS implementation on trains. Working with WIS on trains is a typical illustration of 'mobile teleworking'. It occurs when employees (often equipped with laptop computers) spend more time in the field delivering services to customers on the spot than previously with office-based staff and visits by customers to the company office (6). In addition, the increasing use of laptop computers with Internet access allowing data transfer is facilitating a culture of mobile working environments (7). Based on these studies, positive effects of WIS implementation on trains on the improvement in performance of business travellers can be expected. However, empirical evidence on these effects appears to be limited (e.g.8,9).

The purpose of this paper is to identify and assess the impact of WIS implementation on trains on business travellers' travel and work performance. More specifically, the paper should answer the following questions:

- How will the use of WIS influence business travellers in aspects of their travel and their work during travel?
- What is a business traveller willingness to pay for the use of WIS?
- How important will the WIS operational features be for business travellers in achieving improved performance?
- How important will the WIS environment-settings be for business travellers in achieving improved performance?

The structure of this paper is as follows. Section 2 presents the research approach taken to study the WIS impact, including the development of a conceptual model for measuring business travellers' performance and the set up of a survey which was conducted among potential WIS users. Section 3 focuses on the response rate of this survey and the background characteristics of the respondents. Section 4 offers the results of a detailed data analysis in search of the WIS impacts on all business travellers' performances and how these impacts differ for different user groups. Finally, section 5 presents the conclusions and the recommendations for further research.

2. RESEARCH APPROACH

2.1 The research model and hypotheses

Our conceptual research model, presented in Figure 1, was constructed based on the literature review related to the impacts of information systems (IS) in general, since studies on WIS are not or hardly available. The main objective in this review involved an initial identification of the value-added IS attributes from a user point of view. These were then translated to relevant attributes for WIS from a business traveller's perspective.

2.1.1. Business travellers' performance during train-travel

We first focus on the use of WIS on trains on work performance (Fig. 1: the link between block A and the upper part of block E). Various studies have examined the influence of Internet, wireless technologies, and teleworking on the productivity of employees. For instance the productivity growth of employees in the last decade was seen to be marked by increasing investments in information technology and by maturing Internet technologies (10). Moreover, the increase in employee productivity to enhance companies' capitalisation ability was also revealed through the use of wireless technologies (e.g.11,12). Significant increases in the productivity of teleworkers have been reported (e.g.13,14). For instance, 87% of IBM employees using teleworking facilities believed that their personal productivity and effectiveness on the job had increased substantially (15).

As such, it can be expected that business travellers' work performance on trains might be improved by implementing WIS. By being able to retrieve up-to-date business information through the use of WIS, the quality of their work and the efficiency of working could be improved. Moreover, WIS gives business travellers the ability to prioritise the work-related tasks that are important or urgent at certain moment; consequently it could increase the value of their work on trains. Finally, WIS may encourage business travellers to spend more time on working activities during their train-trips. Taking this view allowed us to propose the following hypotheses (The H's refer to hypotheses – see Figure 1):

- H1a.** The use of WIS will increase the quality of work of business travellers during train-travel;
- H1b.** The use of WIS will improve the work efficiency of business travellers during train-travel
- H1c.** The use of WIS will increase the value of business travellers' work on trains because of the ability to prioritise their work.
- H1d.** Business travellers will spend more time working during travel by using WIS.

Concerning the WIS use on trains on travel performance (Fig.1: the link between block A and the lower part of block E), literatures have shown in general that developments in information technology are likely to influence personal travel and activity behaviour (e.g.16). The WIS impact on travel performance among business travellers originated from a basic WIS feature offering travel information. Internet, for example, has emerged as a general and important source of travel information to assist individuals in making travel choices and planning their journeys (12).

Internet-based journey planners are becoming increasingly popular. In The Netherlands, the most commonly used journey planners for public transport are the national train planner (www.ns.nl) and the public transport route planner (www.9292ov.nl).

In addition to these current journey planners, the WIS implementation on trains offers business travellers the access to real-time travel and traffic information, including timetables, delays, notification of route changes, railroad construction, etc. Hence, business travellers are expected to reduce their train-travel time. After integration with the WIS benefits in work performance, business travel time can also be spent in a more useful fashion and more comfortably. This may lead to prospects of challenging people's perception of different transport modes and a decision to increase train-travel rather than car travel. Based on the above discussion, we then propose the following hypotheses:

- H2a.** The use of WIS on trains will improve business travellers' travel efficiency.
- H2b.** The use of WIS on trains will encourage travellers to use the train for business more frequently.
- H2c.** The use of WIS on trains will increase the usefulness of travel time for business travellers.
- H2d.** The use of WIS on trains will make travel more pleasant for business travellers.

2.1.2. The willingness to pay for WIS

The way that WIS influences the travel and work performance of business travellers will certainly also be affected by factors generated from the use of WIS. We limited these factors to the willingness to pay, the features and the environment-settings (Fig.1: the respective links between block B, C, D and block E).

Cost is commonly believed to be an important element influencing users' adoption of emerging IT. In general, the more business travellers are willing to pay for the use of WIS, the stronger WIS will be perceived to improve travel and work performances. Based on this, we propose the following hypothesis:

- H3.** Once WIS is implemented, the business travellers' willingness to pay for WIS will be positively associated with their travel and work performance.

2.1.3. WIS features

Literature has revealed the operational features of wireless mobile systems to directly influence user demand. Frustrating experiences e.g. slow connections and poor connection quality have been shown to infuriate online users (e.g.17,18). Besides, the accessibility to a company's cooperative network is considered an essential factor in determining the quantity of critical data for access during the train-travel. Next, the concerns about privacy on wireless Internet are increasing (e.g.19,20). Privacy concerns are often arguments when new IT emerges that supports enhanced capabilities for collection, storage, use and communication of information (e.g.21,22). As with any wireless communication technology, WIS is not inherently secure. In order to maximise security, the most common practice today is to install a virtual private network (VPN) and a firewall. As such, users can seamlessly access their network with a certain security ensured. In view of this, WIS could be operationally tested by business travellers against four criteria: efficiency of data transfer, quality of connection, accessibility of cooperative network, and data security. Each criterion may have certain impact on business travellers' effort and intensity in WIS use. This would, in turn, shape their overall work and travel performance. Based on the discussion, we propose the following hypotheses:

- H4a.** The data transfer rate of WIS is positively related to business travellers' performance.
- H4b.** The quality of WIS connection is positively related to business travellers' performance.
- H4c.** The feature of accessibility to cooperative network is positively related to business travellers' performance.
- H4d.** The data security of WIS is positively related to business travellers' performance.

2.1.4. WIS environment-settings

Environment-settings refer to the availability of resources required to use WIS, possibly include hardware, software and other service needed for the use of WIS. It is believed that insufficient or inappropriate environment-settings onboard the train and at the station will create obstacles for business travellers in WIS use and consequently jeopardise their performance in travel and work. Based on the discussion above, we propose:

H5. The environment-settings of WIS (a. the provision of electricity supply; b. the provision of security monitor; c. space of working; d. table size; e. chair size) are positively related to business travellers' travel and work performance.

2.2 Set up of the survey

An Internet-based survey was chosen for data collection for the following reasons. Firstly, a few attempts to select potential respondents from the telephone book, or on trains and at train stations, yielded little response and are thus termed ineffective. Secondly, the survey was supported by Dutch Railways (Dutch: NS) by allowing the survey to be publicised – the questionnaire to be published on NS' official website and the web-link broadcasted by e-mails to all NS regular customers from NS internal national customer panel. Thirdly, the on-line questionnaire was chosen because of its distinctive advantages, shown in many studies (e.g.23,24). It permits wide geographic contact with rapid feedback at minimal cost. In addition, it achieves great anonymity and is preferable when questions demand contemplated answers rather than prompt answers. Moreover, it reduces errors that might result from the personal characteristics of interviewers and variability in their skills. Other advantages are that it results in fewer missing data and the applicability to heterogeneous populations.

Besides the advantages, surveying people by Internet has also shown some limitations. Internet-based surveys might result in an unstable response rate and a sample bias (e.g.25,26). These limitations have been handled in this study in the following way. Since our sample was obtained from an NS' internal panel of national customers, a higher response rate could be expected. Besides, a reminder e-mail has been sent to increase the response rate. The sample bias refers to the fact that respondents via the Internet may have more computing-related experience and as such, the sample might be atypical for the population of interest. However, it is assumed in this study that in our modern society, Internet has already become an integral part of the daily work practice among employees - the Internet penetration in The Netherlands was 58% in 2002, being one of the highest in the world (27)-in particular among business travellers group.

In addition, this study aimed at examining the impacts of an Internet-related application. Sample bias further refers to the issue of representativeness. The population from which our sample was drawn refers to the business travellers within NS panel who used the train as the main transport mode. Typically, sample representativeness could be tested by comparing social-economic and travelling characteristics of the sample with those of the population. However, such tests could not be performed because national statistics on business travel performance was unavailable. Thus, whether the survey findings can be generalised remains uncertain. Nevertheless, it is best to carry out this research as an exploratory study affording insight into the way WIS affects the performance of business travellers.

2.3 Set-up of the questionnaire

a. Screening

Prior to the questions concerning the WIS impacts on performance, potential respondents were questioned as to what extent they could be considered as a business traveller. All respondents were asked to indicate whether they had conducted business travels by train so as to exclude infrequent business travellers and commuters.

b. Variables

All variables provided in Fig. 1 were taken up in the survey. Regarding the work performance variable - working time - respondents were asked to fill in their perceived time (unit: % of travel time) spent on several activities, both with the assistance of WIS and without, during their business travel time (>20 minutes). Activities supported by WIS included work-tasks (accessing information via cooperative

network and public websites, sending/receiving e-mails, downloading/uploading files, video conferencing, others) and private tasks using WIS. Activities without WIS assistance included work-tasks (reading/writing documents, working using a laptop, calling, SMSing, having meetings, planning and administrative tasks, others) and private tasks without WIS. Accordingly, the increase in working time was simply calculated by subtracting the time spent on work-tasks using WIS from the time spent on work-tasks without WIS.

Next, respondents were asked to indicate each of the remaining three work performance variables and four travel performances variables whether they agreed on a five-point scale. They were asked about the amount they were willing to pay for WIS use. They were asked to indicate to what extent they considered the various WIS features and environment-settings important on a five-point scale. Finally, they were given the opportunity to explain their choices by providing them with open spaces for each question.

c. Sample characteristics

The last questions involved demographic information, limited mainly to the frequency of business train-trips, education level, age, gender and business occupation.

d. Analysis design

Next to computing basic descriptive statistics on determinants, the inter-correlation among several determinants was computed to study the relationships between the perceived travel and work performance. Correlations were also employed to explore sub-groups of the sample with different perceived work and travel performance characteristics. MANOVA was conducted to determine the effect of each background variable on the overall work performance. Rank order correlation and comparison of means were applied to relationships between the willingness to pay for WIS and perceived performances, and to the explanation of perceived cost by respondents' background characteristics. Multiple linear regression was conducted to examine the overall perceived performances on the willingness to pay. The choice for a multiple linear regression rather than a non-linear one was based on the following: the model generated from linear regression provides a flexible framework that suits the needs of many analysts, whilst nonlinear regression is usually chosen based on the theoretical considerations from a specific subject matter field for the expectation function rather than an empirical one (28). Since there is no expectation on a nonlinear function according to the research model in this study, linear regression technique were thus applied.

Both multiple linear regression and MANOVA require the collected data to be the interval measurement level. Thus, in this study our ordinal data was assumed to be at the interval level in order to comply with the requirement of the chosen multivariate technique. Such an assumption might create an analysis validity issue, yet, it is still believed to be a practical means to gain an initial insight into the data gathered.

3. RESPONSE AND SAMPLE CHARACTERISTICS

A total of 6100 website links in the on-line questionnaire was sent to the regular NS customers. There were 2141 responses to the questionnaire, forming a response rate of 35%. Of all the respondents, 836 were considered qualified as business travellers for the participation in the study. The non-response might be caused by the seasonal effects (the survey was conducted in holiday season - July and August 2004), the respondents' disinterest in survey, and the problem of ex-NS customers who were still registered as regular customers in NS' internal panel.

From the sample characteristics presented in Table 2, it appears that various types of business travellers participated in this study, each type represented by a sufficient number of respondents, indicating that our survey was recognised as being applicable to the heterogeneous population. On average, the respondent was a well-educated male, 40-49 years old and travelling by train at least 1-3 days per month for business. The most often mentioned business occupations were finance, governmental and computer-related professions.

4. IMPACTS OF WIS

4.1 Work and travel performance

Table 3 presents the descriptive statistics of variables concerning perceived working performance and travel performance. In general, respondents expected that both their work and travel performance would improve by having WIS facilities on the train. With reference to work performance, respondents indicated that the efficiency and value of their work on trains would improve with the use of WIS. The respondents further indicated to be willing to spend, on average, some 12% extra time on work during travel with WIS availability. When WIS is provided, respondents will spend more time performing WIS-supported working activities than without WIS. Nevertheless, regarding the WIS influence on the work quality aspect, respondents were generally neutral. Such a result may indicate that WIS is perceived as an extra tool to enable business travellers to conduct Internet-based work on trains (e.g. emailing) besides their non-Internet-based work (e.g. reading reports); however WIS does not necessarily contribute to improving the quality of work on train. For example, reading reports can result in same quality of work as replying customers' emails. *Therefore, the statistics supporting hypotheses H1b, H1c and H1d, and H1a should be rejected.*

With reference to travel performance, the respondents expect WIS to improve their travel efficiency and travel frequency. Besides, participants perceived their travel time as more useful and more pleasant with WIS assistance during their business trips. *Thus, the statistics support Hypothesis H2a, H2b, H2c and H2d.*

Table 3 also describes the correlation among the work and travel performance variables. The following guidelines were adopted to interpret the values of these correlations (29):

- $R=.10$ to $.29$ or $R=-.10$ to $-.29$ small correlation
- $R=.30$ to $.49$ or $R=-.30$ to $-.49$ medium correlation
- $R=.50$ to 1.0 or $R=-.50$ to -1.0 large correlation

All pair-relationships appeared statistically significant and positive. This suggested that respondents who scored high on one performance variable were likely to score high on the other. In particular, large inter-correlations are detected among work quality, work efficiency and work value ($R=.832, .713, .656$). This indicates that business travellers who expected an increase in one work aspect due to the use of WIS would naturally perceive increase in the other two work aspects. Large correlations also exist between the pleasantness of travel time and each of the following: usefulness of travel time, work quality, work efficiency and work value. ($R=.769, .627, .653, .615$). These suggests that trips become more pleasant when business travellers can make their travel time more useful or can increase the quality, efficiency and value of their work by using WIS. Moreover, the usefulness of travel time increases when an improved quality, efficiency and value of work by WIS are perceived ($R=.599, .643, .586$).

4.1.1 WIS travel and work performance for different user groups

In order to explore whether different types of business travellers had different opinions, the relationships between perceived performances and respondents' background characteristics were examined by rank order correlation and comparison of means. The analysis shows that most correlation coefficient values indicate little relationship ($R < .10$) and are not statistically significant ($P > .05$), suggesting that the perceived performances resulting from the use of WIS were not related to respondents' background characteristics. However, some relationships appeared statistically significant, although with small effects. These will be discussed in more detail.

The increase in working time with WIS availability for male respondents appeared to be higher than for female respondents ($R=.11$). A possible explanation might be that men prefer to carry out WIS-related work in the train more than women. This however is rather speculative. Moreover,

higher educated respondents indicated more willingness to increase their train-trips with WIS access as compared to lower educated respondents ($R=.13$). This might be related to the type of work that could differ between higher and lower educated persons, but also to time pressure differences. Finally, younger respondents indicated considering their business-trips more useful ($R=.16$) and pleasant ($R=.10$) by using WIS as compared to older respondents. This might be related to young people being more willing to adopt new IT facilities compared to older people. According to the explanation from respondents, senior business travellers found out about WIS to be annoyed by being constantly surrounded by other computer players.

MANOVA was conducted to determine the effect of each background variable on the overall perceived work performance (see Table 4). Multivariate tests showed significant differences between genders and among business occupations on the dependent measures (Wilks' Lambda Sig.=.001, .017). This was followed by the test of between-subject effects on each dependent variable. It revealed that the gender difference for both work quality and working time were small but significant ($P=.006$, .003, Partial Eta Squared=.009, .011). This proved that gender made difference in respondents' perceptions of the increases in work quality and working time. Tests of group means comparison were performed. Results showed the mean values of genders in terms of 'increased work quality' to be both 3, indicating that such neutral opinions on 'increased work quality' did not differ between male and female respondents. On the other hand, a clear difference was found between genders in 'increased working time'. This implied that male respondents were, on average, willing to allocate some additional 13% of travel time to work with WIS availability, while for female respondents this was some 8%.

A similar analysis was done for examining the effects of individual background characteristics on the overall perceived travel performance. The variable 'improved pleasantness of travel' was excluded due to its violation of the multicollinearity assumption with variable 'increased usefulness of travel'. Multivariate tests showed significant differences in the dependent measures between different ages and among different education levels (Wilks' Lambda Sig.=.004, .000). Tests of between-subject effects revealed that relationships between 'increased usefulness of travel' and age, and between 'increased travel frequency' and education were small but significant ($P=.001$, .000, Partial Eta Squared=.022, .026.). By comparing the group means, it was shown that respondents under 40 perceived an increased usefulness of travel time with WIS provision, while those above 40 held neutral views. Moreover, respondents with a higher educational level expected increased travel frequency, while those with lower educational level kept to their neutral perceptions.

4.2 The willingness to pay for WIS

The statistics of variable 'the willingness to pay for WIS' (Mean=3.17, S.D.=.98) suggests that respondents were, on average, willing to pay an amount of €3.17 per trip for using WIS during their business train-trip. We note that there were 102 respondents failed to answer this question. This was felt to be due to respondents' lack of knowledge about the common price range of a wireless Internet service.

4.2.1 *Relationship between willingness to pay and perceived performances*

The relationships between the willingness to pay for WIS and individual perceived performance were examined by rank order correlation. The results show that all the relationships are statistically significant ($P=.000$), yet their strengths appeared relatively small ($R<.30$). A scattergram/linear regression analysis was performed to explore the relationship in more detail. The results indicate that the model reached statistical significance ($P=.001$). However, the 'increased working time' explained little (1.6%) of the variance of 'the willingness to pay'.

A multiple linear regression was conducted to examine the overall perceived performance for the willingness to pay for WIS. The results show that the overall perceived performance explain 8.6% of the variances of this willingness ($P=.000$). Comparing all performance variables, 'improved work

value' and 'improved usefulness of travel time' have the largest explanatory power for 'the willingness to pay for WIS' (both Beta =.13, P=.007, .012).

Based on the above results, it is safe to accept the Hypothesis H3, that the business travellers' willingness to pay for WIS is positively associated with their travel and work performance once WIS is implemented.

4.2.2 Relationship between the willingness to pay for WIS and background characteristics

Comparison of means and rank order correlation were employed to study the influence of the respondents' background characteristics on their willingness to pay for WIS. The results show that all coefficients have small values ($R < .10$) and are not statistically significant ($P > .05$). This suggested that the WIS price business travellers are willing to pay is not sensitive to their different background characteristics. A multiple linear regression analysis was also conducted between the willingness and the overall background characteristics. The result prove that the willingness to pay for WIS is not associated with the overall background characteristics ($P > .05$) either.

4.3 WIS features

The descriptive statistics of WIS features are presented in Table 5. Of all the features concerned, data security was considered most important by the respondents, followed by the connection quality and the accessibility to the cooperative network. Interestingly, the data transfer rate was considered less important: on average the respondents considered this feature neither important nor unimportant. A possible explanation is that business travellers are satisfied with a normal Internet speed during the business train trip. *Therefore, the statistics support Hypotheses H4b H4c and H4d (connection quality, accessibility to cooperative network and data security are positively related to business travellers' performance); while H4a (data transfer rate positively related to business travellers' performance) is rejected.*

4.4 WIS environment-settings

Table 5 also explained respondents' opinions on the WIS environment-settings. *Based on the results, Hypothesis H5, (WIS environment-settings are positively related to business travellers' performance) is accepted.* In particular, more than half of the respondents indicated it to be important for them to have larger tables, more comfortable chairs, larger work spaces and electricity supply for their devices. Moreover, the most popular location to use WIS appeared to be the station platforms, followed by platform restaurants, cafés and station halls. Such preferences logically imply table supplies and electrical outlets on the station platform. Finally, security monitors located at the stations were preferred by respondents to onboard the train. This would keep them alert to possible burglars.

5. CONCLUSIONS AND DISCUSSION

This study explored the WIS impacts on Dutch business travellers on trains. An online survey was conducted to obtain the opinions of business train-travellers regarding WIS. The findings in this study may be helpful for policy makers, railway companies, employers and service providers, all for different reasons.

The research showed that the use of WIS is expected to increase the business traveller's work performance. The increase in work efficiency and the ability to prioritise or reschedule work, resulting in greater work value, brought about by the use of WIS were certainly acknowledged. Besides, gender made a difference in the overall expected work performance: male travellers were willing to spend an additional approximately 13% travel time on work, whilst additional 8% in the case of females. Moreover, shifting work from a non-Internet base to an Internet base was also clearly observed.

The results show that WIS will improve the overall travel performance of business travellers. In particular, business travellers with higher vocational or university educations expect to conduct

more business train-trips where WIS is provided. This is felt to be due to the lack of sufficient knowledge among lower educated respondents about forecasting changes of their travel frequency under a non-existing technology. In addition, senior business travellers (40+) perceived their travel time with WIS as being less useful and pleasant because of the annoyance generated by being constantly surrounded by computers users.

These findings support policy makers, railway companies and employers to encourage the use of WIS on trains as a promising enhancement of business travellers' performance. One suggestion is to have NS reserve compartments on trains solely for WIS users, separating them from non-WIS users.

In general, business travellers were found to be willing to spend €3.17 per trip for using WIS during their train-journey. This willingness was determined by the level of their performance improvements, particularly the increase in value of work and usefulness of travel time. However, the willingness didn't differ between respondents whose travel frequency, gender, age, occupation and education varied. This analysis of the willingness to pay can serve as a reference for assisting service providers in establishing a WIS price that is both attractive for business travellers and financially feasible at launching.

When WIS is in operation, business travellers consider the confidentiality of their business data as the most important WIS characteristics as research showed the security issue to be of most importance, followed by the accessibility to cooperative network and connection quality. However, WIS is not inherently secure and thus it becomes important for users to have adequate security safeguards in place, often by installing VPNs and firewalls. Interestingly enough, our research showed data transfer rate to receive the least attention. This could be explained by the limited work space on trains where office facilities are lacking, indicated by the respondents. Thus, business travellers may prefer conducting 'light' work (e.g. e-mailing) during their trips and leaving extensive work (e.g. downloading) at fixed locations. In view of this, service providers may consider to concentrate on improving security and instead of focusing on WIS speed.

In order to improve business travellers' performance by using WIS, the WIS environment-settings must offer maximum convenient. Thus, the railway companies should, with financial and institutional support from the policy makers, deliver complementary facilities where WIS is applied. Our findings provide insight into the preferences and needs of business travellers, both onboard trains and at railway stations. Onboard trains they prefer larger tables and chairs and larger personal spaces. Electricity supply should also be considered. The provision of tables, electricity supplies and security monitors at railway stations, particularly at platforms, to deter possible burglars are recommended.

6. LIMITATIONS

The findings of this research must be considered in light of its limitations. Considering the exploratory nature of this study and the respondents' opinions on a non-existing WIS may be differ from those where WIS is already on the market, a follow-up study is necessary to monitor the real perceptions of respondents, the willingness to pay and the desired WIS features at WIS' launch. In addition, this study addressed the WIS impacts on business travellers; follow-up study could also include other travellers, e.g. leisure travellers and commuters, deal with more factors that might have impacts on the WIS use and valuation of these categories of users, and address more aspects that might be affected by the use of WIS, e.g. duration of trips; type of trains; travel routes and travel modes. Moreover, the entire door-to-door trip in which the amount and the use of time spent both on trains and at stations can also be considered. Such a study into these effects is recommended because it provides actors e.g. railway companies (increase in market share), employers (lower travel costs, increase in productivity), policy makers (less road congestion, increase in productivity) as well as transport planners (better transport network) with relevant information to specify their implementation strategies. Our study could also be extended to include a specific WIS technology (e.g. a 4G application, when it is introduced in the future). The perceptions of WIS impacts on productivity may depend on the quality and nature of the technology.

In addition, the WIS price can be elaborated in the future study, e.g. (i) make an experimental design to focus on price breakpoints and evaluate tradeoffs made by riders, (ii) study the price levels

by market segments and (iii) study to what extent employers or employees intend to pay for the WIS service.

Finally, considering that this survey started in the summer 2004, seasonal effects (e.g. change in travel behaviour due to vacation periods) may have played a role in a relatively low response rate.

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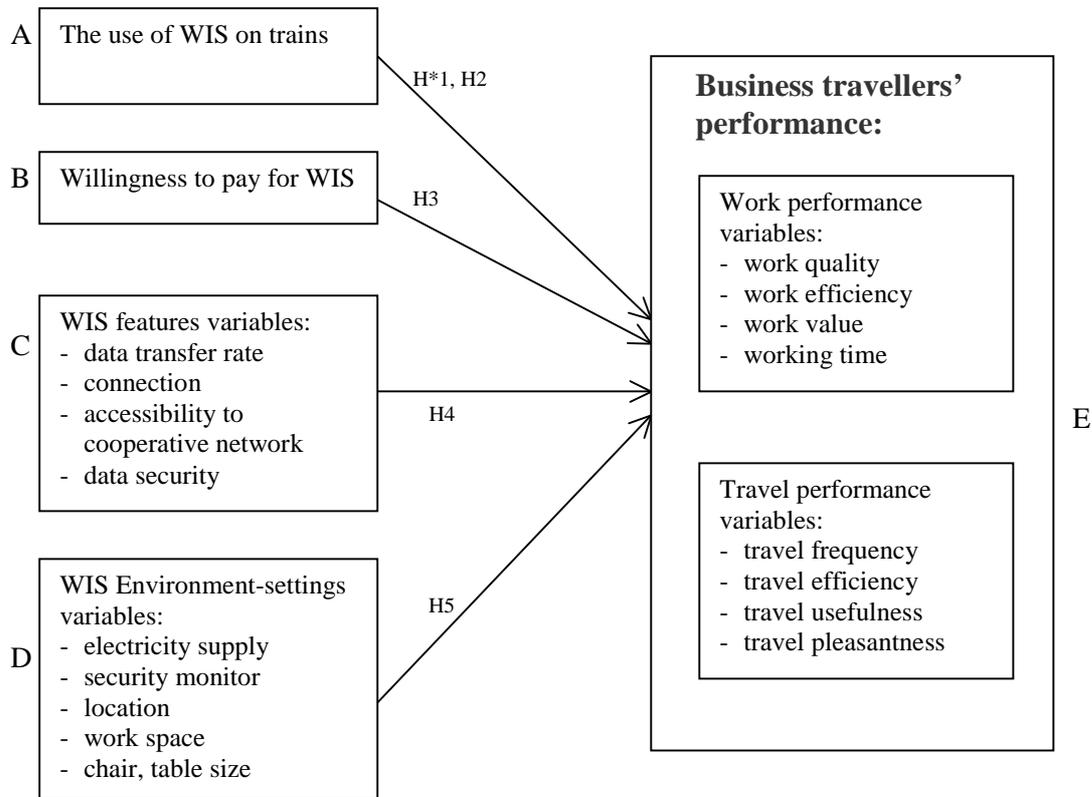
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LIST OF FIGURE AND TABLES

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Figure 1: Conceptual model for the impact of WIS on business travellers' performance



Note: *H refers to hypothesis

Table 2. Descriptive characteristics of survey respondents

Demographic Variables	Number	Percentage
Frequency of business train-trips		
4 days per week or more	96	11.5
1-3 days per week	113	13.5
1-3 days per month	238	28.5
6-11 days per year	175	20.9
1-5 days per year or less	213	25.5
Missing	1	0.1
	<i>N</i> = 836	100.0%
Highest education level		
university or higher	298	35.7
higher vocational	319	38.1
intermediate vocational	109	13.0
senior general secondary	65	7.8
pre-vocational or lower	38	4.6
Missing	7	0.8
	<i>N</i> = 836	100.0%
Gender		
male	560	67.0
female	270	32.3
Missing	6	0.7
	<i>N</i> = 836	100.0%
Age		
50 or older	245	29.3
40-49	309	37.0
30-39	145	17.3
29 or younger	133	15.9
Missing	4	0.5
	<i>N</i> = 836	100.0%
Business occupation		
accounting, financing, auditing, tax, bookkeeping	128	15.3
government-related, politics	126	15.1
computer-related	83	9.9
education and training	77	9.2
research and development	75	9.0
professional (medical, legal, etc.)	70	8.4
marketing, sales, public opinion polling	62	7.4
business and management consultancy	56	6.7
customer service	39	4.7
others	77	9.2
Missing	43	5.1
	<i>N</i> = 836	100.0%

Table 3. Descriptive characteristics of performance variables and their inter-correlations

Performance Variables	Average Response	Inter-correlation***						
		2	3	4	5	6	7	8
1 Increased quality of work (<i>N</i> = 831)	3(2-4)*	.832	.656	.294	.361	.292	.599	.627
2 Improved work efficiency (<i>N</i> = 829)	4(3-4)*		.713	.322	.347	.266	.643	.653
3 Improved work value (<i>N</i> = 828)	4(3-4)*			.287	.341	.238	.586	.615
4 Increased working time (<i>N</i> = 836)	12.11(26.3)**				.120	.125	.249	.259
5 Improved travel efficiency (<i>N</i> = 829)	4(3-4)*					.247	.442	.454
6 Increased travel frequency (<i>N</i> = 828)	4(3-4)*						.251	.263
7 Increased usefulness of travel time (<i>N</i> = 829)	4(3-4)*							.769
8 Improved pleasantness of travel time (<i>N</i> = 822)	4(3-4)*							

Note: * Median (interquartile); the measurement scale of median values is 1-completely disagree, 2 – disagree, 3-neither agree nor disagree, 4-agree 5-completely agree.
 ** mean (S.D.); the unit of mean is % of travel time
 *** Inter-correlations are significant at the 0.05 level ($P < 0.05$, two-tailed)

- “usefulness of travel time” by “age” and by “highest education level”, an alpha level of .01 is chosen due to the violation of equality of variances assumption. Hence the relationship is only considered statistically significant if the F-Test sig. value is smaller than its corresponding alpha level (.025, .017 or .010).
- 4 The test of group means comparison is conducted by assuming “work quality”, “travel frequency” and “usefulness of travel time” as interval data; thus for interpretation the means need to be rounded back to their original ordinal values (positive, neutral, or negative).

Table 5. Descriptive characteristics of the importance on WIS features and WIS environment-settings

Variables	Median (interquartile)
WIS Features	
1 Data security (<i>N</i> = 815)	5(2-4)*
2 Connection quality (<i>N</i> = 815)	4(4-5)*
3 Accessibility to cooperative network (<i>N</i> = 819)	4(3-5)*
4 Data transfer rate (<i>N</i> = 815)	3(2-4)*
WIS Environment-settings	
1 Bigger tables on trains for laptops and documents (<i>N</i> = 803)	4 (3-4)*
2 More comfortable chairs on trains (<i>N</i> = 807)	4(3-4)*
3 More working space on trains (<i>N</i> = 803)	4(3-4)*
4 Electricity supply on trains (<i>N</i> = 789)	4(3-4)*
5 Security monitors on trains (<i>N</i> = 797)	3(3-4)*
6 Table provision (<i>N</i> = 799)	4(3-4)*
7 WIS at station halls (<i>N</i> = 796)	3(2-4)*
8 WIS at platforms (<i>N</i> = 782)	4(2-4)*
9 WIS at station restaurants (<i>N</i> = 793)	3(2-4)*
10 WIS at station cafés (<i>N</i> = 790)	3(2-4)*
11 Electricity supply (<i>N</i> = 789)	4(3-4)*
12 Security monitor (<i>N</i> = 793)	4(3-4)*

Note: * The measurement scale of median values is 1-most unimportant, 2 – unimportant, 3-neither important nor unimportant, 4-important 5-most important