STAKEHOLDERS, INNOVATIVE WAYS OF DELIVERING IMPROVED SATISFACTION

Full paper

USE OF 'VIRTUAL REALITY WALKTHROUGH PANORAMA' TECHNOLOGY TO ASSESS PUBLIC PERCEPTIONS OF PERSONAL SAFETY ON RAILWAY STATIONS

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ABSTRACT

This project originated from the business need of Valley Lines, a UK Train Operating Company, to deliver growth on the rail network serving the city of Cardiff, capital of Wales. The network serves 67 stations handling more than 1 million passenger journeys per year. Spare capacity existed for journeys that customers were not making due to concerns about their own personal safety, whereas in fact across the network as a whole actual recorded crime is very low. Concern was also expressed about access routes to the station, which were outside the control of the company. Improvements would require a good business case if local authorities were to fund them.

The methodology was based on focus groups coupled with a questionnaire, providing a research environment with which the company was familiar. A series of focus groups was convened covering in total 47 respondents from a mix of gender, age and frequent and infrequent users.

The research tool was that of the 'virtual reality (VR) walk-through'. This technique allowed stations to be 'toured' in detail by respondents in a controlled environment, allowing a fully interactive panorama to be developed from the respondent's entry from public areas into the station itself. The respondents were able to view in and out and pan left and right at any stage of the journey and thus accurately mimic their

behaviour as a station customer. Each focus group was asked to suggest measures that could improve their *sense* of personal safety. Considerable preliminary work was undertaken to identify likely issues and to cluster the stations on the network into family groups with similar physical characteristics.   From this analysis six representative stations were selected.

The groups produced a clear hierarchy of concerns and some very practical recommendations, mainly on the theme of improving visibility. As a result, the company has taken action: for example to clear away vegetation, improve lighting levels, and the design and installation of new, transparent shelters.

The project showed the VR walk-through tool was cost effective and versatile. This research tool has application outside the rail industry. Most importantly the research has delivered cleaner and safer railway stations to the people of south Wales, which they also *perceive* as safer place to be.

Keywords: personal safety, VR panorama, railway stations

1.   INTRODUCTION

This project originated from the business need of Valley Lines, a UK Train Operating Company, to deliver growth on the rail network serving the city of Cardiff, capital of Wales, and its hinterland at times of the day and for journeys where spare capacity existed. This capacity existed at times and for journeys that customers were not making due to concerns about their own personal safety and that of their property. In order to deliver this growth and to sustain current levels of patronage there was also an objective to demonstrate to local and regional government, as external funding bodies outside the privatised rail network, that investment in environmental improvements was being undertaken on a sound and measurable basis. The project delivered this through an innovative visual research tool that led to investment in the network and further growth in volume.

This paper presents this work as a case study, starting with a description of the railway network, the company and the issues to be addressed. After a brief review of relevant literature, the methodology and results are described and discussed, followed by a summary of the changes made to the railway stations and the surrounding areas as a result. By way of amplification, a map of the Valley Lines railway network and a pair of 'before and after' photographs of an improved station are shown in an Annex.

2.   THE 'VALLEY LINES' STATION CONTEXT

The Valley Lines network serves Cardiff, the Capital of Wales, with radial routes south to the coastal towns and north to some of the south Wales valleys. Cardiff and most of its immediate surrounding suburbs to the north and south are relatively prosperous. North of Cardiff two thirds of the routes serve the economically deprived valleys of the former South Wales coalfield, with deprivation levels being of such level that GDP falls below 74% of the European Union average.

The decline of the coalfield has meant that 73% of journeys take place into central Cardiff. Journeys are split almost equally between those made for leisure and commuting and tend to take place during the day. Growth in journeys of 40% over the last 3 years to ~7.5 million journeys per annum has led to significant constraints in capacity. An opportunity was identified to increase patronage levels in the evening and for journeys taking place against the peak flows into or out of Cardiff to other locations.

The network serves 67 stations of which 15 are staffed and only two can be considered large (handling more than 1 million passenger journeys per year). Vandalism at the smaller un-staffed stations had been endemic. To combat these issues, prior to commencement of this project, nearly half the stations had been equipped with CCTV, but with little in the way of a formal methodological approach to the assessment of risk prior to installation. Of significance, across the network as a whole, is the fact that *actual* recorded crime is and was statistically very low.

The impetus for the project originated with an advertising focus group in one of Cardiff's affluent northern suburbs served by a well equipped and newly refurbished station. Out of this came some surprising customer concerns. There was a generally high level of disquiet over travel after dark and to unfamiliar stations, particularly for lone females. Significantly, concern was expressed about access routes to the station which were outside the ownership and the direct control of the company. To

initiate improvements here would require a good business case if local authorities were to fund them.

The basic issue therefore was one of perceived personal safety, that appeared to be heightened by darkness, lack of familiarity and concerns over access routes to and within the station.

An extended period of growth and constrained capacity was leading to lack of capacity and consequent overcrowding during the morning and evening peak periods. Two opportunities were identified for potential growth: encouraging customers to consider the network for journeys other than into or out of Cardiff; and to consider using the network more in the evening. These were the two types of journey that the initial research suggested were causing customers the most concern with respect to their personal safety.

3.   BRIEF REVIEW OF RELEVANT PUBLISHED RESEARCH

This paper is essentially a practice-based case study, but a brief review of some of the literature will provide a wider perspective.

There is a general need for more research into rail transport. Clarke (1996) has called for more studies to be funded by transit authorities and the Head of Rail Research UK, Keith Madelin (2003, p31), recently remarked that the rail industry "has ignored the potential benefits of academic research into new technologies and systems that could help to solve some of its problems". In terms of the design of the physical, built infrastructure of railways, there is a need to make more effort to take into account the views and needs of the customers; for example, the preferences of architects and design professionals have been studied and shown to differ from those of the ordinary citizen. (Groat 1982; Devlin 1990; Downing 1992; Purcell and Nasar 1992; Stamps and Nasar 1997).

Published work on crime and personal safety indicates the difficulties of definition and analysis. The British Crime Survey (BCS) (Mirrlees-Black *et al.* 1998) estimates that criminality is as much as four times higher than reported statistics indicate. Furthermore, the 'dark figure' of crime, that which is not reported or recorded, clearly exacerbates the problem of analysing recorded incidents of crime at the spatial level (Scott 1990; Maguire 1997). As a determinant of human behaviour, *perceptions* of exposure to personal risks of criminal activity are as important as the *actual* risk. Fear of crime can result in the withdrawal of the community from a location and a reduction in the number of people that might actively assist in the self-policing of a neighbourhood – known as "eyes on the street" (Jacobs 1961). Likewise, perceptions of crime on the railways have been shown to affect levels of usage and passenger confidence (Brantingham *et al.* 1991*)*. Indeed, Crime Concern and Transport and Travel Research (1997) recently reported that 43% of women and 18% of men felt that rail travel in the UK was "unsafe". They also suggested that a 15% increase in all train journeys could be achieved if a range of communal security measures were successfully implemented.

Investigating how the design and management of stations affects public perceptions is therefore a worthwhile avenue for investigation. Indeed, the crucial role of perceptions in understanding crime and design has been highlighted with regard to residential housing (Tijerino, 1998; Ham-Rowbottom *et al.* 1999; Cozens *et al.* 2001) and public transport (Brantingham *et al.* 1991; Parliamentary Travel Safe Committee, 1998; Cozens 2002). Recently, the Legislative Assembly of Queensland (Australia)

commented that: "the public's perception of crime is an important determinant of people's usage of public transport" (Parliamentary Travel Safe Committee 1998, p16).

4.   METHODOLOGY

The research methodology had to deliver against the commercial requirement that if these concerns were to be addressed, there would be need to attract external funding to make changes.

The Company's 'perception tracking studies' had proved too crude in their application and sample size to justify major improvements, but did raise some negative issues. Other existing methodologies used within the UK to tackle some of these issues consist of two schemes covering the Secure Accreditation of Stations and the Secure Accreditation of Car Parks. However, both of these have been designed to address issues at larger staffed stations and car parks and not the type of smaller and un-staffed stations that predominate on the Valley Lines Network.

The business case required to initiate the project was made on the basis that personal safety issues were being expressed by customers and that existing methodologies did not exist to justify the levels of investment being required. To put this into context the project lasted in total three years at a total cost of about £200k. The cost of a transparent waiting shelter - thought to be a major benefit and later proved as such - was costed at £20k, thus drawing in funding to install just ten of these gave a breakeven position, yet this was just one potential improvement. The installation of even a basic CCTV system costing in the order of £50k per location gave the potential for an even quicker break even position.

The University of Glamorgan was approached because it had a clear social advantage through its knowledge and location within the region and its interest in personal safety.

The research tool developed used the 'QuickTime' virtual reality walk-through. This technique allowed individual stations to be 'toured' in detail by respondents in a controlled environment in order to assess their perceptions of it.   The use of photographs to test perceptions was ruled out at an early stage of the assessment phase due to the limitations inherent in trying to represent the complexity of the station environment, particularly when attempting to assess perceptions of unfamiliar locations. Video was considered as an alternative, but was also rejected because of the concerns that such an approach would only offer one fixed, linear visual journey to the respondent and would not allow them to move through the station in a way that they would do in reality, so running the risk of leading the respondent to draw conclusions driven by the prejudice of the author of the film.

The virtual reality (VR) walk-through allowed a panorama to be developed from the respondent's entry into the station, from public areas, into the confines of the station itself. Once within the station the respondent could then explore within it.   The technique itself involved the photographing of a series of 360 degree panoramas at carefully chosen points outside and within the station. These individual panoramas were then linked together to create the 'virtual' journey through the station, the respondents being able to view in and out and pan left and right at any stage of the journey and thus accurately to mimic their behaviour in the field. (It should be noted that 'QuickTime' is not a full 'virtual reality' tool, using three-dimensional computer

generated models of the station, but is based on photographic panorama views on
the actual stations).

Before the work was undertaken considerable study and analysis was undertaken to
cluster the stations on the network into 'family groups' with similar physical
characteristics. This stage took into account some of the early indications of where
particular problems might be located, such as excessive overgrowth, general visibility
and structural features such as underpasses.

From this initial sorting six representative stations were selected that ranged in
character from isolated, un-staffed, single track stations with little in the way of
security features through to urban stations that were staffed and had a range of
security measures in place including CCTV. These stations, taken together,
possessed all the characteristics that had been identified as potential causes of
concern.

Focus groups were used to allow an open exploration of the respondents' views to be
undertaken. It was also important from a Company point of view that this was a
research method which it used routinely, so the benefits and limitations of the
technique were understood. Respondents were recruited from users of the six
representative stations. A series of 90 minute focus groups was convened covering
in total 47 respondents (26 female and 21 male) from a combination of frequent and
infrequent users, and ranged from 19 to 65 years of age. Each group was taken
through a VR walk-through of 'their' local station and also of another representative
station to which they did not normally travel – a 'home and away approach'. These
walk-throughs included both the station itself and the immediate environment outside
the station. The respondents could control 'where they went' and the level of detail
that they saw. To assist in the codification of the results each respondent completed
a questionnaire in which they were asked to state whether they had personal safety
concerns relating to the various individual segments of the journey for a journey after
dark as well as during daylight hours. They were then asked to suggest a range of
measures that could be undertaken to improve their *sense* of personal safety.

5.   RESULTS AND DISCUSSION

The focus groups produced some very tangible results with a clear hierarchy of
concerns, as shown in Table 1. Female respondents exhibited a significantly higher
level of concern for their personal safety across almost all the factors mentioned.
This was particularly significant when approaching or waiting on the station after
dark. Amongst male respondents the highest concerns related to security of their
cars in station car parks both during the day and after dark.

Waiting on the platform after dark was also a significant area of concern, heightened
by the infrequent nature of some evening train services causing extended waiting
periods. Overall personal safety fears decreased during daylight hours. One of the
overriding factors was the theme of visibility. Observation by nearby houses and
those engaged in other activities near the station were particularly important.

Table 1. Personal Security Concerns at Stations

Personal Security Concerns	Females %	Males %	All %
When waiting for a train on the station platform after dark	93	53	75
When approaching the station after dark.	93	49	73
For the security of vehicle in car park after dark	78	58	66
For the security of vehicle in car park in the day.	72	58	63
When travelling on the train after dark.	80	37	60
When using the car park after dark.	63	58	60
Due to an infrequent service after dark.	57	36	51
When waiting for a train on the station platform in the day.	17	18	19
When travelling on the train in the day.	15	18	16
When approaching the station in the day.	20	6	16
Due to an infrequent service in the day.	13	12	15
When using the car park in the day.	0	22	12

The VR 'walk-throughs' were all undertaken during daylight hours, however the single most important factor in term of proposed improvements mentioned by both males and females was improvements to lighting, which reflected the universal concern by respondents of both gender to travel after dark. CCTV was mentioned by 62% of all respondents, although it was already in operation at 4 of the 6 stations where the walk-throughs took place. Transparent shelters were mentioned by 43% of the respondents as a suggested improvement, cleaner stations (38%), longer trains (34%) and cutting back vegetation (30%).

In interpreting the results it became clear that customer *perception*, given the low crime rates, was crucial. This very much reinforced the original focus group findings that indicated users had personal safety fears with a newly refurbished station in a prosperous suburb. What the further research did was deliver a series of action-orientated results, with a clear hierarchy of importance, as shown in Table 2.

6.   IMPROVEMENTS TO THE STATIONS AND THE SURROUNDING AREAS

The first improvement to be undertaken by the company was vegetation clearance. Since the withdrawal of steam trains in the 1960's the necessity to reduce the risk of fire by regular vegetation clearance had diminished, leading to overgrowth that contributed to concerns of visibility at almost all locations sampled. This was an activity that the Company was able to undertake utilising its own maintenance teams with a small investment in plant and operator training. This gave an immediate impact at the locations identified in the six pilot locations and the lessons learnt were then progressively rolled out across the network.

Most local authorities in the UK now have their town centres covered by CCTV. The fact that respondents put CCTV at the top of their priorities for improvement assisted in reinforcing already held perceptions, but most importantly from a research based background. A progressive programme of CCTV is now being implemented with the majority of the stations outside of Cardiff now being covered.

Table 2. A Hierarchy of Proposed Improvements

Ranking of Improvements – Females	%	Ranking of Improvements - Males	%
More/better lighting	81	CCTV	62
CCTV	62	More/better lighting	52
Transparent shelters	58	More staff	48
More staff	38	Cleaner stations	43
Cleaner stations	35	Longer trains	43
Cut back vegetation	35	Less underpasses/better bridges	29
Longer trains	27	Cut back vegetation	24
Less underpasses/better bridges	27	Get rid of gangs/yobs	24
Better signage	27	More reliable service	24
Help points/panic buttons	19	Transparent shelters	24
Get rid of gangs/yobs	19	More frequent trains	19
More frequent trains	19	Clearer information	19
Coat of paint	15	Better signage	14
Better/easier access	12	Make platform more open	14
Better links to community	8	Better links to community	14
Demolish old buildings	4	Better/easier access	10
More reliable service	4	Help points / panic buttons	5
Busier trains/more people around	4	Coat of paint	5
Clearer information	4	More Spaces between seats	5
More Spaces between seats	0	Busier trains/more people around	5
Co-ordinated transport system	0	Co-ordinated transport system	5
Make platform more open	0	Demolish old buildings	0

Five years ago the company embarked on a partnership with Network Rail, the infrastructure provider, and a manufacturer of street furniture to develop a waiting shelter that would meet the criteria of visibility. The results of this research have assisted in the installation of these shelters on seven sites with more to follow, assisted by substantial funding from external parties – see Annex for photographs.

The depth and realism of the VR technique highlighted the very high concern amongst respondents of their personal safety after dark. There is no doubt that this is not something that would otherwise have become apparent. This led to a secondary phase of the project, again involving focus groups, partly conducted under controlled conditions, but also at stations at night in a controlled trial where luminance levels were raised at a pilot location. Whilst this was successful in confirming the role that lighting levels play in perceptions of personal safety, it also served to highlight the weaknesses of using a focus group in an external environment and the comparative strength of the controlled and standardised images of the VR. Further work on the VR technique in a night-time environment would be useful.

Two other factors were highlighted in particular by respondents. The first was the issue of train service capacity and frequency. The issue of frequency relates to the time spent waiting for trains. Under current UK funding arrangements, in a heavily subsidised urban network, making changes is a much more difficult proposition than might first appear and whilst improvements have taken place they have not as yet been entirely attributable to the research findings.

Secondly, station cleanliness is an issue for which the company has been able to take direct action itself as a consequence of the research. The results of this have been significant enough to be identified on the Company's tracking study.

7.   CONCLUSIONS

The original research brief was orientated to find a commercial solution in order to deliver business investment and hence volume growth.   The project met this objective by delivering a set of tangible, verifiable and applicable results.   The outputs from the study in south Wales are of potential benefit to other parts of the urban rail network in the UK.

What also came out of the project was a research tool in the form of the VR walk-through and a comprehensive methodology for its effective use. This proved to be an extremely cost-effective and versatile solution, providing tangible benefits over other methodologies. This is a research tool that has application outside the rail industry. The technological solution proved to work particularly effectively within the focus group environment, providing a controlled visual stimulus through which to assess respondent's concerns and potential behaviours. It also demonstrated the flexibility and cost-effectiveness of this highly portable medium. This had a number of benefits. It allowed the walk-throughs to be captured easily in a wide variety of different station environments and to give respondents a very real spatial interaction with the environment. The use of focus groups coupled with questionnaires provided a research environment for the company with which it was familiar and also provided the opportunity for observation by members of the company. The technique delivered a set of results that indicated some clear courses of action to be undertaken to promote personal safety.

Most importantly the research has delivered cleaner and safer stations to the people of south Wales that they also *perceive* as safer place to be.

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Annex: Map of the Valley Lines rail network and 'before and after' photographs of a station

Original form of Dingle Road station

Dingle Road station after improvements