

Designing for sustainable transport on campuses: A study of the effects of infrastructural improvements on travel patterns at NUI Galway and other institutions

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Abstract

In recent years, smarter travel initiatives have become increasingly important for educational, business, and other institutions across Ireland. With an increased public awareness of environmental sustainability and a need to decongest urban areas, it is widely accepted that infrastructural investment is required to promote sustainable modes of transport. Furthermore, there are clear economic and health benefits to promoting sustainable travel. It is unclear however, the extent to which specific measures and infrastructural improvements generate modal shift. Universities, alongside large employers, can offer ideal testing grounds for novel initiatives that promote sustainable travel due to their large student and staff cohort, and their generally easily accessible and compact campuses.

This study of NUI Galway staff and students (using over 1,000 survey responses), analysed the distance travelled, time taken, travel mode, and trip generation location for staff, undergraduate students and postgraduate students travelling to NUI Galway. The findings are compared with results of a similar 2012 survey and with other surveys conducted by the NUI Galway Buildings Office over the past eight years to illustrate the evolution of travel patterns at the University. The survey also investigated the impacts of infrastructure improvements at the NUI Galway.

Results show that the overall percentage of students and staff driving to campus has decreased since 2012 and there has been a rise in the modal share of the bicycle. The survey indicates that the development of a new pedestrian and cycle bridge providing access to NUI Galway was positively received. Results of the study indicate that when travelling to NUI Galway, cycling is on average 1.3 km/h faster than the car over distances of less than 5 km (including time to park in a car parking space). Considering distances less than 2 km, the bike can be up to 4 km/h faster. Furthermore over 60% of those travelling to the University live within 5 km, there is therefore great potential to increase uptake of active modes of transport. The survey also facilitated estimations of the potential carbon savings which could result from reduced car usage.

The paper also presents analysis of staff at Galway University Hospital (GUH - located opposite part of the NUI Galway campus). Furthermore the study analysed data from a university campus in the USA (University of Berkeley, California) and the UK (Lancaster University) and identified key infrastructural improvements that have successfully reduced car usage in universities outside of Ireland and may be applicable to Irish Universities.

1. Introduction

Travel to Higher Education campuses, mirroring national trends, has become increasingly unsustainable over the last 25 years. Since 1986, driving a car to college has almost tripled, while cycling has declined by 83%. This data includes all students aged 19 years and over attending all third level institutes. Figure 1 shows the means of travel of college students aged 19 years and over, a category defined in the 2012 census [1]. Travel to higher education campuses is receiving increased attention through An Taisce's Green Campus [2], Smarter Travel Campus [3] and other programmes, and there has been range of infrastructural and cultural initiatives taken on campuses around Ireland – there is a need for research to identify the most effective of these initiatives to yield more sustainable travel patterns.

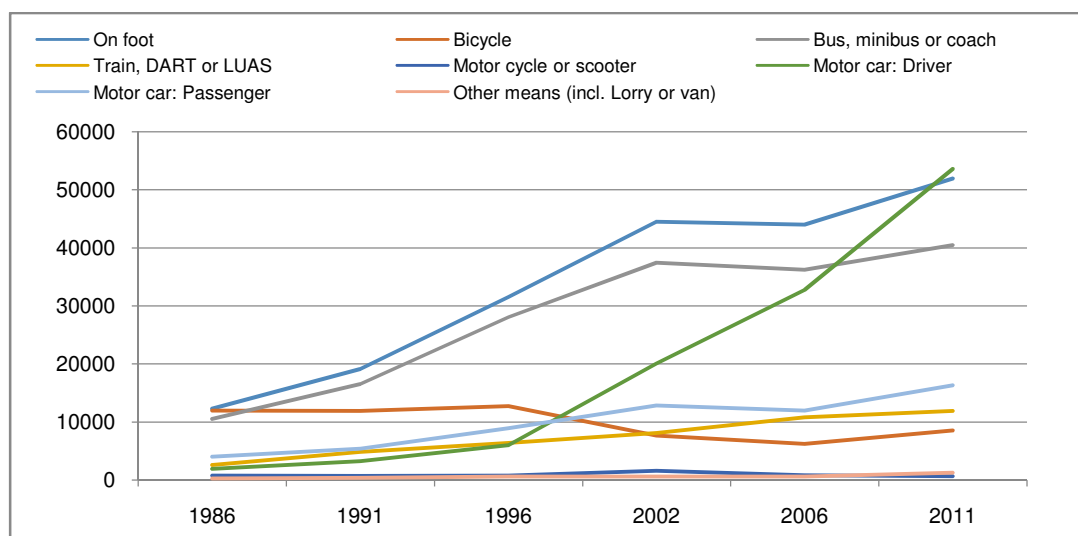


Figure 1 – Modal share of travel to higher education by college students aged 19 years and over [1]

This study focuses on travel patterns at the National University of Ireland, Galway (NUI Galway). The results of the study are compared to similar studies of University Hospital Galway (UHG), University of California, Berkeley (UCB, USA), and Lancaster University (LU, UK), thereby facilitating a cross-campus analysis. The main NUI Galway campus is situated on 102 ha beside the River Corrib in Galway City (Figure 2). There are approximately 18,000 students and 2,000 staff members in the university, who between constitute more than one quarter of Galway City's 75,539 population [4] (though not all live in the city). University Hospital Galway (UHG) is situated across Newcastle Road from the university.



Figure 2 – Galway City including NUI Galway (red) and UHG (purple) (OSI)

2. Literature review

Travel behaviour can be influenced by a wide variety of factors, including infrastructural provision, social context and demographics. For example, the modal share of cycling in cities has been shown to increase with the length of bicycle network in a city [5] and with the percentage student population of the city [6]. This effect of the student population may be due to the behaviour of students themselves (potentially determined by economic pressure, physical fitness, environmental awareness etc.) or as part of a broader social context – a discussion beyond the scope of this paper. Nevertheless, this demonstrates the importance of studying travel patterns to higher education campuses.

To inform the design of effective infrastructure, an understanding of travel motivations is necessary. The motivations for choosing active travel modes can vary widely, however journey time and health/fitness issues, have in recent studies, been found to be key incentives. Previous research at NUI Galway indicated the most important factor for choosing to cycle to campus was journey time for students and fitness for staff, while environmental concerns were considered less important [7]. Similarly, research has shown the most evident motivators for choosing to walk are a desire to improve health and fitness and to reduce/eliminate transport costs [8].

Recent studies of smarter travel infrastructure on campuses have centred on bicycle parking and shower/changing facilities. One challenge facing the provision of sheltered bicycle parking is that although this infrastructure is expensive to provide [6], it has not been linked to significant modal shift and therefore the benefit to cost ratio may not be as high as desired. Other findings suggest that shower and changing facilities may be a more important incentive, particularly for areas that experience a lot of rainfall [7].

When considering the uptake of public transportation, the density of urban areas is of utmost importance – greater density leads to increased modal share of public transport [5]. It is likely that this higher density has a negative impact on private car usage, resulting in increased use of public transport [9]. As with non-mechanised modes of transport, the student population in an urban area has been shown to increase the modal share of public transport. Meanwhile, the proportion of people aged 65 and over living in the city and the proportion of households with children reduces numbers using public transport modes [5].

In addition to the demographic influences, the modal share of public transport can be negatively affected as a result of increased public transport fares and rainfall frequency. However, when weather proof pedestrian facilities are provided, such as bus shelters, it has been shown to increase the demand for public transport during rainy days. Other documented methods of generating an increased modal share for public transport include decreasing headways and providing services such as Real Time Passenger Information (RTPI) [5].

Apart from the environmental impacts and the congestion generated from private car use, the most important problem associated with car-based transportation is the amount of parking infrastructure required [10]. In many cases, parking permits are required for private grounds and are often provided free of charge or at a subsidised annual rate. In method, this is rewarding those who drive by not providing any incentive for those who walk, cycle or use public transport [11]. Many institutions employ a carrot and stick approach to achieve a shift away from the use of the private car. Examples include combining the implementation of cheap public transport fares with congestion charges or high parking charges to discourage car use and encourage car users to consider alternative options.

It is likely that many people choose to drive due to perception of safety, a factor which is especially important for those travelling with children. Policies aimed at making people feel safer and more secure on the road have proved to be successful in generating a positive attitude to the safety of alternative modes, for example, cycling training courses, well-designed cycle lanes and footpaths and well-designed junctions [6]. The speed difference between cyclists and passing cars can also make cyclists feel more vulnerable especially as the difference increases; thus, reducing the speed difference in urban centres where there are higher numbers of commuting cyclists may improve safety and comfort [7].

In this study a comprehensive survey of travel patterns at NUI Galway was completed including modal share, travel time and travel distance. The survey analysed the impacts various infrastructural and other initiatives on travel modes to the NUI Galway campus. The paper also analyses data from university campuses in the UK and USA and from a hospital campus adjacent to NUI Galway. The survey was designed to be comparable (where possible) to surveys at the aforementioned campuses while also filling data gaps from these campuses.

3. Methodology

3.1 Travel survey data

Four campuses were selected for this study: NUI Galway, University Hospital Galway, University of California, Berkeley, and Lancaster University. In the case of NUI Galway, the data resulted from travel surveys carried out by the Civil Engineering (CE) research team at NUI Galway in 2012 and 2014 as well as surveys conducted by the Buildings Office (BO), NUI Galway from 2005. Data was also retrieved from similar surveys conducted at UHG (2008 and 2012), UC Berkeley (2006 and 2008) and LU (2012) (Table 1).

Table 1 – Timeline of surveys included in this analysis

	NUI Galway	UHG	UC Berkeley	Lancaster
2005	✓ (BO)			
2006			✓ (Staff)	
2007				
2008		✓	✓ (Students)	
2009				
2010	✓ (BO)			
2011				
2012	✓ (CE)	✓		✓
2013	✓ (BO)			
2014	✓ (CE)			

3.2 NUI Galway travel survey, 2014

A new survey was also designed in order to capture an up-to-date reflection of the travel patterns of staff and students at NUI Galway. Questions from existing surveys conducted across the three campuses were compared to identify data gaps. Response options provided in the various surveys were also examined in order to provide suitable and appropriate options in the new survey. Where possible, survey questions were designed to enable comparison across all campuses. Figure 1 gives an overview of the NUI Galway travel survey, 2014.

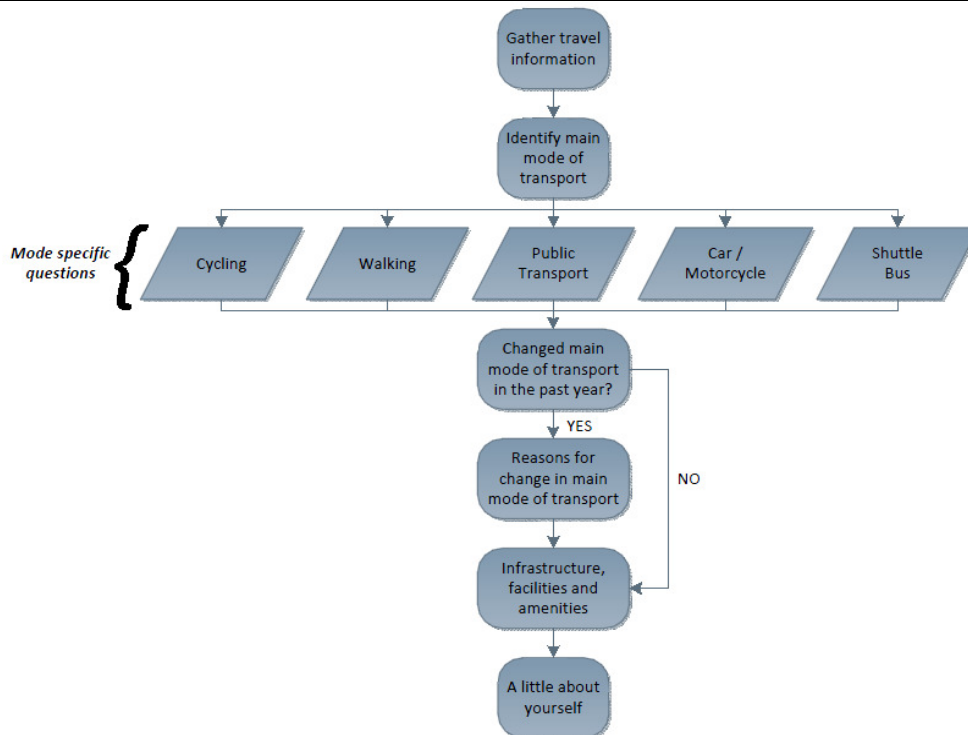


Figure 3 –Flowchart of NUI Galway Travel Survey 2014

Alongside establishing the modal share of respondents, their demographics and residence the survey also focused on whether respondents had recently switched modes, whether weather impacts on their modal choice, the times at which respondents generally start and finish their day at NUI Galway and the estimated distance and time of their daily commute. Respondents were encouraged to use google maps to give more precise distances. When calculating average speeds for each mode it was necessary, on occasion to filter data that may be unrealistic (e.g. if an average walking speed of 15 km/hr was calculated this would be seen as unrealistic). There have been numerous previous studies describing the average speeds attained while walking (4 – 5 km/hr being typical) and cycle commuting (16 – 22 km/hr being typical); though, particularly for cycling experienced cyclists may achieve higher speeds.

3.3 Overview of each campus

The NUI Galway campus is aligned in a North South direction along the River Corriband is located approximately 1 km from Galway City Centre (at the Southern end of the campus). Its Northern campus is approximately 2 km from the city centre. NUI Galway has approximately 17,500 students and 2,500 staff. Galway city has a temperate climate with an average of about 1100 mm of rain annually. As a coastal city wind can be a significant factor on most days.

GUH comprises two campuses in Galway City. Merlin Park is located about 7 km from NUI Galway and University Hospital Galway is located opposite the NUI Galway South campus. Where possible, data from the Merlin Park campus was excluded to give a more direct comparison between GUH and NUI Galway. Approximately 3500 staff work in the University Hospital Campus. UC Berkeley (California, USA) has approximately 36,500 students, about 10,000 full-time and 12,000 part-time staff members. The main campus area is located about 22 km North East of San Francisco. It generally has a dry, warm climate

Lancaster University is located approximately 4.5 km from Lancaster City Centre in North Western UK. It has about 12,000 students and 2,500 staff. It is located on a single campus adjacent to the M6 motorway. The Lancaster climate is relatively similar to Galway though it receives approximately 20% less rainfall on average and can be less windy than Galway; though has more frost days than Galway City.

3.3 Carbon emissions

Using carbon factors published by the UK Department for Environment, Food & Rural Affairs, the potential carbon emission savings were calculated based on targets for reduced modal share of private car usage. The calculations were based on the assumption that all cars travelling to campus are of medium size.

4. Results

4.1 NUI Galway Survey

A total of 1035 staff and student responses were received to the survey. And the breakdown of responses between staff and students and the response rate are presented in Table. Registered student numbers and approximate staff numbers are also provided. The sample rate shows that while approximately 14% of staff responded, just under 4% of students responded.

Table 2 – Survey response

	Staff	Students
Responses	346	689
Total population	2,430	17,483
Responserate	14.2%	3.9%

NUI Galway has previously set targets for modal share which were to be met by 2014. The modal share of travel to NUI Galway based on the total survey results are presented in Figure and compared against the set targets. The University achieved the targets for reduction in car usage which subsequently led to the growth in the overall share of sustainable modes of transport. Public transport for staff and cycling for students are identified as the most challenging areas.

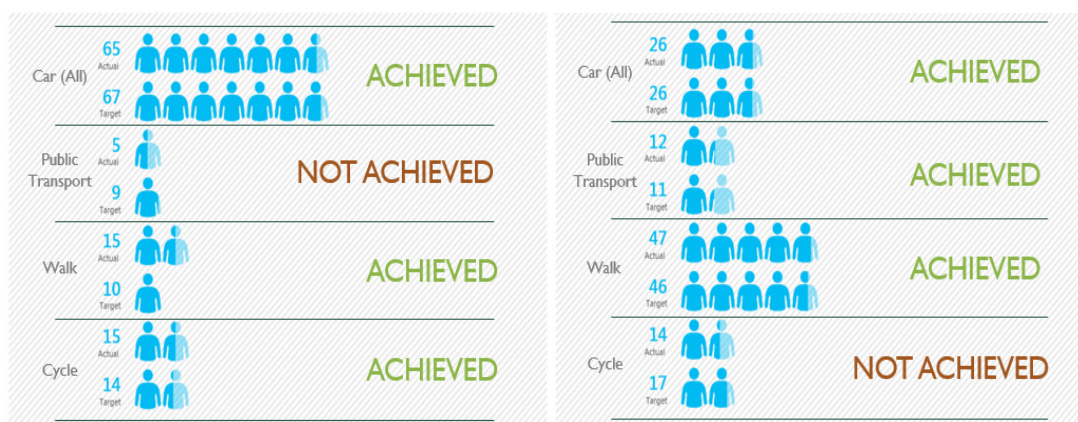


Figure 3 – Actual and targeted modal share for NUI Galway staff (left) and student (right)

Figures 4 and 5 show the evolution of modal share in NUI Galway for staff and students between 2005 and 2014. The surveys indicate a significant shift in the numbers of staff

cycling to NUI Galway and walking; however there has been no overall increase in the modal share of public transport. The trends for students are mixed results with the overall modal share of the car similar to 2005 (though there has been a marked decrease since 2012) while walking as modal choice decreased between 2005 and 2013 but showed an increase in 2014. Public transport has shown a steady increase since 2010, however cycling which had shown a steady increase between 2005 and 2013 was down from 17% to 14% between 2013 and 2014. It should be reiterated that the surveys prior to 2014 were carried out by the Buildings Office at NUI Galway with the exception of the conducted in 2012 by the Civil Engineering Dept.; thus results may be impacted by the timing of the surveys and response numbers.

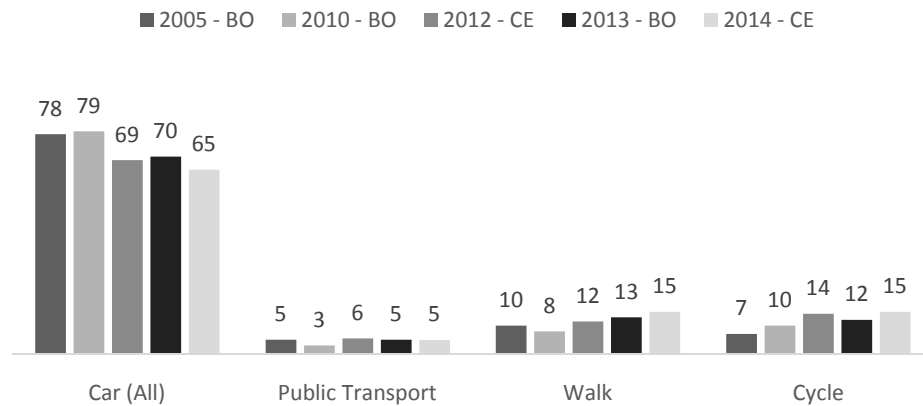


Figure 4 – NUI Galway staff modal share: 2005-2014

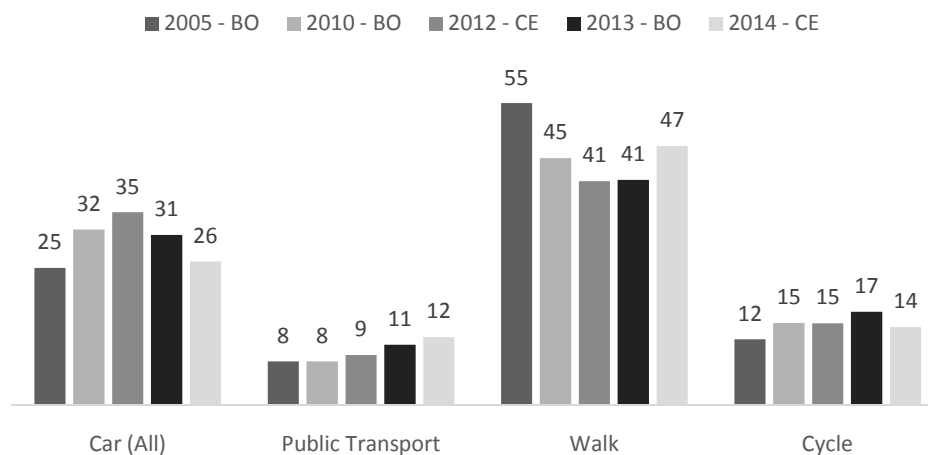


Figure 5 – NUI Galway student modal share: 2005-2014

From this recent survey at NUI Galway a number of other observations could be made. The modal share of private car usage was recorded as decreasing throughout the morning period. The restricted availability of parking on-campus after 9am and a higher student/staff ratio entering campus at later hours in the morning may explain the increased use of alternative modes of transport after 9 am (Figure 6).

The average speed achieved by the various modes was also calculated (independently of the and showed that cycling is on average 4.1 km/hr faster than the car over distances <2km, and 1.3km/hr faster in distances <5km. When time taken to find a parking space is excluded from the calculation, car is the faster mode of transport. This suggests that while

commuting by car may achieve greater speeds in travelling to the campus, the time taken to park the car results in cycling being the faster mode overall for distances less than 5 km.

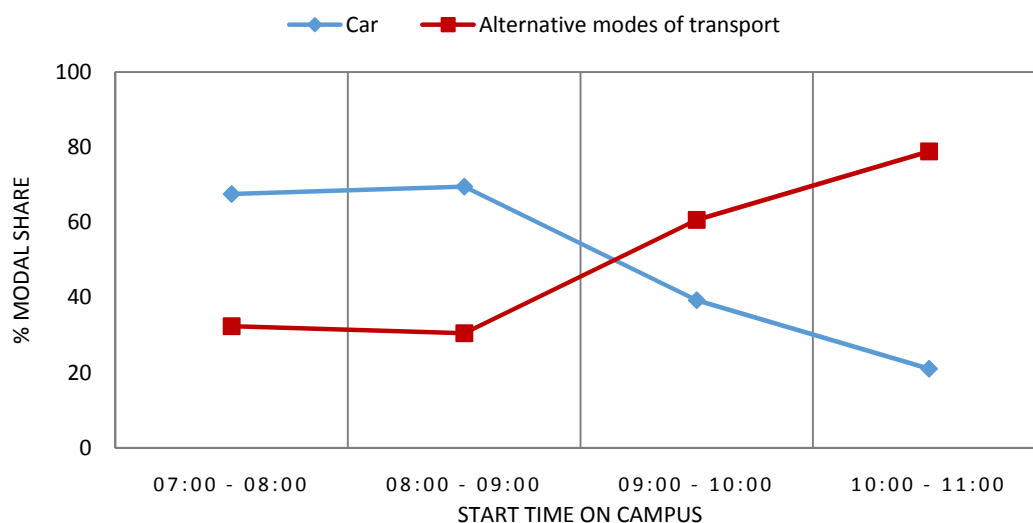


Figure 6 – Modal share of car and alternative modes of transport 7-11 am. Alternative transport modes include cycling, walking and public transport (It should be noted that the public transport modal share is low at all times).

4.2 Cross-campus comparison

Use of public transport at NUIG and GUH is quite low compared to UCB; though, notably cycling and walking rates are higher at NUI Galway when compared to the other campuses. Significantly the car usage for staff at GUH is in excess of 80% which is high when compared to the other campuses. Varying in working practices may account for some of the differences found between GUH and the university campuses.

Table 3 – NUI Galway Staff | Number of users per mode by start time

	Car	Public Transport	Walk	Cycle	Total No. of Responses
07:00 - 08:00	7 (78%)	0	1	1	9
08:00 - 09:00	113 (80%)	1	10	18	142
09:00 - 10:00	72 (52%)	11	33	23	139
10:00 - 11:00	5 (38%)	3	2	3	13

Table 4 – GUH Staff | Number of users per mode by start time

	Car	Public Transport	Walk	Cycle	Total No. of Responses
07:00 - 08:00	38(70%)	2	7	3	50
08:00 - 09:00	116(72%)	5	16	15	152
09:00 - 10:00	49(73%)	1	10	2	62

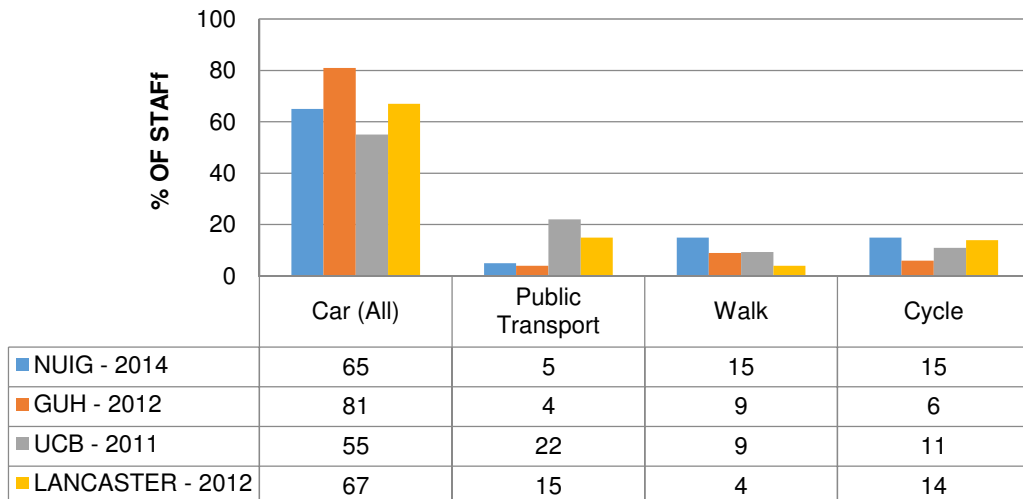
As shown in Table 3 car is consistently the most popular option throughout the morning rush period for NUI Galway staff. Walking, cycling and public transport all peak in popularity between 09:00 and 10:00 which likely due decreased availability of parking on-campus after 9am, as discussed earlier. Similar to the staff of NUI Galway, GUH staff show a high reliance on car for each hour of activity in the morning. The use of each mode peaks between the

hours of 08:00 and 09:00. It is evident there is no significant shift away from car at any stage throughout the morning, unlike NUI Galway staff. The availability of parking may be less of a concern on the hospital campus which may be the reason why modal share for car remains constant.

A cross-campus comparison of overall modal share for staff and students was conducted. The staff groups from NUI Galway, UC Berkeley, GUH and Lancaster University are shown in Table 2. While modal share of student groups in NUI Galway, UC Berkeley and Lancaster University are given in Table 3.

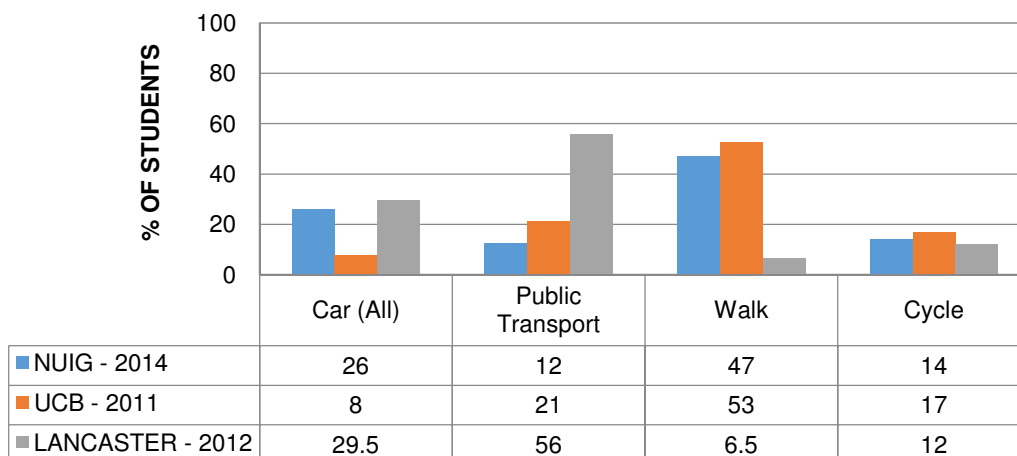
For staff, the popularity of car is consistent across all campuses. Public transport on both the Galway campuses is shown to be quite low in comparison to the other two. It is reasonable to assume that the explanation for this is that i) Lancaster University is quite isolated and therefore places a greater demand on public transport services and ii) UC Berkeley is served by a multitude of frequent and reliable public transport systems. Walking and cycling are most popular in NUI Galway which is likely due to the average living distance from campus being quite low. The NUI Galway results however are the most recent of the other campuses used in the comparison which may not portray a true representation of current modal shares.

Table 2 – Crosscampus comparison of modal share for staff



For students, car use is significantly lower in UC Berkeley than in either of the other two campuses. As mentioned previously UC Berkeley is served by a multitude of frequent and reliable public transport systems which is likely the reason for less reliance on private car usage. The data also indicates that NUI Galway has roughly the same modal share for car as Lancaster University, a rural campus located 4.5km from the city centre. The instalment of dedicated cycling routes connecting LU to the city and surrounding residential hubs may therefore be a huge incentive to choose to cycle rather than drive.

Table 3 – Crosscampus comparison of modal share for students



5. Impacts of infrastructure

5.1 Existing facilities at NUI Galway

Respondents at NUI Galway (2014 survey) were asked for key infrastructural changes that have improved their travel experience to the campus by foot, bicycle and bus. Key improvements identified include that the new O'Shaughnessy Bridge has been successful in improving active travel experience to the South campus (this enables access to the campus from Galway City centre while by-passing University Road). Students also consider a new pedestrian access stairs on the Quincentennial Bridge as a welcome improvement (the access stairs facilitates direct access to the campus from the South side of the bridge to the North campus). While the survey showed high awareness of facilities which are in clear view, there was limited awareness of the presence or location of shower and changing facilities.

Infrastructure improvements: Lessons from cross-campus comparison.

Table 5 summarises an analysis of survey data from the four campuses identified potential areas for improvement that could encourage growth in the modal share of sustainable modes of transport.

Table 5 – Successful infrastructural improvements

Mode	Key successful infrastructure improvements
Cycling	➤ Increased availability of covered bicycle parking and
	➤ Improved off-campus cycle lanes
	➤ Provision of bicycle maintenance facilities on-campus
	➤ The shared bike scheme 'SPIN' which was in operation on the NUIG campus for a number of months, proved hugely popular.
Walking	➤ Minimise conflict between pedestrian and vehicular activity will make walking more appealing.
	➤ Provision of well-maintained footpaths of suitable width.
	➤ Periodic shelters along walking routes
	➤ Suitable street lighting was identified as a key concern
Public Transport	➤ Provision of shelter at all bus stops
	➤ Real time public information was considered to have a major impact on uptake of public transport

In terms of public transport other key successful initiatives reported included (i) introduction of flexible ticketing options that ensure public transport is cheaper than private car as a transport mode (ii) enable flexibility in the use of bus routes and other public transport options (e.g. integrated ticketing across bus providers) and (iii) increasing the cost of parking on-campus while offering subsidised ticketing options for the bus.

Potential savings in carbon emissions

As mentioned previously, UC Berkeley has a lower modal share for car than NUI Galway. A calculation based on the assumption that NUI Galway achieves a modal share for car similar to that of UC Berkeley shows that a combined total of 645kgCO₂e/km/day could potentially be saved by those driving to NUI Galway. It was acknowledged that for this to occur it would likely result in greater demand for public transport modes, thereby increasing carbon emissions of these services. This study solely looked at the potential for savings in carbon emissions from private car usage and therefore those for public transport were not quantified. Policy changes alongside infrastructural improvements on the NUI Galway campus could help achieve these savings. In doing so, the carbon emissions produced by those driving to the University campus could fall by 45%.

6. Conclusion

Analysis of modal share data shows that the Galway campuses have a heavy reliance on car usage in comparison to UCB. Implementing issues highlighted as promoters of sustainable modes could result in reduced car usage and the associated carbon emissions. Encouraging modal shift requires investment in sustainable transportation infrastructure alongside promotion of available facilities and amenities. In order for infrastructure and facilities to make any substantial impact on modal share they must be promoted as much as possible so that awareness is increased. This is especially important for those which are not clearly visible, such as shower and changing facilities. Awareness should be raised of the pros and cons to using each mode e.g. cycling is faster than driving in distances <5km. Cycling can be a viable alternative to the car for those living within 5km, as it provides the same flexibility which is not achievable when relying on public transport while also being as fast as driving. Therefore, infrastructure which provides for and encourages cycling is very important with regards to sustainability.

Work ongoing within the research group will focus on a number of key studies including annual continuation of the travel surveys, longitudinal surveys of individual student cohorts over a number of years. Such surveys will identify the cost-effective and successful infrastructural, social and policy initiatives that increase uptake of public transport and active travel modes. The will furthermore identify "roadblocks" that may limit such modal shifts. The work will also be broadened to include off-campus organisations including Galway City Council and other large employers.

Acknowledgement

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