The Sheffield Hallam University Natural Environment Research Transactions

Purpose of the Series

The aim of this publication is to provide an opportunity for students to publish the findings of their undergraduate or postgraduate work. Guidance on publication will be given by staff who will act as second authors. It is hoped that by providing a guided transition into the production of papers that students will be encouraged throughout their future careers to publish further papers. Guest papers are welcomed in any field relating to the Built Environment. Please contact E.A.Laycock@shu.ac.uk. A template will be provided on request.

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HOW THE TRANSPORT INFRASTRUCTURE OF MILTON KEYNES AFFECTS THE WAY PEOPLE TRAVEL

AN I-TREE ECO EVALUATION OF THE ECOSYSTEM SERVICES PROVIDED BY STREET TREES

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Trees are a vital component of any urban environment, they provide a plethora of environmental, economic, social and health benefits known as ecosystem services (Johnston 2015). Green infrastructure tools such as i-Tree Eco have been developed to quantify the ecosystem services provided by urban trees. However, this is a relatively new approach to valuing green infrastructure in the UK (Natural England 2013). Previous UK based i-Tree Eco studies have all been conducted at a city-wide scale. In contrast, this report quantifies the ecosystem services provided by urban trees at the scale of a single suburban street. The i-Tree Eco model was run using collected data to estimate the ecosystem services provision. The 53 trees on Western Road covered an area of 3.5 hectares and consist of ash (*Fraxinus)*, sycamore (*Acer pseudoplatanus)* and Common lime (*Tilia* x *europaea)* with a combined structural value of £981,000. The trees annually produce around 33,000 kg of oxygen and remove an estimated 13.8 kg of air pollution. Each year 1,222 kg of carbon is sequestered from the atmosphere with an estimated 290,382 kg of carbon stored in the trees. Furthermore, the Western Road trees alleviate flooding in Sheffield by reducing run-off by 42.8 m³ annually.

Keywords: Ecosystem services, I-Tree Eco, Green Infrastructure, Sheffield.

INTRODUCTION

Sheffield is widely known as the greenest industrial city in Western Europe (Sheffield City Council 2016). However, recently removal notices have appeared on 23 of the 53 mature street trees on Western Road (Perraudin 2016). Located at 53.38625, - 1.504083, Western Road is a small, suburban street in the Sheffield suburb of Crooks.

The removal notices are a result of a significant tree management program conducted by the consultancy AMEY to improve the city's highways. Named the 'Streets Ahead Highways Maintenance and Management Program', it is a result of a £2.4 billion contract signed by Sheffield City Council in 2012 to maintain Sheffield's highways for the next 25

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years (Barkham 2015). The highways contract has taken a controversial approach to managing street trees (Perraudin 2016). Whilst there is a need for street tree maintenance in Sheffield, and sometimes removal due to disease or when trees present a danger to the public and cause disruption to pavements and roads, the recent work goes way beyond this (Barkham 2015). Healthy and mature trees are currently being removed and replaced by small saplings in an attempt to lower potential maintenance costs over the short-term life of the contract instead of properly maintaining the mature trees (Johnston 2015).

It is important to understand that mature trees do not simply provide aesthetic value, they generate multiple ecosystem services that can benefit a city in numerous ways. Ecosystem services both improve the urban environment and positively influence human health (Schroeder 2011). The benefits gained from trees are best described as 'ecosystem services' defined as the important benefits for human beings that arise from healthily functioning ecosystems (Corvalan et al. 2005). A Forestry Commission (2004) report separates the ecosystem services provided by urban trees into environmental, economic, health and social benefits.

The small, immature saplings used as replacements for the mature street trees have a high fail-rate and cannot provide near the same amount of ecosystem services due to their smaller canopies and stem diameter (Tyrväinen et al. 2005). Unfortunately, the problem faced on Western Road is not an isolated one; up to 10,000 trees currently risk removal in Sheffield (Perraudin 2016). This study quantifies the value of ecosystem service benefits provided by the 53 mature street trees on Western Road.

Figure 1 - Photograph of Western Road taken during surveying (source: author).

LITERATURE REVIEW

Western Road

Since Western Road is a controversial site in the Sheffield street tree context, it makes a good case study. The avenue of trees was planted to commemorate the fallen of World War 1. It has often featured in the media with Jeremy Barrell, a highly qualified arboricultural

consultant, for example, expressing his opinion on the Sheffield trees on the BBC's 'The One Show'. He stated that "From a health and safety point of view, none of the trees need to come out" (Arboricultural Association 2017, online). In response to 'The One Show' coverage, the Arboricultural Association issued a statement questioning the Sheffield City Council on its current tree-felling programme stating "The removal of trees which are not dangerous but are merely seen to be "damaging" (to the pavement or nearby walls) or "discriminatory" (causing alleged obstruction to people with visual or physical impairments) should be questioned" (Arboricultural Association 2016).

Furthermore, Mark Johnston, author of 'Trees in Towns and Cities', criticises the practice of replacing mature street trees with small saplings stating "Local authorities are cutting back on their spending on tree maintenance and management so tree officers are reluctant to put in large trees" (Johnston 2015, p81). Sheffield City Council argues that all the trees facing removal on Western Road are being felled due to being damaging to the road and pavement, or potentially obstructing (Barkham 2016). However, Johnston (2015), disagrees, noting that the mature trees are simply in need of maintenance, something which has reduced dramatically over recent decades.

Environmental Benefits

As noted in the wider literature, environmental benefits are often discussed as the main advantage of urban trees (e.g. Grant and Gallet 2010). These benefits include improved air quality, carbon sequestration, flooding alleviation and many others (Forestry Commission 2004). It is worth noting that most previous studies focusing on how urban trees influence air quality are located predominantly in the USA. However, this does not affect the relevance of the studies to the present work as the same theories still apply. Urban trees influence both local micro-climates and longer–term climate change. Carbon sequestration and storage is one way that trees can positively influence longer-term climate change (Nowak 2000). Trees remove and store carbon that would otherwise remain in the atmosphere (Bidwell and Fraser 1972). Highlighting the potential role of urban forests in reducing atmospheric carbon dioxide, the Nowak and Crane (2002) study is the most relevant literature surrounding the carbon sequestration and storage by trees. They found the carbon storage and sequestration by urban trees in the USA amounted to between 350 and 750 million tonnes of carbon, this established their importance as carbon sinks.

There is much literature on the important role street trees have on urban hydrology, however there are few studies testing the theories in practice (Dwyer et al. 1992). Two studies by Xiao and McPherson (1998 & 2002) focus on the rainfall interception by Sacramento (1998) and Santa Monica's (2002) urban forest. Both studies feature a similar one-dimensional mass energy and balance model to simulate rainfall interception. However, the more recent Santa Monica (2002) study features annual values of avoided storm water treatment and flood control costs, mentioning how specific species contribute to rainfall precipitation (Xiao and McPherson 2002). This is an improvement on the Sacramento (1998) study it is thorough and considers more variables.

Economic Benefits

The economic benefits of urban trees include increased residential property values of houses near to urban trees and savings from reduced heating and cooling costs (Dwyer et al. 1992). A recent study by The University of Washington (2016) stated that urban trees in

Portland Oregon yielded an increase in house prices of $1.35 billon, with potential to increase annual property tax revenues by $15.3 million (Donovan and Butry 2010). This is further supported by Tyrväinen and Miettinen (2000, p205) who noted "dwellings with a view onto forests are on average 4.9 percent more expensive than dwellings with otherwise similar characteristics". These studies identify a correlation between the proximity to urban trees and an increase in property value. Grant and Gallet (2010) describe how urban trees can affect the energy useage of buildings. In hot regions cooling costs can be decreased by shading and in cooler regions the reduction of wind speed around buildings lowers heating costs. Evidence of this can be seen in the study by Justuf et al. (2007) 'The influence of land use on the urban heat island in Singapore' in which they state that urban trees can offset or even reverse the heat island effect by transpiring water and shading surfaces.

Health Benefits

The health benefits of urban trees were first noted when Ulrich (1984) discovered that hospital patients recovered quicker from surgery when the room they were recovering in had a view of green space. Since then, there have been numerous studies focusing on the positive influence urban green space has on human health. A recent study set in Toronto, Canada by Kardan et al. (2015, p1) states that "people who live in neighbourhoods with a higher density of trees on their streets report significantly higher health perception and significantly less cardio-metabolic conditions (adjusted for socio-economic and demographic factors)". Additionally, research by Wolf (2004) on the effect urban green spaces have on stress, wellness and physiology agrees with Ulrich (1984), by explaining how exposure to nearby nature can effectively reduce stress and simply having a view of nature can aid recovery. Wolf (2004) continues to explain how living near green space may boost exercise frequency and therefore one's health. There are very few arguments opposing the health benefits provided by trees. The only negative health impact because of trees is the production of volatile organic compounds (VOCs) as they can contribute to the creation of tropospheric ozone. However, research has revealed this is only minor and overall trees reduce ozone levels (Nowak et al. 2001).

Social Benefits

Whilst the social benefits provided by urban trees are still being investigated, there is evidence of urban trees leading to stronger community ties, a sense of belonging and reduced crime and violence (Kuo 2003). An article by Dwyer et al. (1991) considers the significance of the social values provided by urban trees. Despite the report not being recent, it suitably highlights the main social values developed because of urban trees, focusing on the personal ties and attachments residents have towards neighbourhood trees (Dwyer et al. 1991). In contrast to Dwyer et al. (1991), Kuo (2003) focuses on the community and reductions in crime and violence in relation to urban trees. The study, set in Chicago notes, urban trees lead to "stronger ties amongst neighbours, a greater sense of safety and adjustment, more supervision of children in outdoor spaces, healthier patterns of children's play, more use of neighbourhood common spaces, fewer incivilities, fewer property crimes, and fewer violent crimes" (Kuo 2003, p148). This statement is supported by an earlier study by Sullivan and Kuo (1996), that found signs of stronger communities where there are urban trees and a connection between those trees and lower levels of violence.

RESEARCH METHOD

i-Tree Eco (also known as UFORE) is a free, downloadable software package used to calculate the benefits provided by the trees (i-Tree 2016b). Created in the USA, by the USDA Forestry Service, it is a software package designed to quantify the benefits provided by urban trees. However, the software has only been recently adjusted for the UK. i-Tree Eco works by combining numerous tree measurements and parameters, recorded for this study on Western Road with local pre-processed hourly weather and air pollution data to produce the output of an estimation and valuation of ecosystem services provided by urban trees. i-Tree Eco uses previously submitted data from trees of a similar size and same species to produce an estimation of ecosystem services. While i-Tree Eco can be run with as little information as the species of the tree, the DBH at 1.5 m, height to live top and height to crown base. The Western Road study also included GPS coordinates, total tree height, crown width, percentage of crown missing, percentage of crown dieback, crown light exposure and distance and direction to the nearest building. The ecosystem services estimations produced by i-Tree Eco include air pollution remediation, oxygen production, carbon dioxide sequestration and storage, avoided run-off, energy conservation due to tree shade and several biophysical results (i-Tree 2016b).

As i-Tree Eco is a recent software package, it has only been applied in the UK at a city-wide scale. During the current ongoing tree controversy in Sheffield, trees are being removed road-by-road, and therefore a more localised scale was adopted for this study. Along with quantifying and valuing the ecosystem services provided by the street trees on Western Road, this project is also a test of the application of the method on this scale by trial of i-Tree Eco's application to a small sub-urban street tree population. Because of this, there could be many unexpected limitations. To consider any such limitations, previously conducted i-Tree surveys from the UK were also reviewed.

Rodgers et al. (2011) noted in the Torbay i-Tree study that due to tree species in the UK having different growth rates, biomass and leaf area, the ecosystem services predictions may differ from the USA studies. However, they concluded that through the estimation of ecosystem services, i-Tree Eco provides a useful indicator of the monetary value of the benefits provided by street trees in the UK (Rodgers et al. 2011). This has since been rectified as the software package has been adapted for the UK. The report outlined the importance of i-Tree and its potential benefits of raising awareness of the ecosystem services provided by street trees in the UK. Rumble et al. (2014) opted to use Capital Asset Value for Amenity Trees (CAVAT), an additional green infrastructure valuation tool. CAVAT is an approach designed to assess the public amenity value of urban trees in monetary terms. It has been suggested that this approach was previously used to assess the monetary value of trees before i-Tree Eco was updated to include a structural valuation (Neilan 2009). In comparison to the Torbay and Wrexham reports, 'Valuing London's Urban Forest: Results of London's i-Tree Project', by Rodgers et al. (2015), is a more recent and refined document. As London is the capital, the London i-Tree report received more publicity and recognition in comparison. It is worth noting, that no significant limitations or draw-backs of the i-Tree software were stated in the London i-Tree report.

RESULTS

Composition and Structure

Western Road features 53 street trees covering a leaf area of 3.5 ha with a biomass of 1.8 tonnes (Table 1). The trees consisted of ash (*Fraxinus)*, sycamore (*Acer pseudoplatanus)* and Common lime (*Tilia* x *europaea)*. The most dominant species in terms of number of trees and leaf area was sycamore (84.9%). All the trees featured on Western Road were mature specimens with diameters at breast height (DBH at 1.5 m) ranging from 83 to 260 cm (Table 2). The trees were in a healthy condition, the i-Tree Eco estimate being an average of 98.9% condition which is deemed 'excellent' (Table 2).

Species	Number of Trees	Percentage of population (%)
ash	5	9.4
sycamore	45	84.9
Common lime	3	5.7
Total	**53**	**100**

Table 1 Population summary by species on Western Road (Data from i-Tree 2017).

	Leaf area		Leaf biomass		Tree dry weight biomass		Average condition
Species	**hectare (ha)**	**SE**	**tonne**	**SE**	**tonne**	**SE**	**%**
ash	0.265	±0.000	0.238	±0.000	48.670	±0.006	98.50
sycamore	3.099	±0.000	1.424	±0.000	503.558	±0.010	99.06
Common lime	0.160	±0.000	0.074	±0.000	28.537	±0.005	97.83
Total	**3.524**	**±0.000**	**1.736**	**±0.000**	**580.765**	**±0.004**	**98.93**

Table 2 Structure summary by species on Western Road (Data from i-Tree 2017).

Air Pollution Remediation

It is estimated that the trees on Western Road remove 13.8 kg of air pollution including ozone (O_3), nitrogen dioxide (NO_2), particulate matter less than 2.5 microns ($PM_{2.5}$), and sulphur dioxide (SO_2) per year with an associated value of £88.60 (Table 3). Pollution removal peaked during the summer months and was greatest for Ozone and lowest for sulphur dioxide (Figure2). Annually, the trees also remove up to 7.6 kg of ozone and this has an associated value of approximately £60. Despite having the second lowest amount removed, $PM_{2.5}$ has the highest associated removal value of £40.

Pollutant	Amount removed per year (kg)	Value (£)
Carbon monoxide (CO)	0.269	0.27
Nitrogen dioxide (NO_2)	4.200	2.64
Ozone (O_3)	7.582	31.88
Particulate matter less than 2.5 microns ($PM_{2.5}$)	0.366	53.46
Sulphur dioxide (SO_2)	1.414	0.32
Total	**13.831**	**88.57**

Table 3 Air pollution removal by trees on Western Road (Data from i-Tree 2017).
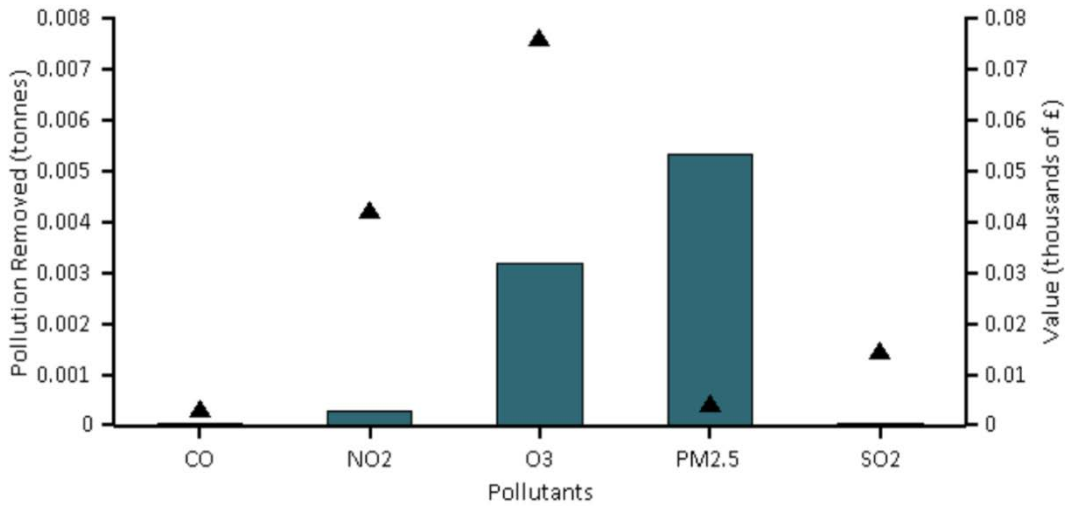
Figure 2 Amount and value of air pollution removal (points) and value (bars) by trees on Western Road (Results from i-Tree 2017).
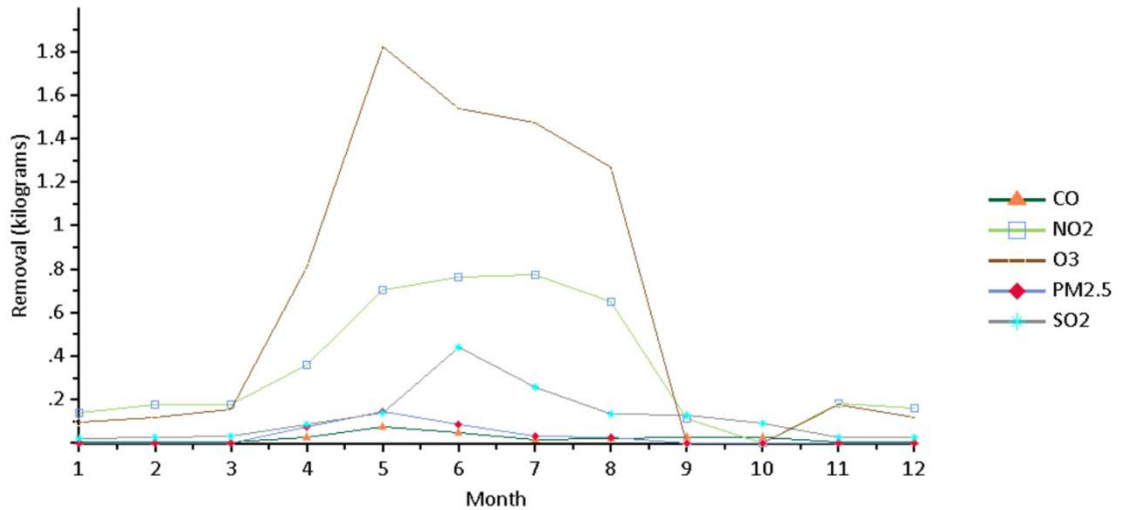
 Figure 3 Amount of air pollution removal by trees on Western Road (Results from i-Tree 2017).

Oxygen Production

The street trees of Western Road are estimated to produce 3.6 tonnes of oxygen annually (Table 4). This figure may seem unimportant considering the large and relatively stable amount of oxygen in the atmosphere (i-Tree 2016a). However, when viewed on a larger scale through extrapolation, the 36,000 street trees in Sheffield would produce an estimated 244,528 tonnes of oxygen annually, a more noteworthy amount.

Species	Number of trees	Leaf area (ha)	Oxygen (tonne)
ash	5	0.265	0.44
sycamore	45	3.099	2.49
Common lime	3	0.160	0.33
Total	**53**	**3.524**	**3.6**

Table 4 Oxygen production of trees by species on Western Road (Data from i-Tree 2017).

Carbon Sequestration and Storage

The trees of Western Road are estimated to store around 290,400 kg of carbon with the associated cost of about £18,500 (Figure4 and Table 5).
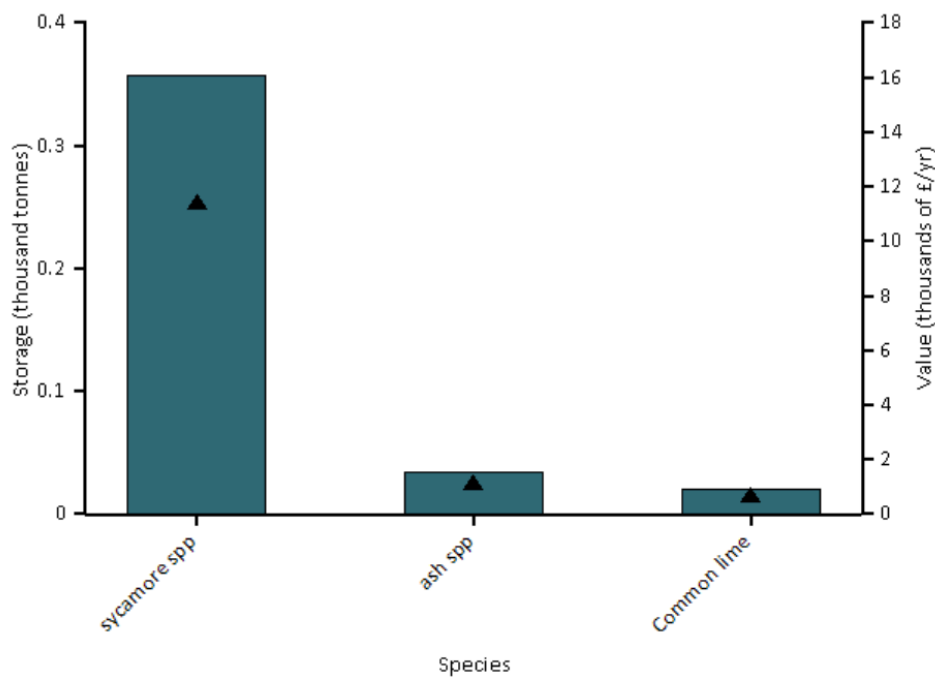
Figure 4 Estimated carbon storage (points) and value (bars) for trees by species on Western Road (Results from i-Tree 2017).

Of the species sampled, sycamore sequestrates and stores the most carbon (approximately 76.4% of all carbon sequestrated and 86.7% of the carbon stored). The gross carbon sequestration from trees on Western Road was estimated at 1,222 kg of carbon per year with the associated value of £78 (Figure5 and Table 6).

Species	Carbon storage (tonne)	Carbon storage (%)	CO_2 equivalent (tonne)
Ash	24.3	8.4%	89.2
Sycamore	251.8	86.7%	923.3
Common lime	14.3	4.9%	52.3
Total	**290.4**	**100%**	**1,064.8**

Table 5 Carbon storage of trees by species on Western Road (Data from i-Tree 2017).
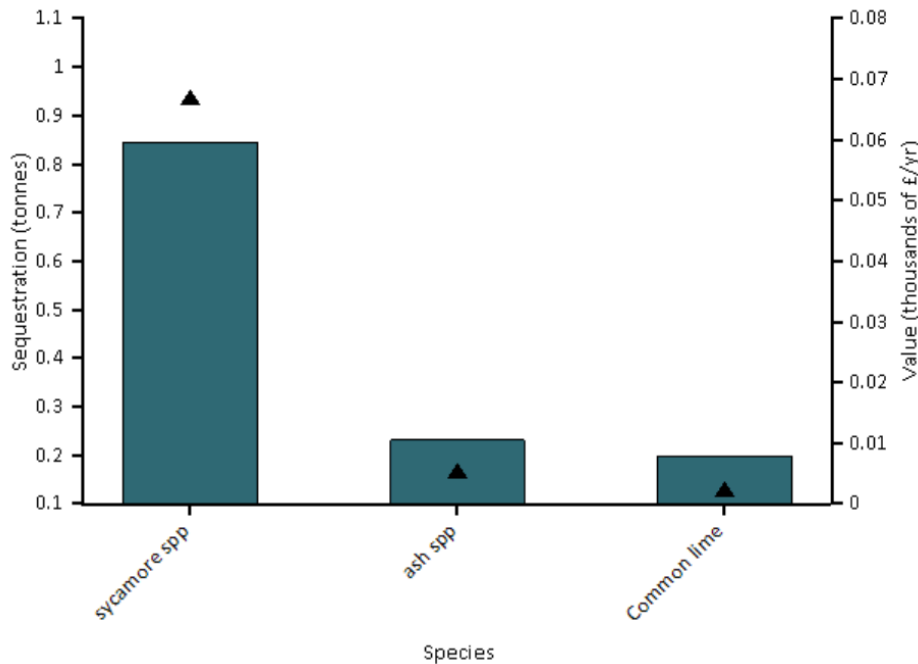
Figure 5 - Estimated annual carbon sequestration (points) and value (bars) for trees by species on Western Road (Results from i-Tree 2017).

Species	Gross carbon sequestration (tonne/yr)	CO_2 equivalent (tonne/yr)
Ash	0.16	0.60
Sycamore	0.93	3.42
Common lime	0.12	0.46
Total	**1.22**	**4.48**

Table 6 - Annual carbon sequestration of trees by species on Western Road (Data from i-Tree 2017).

Avoided Run-off

The 53 street trees of Western Road annually intercept 258.3 m^3 of water and help to reduce surface run-off by an estimated 42.8 m^3 per year with an associated value of £64 (Figure 6 and Table 7). Annual avoided water run-off is calculated from the difference between annual run-off, with and without the trees (i-Tree 2016a). Although leaves, branches and bark may intercept precipitation therefore mitigating surface run-off, only

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precipitation intercepted by leaves is accounted for by the i-Tree Eco algorithm (Nowak et al. 2008).
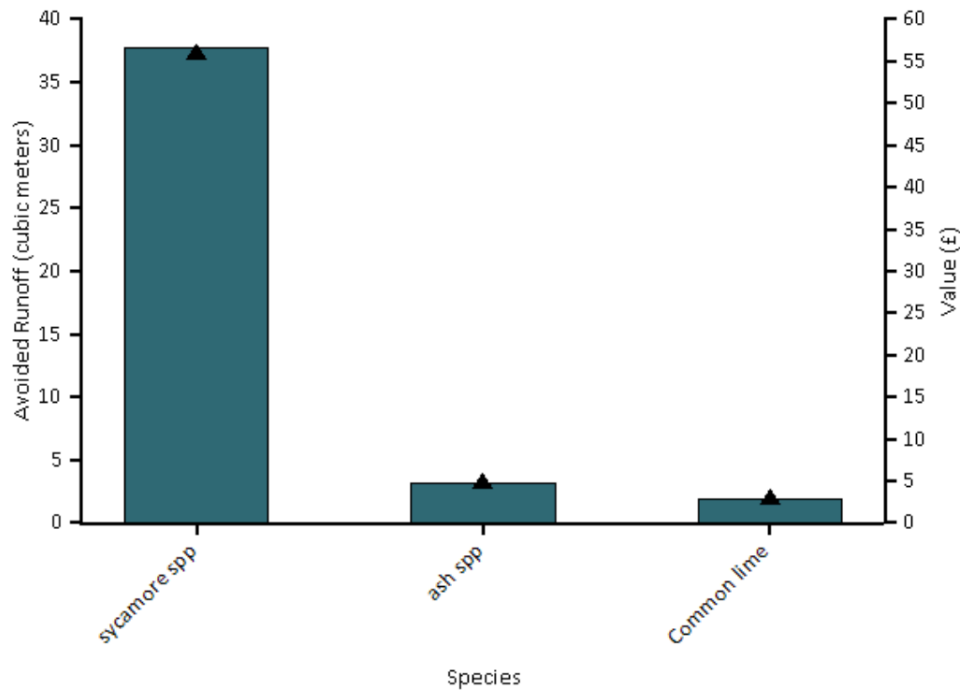
***Figure 6** - Avoided run-off (points) and value (bars) by trees species on Western Road (Results from i-Tree 2017).*

Species	Number of trees	Leaf area (ha)	Potential evapotranspiration (m³/yr)	Evaporation (m³/yr)	Transpiration (m³/yr)	Water intercepted (m³/yr)	Avoided run-off (m³/yr)	Avoided run-off value (m³/yr)
Ash	45	0.265	1,305.31	225.83	340/29	227.19	37.28	56.53
Sycamore	5	3.099	111.44	19.28	29.05	19.40	3.18	4.83
Common lime	3	0.16	67.33	11.65	17.55	11.72	1.92	2.92
Total	**53**	**3.524**	**1,484.08**	**256.76**	**386.89**	**258.30**	**42.83**	**64.27**

***Table 7** - Avoided run-off from trees by species on Western Road (Data from i-Tree 2017).*

Trees, Buildings and Energy Use

Urban trees can either increase or decrease building energy use in the winter months (Simpson 1998). Trees can increase heating costs by shading buildings preventing the sun from warming the building during the day resulting in more energy being required for heating (i-Tree 2016b). They tend to reduce building cooling costs in the summer months by reducing the amount of air conditioning needed (Dwyer et al. 1992). As Trees can both reduce or increase a buildings heating and cooling cost this study produced some negative values associated with increased energy consumption. The trees on Western Road are estimated to increase energy-related costs from residential buildings by £163 annually

(Table 8). However, the trees provide £11 in value by reducing the amount of carbon released by fossil-fuel based power plants (a reduction of 0.164 tonnes of carbon emissions) (Table 8). Energy use is calculated to was specifically designed for the US, this work will produce energy results based on the US climate region (i-Tree 2016a). This means that whilst the energy consumption values provide a good estimation, they should be used with caution.

Type	Amounts			Values		
	Heating	Cooling	Total	Heating	Cooling	Total
MBTU	-23.417	n/a	-23.417	-330	n/a	-330
MWH	-1.197	2.315	1.118	-179	345	167
Carbon Avoided (tonne)	-0.177	0.342	0.164	-11	22	10

Table 8 - Energy effects of trees on Western Road (Data from i-Tree 2017).

Structural and Functional Values

Street trees have a structural and functional value (i-Tree 2016b). The structural value is based on the physical resource of the trees themselves (the cost of having to replace the tree with an identical tree) whereas the functional value is based on the benefits they provide (ecosystem services) (Nowak et al. 2002b) (Figure 7 and Table 9).
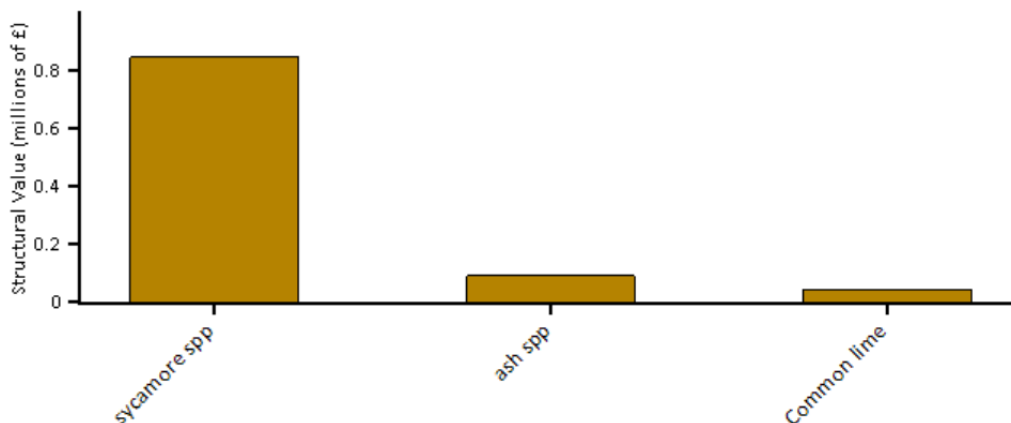
Figure 7 - Structural value of tree species on Western Road (Results from i-Tree 2017).

Species	Structural value (£)
ash	91,351.92
sycamore	843,021.09
common lime	46,753.13
Total	**981,126.14**

Table 9 - Structural value of tree species on Western Road (Data from i-Tree 2017).

The street trees of Western Road have the structural values of:

- Structural value: £981,000.
- Carbon Storage: £18,500.

The street trees of Western Road have the functional values of:

- Carbon sequestration: £78.00.
- Avoided run-off: £64.30.
- Pollution removal: £88.60.

DISCUSSION

This discussion focuses on the most significant ecosystem services revealed by the i-Tree Eco results. Findings on oxygen production and on trees and building energy use have not been discussed further.

Composition and Structure

The 53 street trees consisted of ash, sycamore, and Common lime, covering a leaf area of 3.5 hectares. The low species diversity is due to most trees having been planted in 1919 as memorial trees by the local school to remember former students who died during the First World War (IWM 2016). Low species diversity is a common trait in a street tree population as the trees tend to have been planted at the same time (Sanders 1981). The results revealed the street tree population to consist of mature trees with a DBH at 1.5 m ranging from 83 to 260 cm. The larger mature street trees have a greater functional value and provide more ecosystem benefits than younger and smaller trees. However, an entirely mature population is not necessarily a sustainable one (Bradshaw et al. 1995). Size and age distribution is important for a resilient tree population, as young trees are required to restock the tree populations once the mature trees eventually die (Rogers et al. 2011).

The trees on Western Road were estimated to have an average condition of 98.9%, which is deemed 'excellent' by i-Tree. This means the trees are all in a good, healthy condition. Taking this into consideration, the results suggest the mature trees are not damaged, diseased or dying. The main factors limiting street trees are the environment surrounding them and their potential future management. With the correct management, most of the trees on Western Road will survive and provide ecosystem services for many years to come. In comparison to the previously conducted UK i-Tree Eco studies of Torbay, Wrexham and London, the 53 street trees of Western Road were less diverse in both species and size as expected. The i-Tree Eco composition and structure tool is suited to a larger, city-wide representative sample as opposed to an individual street of trees such as this project.

Air pollution removal

Street trees make significant contributions to improving air quality by absorbing gaseous pollutants, intercepting particulate matter and lowering temperature, therefore reducing ozone levels (Nowak et al. 2006). Trees also indirectly improve air quality, by lessening the energy demand for heating and cooling buildings thereby reducing the energy demand from fossil fuel power plants (Nowak et al. 2014). As temperatures rise, gaseous particles move more quickly, speeding up the reaction in which pollutants are formed (Seinfield and

Pandis 2012). Temperature gives seasonality to atmospheric pollution, so pollutant levels tend to be higher during the spring/summer months (Nowak et al. 2014). The results support this, showing pollutant removal levels of all pollutants peak during the summer months (Figure3). This could be due to deciduous trees having their leaves during the summer months. The increased leaf surface area and longer days cause greater stomatal activity, thereby removing more atmospheric pollutants (Bidwell 1972). As pollutant removal is directly proportionate to the healthy leaf area present, the maintenance and protection of larger, mature trees should become the priority. Their larger size and increased leaf area provide increased levels of pollution removal (Rogers et al. 2011). Tropospheric ozone (O_3) is the pollutant most removed by the trees of Western Road, at 7.6 kg annually. Tropospheric ozone is an anthropogenic pollution found in the troposphere (<6.2 miles above ground), it has numerous adverse health and environmental effects (Nowak 2000). Trees can help reduce atmospheric ozone either by absorbing it through leaf stomata and the plant surface or by lowering the air temperature and therefore reducing ozone (Cardelino and Chameides 1990). Certain tree species produce VOCs that contribute to the formation of tropospheric ozone, research has revealed an increase in trees leads to an overall reduced ozone formation (Nowak 1995). Particulate matter (PM) is a term used to describe the mixture of particles and water droplets in the air. It occurs both anthropologically and naturally, the inhalation of particulate pollution can lead to numerous adverse respiratory and cardiovascular health effects (Beckett 1998). The greatest anthropogenic source of particulates with a diameter of 2.5 microns or less ($PM_{2.5}$) is road vehicles, notably diesel vehicles (Van Essen et al. 2011). Trees reduce atmospheric particulate pollution by intercepting airborne particles (Nygren 2015). Intercepted particulates can either be absorbed into the tissues of the tree or simply deposited onto the surface (Harrison et al. 1997). Though most of the intercepted particles are eventually washed off by precipitation or re-suspended, the temporary removal of the atmospheric particulates is a valuable benefit (Nowak et al. 2013).

Carbon Sequestration and Storage

Carbon sequestration and storage is one way trees positively influence climate change (Nowak 2000). Carbon sequestration is the process by which carbon dioxide is removed from the atmosphere (Nowak et al. 2002a). As trees grow, they sequester atmospheric carbon, some of which is stored and held in the trees tissues (roots, stems and branches) (Baldocchi 1987). The trees of Western Road annually sequester an estimated 1,222 kg of carbon that would otherwise remain in the atmosphere. On Western Road, individual Common lime trees annually sequester the most carbon at 40 kg per year, compared to ash at 32 kg and sycamore at 20.7 kg. Once trees die and decompose, the carbon stored over the lifetime of the tree will be re-released. i-Tree Eco calculates the carbon stored in trees by how much carbon would be released if the tree were to die (i-Tree 2016b). The amount of carbon stored by a tree depends on the health and individual biomass of each tree (EPA 2015). However, maintained trees tend to have less biomass and therefore less carbon storage than forest derived trees (Nowak and Crane 2002). The trees of Western Road are estimated to store about 290,000 kg of carbon, a sizeable figure considering the trees on Western Road represent 0.15% of the recorded street trees in Sheffield. By removing large healthy trees, the speed at which carbon is re-released back into the atmosphere is increased (Abdollahi et al. 2000). As the amount of carbon stored within a tree increases

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with biomass, where possible, mature trees should be maintained and preserved to ensure the carbon from these effective stores is not released at an accelerated rate.

Avoided run-off

Surface run-off is a concern in Sheffield. The city is prone to flooding due to its location at the base of the Peak District, and the convergence of multiple, fast-flowing rivers and its valley-dominated topography (Environment Agency 2010). Sheffield's city centre is heavily urbanised because of its industrial past, containing many impermeable surfaces in the form of buildings, car parks and roads. This subsequently prevents water from permeating into the ground, thereby increasing the potential of flooding. Previous notable flooding events in Sheffield include the devastating floods of 2007 and 2012 (Environment Agency 2010). When Sheffield floods, the water quality of Sheffield's streams and rivers can decrease as storm water run-off washes the urban streets carrying pollutants into local watercourses. Additionally, high levels of run-off water can lead to combined sewer overflows (CSO) being released, polluting watercourses. Street trees are essential for reducing storm water run-off, as during a storm event trees intercept precipitation, increasing the time taken for the storm water to reach the drains, lessening the potential for flooding (Zinke 1967). The 53 street trees of Western Road annually intercept 258 m^3 of water and help to reduce surface run-off by an estimated 43 m^3 per year. Flooding is an ongoing issue in Sheffield with millions of pounds being invested in flood alleviation schemes to prevent large flooding events such as those in 2007 (Environment Agency 2010). It is counter-intuitive removing mature street trees that reduce the chance of flooding whilst spending millions of pounds on flood alleviation.

Structural and Functional Values

Structural and functional values tend to increase with a rise in the number of large and healthy trees, as they provide the most value (Nowak et al. 2002b).

The structural value of trees on Western Road is £981,126.14. This valuation is based on the trees physical resources (i.e. the cost of replacing the trees with similar trees) (i-Tree 2016a). Unfortunately, as i-Tree Eco is unable to calculate how urban trees influence property value, it was not possible to test Donovan and Butry's (2010) theory that urban trees increase surrounding property values.

Social, health and cultural values

i-Tree Eco is unable to quantify social, health and cultural values such as: health and well-being, pride, education and inspiration (Hirabayashi 2011). The trees on Western Road were planted as memorial trees by the local school in 1919, each in memory of a fallen former student. This makes these trees valuable to the local area (Barkham 2015). There is currently no existing green infrastructure valuation tool that can quantify the cultural value street trees provide. However, it should be considered when deciding how to manage the trees. The trees are regularly praised for their aesthetic beauty and the connection to nature they provide to the community (Perraudin 2016). They give a sense of personal pride and ownership to the residents of Western Road (Barkham 2015). As previously noted, Ulrich (1984) discovered hospital patients recovered quicker from surgery when the room they were recovering in had a view of green space. Street trees perform a similar function,

improving the health and well-being of the residents that live around them (Bradshaw 1995).

Additional benefits

In addition to the previously noted ecosystem services, there are numerous other benefits provided by urban trees. It is important to remember the habitat provision provided by mature street trees. Street trees provide habitat and food for insects, birds and mammals. Likewise, trees with large canopies such as on Western Road provide a green highway above the roads for wildlife to move without danger (Johnston 2015). In particular, street trees join otherwise fragmented urban habitats in effective 'green corridors'. They also provide substantial but unquantified habitat value for now-threatened pollinating insects. Noise mitigation from street trees is often overlooked as an ecosystem service. Street trees can reduce urban noise by absorbing sound waves, branches, leaves and stems obstruct and mitigate noise (Davies et al. 2011). Together with noise mitigation, urban trees also reflect more short-wave solar radiation than materials such as tarmac or brick, cooling air temperatures and thereby reducing the 'urban heat island' effect (Davies et al. 2011). Urban trees reduce urban warming through evapotranspiration as this cools the surrounding air (Doick and Hutchings 2013).

CONCLUSIONS

Despite having no documented use on a localised scale before in the UK, i-Tree Eco successfully quantified the ecosystem services provided by the 53 street trees on Western Road. The results suggest the trees on Western Road were in 'excellent' condition and not damaged, diseased or dying. This study demonstrates the green infrastructure tool is functional on a small suburban street tree population and should encourage its application at differing spatial scales. The success of this study should raise awareness for the ecosystem services provided by mature street trees and in turn strengthen the case for maintaining Sheffield's trees and increasing urban greening to ensure the benefits continue for future generations. However, i-Tree Eco is limited by its inability to quantify experiential values such as social, health and cultural benefits. Further research into experiential values would provide a greater holistic understanding of all ecosystem service benefits provided by street trees. This study demonstrates the substantial values provided by these trees, but also highlights that this is essentially a 'minimum' estimate since there are other aspects not yet included in the estimate of benefits. The next step for future research in Sheffield would be to conduct a city-wide i-Tree Eco survey, like the previous studies of Torbay, Wrexham and London. However, a full city-wide ecosystem analysis using sample inventory opposed to recording a full sample of the single suburban street tree population which would take longer and most likely require a team of surveyors.

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EXPLORING THE ROLE OF URBAN GREENSPACE (UGS) IN THE DEVELOPMENT OF A CONCEPT TERMED THE 'URBAN IDYLL'

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Dominic Emery studied BSc [Hons] Geography at Sheffield Hallam University and graduated in 2017 with a second class upper division [2:1]. Suzanne Leckie, Senior Lecturer in the Department of Natural And Built Environment at Sheffield Hallam University, supervised the dissertation and has a research interest in people's relationships with the natural environment.

The 'rural idyll' has been used as a starting point to examine whether the concept of an 'urban idyll' can be developed to serve academics and practitioners interested in improving urban places and lives. This has been achieved by investigating people's perceptions of the urban idyll and examining its physical embodiment, particularly the role that urban greenspace might play. The rural idyll concept is set up in literature as a direct contrast to urban life. Despite this common understanding, the concept is still contested amongst academics, with its subjective nature and mythical status being dominant criticisms. Sheffield was used as a case study location for this paper due to its industrial past, its proximity to the Peak District (which might typically represent the rural idyll), and the plentiful urban greenspace provided within the city. Qualitative research was undertaken using an on-line questionnaire survey, with results establishing that the majority of respondents related to the term 'urban idyll', and finding that they did not conceive it to be direct opposition to the countryside. Rather, it incorporated a number of characteristics associated with the rural idyll. However, it was noted that alternative conceptions and characteristics of the urban idyll also existed, and the concept was contested by a minority, in a similar vein to the rural idyll. Concepts develop to meet the needs of the times and this research paper indicates the urban idyll concept has sufficient potential to merit further research.

Keywords: idyll, urban greenspace, qualitative

INTRODUCTION

Academic studies have analysed and contested the concept of the 'rural idyll' in some depth. However, the idea of an 'urban idyll' has received less attention to date, with discourses turning instead towards more overarching visions of utopian urban life or the

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power of urban design, architecture and planning. This research is based on the premise that many people may nonetheless have a concept of the urban idyll, and that this may have some relationship with the rural idyll. Given the potential relationships between the two idylls, this research has elected to explore in particular the role and contribution that urban greenspace may have within the urban idyll.

The primary aim of this research study was therefore to develop and clarify the concept of the urban idyll, and explore the role of urban greenspace within the urban idyll.   The findings could benefit planners, greenspace managers, community activists and academics interested in improving urban living and responding to people's needs.

The objectives of this research paper were to:

- Establish what the public understand and recognise as the 'urban idyll'
- Establish the strength of association between people's perception of the urban idyll and urban greenspaces
- Identify the aspects of urban greenspaces which are most valued by the public
- Evaluate the usefulness of the concept of the urban idyll

LITERATURE REVIEW

The literature review deconstructs the rural idyll to help predict how an urban idyll may be understood and recognised. It also examines the potential for urban greenspace to contribute towards the urban idyll.

The development of the rural idyll

The Latin word 'idyllium' is derived from the Greek eidullion, meaning 'little picture'. The dictionary definitions for the idyll are, "*a very happy or peaceful period or situation*" and, "*a short poem or piece of writing describing a picturesque country scene*" (Oxford Dictionary, 2012: 502).

The attachment of a rural context to the concept of an idyll is well established. As far back as Greek and Roman periods the idea of a golden, agrarian age has been influential (Bunce, 2003). In the UK the Industrial Revolution during the 18th and 19th centuries cemented the union of the rural and the idyll as a beguiling contrast to the sometimes harsh urban lives and landscapes created by rapid population growth and urban development. Scholars (Bunce, 1994; Mingay, 1989; Rankin, 1999) suggest the rural idyll provided an escape from the industrial city, and bolstered a sense of nostalgia and yearning for the simple pastoral life that existed prior to the industrialisation era (Harrison, 1982). The Romantic Movement celebrated personalised responses to the countryside in pastoral poems and paintings, further idealising the countryside. Bunce (2003), Emmery (1999) and Shackford (1904) note the appreciation of landscape quality and aesthetics, describing the rural idyll as rural areas of scenic beauty which are separate from the urban environment. A key premise in these analyses of the rural idyll is that it is set in direct opposition to urban life (Bunce, 1994; Rankin, 1999).

It is clear that perceptions of an idyllic situation or place is subjective in nature. The term or phrase idyll is therefore open to interpretation and is thus seen to be equivocal. The usefulness of the rural idyll concept is further contested within the literature; given the

nostalgic, romanticised and aspirational nature of the rural idyll, Bell (2006) and Lacour & Puissant (2007) question whether it is a reality or a myth. Despite this, the rural idyll is a powerful and evocative idea, with frequent allusions to it in popular discourse.

The urban idyll concept

In contrast, there is little discussion or definition of the urban idyll in academic literature. Edgecombe (1994) notes that The Life and Adventures of Martin Chuzzlewit (Dickens, 1884) conveys an urban idyll as an oasis within a city that offers pastoral or natural features such as water fountains, and facilitates a mental escape from the urban environment. This poses the possibility that an urban idyll allows people to escape into a more natural setting, despite being located within the city.

Similar facets of the urban idyll begin to be articulated within visionary, utopian planning ideas published towards the beginning of the twentieth century. These include Ebenezer Howard's garden city concept, which aimed to hybridise rural and urban life, "with all the advantages of the most energetic and active town life, with the beauty and delight of the country" (Howard, 1902 cited in Cherry 1988). According to Barton (2017: 50) the garden city movement itself "echoed the utopian ideals of William Morris ….who dreamt of egalitarian communities living in a rural/urban idyll, at one with the natural environment". However, mid-century modernist architects such as Le Corbusier had a different vision, incorporating economic and rational functionality and promoting new aesthetic values including monumental tower blocks and long vistas over open landscapes. These examples briefly illustrate how the cornerstones of a utopian vision change over time and between individuals. The latter stance also gives rise to the possibility that the urban idyll could be set up in direct opposition to rustic life, capturing a positive image of urban life. This may include celebrating modernity, stimulation and social diversity in contrast to the slow paced, traditional and nature orientated characteristics of rural life. Notions of urban utopias are also concerned with the nature of citizenship and governance, and therefore some desire for participation or agency in the process of creating the urban idyll may emerge in people's conception of it.

Analysis of potential characteristics of the urban idyll

The two positions identified above provide a useful starting point, but a more nuanced analysis of the factors likely to contribute to the idea of an urban idyll is needed. The following section attempts this, principally by examining the factors that underpin our understanding of the rural idyll in order to see whether, and how, they may influence a conceptualisation of the urban idyll.

Feelings, emotional responses, values and experiences

Feelings, emotions and values are key components of the rural idyll and are therefore also likely to be referenced in people's expression or description of an urban idyll. Articulations of the rural idyll allude to feelings such as happiness, tranquillity, harmony, enchantment (with the natural environment), and nostalgia (Bunce, 1994; Gullone, 2000; Kellert & Wilson, 1993; Rankin, 1999; Wilson, 1984). Whether the 'urban idyll' does produce such emotions, and what type of urban environment or location produces these will be a useful line of enquiry.

A 'sense of escape' features strongly in conceptions of a rural setting, but Edgecombe (1994) and Tickle & Newman (2001) also suggest we can feel a 'sense of escape' and separation from the bustle of the city whilst still being incorporated within an urban environment. This ties to the 'extent' stage of Kaplan's (1995) Attention Restoration Theory (ART). The theory suggests that the brain can only focus on a specific stimulus or task for a limited amount of time before resulting in 'directed attention fatigue'. It proposes that mental fatigue can be reduced via time spent in nature where restorative environments must have the four following properties: extent (feeling immersed in the environment); being away (escaping from habitual activities); soft fascination (aspects of the environment that capture attention effortlessly); and compatibility (wanting to be exposed to, and appreciate, the environment).

Harrison (1982) suggests that feelings connected to the bucolic are largely sustained by the values people attach to land, nature and community. These are also inferred to be less prevalent in the urban environment. Therefore, exploring the values that underlie people's sense of an urban idyll, and whether an urban idyll provides a sense of escape from the pressures of urban life would have relevance for this research study.

In addition to feelings and values, the lived experience may be an important dimension of the idyll. Farming, traditional rustic crafts and various forms of countryside recreation and leisure are associated with people's experience of the rural idyll. Activities and experiences could therefore be speculated to play a role in the urban idyll, but it is unclear exactly what these might be.

Physical features and locations

Certain types of rural landscape have been more strongly linked with the rural idyll, namely pastoral, bucolic and natural. Additionally, landscapes that enable people to experience a sense of wilderness and remoteness are deemed important by Hoskins & Tallon, (2004) and the Peak District National Park Authority, (2012). Pastoral landscapes are associated with areas of traditional animal grazing and 'bucolic' is a term that describes rustic, country life characterised by historic buildings, natural heritage and culture and landscape features (Hoskins & Tallon, 2004; Peak District National Park Authority, 2012). Some of these physical features may play a part in the urban idyll too. Current thinking suggests that nature is crucial to people's sense of well-being. The Biophilia Hypothesis states that humans have evolved from the natural environment and have an innate need to connect with other living things such as fauna and flora (Richardson & Hallam, 2013). By doing this, humans feel connected to nature and feel mentally restored.

However, it can be equally conceived that an urban idyll might be characterised by distinctive urban features, for example iconic buildings, historic architecture, urban infrastructure, or modern materials. Tickle & Newman (2001) suggest admiration of archaic buildings allows viewers to mentally escape and feel distant from the city, relating to the 'being away' stage of the Attention Restoration Theory (ART).

The role of urban greenspaces in the urban idyll

The role of the natural environment and natural features is of particular interest for this research, given their potential to figure in the urban idyll.

Scholarly definitions for an urban greenspace (UGS) is, '*land that consists predominantly of unsealed, permeable 'soft' surfaces such as soil, grass shrubs and trees*' (Dunnett et al., 2002:8); from parks, to urban agriculture to residential lawns (Breuste et al., 2013; Kabisch & Haase, 2014). It has been noted that the term UGS is just as ambiguous in its meaning as the term idyll, and that people hold conflicting views and values about the same spaces (Jorgensen et al., 2010). Both Hegarty's (2010) Nature Connectedness Perspective and Downs' (1970) Environmental Cognition Model emphasise that feelings towards nature are not objectively shared by humans. Rather, they are subjective and this is the reason why people value greenspaces within a city differently.

Nonetheless, research on the correlation between greenspaces and health show how these spaces have offered restorative effects on physical and mental wellbeing (Lee et al., 2015). Tyrävinen et al. (2007) and Dunnett et al. (2002) have also shown people value natural greenspaces more than urban greenspaces. Sheffield City Council (2010) have responded to these ideas by designing parks and gardens within the city to improve public health by attempting to create tranquil spaces, replicating natural environments and incorporating existing geographical features such as the Porter Brook, in Endcliffe Park.

Experiences of space and the qualities UGS possess, such as their design and layout, influence how that space is interpreted and whether it is perceived as idyllic. Abkar et al. (2010) and Karmanov & Hamel (2008) have found that well-structured and purpose-designed UGS are perceived as aesthetically pleasing and stress-reducing. Kaplan, (1995) attributes this to the 'extent' stage of ART where it can be argued that the 'sense of escape' can be facilitated through the designs and layouts of Sheffield's UGS. Park paths may provide a sense of being connected to nature whilst historical monuments may promote the sense of being connected to heritage (Richardson & Hallam, 2013; Beaney, 2009). Therefore, it might be anticipated that the designs and layouts of UGS are likely to influence whether users perceive them as idyllic.

RESEARCH METHODS

A case study approach based on Sheffield was undertaken. Sheffield has a distinctive industrial history and is also rich in urban greenspace, being described as Europe's greenest city (Sheffield History Team, 2007), see Figure 1.

The city is also on the doorstep of the Peak District National Park. This combination of characteristics reflects various ideas related to the rural or urban idyll, which may be illuminated by the public's responses to the survey questions.

Key to sites
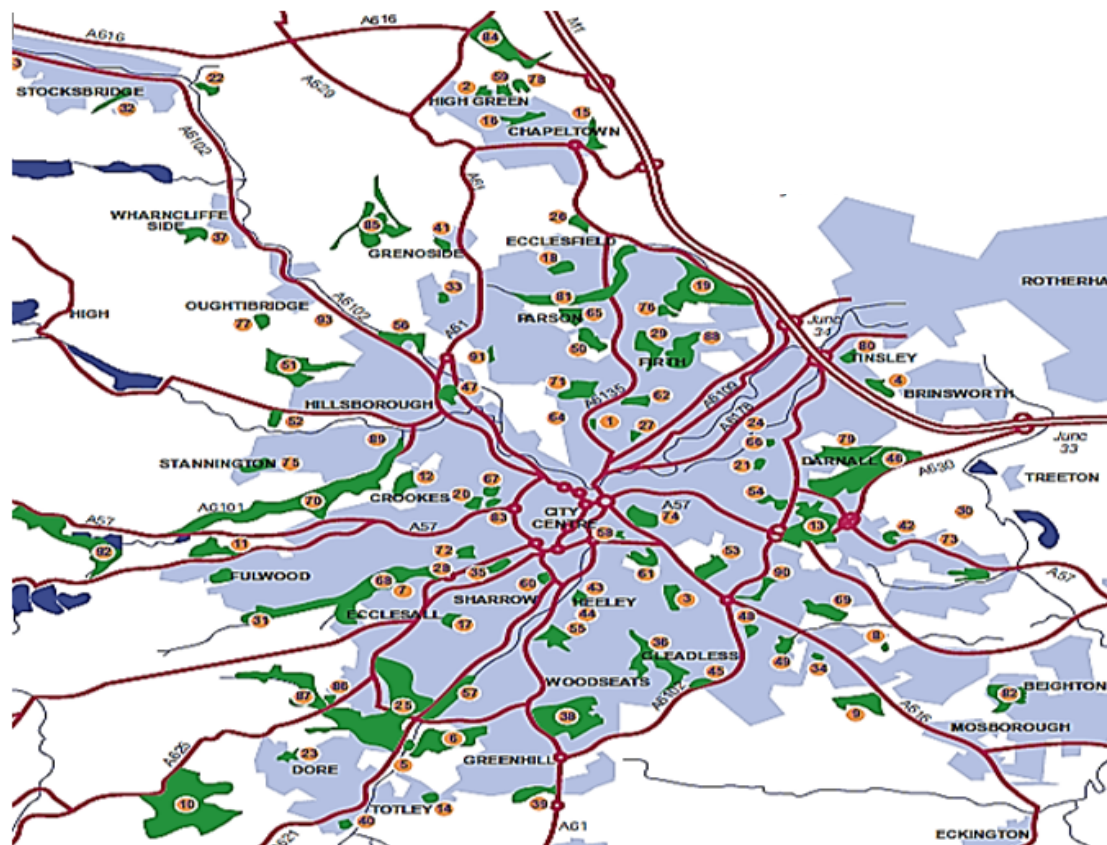
1 Abbeyfield Park	19 Concord Park/Golf Course &	46 High Hazels Park & Tinsley Park	71 Roe Wood
2 Angram Bank Recreation Ground	Woolley Woods	Golf Course	72 Sheffield Botanical Gardens
3 Arbourthorne Playing Field	20 Crookes Valley Park	47 Hillsborough Park & Walled	73 Shire Brook Valley Visitor Centre
4 Bawtry Road Sports Ground	21 Darnall Community Park	Garden	74 Sky Edge Playing Field
5 Beauchief Gardens	22 Deepcar Recreation Ground	48 Hollinsend Park	75 Stannington Park
6 Beauchief Golf Course	23 Dore Recreation Ground	49 Jaunty Park	76 Steel City Recreation Ground
7 Bingham Park	24 East End Park	50 Longley Park	77 Sycamore Park
8 Birley Spa	25 Ecclesall Woods	51 Loxley and Wadsley Commons	78 Thorncliffe Recreation Ground
9 Birley Wood Golf Course	26 Ecclesfield Park	52 Loxley Recreation Ground	79 Tinsley Park Hill
10 Blacka Moor	27 Ellesmere Park	53 Manor Fields Park	80 Tinsley Recreation Ground
11 Blackbrook Wood	28 Endcliffe Park	54 Mather Road Recreation Ground	81 Tongue Gutter
12 Bole Hill Recreation Ground	29 Firth Park	55 Meersbrook Park	82 Waterthorpe Park
13 Bowden Housteads Wood	30 Flockton Park	56 Middlewood Park	83 Weston Park
14 Bradway Recreation Ground	31 Forge Dam	57 Millhouses Park	84 Westwood Country Park
15 Chapeltown Park	32 Fox Glen Recreation Ground	58 Monument Gardens &	85 Wheata Wood
16 Charlton Brook	33 Foxhill Recreation Ground	Clay Wood	86 Whinfell Quarry Gardens
17 Chelsea Park	34 Frecheville Pond	59 Mortomley Park	87 Whirlow Brook Park
18 Colley Park	35 General Cemetery	60 Mount Pleasant Park	88 Wincobank Wood
	36 Gleadless Valley Woodland Park	61 Norfolk Heritage Park	89 Wood Lane Countryside Centre
	37 Glen Howe Park	62 Osgathorpe Park	90 Woodthorpe Ravine
	38 Graves Park	63 Oxley Park	91 Wordsworth Avenue Open Space
	39 Greenhill Park	64 Parkwood Springs	92 Wyming Brook
	40 Greenoak Recreation Ground	65 Parson Cross Park	93 Worral Recreation Ground
	41 Grenoside Recreation Ground	66 Phillimore Park	
	42 Handsworth Recreation Ground	67 Ponderosa	
	43 Heeley City Farm	68 Porter Valley Parks	
	44 Heeley Millennium Park	69 Richmond Park	
	45 Herdings Park	70 Rivelin Valley	

Figure 1: A map of all the greenspaces in Sheffield, UK (Sheffield City Council, 2007)

Questionnaires

The questionnaire was organised into three sections. The first section contained questions asking respondents what they thought of when presented with the terms 'rural idyll' and 'urban idyll'. These aimed to establish the public's conception of the urban idyll. The second section asked a series of questions exploring what respondents liked about Sheffield's urban greenspaces, and the third section focused on establishing which settings or places in Sheffield respondents perceived as idyllic. These lines of enquiry were designed to provide data to analyse the relationships between urban greenspace and the urban idyll, addressing the remaining two key research objectives.

Initially, a pilot questionnaire was trialled using social media, which produced 30 responses. These questions were largely formulated in an open-ended style and the responses were used to gather insight on likely themes and locations (for example, responses highlighted the influence of the distance of an urban greenspace from residential location on the likelihood of people exploring it), and to refine the wording and scope of questions for the final questionnaire. The final questionnaire, producing the data used in this paper, was distributed randomly via social media where 60 responses were collected, with the majority of respondents being in higher education and/or being in the 20-30 age range.

'Open coding' of the data was undertaken where the data was placed into themes and then categorised (Corbin & Strauss, 2013). An 'axial coding' was then applied to assemble the data in a new form and refine the categories further (Bryman, 2012; Corbin & Strauss, 2013). The frequency of responses in each category was then recorded. Themes were chosen to broadly categorise the different aspects of people's conception of an urban idyll and their response to urban greenspace: Culture, History and Heritage; Design and Layout; Distance and Location; Experiences; Features; Feelings; and Uses. The categorisation process was influenced by the analysis of the literature outlined in the previous section of this paper, and also by detailed analysis of the participants' responses which allowed additional aspects, that had not been highlighted in the literature, to emerge. Sub-categories of the 7 themes were created where useful, for example 'Features' were refined into 3 further sub-categories: flora, fauna and water bodies.

RESULTS AND DISCUSSION

The findings have been presented in a sequence reflecting the themes of the research objectives, rather than the questionnaire.

The responses to questions on the rural and urban idyll were categorised as described above, and the frequency with which different aspects of the idylls were mentioned is shown in Figures 2 and 3. The text reveals the type of responses within each of the categories with some quotations, and examines whether there are any significant dichotomies within the categories.
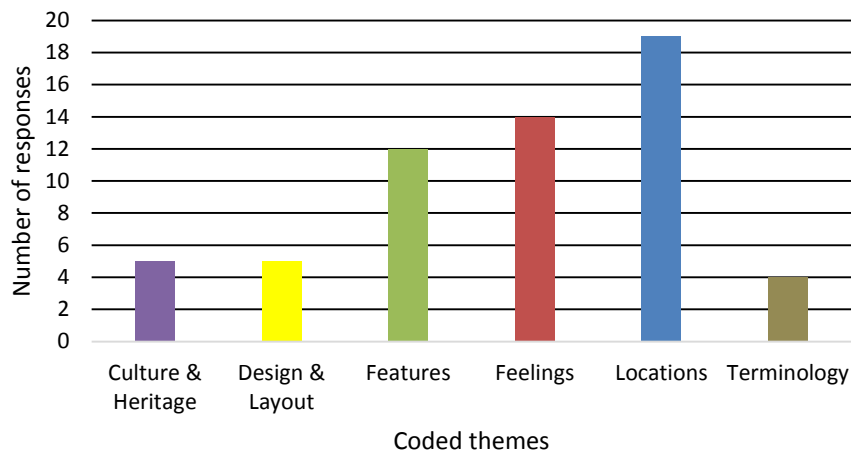
Respondent's perceptions of the rural idyll

Figure 2: A summary of responses by theme to the question,What do you understand by the phrase 'Rural Idyll'?

Respondents understood the term 'rural idyll' to be most strongly associated with a 'countryside' location (Figure 2). Locations cited in the Peak District and on the edge of the city included, 'Win Hill' and 'Stanage Edge', echoing Hoskins & Tallon's (2004) observation that the rural idyll can be experienced in wild and remote landscapes. Feelings of 'tranquillity' and 'peacefulness' were the second most frequently mentioned characteristic of the rural idyll (Figure 2) reflecting one of the key attributes identified in the literature (Bunce, 1994; Rankin, 1999; Shucksmith, 2016). Responses referencing descriptions such as 'like Constable Paintings' and 'antiquated, quite romanticised and of the past', were classified as cultural heritage and reflect the Romantic Movement. The rural idyll was also described by features which were largely rustic and natural, such as 'wildlife', 'trees', and 'rolling hills'. References to its ambiguous terminology, 'sounds like corporate speak' , and its contested nature, such as 'exclusivity' and 'fake pastoral memories' reflect scholarly debates on the mythology of the rural idyll. Overall, the perceptions of respondents echoed the characteristics of the 'rural idyll' identified in the literature.

Respondent's perceptions of the urban idyll

'Feelings' and 'Features' were the dominant attributes of the urban idyll, together comprising over half the total themes mentioned (at 27% each), as illustrated in Figure 3. Predominant physical features included, 'green space' and 'trees', suggesting that contact with nature is a key characteristic that is shared by both rural and urban idylls. However a smaller proportion of respondents included distinctly urban features such as 'shops and facilities, polished aluminium and glass' and 'typical urban structures'. Feelings included 'peaceful', 'quiet', and 'escape' which re-enforces the importance of the 'being away' stage of ART, and also echoes similar emotional responses to those generated by the rural idyll. This illustrates that people do not have to actually escape the city to feel its absence and be at peace with nature; this can also happen within an urban setting. On the other hand, Figure 3 shows that some respondents (11%) felt the concept of urban idyll was unattainable, calling it 'impossible' and an 'oxymoron'. The term also caused confusion

and was pronounced, 'a strange word' and 'nonsense'. Locations that captured respondents' sense of an urban idyll included 'Sheffield' in general, 'parks' and specific sites such as the 'Botanical Gardens' and 'Winter Gardens'. Locations outside of Sheffield such as 'Canary Wharf' and 'New York' were also used as indicators of an urban idyll, suggesting that the urban idyll is seen as a universal concept and applicable to other urban settings. The contrasting features and locations quoted by respondents reflect the subjective nature of people's response to space (Hegarty, 2010 and Downs, 1970). Culture and Heritage was not often mentioned (1%), although 'Victorian gardens' and 'old urban areas' were identified. It is possible that some locations were mentioned because of their historical or cultural value to the respondent, but without explicit mention of these characteristics. However, it should be noted that some responses on the urban idyll may be preconditioned since the rural idyll question was asked before the urban idyll. Therefore, the results may not have been kept entirely independent of each other and this may be a potential source of bias.
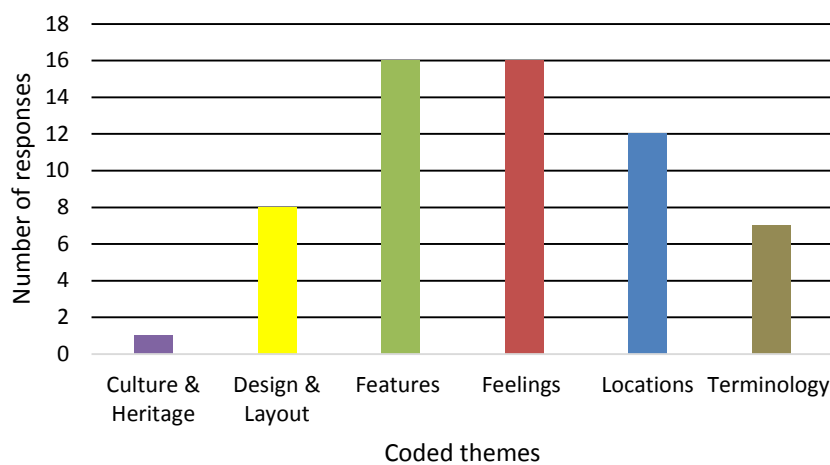
Figure 3: Summary of responses by theme to the question ,What do you understand by the phrase 'Urban Idyll'?

Respondents were asked to ground their conception of an urban idyll by identifying idyllic locations in Sheffield. Figure 4 shows these idyllic settings to be mostly urban greenspace of different types, but notably parks and woods. Most are council owned Sheffield greenspaces (Figure 1), the others are owned by conservation organisations, or are part of the 'wider countryside' on the edge of Sheffield. There are, however, 5 notable exceptions to the urban greenspace pattern; the Winter Gardens (a large, modern glasshouse), St Paul's Place (an urban square), and the Peace Gardens (another urban square, with a fountain feature and ornamental tree planting), South Street Park and Kelham Island. With the exception of Kelham Island the sites identified are located next to each other in the city centre providing connected public open space in the heart of the city.

Kelham Island is the hub of a regenerated heritage and cultural quarter, and contains the Kelham Island Industrial Museum. It would not be classed as a typical greenspace, though the River Don runs through it, with attractive vegetation along the river banks. The newly created South Street Park is also part of a regeneration scheme and has a large open-air amphitheatre to host public events, as well as an arboretum. These 5 inner-city sites

comprise over one fifth (22%) of the idyllic locations cited by respondents in Figure 4, and produced a quarter of the citations of idyllic places in Sheffield (15 out of 60 citations).
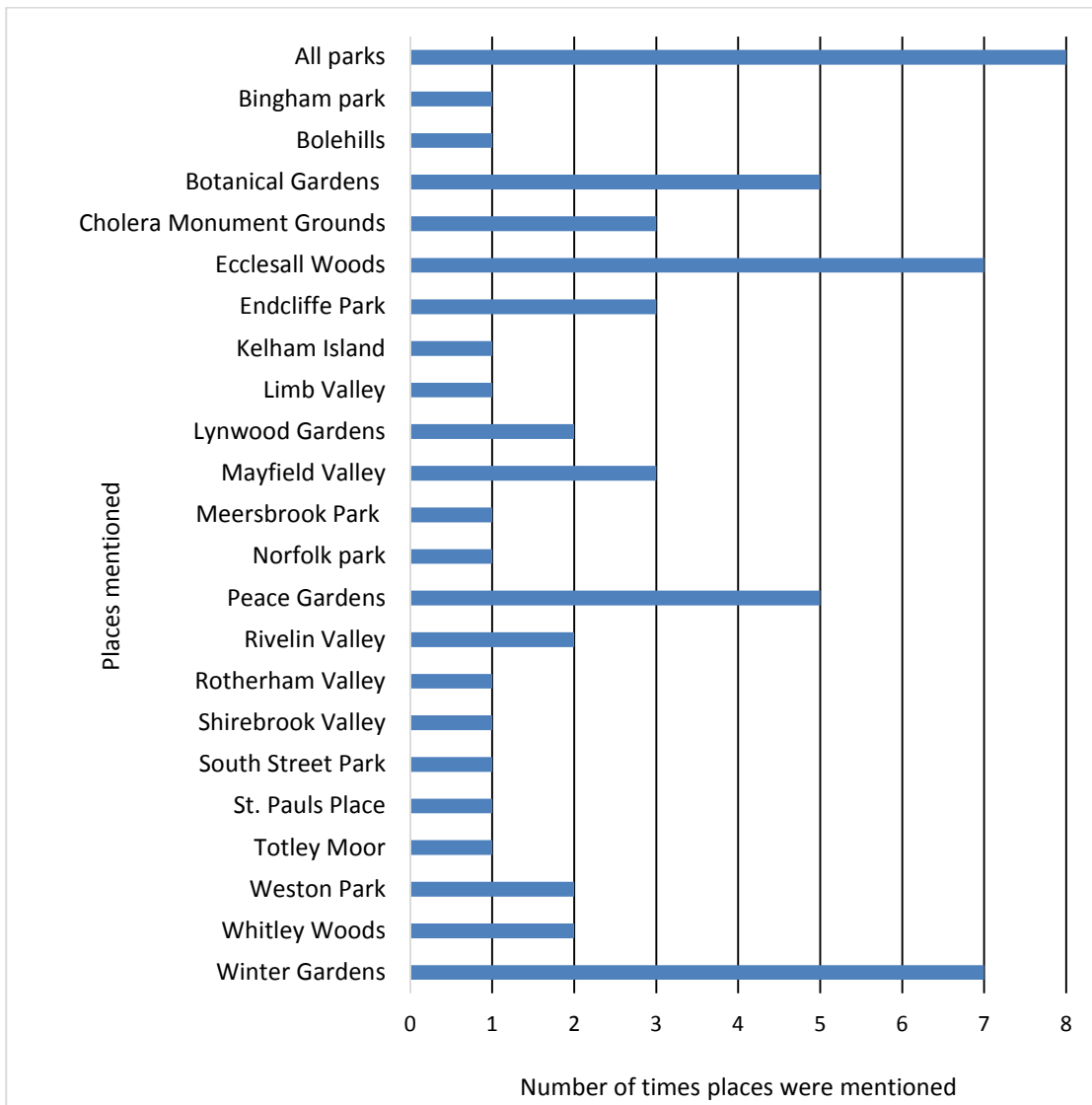
Figure 4: Locations respondents perceived as idyllic places within Sheffield, UK

The respondents' identification of so many idyllic urban locations that are typified by 'greenery' and natural features re-enforces the important role that greenspace can have in creating an 'urban idyll'. However, natural features are not the only characteristics of these locations; some also have historic buildings and cultural connection, public art, and facilities to encourage play or exercise. The fact that the 5 inner-city sites described above contained strong urban character (for example buildings with urban function, architecture and materials and a marked level of human presence and activity) means that the urban idyll is not wholly represented by a replication of the rural idyll.

The role of Urban Greenspace in an Urban Idyll

Respondents were asked to name their favourite urban greenspace and explain why they liked it. The results in Figure 5 show the majority of respondents favourite UGS locations were parks and gardens, with a small number mentioning recreation grounds.

Interestingly, spaces that may not be classified as urban greenspace by the City Council, or do not fall into Dunnett et al.'s (2002) definition are nonetheless perceived as urban greenspace by the respondents (e.g. the Peace Gardens, Barker's Pool) possibly because of water features and planting.

Features were found to be the principle factor determining people's favourite UGS in Sheffield (Figure 5) with responses highlighting three main types of features: water bodies such as 'ponds', flora such as 'trees', and fauna such as 'ducks'. These results support the importance of pastoral and natural features, and support Sheffield City Council's approach to incorporating natural features in their urban greenspace to make it more appealing to users. Being able to access and use the site is also important. When collated together the responses classified into the 'Uses', 'Distance and Location' and 'Experiences' themes are very significant in determining the value of urban greenspaces, accounting for 72% of themes mentioned (see Figure 5).

Comparison of the responses in Figure 5 (respondent's favourite UGS) with those in Figure 4 (Sheffield locations identified as idyllic) indicates a noteworthy, but not complete, degree of matching between respondents' favourite UGS and the places they identified as idyllic, with 10 of the 17 favourite named UGS locations also featuring in the list of idyllic locations in Sheffield.   It is noted that 4 parks were identified in the list of favourite UGS, but not included in the list of idyllic locations; however they may have been encompassed with in the 'all parks' response in the idyllic locations illustrated in Figure 4. It is also possible that particular qualities of the UGS, such as functionality or familiarity, may elicit a 'favourite' response, yet fail to trigger an 'idyllic' response. Three other favourite UGS did not feature in the list of idyllic locations, namely Barkers Pool, Mount Pleasant and Grenoside Woods, although the first two are not typical UGS.
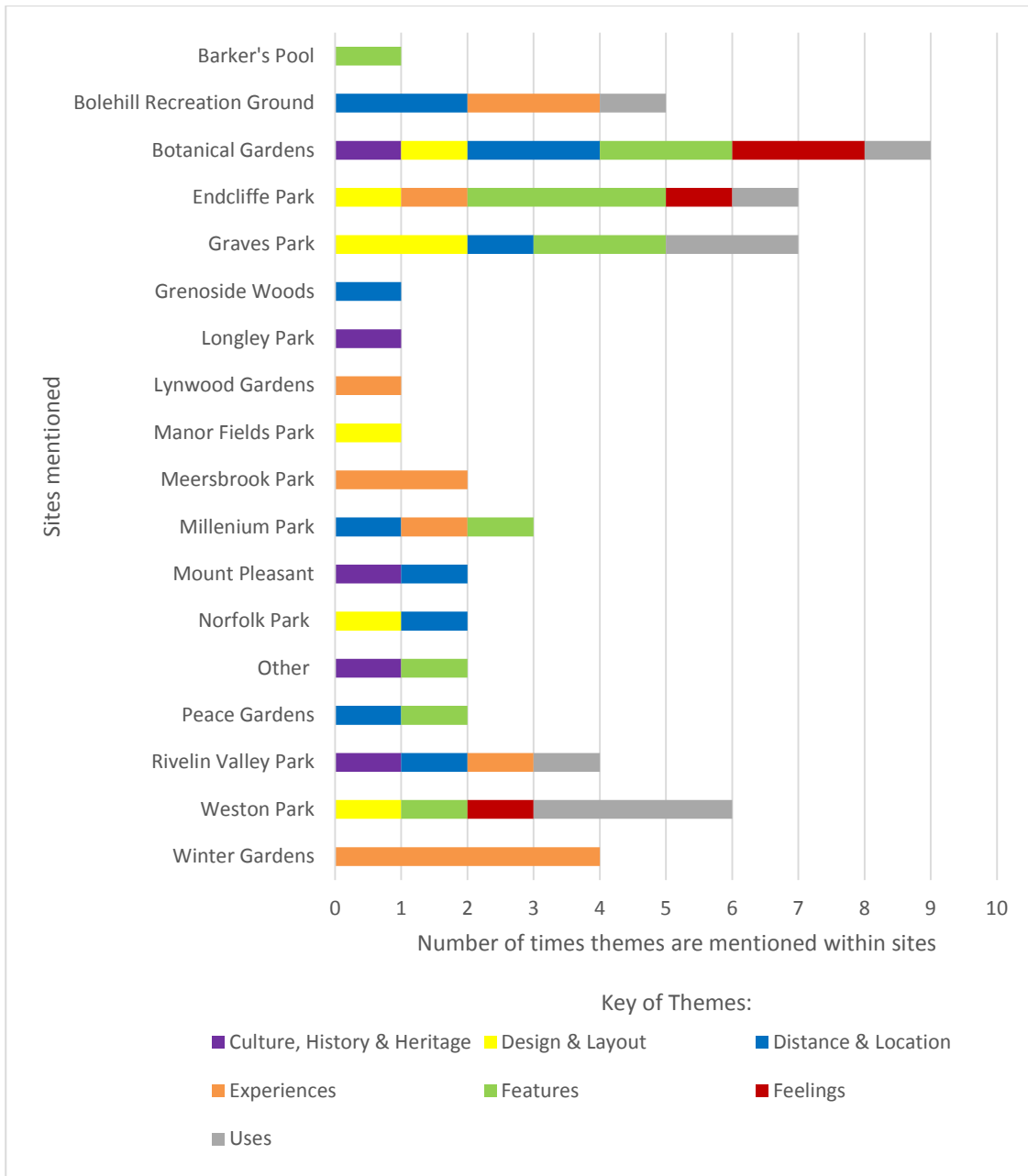
Figure 5: Respondent's favourite urban green space in Sheffield with their justifications categorized into themes

CONCLUSIONS

A key objective of this research was to establish how the public understood and conceptualised the idea of the 'urban idyll'. The findings confirmed that most respondents were able to conceive of an urban idyll and give examples of locations which captured the concept. It may also be concluded that the majority of people's understanding of the concept, and the way they defined it, is significantly influenced by their perception of the rural idyll. However, a small number of the respondents rejected the reality of the concept of an urban idyll, corroborating some of the conceptual difficulties academics previously identified with the concept of a rural idyll. The subjective nature of an idyll is also re-

enforced by the wide range of characteristics cited in respondents' descriptions of an urban idyll. This finding cautions against accepting any singular vision of an urban idyll, especially given the social diversity of cities. Nonetheless, the findings suggest that the term 'urban idyll' resonates powerfully with many people, and consequently there is value in understanding perceptions of it more deeply.

The most telling quality associated with the public's perception of the urban idyll was found to be in emotions and feelings associated with it, with tranquillity, relaxation and 'escape' being key. Furthermore, the findings show that natural elements are important physical characteristics of the urban idyll; they are present even when juxtaposed against modern man-made features in places such as Peace Gardens and Winter Gardens. The frequency with which these two factors occur supports claims that contact with nature can influence mental states, and Kaplan's (1995) Attention Restoration Theory could provide a useful framework for further exploration of the urban idyll.

The study confirms the influential role of urban greenspace in the urban idyll. Most respondents identified urban greenspaces as their favourite or most idyllic place in Sheffield. This offers some support to Sheffield City Council's strategy of incorporating or leaving natural features within their parks and green spaces as they contribute to many people's vison of an urban idyll. However, this study did unearth visions of urban idylls that reflect more distinctively urban characteristics, such as modern architecture in St Paul's Place, and designed public spaces and social hubs such as the Winter Garden and the Peace Garden.

To conclude with an evaluation of the usefulness of the concept of the 'urban idyll' is not straightforward. This study suggests a strong overlap between people's conception of the urban idyll and the rural idyll. For some, this would call into question whether the concept of the urban idyll can be really useful if it cannot be sufficiently differentiated from the rural idyll. However, others might argue that a strict division between rural and urban is unnecessary and unrealistic, and the concept of an urban idyll having many shared characteristics with the rural idyll could be expected and accommodated.   It is also conceivable that conceptions of the urban idyll will change over time in response to urban trends and movements such as the call for sustainable cities and 'cities of well-being', and reflecting people's changing aspirations. Further research on the urban idyll in cities other than Sheffield, such as those with a different history, culture, urban form and proximity to National Park landscapes, would help determine more fully whether the concept of an urban idyll could have value and become useful to urban designers and green space managers.

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A SOCIO-ECONOMIC INVESTIGATION OF PRE-HARVEST AND POST-HARVEST CROP LOSS BETWEEN PRODUCERS AND RETAILERS IN FENLAND

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This paper presents the results of an investigation which identified causes of both pre- and post-harvest crop losses and retail-induced crop losses within Fenland, Cambridgeshire. This study used semi-structured face-to-face interviews with local fruit and vegetable producers. Constructivist grounded theory was utilised for data analysis which revealed aspects not previously identified within academic literature. The causes of crop loss are heavily influenced by external forces situated near the consumer-end of the food supply chain in addition to natural factors, such as weather events, were identified to form a small percentage of loss. While crop loss cannot be totally mitigated; producers appear to use a plethora of strategies including the use of technology to minimise these losses. Producers were found to be directly affected by the high demands of retailers and consumers, however, the significance was found to be dependent on the scale of production and the crop grown. This study establishes the need for new future policies to ensure equality for producers in the UK fresh food supply chain, in addition to the promotion of sustainable food production.

Keywords: Crop Losses, Producers, Food Supply Chain, Sustainability.

INTRODUCTION

The issue of waste has gained significant status in recent years as a considerable problem within sustainable growth and development policies. One of the largest waste issues present in the UK is food waste. WRAP (2008) identified the scale of food waste in the UK at approximately 6.7 million tonnes per year, 40% of this waste originates from fresh fruit and vegetables. Transitional changes within the food supply chain have been seen since 1945 (Bourlakis & Weightman,2003; Ramsay,2000) wherein agri-food networks have significantly expanded from globalisation and thus have contributed to the rise of retailers

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and supermarkets. This expansion has led to a significant change in 'market power' and thus additionally increased the excess margin, directly affecting the prices received by producers (Zachariasse & Bunte, 2003) through asymmetrical price transmission.

Situated in north Cambridgeshire, bordering with Norfolk and Lincolnshire, Fenland covers an area of approximately 200 square miles (Cambridgeshire Fens, 2017) and makes up a small part of the wider area known as 'The Fens'. The Fens is renowned for its high quality grade 1 soils, accounting for 50% of the total grade 1 soils in England (Fens for the Future, 2017). Fenland was chosen as the area of study for this research paper due to its relatively small area and high agricultural output of wheat, root crops, vegetables and fruits (Natural England, 2015, p.7).

RESEARCH METHOD

The formulation of research objectives identified below arose from omissions discovered within academic literature relating to the research aim. The aims seek to investigate the causes of both pre-harvest and post-harvest crop losses and the socio-economic implications producers face arising from such losses.

- Investigate the causes of pre-harvest and post-harvest crop loss in Fenland.

- Investigate whether retailers are a direct cause of crop loss within the food supply chain.

- Identify the socio-economic impacts of crop loss faced by producers.

Due to the investigative nature of this dissertation topic, a qualitative approach has been chosen as the main methodological approach over a quantitative approach. As highlighted by Thorne (2000), qualitative research studies utilise an inductive reasoning approach as opposed to deductive reasoning processes A process of inductive discovery is used for qualitative research (Gray, 2014, p.16), whereby data are collected and then analysed to distinguish emerging patterns, consistencies and meanings. Thomas (2006) highlights the emergence of patterns, consistencies and meanings may include frequent, dominant and significant themes emerging from the raw data through the interpretations made by the researcher. In light of this, the inductive approach is closely linked to exploratory research, within which the objective of the research is to "develop a hypothesis rather than their testing" (Kothari, 2004).

The research methodology for this study follows a guide illustrated by Gray (2014, based on work by Crotty (1998). For this research study, a constructivist grounded theory was employed which utilises multiple accounts to construct reality and meaning through the interaction between the researcher and the respondent, whilst acknowledging that the positionality of the researcher may lead to a form of bias (Charmaz, 2008, p.402). Constructivist grounded theory has been chosen over other grounded theory methods, due to the recognition that a study cannot be devised without prior knowledge and theories of the topics (Charmaz, 2008) and that a literature review should be used at every stage to enable theory to be constructed.

As there was little theory based on the relationship, and causes of, post harvest losses and the effects on producers within academia and industry, qualitative data collection was utilised in accordance to the constructivist epistemology with interviews as the primary data collection tool. Theoretical sampling was undertaken, whereby participants were

selected as the construction of concepts and theory began to occur. Finally, there was an element of judgemental sampling which occurred within the study, whereby a snowball sampling strategy (Marshall, 1996) was used. Eleven individuals were identified and invited to participate which recruited a total of six interviewees. Prior to the commencement of interviews, a pilot study was undertaken, conducted in an informal environment on a voluntary participant with prior experience of the subject under study. A number of ambiguities were identified within the initial pilot study so minor changes were made, including the addition of open ended questions, in order to satisfy the requirements of the study. All work was undertaken within the SHU guidance for undergraduate studies.

As noted by Charmaz & Belgrave (2012), studies utilising grounded theory approaches combine data analysis with data collection. Memo writing was undertaken immediately after interview, to explain concepts and create links to data whilst relatively fresh. Prior to data analysis, the interviews were transcribed with any uncertainties arising from poor recording marked as "unintelligible word". Coding was undertaken immediately after the data were transcribed. A coding framework was followed as suggested by Starks & Brown Trinidad (2007) and Charmaz & Belgrave (2012) initially using open coding and later selective coding. This ensured the constant comparison of categories and codes between interviews, highlighting key themes which were then explored in other interviews as part of a reflective process (Scott, 2004).

LITERATURE REVIEW

Food waste is an increasing problem both globally and within the UK. Bond, Meacham, Bhunoo & Benton (2013) recognise the definition of food waste as: "edible food products which are intended for human consumption but have been discarded, lost, degraded or consumed by pests".

Lipinski et al. (2013) identify areas within the food supply chain where food loss occurs, including:

- Production,
- Handling and storage,
- Processing and packaging,
- Distribution and marketing,
- Consumption.

Although food waste has two sub-definitions, the UK uses food waste as a generic term, covering all food and drink waste/losses throughout the entire food supply chain (Parfitt et al., 2010 and Bond et al., 2013). Food waste can be classified into three different categories: avoidable, possibly avoidable and unavoidable (WRAP, 2009). These categories can be associated with the consumption stages of the food supply chain system and literature from The Economist (2014) identifies 5 stages of the food supply chain system, albeit with subtle differences present with reference to 'food loss' and 'food waste', where the latter is associated with consumerism and behavioural issues (Parfitt et al., 2010).

Post-harvest food losses (PHL) are the first stages of food loss within the FSC and directly link back to the agricultural production of food food (Lipinski et al., 2013; The Economist,

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2014; Parfitt et al., 2010 & Aulakh & Regmi, n.d.). PHL may arise from human-induced factors or from natural factors including drought or excessive rainfall (Segre et al., 2014) which can affect soils, growing conditions, harvesting and planting conditions (Benton et al., 2012). Imperfections arising from poor climatic conditions may cause PHL as crops are not harvested due to a commercial decision. Plant and crop diseases are responsible for the loss of between 10% (Strange & Scott, 2005) and 20-40% (Ficke, Aubertot & Hollier 2012) of global food production.

Amani & Gadde (n.d.) highlight the potential for food spoilage to occur when food reaches its "best before" or "saleable date". Parfitt et al. (2010) establish the cause of food spoilage can be traced back to whether the product is perishable or not; where horticultural crops (fruits, vegetables, roots and tubers) tend to be much more perishable than cereal and oilseed products (FAO, 1981). Kader (2005); Kiaya (2014) and Parfitt et al. (2010) all confirm that fresh fruit and vegetables are subject to a higher level of perishability than cereals.

A number of advances in technology have enabled PHL to be reduced significantly within 'developed' countries. Such methods include: advanced agricultural machinery, cold chain storage systems (Gustavsson et al., 2011; Hodges et al., 2010; Bond et al., 2013; Parfitt et al., 2010; Lipinski et al., 2013 & Kummu et al., 2012) and sophisticated management techniques within logistics (Parfitt et al., 2010; Hodges et al., 2010). Gustavsson et al. (2011) indicate that mechanical damage and spillage are the primary causes of PHL in the UK. Other significant areas of crop loss include grading (Kader, 2005; Kummu et al., 2012) which can be directly linked to quality control procedures set by retailers and losses from poor handling (Kiaya, 2014) where degradation occurs between the farm and distribution stages (Gustavsson et al., 2011).

Supermarkets & Globalisation

Hingley (2005) illustrates the success of supermarkets within the UK, where sales have reached approximately £118 billion. Oosterveer & Sonnenfeld (2012) identify Tesco, Sainsburys, Asda and Safeway (now mostly Morrisons) as the four major retailers operating as oligopolies, accounting for over two thirds of the UK food sector sales (Hingley, 2005, p.65 cited IGD 2003). The buyer power of supermarkets can be used to obtain terms which are more favourable than those available to other competitors (Mills, 2003, p.145) and is linked to economies of scale (Burt, 2000). Supermarket supply chains offer a network for the sale of goods to consumers (Dobson, 2002) with producers being chosen by their willingness to produce under the retailer's specification at a set price (Burt, 2000).

According to Burt (2000) this is a change from traditional supplier-retailer relationships based on trading principles of negotiation and conflict towards more co-operative and constructive relationships with suppliers. Dobson (2002) however notes that these demands significantly favour retailers at the expense of the supplier or producer, as bargaining power can be used to pressurise suppliers to make concessions on behalf of their customers. The power of information regarding customer purchases has been strategically utilised by retailers to manage the "distribution channel," (ibid:881), with an emphasis on price to create differentiation in the marketplace (Burt, 2000), shown in Figure 1. Fragmentation of the supply chain significantly affects agricultural producers as

the bargaining power of retailers and supermarkets is increased due to the trade of non-branded products including fresh fruit and vegetables (Consumers International, 2012).
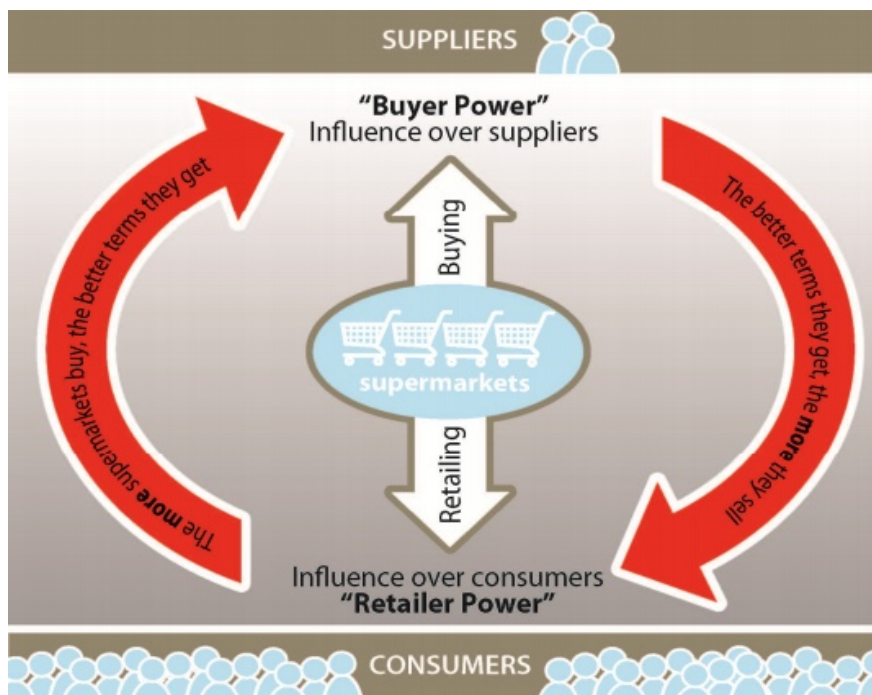

Figure1: Buyer and retailer power differentiation (Consumers International, 2012).

Promotions & Discounts

Simpson (2006) and Mohr & Low (1993) stated that the aims of retailers are to "develop a low-price image and short-term sales increases". The resulting disparity in terms of profit margins is shown by Mills (2003) whereby retailers make approximately 5-8% profit on sales, whereas the producer and suppliers operate on a 2-3% profit margin.

Buying Power Abuse

Buyer power can affect the producer or the supplier considerably, particularly small suppliers, whereby they may sell all of their output to a single chain or retailer (Mills, 2003). In addition to buyer power and globalisation, Dobson (2002) recognises that producers and suppliers are competing on an international scale for the supply of goods to retailers. Furthermore, Howard (2016) and Fishman (2003) highlight that supermarkets and retailers can use international competitors as a bargaining chip to threaten suppliers and coerce them to conform to demands.

The Power of Consumer Demand

The on-site interaction with customers means that retailers are much more connected to customers than producers and manufacturers (Simpson, 2006). This enables the generation of knowledge with reference to consumer preferences and thus enables retailers to predict shifts in consumer purchasing behaviour, heavily influencing the promotion of 'popular' products (Simpson, 2006 cited Kahn & McAllister, 1997). Oosterveer & Sonnenfeld (2012, p.202), Dobson (2002) & Mills (2003) recognise supermarkets have considerable influence on the consumer in addition to producers and suppliers. As suggested by

Oosterveer & Sonnenfeld (2012) cited Hawkes (2008), the result of technological has enabled suppliers to "create consumer demand, not just meet it," thus demonstrating the dominance of control of the FSC.

Burt (2000) state that both price and quality perceptions form a special link within the FSC, whereby these affect the retailer's brand quality in the eyes of the consumer. Within the FSC, buying and retailing power has been associated with the rise of private food safety and quality standards (Henson & Reardon, 2005; Fulponi, 2006 & Reardon et al., 2001). Henson & Reardon (2005) note that such standards are run alongside regulatory systems, however, they are not legally binding and therefore are voluntary. Henson & Hooker (2001, cited Henson & Reardon, 2005) recognise a shift of drivers in the FSC, whereby private standards are gaining dominance over public standards. Stuart (2009, p.102), notes that supermarket standards exacerbate waste and are directly responsible for the rejection of up to 40% of British grown fruit and vegetables, with one cause for rejection including the non-conformity to supermarket cosmetic standards, in addition to surplus stock.

RESULTS & DISCUSSION

Results are initially presented as a series of themes as raised by the respondents during the interviews and summarised into conceptual frameworks.

Crop Losses Pre-Farm Gate

When asked about the causes of crop loss prior to the crop or product being taken off the farm, all participants identified and stressed that natural causes are one of the main issues for them. Unsurprisingly, weather and climate conditions were a commonly discussed issue for all producers interviewed, whereby incidences of particular weather patterns have directly led to the loss of their crop. One individual recognised the severity of the weather such as hailstorms as an important factor, whereby this can change the extent of the loss from between 5-100% of the total crop. One respondent explicitly stated that such events of inclement weather are rare, however, instances of hail were found to be a cause of crop loss for leek and onion crops particularly when the plants are small. Extreme cases of hail were said to cause "complete write-offs," of crops.

Cold weather events including frost affecting the crop yield were identified by 3 individuals as an issue for fruit growers, affecting the quality by formation of "rings on the fruit", while one further added that cold weather periods can lead to the entire crop being wiped out or affected by rots. Higher temperatures were also problematic and one respondent raised "growth cracks where the potato grows very quickly and then it gets a crack in it and there's nothing you can do about that". Pathogens were raised by 2 respondents as occurring independently of weather and affecting fruit crops and one interviewee stated "there is just a natural rot which occurs within the orchard". Fungal disease for strawberry plants such as Phytophthora were said to create a significant impact on the yield of the crop and led to reduced resistance capabilities of the plant to further disease.

Disease was revealed to be a common cause for the loss of both fruit and vegetable crops. The extent of loss due to potato blight reduced yield in one case from 22-23 to about 14 tonnes per acre. A level of natural mortality was widely spoken of within interviews. Two participants who noted this described mitigation through the calculation of waste budgeting

with the extent of loss occurring between seed and harvest estimated to be around 50%. This extent of loss is considerably higher than figures suggested by Garnet (2006), stating average losses of approximately 10%.

In this study, human-induced losses were identified within a number of interviews as responsible for harvesting losses which aligns with the findings of Kiaya (2014). However, one interviewee believed that if correct procedures are in place the weather is the leading cause of loss. Hodges et al., (2010) identified that poor storage conditions may result in both quality and weight losses and this was mirrored by one respondent on the impact to potato crops from poor (too cold) storage. The need to meet retailer standards was mentioned frequently, and while no figures were specifically obtained, Stuart (2009, p.102), recognised retailer standards may lead to the rejection of up to 40% of harvested crop. This hierarchy of loss is evident within the account of one interviewee.

Loss Mitigation

Another commonly occurring theme arising from the interviews with producers was the mitigation of losses both pre-harvest and post-harvest. Axial coding of loss mitigation revealed seven contributing sub-categories to loss mitigation measures, including:

- active management,
- consumer education,
- alternative markets,
- growing procedure,
- technology,
- natural loss, and
- producer-retailer relationship.

Interviews revealed that active management strategies were frequently used by producers to counteract natural and human induced losses both pre-harvest and post-harvest. Open codes for active management strategies include a number of technical procedures including:

- Orchard design
- Bio controls
- Planting efficiency

Additionally, other codes associated with active management strategies were also identified within interviews linking to managerial procedures:

- Quality assessments
- Procedure re-evaluation
- Time management and efficiency

One interviewee noted the use of quality assessments for the reduction of PHL during picking, particularly for bruised and undersized fruits which do not meet the specification. Procedural re-evaluation strategies were noted within interview 6, whereby producers re-

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evaluate their methods of growing crops with the aim of reducing crop and financial losses. However, Costa (2015) illustrated the development level of producers will subsequently affect their ability to use mitigation strategies. This is evident, particularly with smaller producers. The possibility for automation to reduce losses in the future was also briefly discussed. A number of growing procedures were indicated by producers to mitigate loss. A majority of producers highlighted the use of fertilisers and chemicals as well as pesticides and fungicides as a form of crop protection and enhancement. Other methods included the use of 'growbags' to control fungal disease within a strawberry crop.

Interestingly, producers highlighted a variety of alternative markets to which they could send their crop to as an alternative to the retail markets in order to prevent total loss. Unwanted crop used as stock feed was mentioned by 2 interviewees, and a further 2 discussed the use of an anaerobic digestion plant to turn crops into a source of energy. In this case 120 tonnes of feed stock are required to produce 0.5 MWh of energy per day. For fruit growers the juicing industry and cider industries are loss mitigation strategies although relatively small volumes of crop went to juicing in comparison to the volume going to retail sales.

Technology

Throughout all interviews with producers, technological innovation was identified as a crucial crop loss mitigation tool. Unsurprisingly, a majority of producers deploy low-tech solutions including manual labour to harvest their crops and to prevent loss from occurring; a laborious and labour intensive process. Where process mechanisation was used (in this case for harvesting rigs and mechanical pruning) losses were reduced. While Bond et al. (2013) noted the benefits of mechanisation, there was little literature to highlight innovation in technology. While technology was seen by the participants to have some positive outcomes, it was also felt that the waste would occur not in the fields, but in the pack-house, resulting in higher transport costs.

Two interviews highlighted genetic enhancements to have led to the reduction in pre-harvest and post-harvest crop loss, and while adoption of new varieties can be a viable business strategy, the limitations with new varieties include reduced pest and disease resistance. Mitigation of loss through genetic enhancements was not identified within literature studied related to this topic, although this may occur within more specialised journals. Changes to storage were identified by all producers as having a positive impact on reducing PHL. The use of cold storage or controlled atmospheres was identified by 5 of the interviewees. Controlled atmospheres can extend the life of a crop from 4-6 weeks (leeks) and for fruit up to a year. The major limitation to more extensive use is cost, both in capital expenditure and running costs. Parfitt et al. (2010) demonstrated a similar viewpoint, noting the substantial investment required to eradicate PHL.

Relationships

Relationships between producers and retailers were highlighted as a cause of both pre-harvest and post-harvest crop losses occurring. Retailer buying power was a frequently discussed issue amongst the interviewees, with one noting the supermarkets' preferences to work with larger, more commercialised growers where economies of scale are used by larger producers to gain contracts with retailers and supermarkets over smaller producers, as noted by Burt (2000). One respondent stated instances of one-sided communications

with supermarkets regarding specifications and waste as a cause of increases of crop loss and waste pre-farm gate. As Dobson (2002) found the supermarket specification significantly favours the customer over the producer. No other producers displayed a negative image of the producer-retailer relationship to the extent demonstrated above, rather stressing the requirement for "healthy relationships," with retailers and marketing companies to ensure a yearly supply. The interviews demonstrated key merits between the producer-retailer relationship in regards to crop loss, whereby extensive communications and information sharing is used to reduce losses. It was suggested that further work could be done with supermarket staff to mitigate losses, a point not identified within the review as being a supermarket operating procedure issue.

Retailer Specification

The specifications set by retailers were identified to be a cause of both pre-harvest and PHL. A common finding arising from interviews was the specification variability between the retailers, although the sentiment was that supermarkets were all in competition so wished to avoid having markedly lower quality produce for sale. Interviewees identified different specifications existing for different markets, particularly higher end supermarkets such as Waitrose, Marks & Spencer's. The interviews also revealed the flexibility of specifications set by supermarkets, whereby the specification is based on the supply and demand for crops. This was identified for both fruit and vegetable markets within 3 separate interviews, although is absent from the literature.

 "Supermarkets will relax their standards in situations where they are short of fruit; if we are talking about the size or shape, they might relax ... [their standards] … for a couple of weeks and then they will re-introduce their normal specification after that."

Size grading was identified as a source of loss for onion crops and reduced payments, due to the requirements for pre-pack produce. This was said to have led to increases in waste in recent years as specifications have evolved. Size grading affected both under and oversized crops. Production audits, including unannounced audits, were used to monitor and compare the performances of producers. The use of such audits was not identified within literature, despite mentions of retailer power. This was linked to the supermarket specifications being loosely based on the DEFRA standards system for the cosmetic quality of the produce. These requirements to meet size and cosmetic requirements of the retailer, and the use of audits illustrate the power of the specification on the producer. Hatanaka et al. (2005) also found that the specifications set by retailers were significantly higher than bodies such as DEFRA.

Interestingly, no literature identified differences in specifications for differing markets, although a majority of the literature looks at the impacts of retailer and processing specifications. All drivers of cause and the impacts arising from the retailer specification can be seen in the conceptual model Figure 2.
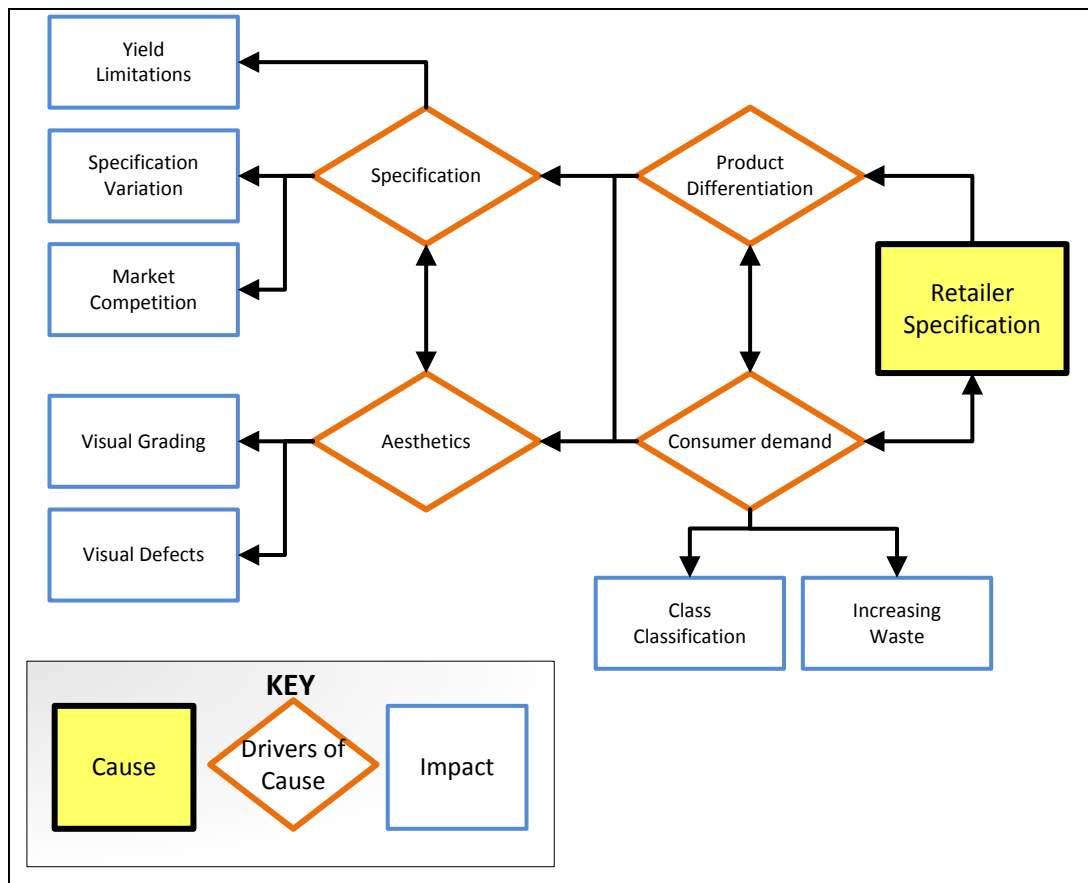
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Figure 2 Conceptual Model of the Retail Link to Post-Harvest Losses (Authors Own)

Consumer Expectations

The expectations of consumers was a frequently discussed topic within all interviews. One aspect which frequently arose was the aesthetic demands and expectations of consumers for both fruit and vegetable produce. As one interviewee stated "We buy with our eyes. We do expect to have the right shaped product, the right coloured product and the right eating quality."

Consumers are selective with regards to blemishes, despite produce conforming to the class 1 standards. They want to buy something which represents value for money, and in a condition which will last a reasonable time so that they can eat it without it going to waste. This emphasis on perfection and value for money are inextricably linked to consumer behaviour and buyer power and this can be considered alongside the retailer specification as a cause of crop loss both pre-harvest and post-harvest. Consumer selectivity and demand were also found to be linked to PHL for undersized potatoes, where specifications and oversupply have led to the collapse of prices. In contrast there is the emergence of secondary grade products such as "wonky fruit," within the retailer markets due to consumer demand and frustration. This was not identified within literature, due to the recent adoption of such produce by retailers and offers a potential area of research for future studies. Producers also noted instances of selling a percentage of their produce directly through consumer-producer networks in addition to retail sales. Interviewee 5 mentioned this network, through the sales of soft fruits to the catering industry and the

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general public as a sub-business. The diversity of markets can be seen as a mitigation tool for producers, enabling produce of varying qualities to be sold on, thus reducing PHL.

Two interviewees suggested that losses associated with consumer expectations and demands would be reduced through educational means. Parfitt et al. (2010) found consumer education is required to reduce PHL within the FSC. A conceptual model is illustrated in Figure 3 highlighting the relationships between the recognised causes of pre-farm gate losses identified within the interviews.
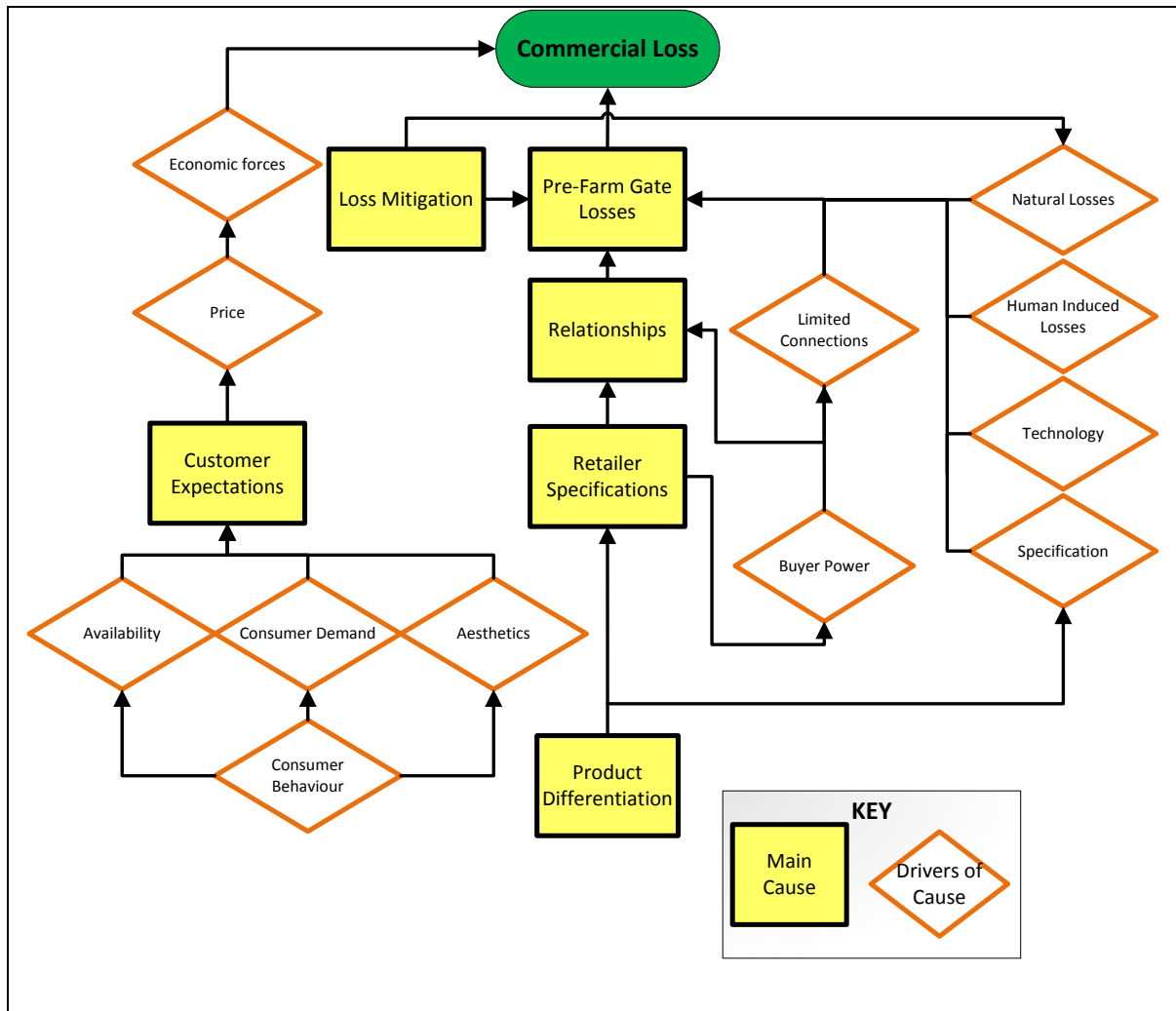

Figure 3 Conceptual Model of Causes of Commercial Loss (Authors Own)

Commercial Loss

A number of commercial losses have been identified throughout the interview process arising from crop losses pre-farm gate and also PHL, these have been broken down through four axial codes:

1. Business strategies,
2. Economic forces,
3. Financial cost,
4. Social cost.

Furthermore, due to a lack in literature around the financial and social costs associated with crop loss, no comparisons could be made to other studies looking at the issue. A conceptual model (Figure 4) demonstrates the links of commercial loss, leading to the financial and social costs faced by Fenland producers.

Business Strategies

Three interviewees identified measures of cost mitigation in reducing commercial losses. The reduction of hired casual labour was stated by 1 interviewee as a strategy to reduce costs, and it is likely this can be associated with the nature of business in small, family producers where profit margins are likely to be tighter than those of larger more commercialised businesses.

Economic Forces

Economic forces were identified to be a significant cause of commercial loss for producers as ex-situ factors. The deflation of food prices within the previous 20 years was identified as significantly contributing to the commercial pressure faced by producers. Additionally, consumer demand was highlighted as an ex-situ factor leading to commercial losses within an interview which illustrated the extent of commercial loss associated with undesirable produce:

"But the thing is that he couldn't sell … [the undersized produce]… he sold 7 bags out of 20 in 3 weeks and he said he couldn't get people to buy them when each 25kg bag was priced at £3."

Poor consumer demand and the price reductions needed to sell them leads to financial loss. Two interviewees noted the difficulty in balancing the cost of production and the price of produce, expressed as a "juggling act," whereby "if you bring down the quality too low and you bring the price down, there's no money in it". The tight cost margins faced by producers are the likely cause of this difficulty.

Financial Cost

A frequently shared issue amongst producers was the increasing production costs as rates for energy and labour costs rise. While production was noted to account for a small percentage of financial costs incurred in a larger business, two thirds of the total costs were associated with the processing, marketing and distribution. For smaller producers the cost of labour was identified to account for 45% of total costs. Labour costs may mean it is not economical to harvest lower grade fruit, for example, as it would cost more to pick it than they would get for it. At worst this may lead to the threat of crop rejection as stated by 2 interviewees. The implication of rejection by a retailer due to failure to meet the specification includes the disposal of hundreds of tonnes of waste crop. This rejection of crop is deemed legal since it does not feature on the abusive buying practices listed by Consumers International (2012). The reduction in prices for both undersized and oversized produce may be seen as a punishment resulting from non-conformity to the specification and thus illustrates the power of retailers over producers.
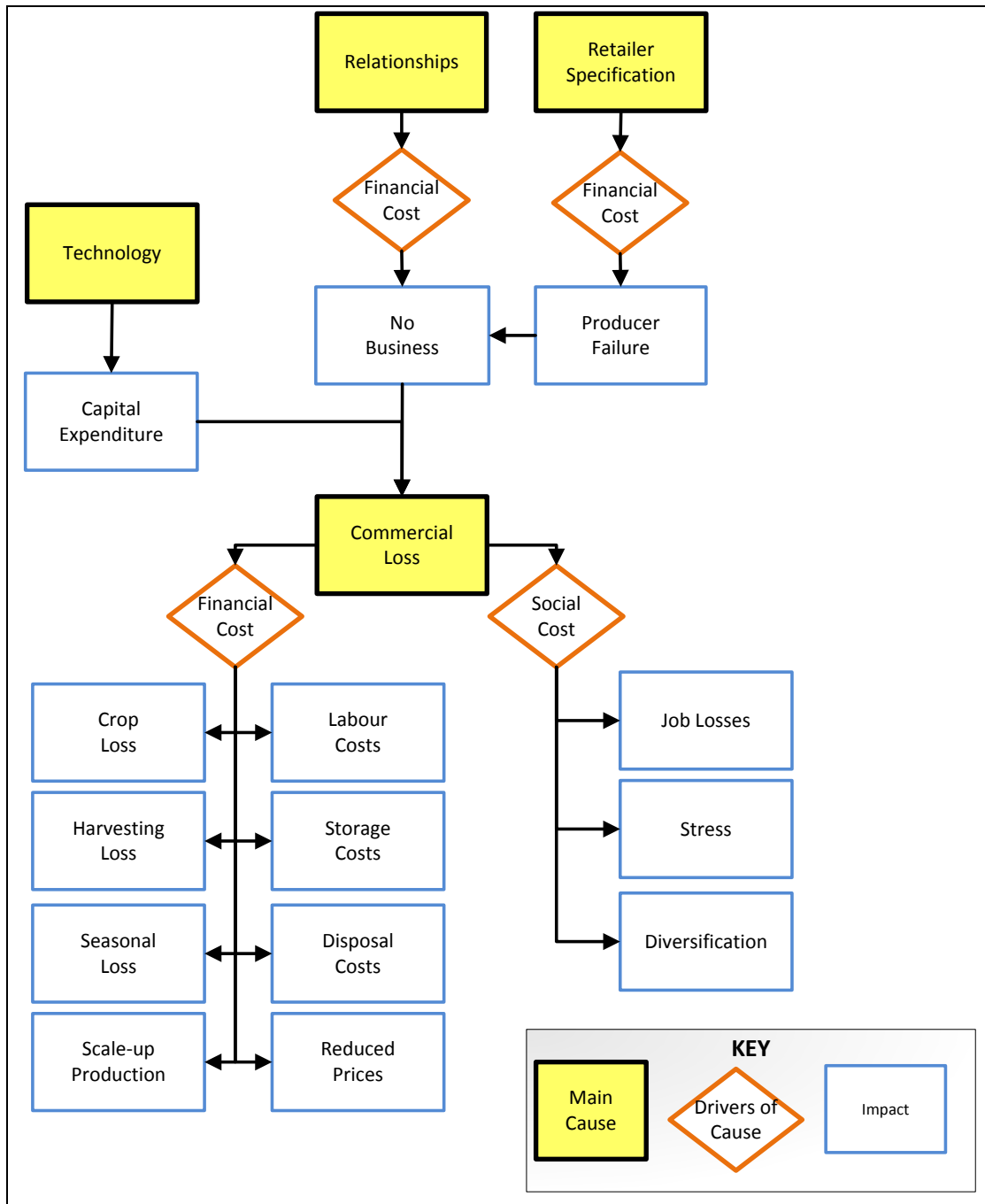
Figure 4 Commercial Loss to Producers Conceptual Model (Authors Own)

Social Cost

The social costs associated amongst commercial losses to producers as a result of both pre-harvest and post-harvest losses were also identified within the producer interviews. One interviewee identified the need for diversification into additional sources of income as well as to scale-up production; another in contrast presented additional stress factors associated with commercial losses and pre-farm gate losses. This can be linked to ex-situ factors such as the retailer specification and consumer demand (Figure 4), whereby there is demand for

aesthetically perfect crops. Furthermore, job losses were identified as potential social costs by 2 interviewees whereby mechanisation and the use of automation would eradicate jobs.

CONCLUSIONS

Interviews with producers found natural causes to be a significant cause of crop loss, particularly from disease and rots as a result of poor weather conditions, identifying up to 100% crop loss. Producers identified the extensive use of mitigation measures including managerial and technological measures to reduce crop loss. Furthermore, the study found human-induced losses to be rather insignificant in scale in comparison to natural losses. These were seen to be mitigated through the use of active management and staff training.

This study found the role of the retailer to be a significant cause of both pre-harvest and post-harvest crop loss. Previous literature has predominantly looked at the consumer causes of post-harvest crop loss, however, this study found a clear link between the retailer and crop loss arising from retailer buyer power and product differentiation.

Furthermore, the study identified the need for greater producer-retailer communication to reduce the asymmetrical relationships currently present within the FSC. Interviews identified that the preferential treatment towards consumers by supermarkets is detrimental to producers, and is related to the demand for higher quality produce to outperform other retail competition. This competition and differentiation was identified as a direct cause of post-harvest crop loss and the creation of waste arising from aesthetic quality, accounting for 25% of crop loss in some cases.

Additionally, the study identified consumer demand to significantly influence retailer specifications and vice versa, wherein consumers are only willing to purchase aesthetically perfect fresh fruit and vegetables from retailers. However, despite supermarkets introducing schemes such as "wonky" produce, the study identified producers were unwilling to grow this, due to the financial loss arising from sales at reduced prices.

Instead, producers displayed a preference for growing higher grade produce despite the potential crop losses associated with this. The need for consumer education was highlighted by producers as the key for the reduction in post-harvest crop losses in the future.

Considerable financial losses were identified, arising from increasing production costs and reductions in retail prices for produce. Furthermore, social losses and commercial loss were found to be inextricably linked. Social impacts identified included stress and job losses, leading to further income diversification and scaling-up production. This illustrated the extent to which producers in Fenland are affected by the standards imposed by retailers and demonstrates the need for change.

Further Recommendations

The impacts on producers arising from crop losses are still relatively unknown due to the geographical area of study and small sample size and the results generated within this study are not representative of other areas within the UK. This study has the potential to illustrate the socio-economic impacts faced by producers within other areas in the UK. Further studies are warranted to enable the comparison into the causes of crop loss amongst producers in the UK. This is needed to identify the full extent and impact of crop

loss induced by retailers, through buyer power and specifications; to reduce the impact of crop loss and move towards greater sustainability.

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HOW THE TRANSPORT INFRASTRUCTURE OF MILTON KEYNES AFFECTS THE WAY PEOPLE TRAVEL

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Georgina Marum studied BA (Hons) Human Geography at Sheffield Hallam University and graduated in 2017 with First Class Honours. She is now working as an Operational Planner at Network Rail. Alan Patterson is the Principal Lecturer in Human Geography at Sheffield Hallam University and supervised the dissertation.

The new town of Milton Keynes (MK) is home to a globally renowned grid system, comprising vertical and horizontal grid roads, uniquely intertwined by a network of pedestrian and cycle paths, known as 'redways.' This paper explores how this transport infrastructure affects the way the population of MK travels, through the use of a questionnaire survey and semi-structured interviews. A range of relevant literature is reviewed and the data gained from the questionnaire and interviews is examined, using both quantitative and qualitative methods of analysis. The results reveal that the leading travel trend in MK is car use, with the car dominating as the most popular transport mode, to the considerable detriment of other transport modes. Overall, it is clear that MK's transport infrastructure affects the way people choose to travel, in particular promoting car use.

Keywords: transport, travel, new towns, urban planning

INTRODUCTION

> *'a paradise of parking lots, roundabouts and concrete cows'*
>
> *'a centrally-planned slice of Los Angeles,'*
>
> (Barkham, 2016:1).

Since its birth in the 1960s, Milton Keynes (MK) was 'always destined to be at the cutting edge of transport' (Westcott, 2013:1), adopting the American model of a low-density town built on a grid system, but it is also uniquely interlinked by a network of cycle paths, known as 'redways'. The aim of this research is to assess the effect of this infrastructure on the way MK's residents choose to travel. Hence the research focuses on individual travel patterns, preferred transport modes, and the effects of the transport infrastructure on these trends. This broad aim is divided into three smaller, more manageable, research objectives:

- to identify and explain the travel trends of MK's population;

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- to determine the factors that influence the use of travel infrastructure;
- to examine the relationships between particular travel trends and certain types of travel infrastructure.

The next section of the paper identifies, evaluates and synthesises a wide range of literature, providing a foundation for the study and enabling comparisons and contrasts to be made with the key findings of this research (Blaxter *et al.*, 2010). The methods used for this research are then explained; assessing their strengths and weaknesses. In addition, the methods of data analysis and the ethical considerations are also discussed (Walliman, 2016). The next section then provides a detailed analysis of the findings from the questionnaire responses and the semi-structured interviews, using both quantitative and qualitative methods of analysis in order to understand and explain the results. The final section recaps the main findings, summarises the key points of the literature review, reflects upon the methods used, and makes recommendations for further research.

HOW AND WHY WE TRAVEL

This section discusses and evaluates a range of literature and secondary data relevant to the main topics of this study, focussing on the themes of: travel patterns, car dominance, peak car, MK, and its travel trends. This literature is fundamental to the research, providing the rationale for exploring this topic, and informing the selection of the methods used (Steane, 2004).

Travel Patterns

According to Hoyle & Knowles (1998:1) 'Transport is part of the daily rhythm of life' and has grown to become a crucial part of contemporary life (Nijkamp *et al*., 1998). As Metz (2008) argues, how, when and where we travel has become a continual obsession for many, whether it is the daily commute, or longer journeys to distant destinations.

In England, compared to the 1970s, the average number of trips made and the average total time spent travelling, has remained roughly constant (see Figure 1). In contrast, the average distance travelled soared by 71% between 1965 and 2014 (Department for Transport, 2015). Therefore, it is clear that for a similar number of trips made and the amount of time spent travelling, the English population now travel much further. This is reportedly attributable to the changes in how, not why, people travel, specifically rising car availability (Department for Transport, 2016a).
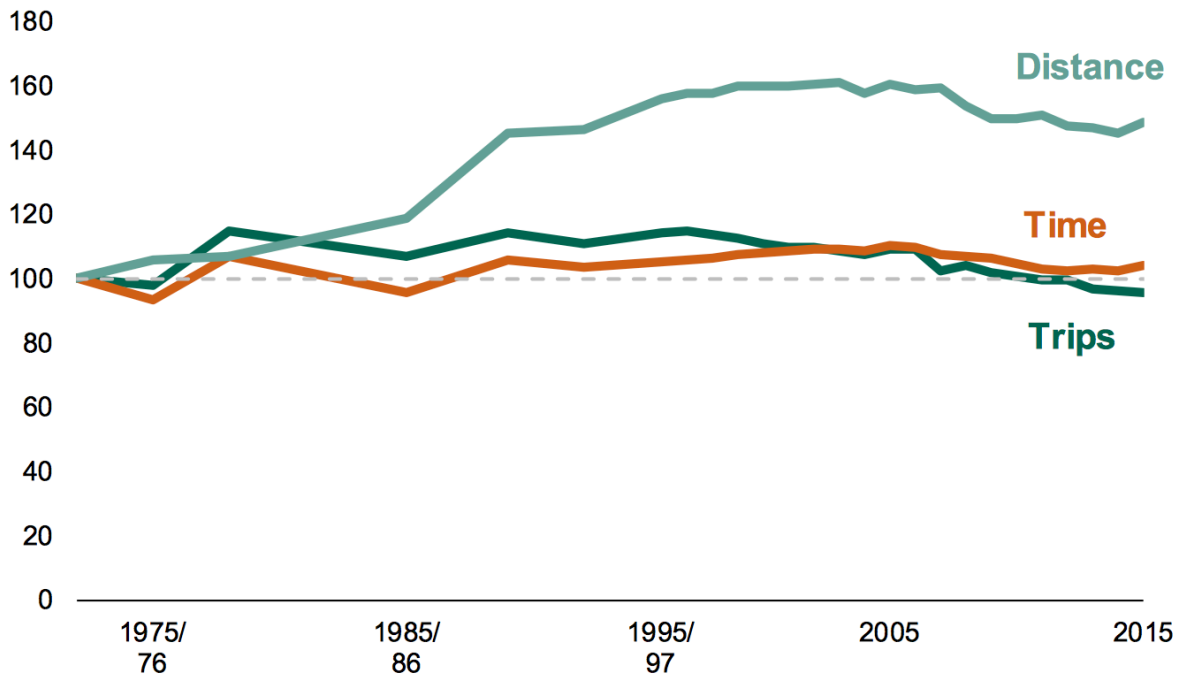
Figure 1: Travel Patterns in England, 1975/76 to 2015 (Source: Department for Transport, 2016a)

Car Dominance

The car has become the 'prime mover' (Metz, 2008:1) and an 'icon of the twentieth century' (Banister, 2005:5). Rapid motorisation has been the dominant travel pattern throughout the developed world since the end of the Second World War (Black, 2003; Giuliano, 1998). The total number of licenced vehicles in the United Kingdom has grown every year (except 1991), and the car is now the leading mode of transport in England, accounting for 64% of all trips made (584 trips per person per year on average) and 78% of the distance travelled in 2015 (5,159 miles per person per year on average) (Department for Transport, 2016b).

Rising incomes, the falling cost of purchasing a motor vehicle, and the perceived advantages of car travel, have contributed to the continued growth of car ownership (Department for Transport, 2016b; Paterson, 2000; Turton, 1992). Now, fewer people do not own a car, with the number of English households without a car dropping 13% between 1985/86 and 2005 (Figure 2). Instead, people now own more cars, approximately 33% of households in England having access to two or more cars (Department for Transport, 2016b), in contrast to an average of just 0.07 cars per household in 1946 (Maltby & White, 1982). As Metz (2008:10) argued 'When we acquire cars, we travel more'. On average, people in households with cars make 1.4 times more trips, spend more time travelling (22 minutes per car trip), and travel 2.6 times further (Department for Transport, 2016b). In addition, the acquisition of a household's second or third car allows for even more travel (Farthing *et al.,* 1996; Metz, 2008).
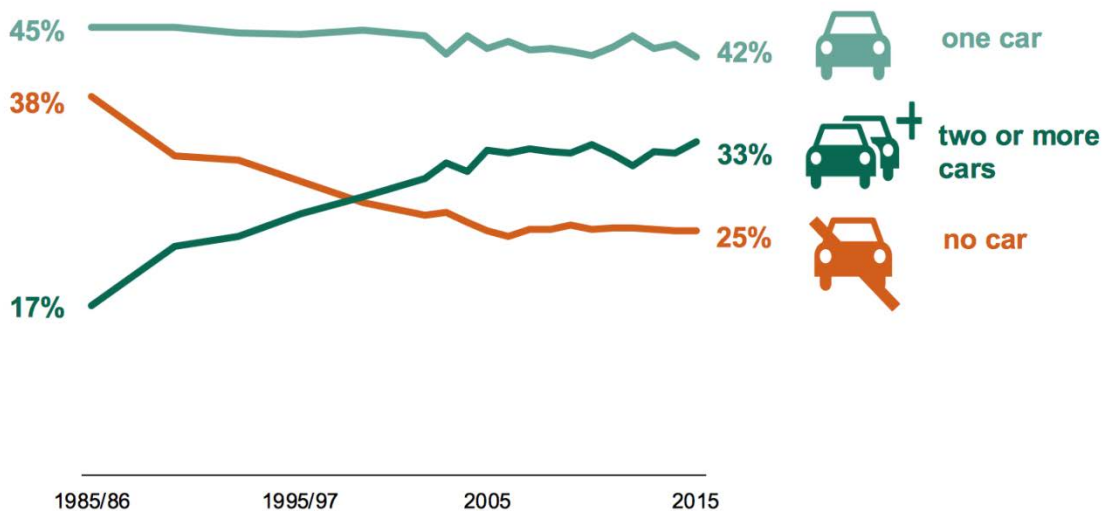
Figure 2: Car Ownership in England, 1985/6 to 2015 (Source: Department for Transport, 2016b:7)

Peak Car

There have been slower rates of growth, a levelling off, or a reduction, in car use in the majority of developed countries (Goodwin & Van Dender, 2013). This phenomenon is known as 'peak car' (Le Vine & Jones, 2012; Metz, 2013). In the UK, the concept that an upper limit of car ownership and use would occur, was first developed in the 1950s, with forecasters predicting a saturation level of around 400-450 cars per 1000 by 2010 (Goodwin & Van Dender, 2013). The percentage of journeys made by car in London has declined, from a peak of 50% in 1990, to the current rate of 37% (Metz, 2015). Metz (2013:267) suggests that we have now entered a 'fourth era of travel' in which personal daily travel has fallen and 'travel time, trip rate, and distance travelled hold steady.'

Milton Keynes

The Ministry of Housing and Local Government in 1967 called for the new town of MK to accommodate an inward population of 150,000 Londoners over a 20-year period, eventually resulting in a total population of approximately 250,000 (Chesterton Consulting & MKDC, 1992). The original Designated Area was approximately 9,000 hectares in size and included the existing towns of Bletchley, Stony Stratford, Wolverton and New Bradwell, along with 13 villages (Chesterton Consulting & MKDC, 1992).

The Master Plan for MK was not just a town map or a blueprint, but was a flexible strategic framework, intended to be capable of responding to changing needs (Bendixson & Platt, 1992). The Master Plan defined key structuring principles, which have defined the city, notably: the grid system, a 'grid of dual carriageway roads for through traffic was planned to intersect at approximately 1km intervals (Chesterton Consulting & MKDC, 1992:17), and the redways - dedicated separate pedestrian and cycle routes, 'a length of shared use public highway prescribed for pedestrians and cyclists' (Chesterton Consulting & MKDC, 1992:52).

Travel Patterns in Milton Keynes

The car is dominant in MK. The new town experienced a steady growth of approximately 10% in total traffic on major roads by all motor vehicles between 2000 and 2015, with the car accounting for 75% of this (Department for Transport, 2017). The number of journeys to work (61%) and school (29%) made by car, along with car ownership levels (83%), all exceed national averages (MK Council, 2016). In addition, over 80% of MK households owned at least one car in 2001 (cf. 73% nationally), with an average of 1.26 cars per household (compared to the national average of 1.11). However, car ownership levels are inconsistent across MK, with some wards, such as Emerson Valley and Sherington, having extremely high rates of car ownership (over 90%), whereas other wards have far lower levels, particularly Netherfield (57%), Beanhill (60%) and Coffee Hall (65%) (MK Council, 2008).

Due to the grid system, traffic flow within MK is generally efficient and well distributed spatially. Although, heavy concentrations of traffic have been reported during peak hours (especially between 8am and 9am), particularly on routes connecting MK with the surrounding areas, notably on the M1 around J13 and J14, along the A509/A422 corridor, and on the A5 at the junctions for Old Stratford and Fenny Stratford (MK Council, 2008). At current population growth rates, a 57% rise in car journeys at peak travel times is predicted to occur by 2031, yet MK can only provide an additional 25% capacity (MK Council, 2011). This implies a growth in traffic congestion in the coming years and arguably demands a change in MK's current travel patterns away from car use.

Additionally, MK has 290km of 'off-road cycleways and pedestrian footpaths, (the redways) that are incorporated within the grid system (MK Council, 2011:8), and which were intended to provide opportunities for cycling and walking away from the grid roads. However, the redway network is generally underutilised and public perceptions are frequently negative, with many regarding the network as unsafe, due to poor lighting, winding paths and overgrown vegetation (Treasure, 2012). Furthermore, the network does not fully stretch into central Milton Keynes and does not reach many of the older towns or the rural areas. Consequently, they are often regarded to provide indirect routes (MK Council, 2012).

Almost half of all journeys to work in MK are less than 5km in length, a distance easily cycled, and 47% of MK households own two or more bicycles. Despite this, the percentage of journeys to work by bicycle was just 3.02% in 2001, in comparison to 72.73% by private motor vehicles, 8.49% by public transport and 6.85% by foot (MK Council, 2012). MK may be home to a unique system providing safe routes away from road traffic, but the share of active modes (both cycling and walking) remains low and the car continues to dominate (MK Council, 2012).

The literature concentrates on global and national travel trends, with some focus on the situation in MK. However, it is clear that further study is essential in order to understand how and why MK residents travel, and the effect of the new town's infrastructure on this.

RESEARCH METHODS

Arbnor & Bjerke (2008:5) emphasise that 'you can never empirically or logically determine the best approach,' however it is important to evaluate the strengths and weaknesses of the various methods in order to identify those which are most suitable for this study. The collection of primary data, involving a questionnaire and semi-structured interviews, supported by the analysis of secondary data was chosen for this research. This allowed triangulation, the incorporation of both quantitative and qualitative data, in order to counteract potential weaknesses of the data types and to provide different perspectives on the data (Dawson, 2009; Robson, 2014). The questionnaire collected information from 224 MK residents on their personal travel patterns and their views about MK's transport infrastructure, and was supplemented by data gained from two semi-structured interviews.

Three types of coding were used, descriptive, topic and analytical, to analyse the qualitative data gained from the questionnaire and interviews, so as to identify ideas about the data, highlight themes and patterns, and uncover hidden meanings and messages from the responses (Richards, 2015; Walliman, 2016).

ANALYSIS

This section examines the findings from the questionnaire responses and the semi-structured interviews. Data analysis can be regarded as a 'process of interpretation', which involves studying the collected data in several ways so that any concealed messages and meanings can be made clear (Robson, 2014:107).

Transport Use

Firstly, questionnaire participants were asked to select their most used transport mode, with the options being: car, bus, bicycle, walking or other (see Table 1). The clear domination of the car is obvious, accounting for 82.1% of the responses, greatly surpassing any other option. The second most common answer, 'walking,' accounted for 170 fewer responses than 'car' (equal to just 6.3%), and 'bus' and 'bicycle' represented only 8% of answers combined. Additionally, three quarters of those that selected the answer, 'other,' (6 out of 8 respondents) revealed that taxis were their most used transport mode. This therefore intensifies car dominance because taxi use and car use are arguably equivalent.

Transport Mode	Quantity	Percentage
Car	184	82.1%
Bus	13	5.8%
Walking	14	6.3%
Bicycle	5	2.2%
Other	8	3.6%

Table 1: Most Used Transport Mode

These findings emphasise the notion of car dominance in support of both Metz (2008:1) and the Department for Transport's (2016b) report findings. In addition, questionnaire participants were asked to explain their choice of most used transport mode. Respondents who selected 'car' usually provided positive justifications, frequently highlighting the advantages of car use. Words, such as 'convenient,' 'quick' and 'easy' were commonly used, being included in 63.5% of the answers. From the use of coding, these words can be

linked by the theme of practicality. Likewise, both interviewees stressed the significance of MK's transport infrastructure, especially the grid system, at promoting car use, most notably the 'fast,' 'easy' and 'uncongested' journeys by car that it creates.

However, the questionnaire respondents who chose transport modes other than the car generally provided less positive explanations. Just five individuals emphasised the advantages of these transport modes, highlighting either the low cost or health benefits of walking and cycling. But most of the respondents who did not select 'car', explained their answer by stating that they 'do not own a car' or 'cannot drive.' This implies that car use is still favoured by the majority of those using other transport modes.

In a following section of the questionnaire, participants were asked to select the percentage of journeys within MK they travel by car, bus, bicycle, and on foot (see Figure 3). Once again, it is clear that the car dominates at the expense of the other transport modes. 73.7% (equivalent to 165 answers) either 'always,' or 'almost always,' travel by car and only 5.4% (equal to just 12 respondents) 'never,' or 'very rarely,' travel by car, with 'I almost always travel by car,' the most common answer, accounting for almost half of responses (46%). In comparison, 94.2% 'never,' or 'very rarely,' travel by bicycle, 88.9% 'never,' or 'very rarely,' travel by bus and 65.6% 'never,' or 'very rarely,' travel on foot.
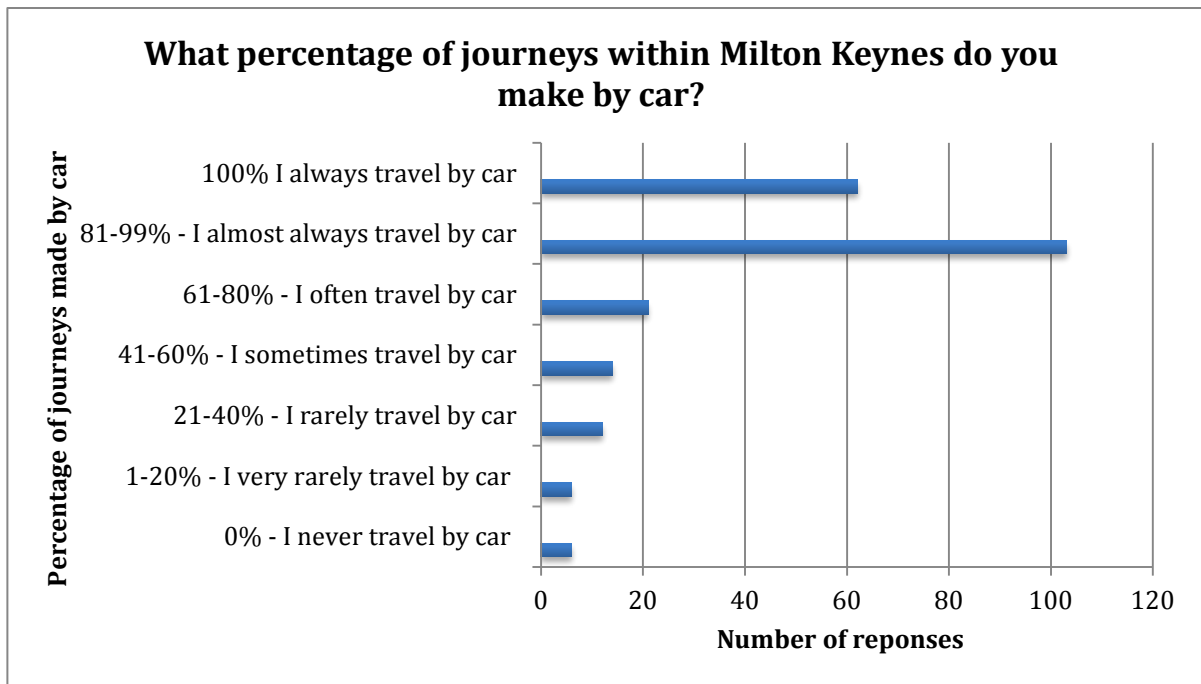

Figure 3: Percentage of Milton Keynes Journeys by Car

Car Ownership

Questionnaire participants were also asked to state the number of cars their household owned, in order to examine the level of car ownership in MK (Figure 4). The responses illustrate an extremely high car ownership level, with 92.4% owning at least one car. This clearly supports Banister's (2005) claim that car ownership has grown substantially in the recent past and, as just 7.6% of respondents did not own a car, this also confirms the Department for Transport's (2016a) report that few people do not own a car. These findings clearly illustrate car dominance in MK and strongly suggest car dependence, with the vast majority of respondents owning and using cars.
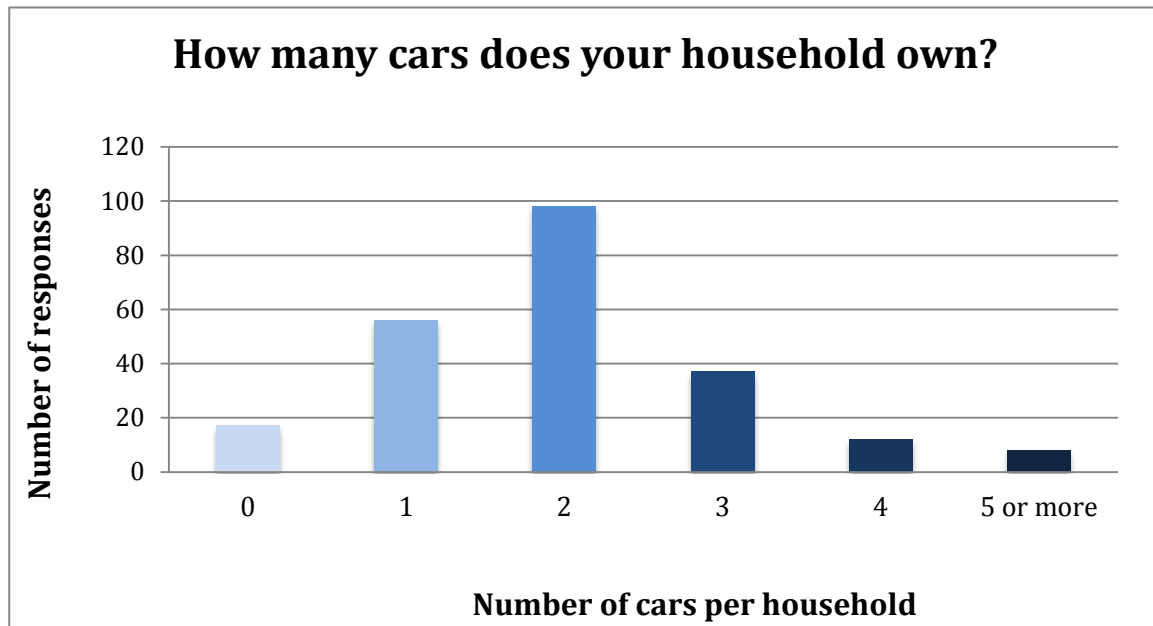

Figure 4: Car Ownership in Milton Keynes

In addition, the questionnaire responses reveal that multiple car ownership is common in MK. 70% of respondents disclosed that their household owned two or more cars, with 'two cars', the most popular answer, accounting for 98 responses (43.8%). This clearly shows car dominance in MK, with almost 70% of respondents owning two or more cars, and even 9% (20 respondents) owning four, five or more cars.

These findings reinforce the Department for Transport's (2016b) report that English households now own more cars, with recent figures stating that 33% have access to two or more cars. However, this study shows a much higher level of multiple car ownership than this (36.3% higher), thus suggesting a greater than the national average level of car ownership in MK. Moreover, the data gained from the questionnaire responses also reveals a growth in multiple car ownership in MK. MK Council (2008) reported an average of just 1.26 cars per household in 2001, but the average car ownership for the questionnaire sample was 1.97 cars per household. It is clear that these findings do not support the notion of peak car because car ownership appears to be continuing to grow, rather than stabilising or decreasing.

Furthermore, from examining the questionnaire responses, it is obvious that car ownership levels greatly fluctuate across MK. The wards of Shenley Church End and Two Mile Ash

have extremely high levels of car ownership, with an average of 4.6 and 3.8 cars respectively, figures far greater than the questionnaire sample average of 1.97 cars. In contrast, the wards of Wolverton and Fenny Stratford have much lower levels of car ownership, with averages of just 1.5 and 1.0.

From this, it is obvious that large variations in car ownership can exist within MK, with a range of 3.6 cars between the 11 wards examined: Shenley Church End (4.6), Two Mile Ash (3.8), Stony Stratford (2.1), Oxley Park (2.1), Newport Pagnell (2.1), Bletchley (1.8), Loughton (1.8), Monkston (1.8), Great Holm (1.7), Wolverton (1.5) and Fenny Stratford (1.0). Car ownership and affluence are clearly linked as the wards of Shenley Church End and Two Mile Ash are generally fairly affluent and this is reflected in these ward's high car ownership levels. In contrast, the wards of Fenny Stratford and Wolverton are less affluent and have lower levels of car ownership.

The Bus System

In addition, the questionnaire participants were asked to provide their own opinions on MK's bus system and a mix of interesting comments were provided. Answers were mostly negative, with only 6.25% (equal to just 14 respondents) providing entirely positive views. Words such as 'expensive,' 'late,' 'slow' and 'infrequent,' were commonly used to describe the bus system, accounting for 57.4% of negative responses. Moreover, the most common answer, accounting for 41.1% of questionnaire responses (equivalent to 92 answers), was 'I never use the bus and so cannot comment,' or similar, further highlighting the underutilisation of MK's bus system.

Furthermore, when the interviewees were asked about the impacts of MK's grid system on bus routes, both agreed that the grid sytem negatively affects bus use. From the use of coding, the answers can be connected by the theme of time, particularly the long travel times associated with bus use in comparison to other transport modes, notably car use. Firstly, one interviewee highlighted the long journey times by bus, emphasising the difficulty to plan effective bus routes on a grid system, as buses are forced to move off the grid roads and into estates to pick up passengers. Moreover, the second interviewee stressed the benefits that the grid system brings to car users, therefore impacting negatively on bus use. The fast, direct and uncongested road routes are appealing, and consequently make bus use unattractive as it is long and indirect in comparison.

The redway network

In a further section of the questionnaire, participants were asked to select how frequently they used MK's redways, in order to aid the examination of walking and cycling levels in the town, choosing from: often, sometimes, rarely or never. Studying the responses to this question, the answers gained were fairly mixed (see Table 2). 'Sometimes,' was the most common answer, accounting for 32.6% of responses (equivalent to 73 answers), closely followed by 'often,' representing 25.9% and 'rarely,' accounting for 24.6%. These figures reveal that just one quarter of respondents regularly use the redways and therefore are highly likely to either walk or cycle when doing so. Yet, over 41% of respondents, a much higher proportion, 'rarely' or 'never' use the redways, implying that these individuals also walk and cycle infrequently. Thus, this reinforces this study's other findings, that 65.6% of respondents never or very rarely travel on foot and 94.2% of respondents never or very rarely travel by bicycle.

64

Frequency of redway use	Quantity
Often	58
Sometimes	73
Rarely	55
Never	38

Table 2: Use of the redways

In the semi-structured interviews, both of the interviewees were asked whether they considered the redways to be successful at encouraging walking and cycling. Once again, the answers were varied, as one interviewee deemed the redways to be successful and the other unsuccessful. Firstly, the interviewee who provided the positive answer, argued that the redways provide a 'safe refuge' away from road traffic, thus encouraging more to walk and cycle as many perceive them to be safe transport modes. But the interviewee who deemed the redways unsuccessful at promoting walking and cycling, stated that, due to the lack of underpasses, cyclists and pedestrians are sometimes forced to cross busy roads, which many regard as hazardous. Instead, this interviewee highlighted that the grid road system is so successful that it has a detrimental impact on redway use. The two interviewees provided conflicting views on the redways, however it is clear that the theme of safety is apparent throughout.

The Grid System

In addition, questionnaire and interview participants were asked whether they regarded MK's grid system to be successful or unsuccessful and why. In general, the questionnaire answers were positive, with 91.5% (205) of the respondents deeming the grid system to be a success. Answers, such as 'reduces congestion,' 'easy to navigate around', 'can correct wrong turnings easily' and 'difficult to get lost' were commonly used, accounting for 47.3% (106) of all answers.

It is clear that a prominent theme of ease connects these questionnaire answers, with the majority of positive answers (159), implying that the grid system makes journeys within MK, easy, quick and straightforward, thus supporting MK Council's (2008) report that the traffic flow is efficient and well-distributed spatially in MK as a result of the grid system. In addition, on this topic, both of the interview responses were very similar to the majority of questionnaire responses, deeming the grid system to be successful and emphasising the ease of journeys through the grid system.

Despite this, there were a small number of negative questionnaire responses (19), criticising the grid system. One questionnaire participant, in particular, explained that the grid system simply makes it 'too easy to use the car,' arguing that the grid system completely fails to encourage alternative forms of transport. Adding to this, an interviewee similarly stated that the grid system was 'unsuccessful for some,' most notably individuals without a car. It is clear from this study that car use is dominant in MK, owing to speed, ease and convenience of car journeys, advantages arguably generated by the presence of the grid system. Furthermore, when the two interviewees were asked the additional

question of whether they agreed the grid system encourages MK residents to drive more, both interviewees agreed, stressing that the grid system makes the car the most attractive transport choice.

DISCUSSION

Car dominance is highly evident from the results of this research, with the car 'the most used transport mode' and nearly three quarters of questionnaire participants revealing that they 'always,' or 'almost always,' travel by car. Over 92% of questionnaire respondents owned at least one car and 70% owned two or more cars. This is further demonstrated by the failure of the questionnaire participants, who did not choose the car as their most used transport mode, to highlight any benefits of their preferred transport mode. Instead, the majority of these simply stated that they 'do not own a car.' The car is clearly a powerful preoccupation for most MK residents and it is arguable that the high level of car use in MK is to the detriment of other available transport modes, with 94.2% of respondents 'never,' or 'very rarely,' travelling by bicycle; 88.9% 'never,' or 'very rarely,' travelling by bus; and 65.6% 'never,' or 'very rarely,' travelling on foot. Additionally, one interview participant highlighted that the grid system makes car use 'too easy' and therefore encourages residents to drive regularly.

It is possible to criticise the initial plans for MK for this car dominance, as MK was built for, and around, the car thus making car use highly attractive, in comparison to other transport modes. It can be argued that a large-scale public transport system should have been integrated into the original plans for Milton Keynes, in order to diminish high car use and encourage the use of public transport. It is clear that it would be very difficult to introduce such a system to Milton Keynes now and this raises the question whether the trend of car dominance will change or can ever be tackled. Furthermore, the issues of population growth and climate change increase the need for a shift in the way MK residents travel. The population of MK is still growing rapidly, suggesting that increases in car ownership and road traffic will continue. It is predicted that there will be a 57% rise in car journeys at peak travel times by 2031, however MK's roads are only able to provide an additional 25% capacity (MK Council, 2011). An improvement in public transport is thus necessary, making public transport viable and attractive as an alternative to the car, and helping to combat this growing problem. Furthermore, the important issue of climate change reinforces the need for improved public transport in Milton Keynes because in the long term the car is an unsustainable transport mode.

From the results of the research, it is clear that the grid system is a success, enabling fast, direct and uncongested journeys and thus promoting car use in MK. It is questionable whether the trend of high car use will change without the introduction of new public transport infrastructure or the improvement of existing public transport systems. MK's population growth and the issue of climate change arguably add increasing pressure for a change in the way MK residents travel.

SUMMARY

The results demonstrate a clear overarching theme of car dominance, therefore supporting Metz's (2008:1) claim that the car has become the 'prime mover'. It is highly evident that the car is currently the leading mode of transport in Milton Keynes: demonstrated by the car dominating as the 'most used transport mode' and nearly three quarters of

questionnaire respondents stating that they 'always' or 'almost always' travel by car. Moreover, the results from the questionnaire display extremely high levels of car ownership in Milton Keynes also, thus reinforcing the clear theme of car dominance. Over 92% of questionnaire participants own at least one car and 70% own two or more cars.

In addition, the results suggest that the trend of car dominance in Milton Keynes has a negative effect on the use of other transport modes, namely bus use, cycling and walking, with just 14.3% of questionnaire respondents choosing either bus, bicycle or walking as their most used transport mode, and 94.2% of respondents 'never,' or 'very rarely,' travelling by bicycle, 88.9% 'never,' or 'very rarely,' travelling by bus and 65.6% 'never,' or 'very rarely,' travelling on foot.

Most importantly, the results strongly suggest that Milton Keynes' transport infrastructure does affect the way people travel. In particular, it is clear that the grid system promotes car use in Milton Keynes. This is evidenced both from the results of the questionnaire survey and from the two interviewees who agreed that the grid system encouraged Milton Keynes' residents to drive more. Both highlighted the benefits the grid system generates for car users: fast, direct and uncongested journeys.

CONCLUSIONS

A number of interesting conclusions have been reached from this study. Firstly, the results reveal car use to be the dominant transport trend in MK. This is evidenced by the car dominating as the 'most used transport mode,' nearly three quarters of respondents exposing that they 'always,' or, 'almost always,' travel by car, as well as over 92% of questionnaire participants revealing that they own at least one car. Secondly, the results suggest that people desire straightforward and convenient transport modes. This is demonstrated by the words 'convenient,' 'quick' and 'easy' commonly being used by both questionnaire and interview participants in order to justify the high levels of car use in MK. Adding to this, the themes of ease and practicality were present throughout the results.

It is also apparent from the results that MK's transport infrastructure does affect the way people travel, most notably the efficiency of the grid system promoting car use, but also the problems with the redways reducing cycling and walking. When asked whether the grid system encourages individuals to drive more, both interviewees agreed, highlighting the advantages the grid system brings car users, notably fast, direct and uncongested journeys. Hence, it is clear that car use is the main form of travel in MK because car journeys within the town are quick, easy and convenient as a result of the grid system.

The questionnaire's sample size (224 respondents), along with two semi-structured interviews, was suitable, providing sufficient data to be analysed. However, further increasing the sample size, by distributing the questionnaire to more MK residents and completing additional interviews, would be advantageous. In addition, it would be valuable to ensure individuals are surveyed from as many different parts of MK as possible, to further guarantee that the MK population is fully represented. Robson (2014:11) explains that conclusions made from research with a large sample size are generally 'more convincing' than conclusions made from a smaller sample size. It is clear that increasing the sample size would be highly beneficial for future research on this topic.

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