"I won't cycle on a route like this; I don't think I fully understood what isolation meant": A critical evaluation of the safety principles in Cycling Level of Service (CLoS) tools from a gender perspective

Abstract

This paper contributes to debates on gender, mobility and planning through an analysis of Cycling Level of Service tools (CLoS). Whilst many UK cities have had some success increasing overall cycling numbers in recent years, women are still far less likely to cycle, often because of concerns with journey quality related to traffic safety and social safety. CLoS tools are used by planners and engineers to assess existing routes and ensure they are safe, direct and continuous. However, whilst CLoS tools are seen to provide objective measures of some principles, we argue that they fail to attribute enough importance to gendered differences in perceptions of social safety. Based upon qualitative go-along and interview data, we assess the Welsh CLoS tool, demonstrating that it allows routes considered to be unrideable by female cyclists to be designated as rideable because there is no requirement to take mandatory remedial action regarding what are shown to be critically low scores on indicators of social safety. Whilst larger studies are required to validate these findings, our data suggests that the safety component of the CLoS tool can only be considered objective from a male point of view and inadequately considers the perspectives and needs of women. Moreover, we argue that in mandating socially unsafe routes as safe, CLoS actively reproduces gendered 'essences' such as vulnerability. As a result we suggest that CLoS urgently needs to be incorporated into gender and equalities audits if it is to accurately reflect the needs of more diverse user groups.

Keywords: Cycling; Gender; Transport; Planning; Mobility

1. Introduction: Why should we care about this topic of study, why is it important?

Cycling has long been recognized as an energy-efficient urban transport mode with a high potential to reduce energy consumption and enhance city liveability (Aldred et al 2016). As an active transport mode, cycling can also integrate physical activities into people's everyday lives and hence is beneficial to human health (Jones et al 2016; Pucher and Dijkstra, 2003; Cahill,

2010). In light of this knowledge, many cities are making considerable efforts to foster a "cycling culture" through improving infrastructure and service, and producing promotional programs (Aldred, 2010). Although lack of adequate bicycle infrastructure is a proven barrier to cycling (Parkin et al, 2007), it is argued that the installation of cycling infrastructure alone is not sufficient to attract new cyclists (Handy and Xing, 2010). Recent attempts to encourage cycling in London (UK) for example have met with limited success in attracting women, the elderly and ethnic minorities (TfL, 2010:29-30) as mobility choices are made within broader societal structures (Steinbach et al, 2011; Begum, 2014; Spinney, 2012; Cycle Boom, 2016). As Aldred et al (2016) confirm, despite increases in overall cycling numbers in UK towns and cities like London and Cambridge, there has been no increase in the representation of women (28).

Numerous authors have suggested that increases in overall bicycle mode share are closely linked to the bicycling rates of women with female participation in cycling viewed as an "indicator" of a cycling-friendly culture and environment (Garrard et al, 2008; Pucher and Buehler, 2008). However, men heavily outnumber women as a proportion of cyclists in many nations, including the UK (Aldred et al 2016; Krizek et al, 2005; Moudon et al, 2005; Emond et al, 2009; Winters et al, 2007). In Cardiff (the location for this study), among all frequent cyclists, only one third are women (Sustrans, 2015:11). This notable gender imbalance begs the question why far fewer women cycle and foregrounds the need for gender-sensitive and inclusive transport policies and planning that could effectively address women's needs. Given such discrepancies, the importance of considering cyclists of all genders, abilities and ages to promote transportation sustainability and city liveability has become a source of increased attention (Aldred & Woodcock, 2008; Aldred et al 2016; Asadi-Shekari et al 2013; Clayton et al 2017).

Due to their current under-representation in UK cycling, women have been regarded as a target group in cycling development. Efforts have been made to understand the barriers stopping women from cycling with concern about cycling safety recognized as one of the main reasons (Garrard et al, 2006; Garrard et al, 2008). It is argued that women are especially sensitive to assumed transport danger partly because of their low transport cycling rates (Heesch et al, 2012). Consequently, measures that address women's risk perception more effectively (such as separated infrastructure) may increase the number of women cyclists (Blais and Weber, 2001), and thus improve the percentage of women cycling for transportation. However, whilst attention has been paid to the gendered outcomes of different forms of cycling infrastructure

in terms of overall numbers, much less attention has been given to the gendering of tools (such as CLoS) that male-dominated professions of planning and engineering[1] use to guide the development of infrastructure.

In order to help measure and improve quality of infrastructure for cyclists, a number of CLoS tools have been created in the past decades to assist transport planners, engineers and practitioners. Generally, CLoS include a range of factors including traffic safety, route continuity and directness, attractiveness, and social safety, allowing both quantitative and qualitative analysis of cycling environments (Bhuyan & Nayak, 2013). Because CLoS act as guidance and measurement standards for cycle developments, their efficacy in reflecting gender sensitivity significantly influences the achievement of an inclusive and sustainable cycling environment. Victoria Pinoncely, Research Officer at the Royal Town Planning Institute (RTPI) suggests that one of the questions we should be asking, "…is what planners (men and women) are doing for women in their work?" She goes on to elaborate that, "…in order to provide spaces that meet everyone's needs it is necessary to look at cities through the lens of gender" (Pinoncely 2016:n.p). Accordingly, this paper brings together work in the fields of transport, planning and mobilities to argue that a significant source of gender inequality in everyday mobility – specifically differences in experiences of social safety – is not adequately recognised in the audit tools used to assess the quality of cycle routes. The results of such discrepancies are cycle routes that appear to be suitable for all users but in reality only reflect the needs of a minority of male cyclists. Thus, the main contribution of this paper is to highlight the gender blindness of Cycling Level of Service (CLoS) tools with specific reference to the narrow and inadequate conceptualisation of safety they prioritise.

Based upon the study of three cycle routes in Cardiff (UK), this paper provides an analysis of the objectivity of the safety principles of the CLoS assessment tool utilised by Welsh Government in its "Active Travel: Design Guidance (2014)" from a gender perspective. Whilst CLoS tools are presented as providing objective measures of quality, we demonstrate that the WG CLoS fails to attribute sufficient importance to gendered differences in perceptions of social safety. Based upon qualitative go-along and interview data, our findings demonstrate[2] that the

[1] The UK has the lowest number of registered female engineering professionals in Europe at only 6% of the workforce (Women's Engineering Society, 2016:1).

[2] Whilst the pronounced nature of the results in this study gives us confidence that a larger study would come to very similar conclusions, we also acknowledge that this paper is based on a small sample size and that further research with a larger sample and in other study locations is required to validate them.

CLoS tool in its current form allows routes considered to be unrideable by female participants because of social safety concerns, to be passed as rideable because there is no requirement to take mandatory remedial action regarding what are shown to be critically low scores on indicators of social safety. These findings affirm that the safety assessment matrix of the CLoS assessment tool is only objective from a male point of view and inadequately considers the views and needs of women. The significance of this is threefold: firstly that gendered methodologies such as the CLoS act as a barrier to creating infrastructure suitable for both men and women, and therefore act as a barrier to increasing the numbers of women cycling; secondly, that such tools and routes are 'performative' (Butler, 1999) in that they serve to reproduce gendered 'essences' such as vulnerability and fear of assault; and thirdly that gender mainstreaming (Greed 2005) is urgently required to rectify this problem.

The structure of the paper is as follows: Section 2 will present a critical literature review of gender inequalities in cycling and planning; Section 3 will outline the methodology applied to conduct the research including CLoS observation, semi-structured interviews, and go-alongs in Cardiff (UK). The research framework, data management and analysis are also discussed; Section 4 will start with a thorough introduction to the safety element of the WG CLoS tool, followed by findings from applying it on three cycling routes; Section 5 discusses interview data from study participants with a view to highlighting any gender variation of cycle route safety. This section also compares the results of the CLoS assessment reported in section 4 with the interview data to examine the objectivity of the CLoS; finally Section 6 summarises the main findings from the data and Section 7 gives specific suggestions for improvement of the WG CLoS tool, and CLoS tools more generally.

Literature review: Gender, mobility and the tools of planning

The concept of 'gender' is defined by Greed as a "…package of cultural differences and factors that shape the lives and expectations of women and men, in relation to their social role and duties" (Greed 2006:268). However, as Butler (1999) states, "…rather than a stable signifier that commands the assent of those whom it purports to describe and represent, *women,* even in the plural, has become a troublesome term, a site of contest, a cause for anxiety. (1999:6). Accordingly, for Bowlby, whilst gender is often used to refer to 'women' it is rather, a set of

(patriarchal) relations comprising "…contrasting levels of power, different biological pressures, varying sexual identities and differing roles for women and men" (Bowlby *et al*. 1986 in Greed 2006:268). Whilst this paper explores the experiences of cyclists self-identifying in terms of gender binaries of 'men' and 'women' and all the limitations that implies, it must be recognised that gendered differences are more nuanced than this, and moreover are cut across by issues of ethnicity, class and disability amongst others (Greed 2005). As Butler (1999) has argued there are no 'true' or 'false' gendered expressions as individuals experience gender in multiple and dynamic ways (viii).

Since the 1970s, the British planning system has been critiqued from a broadly feminist perspective for contributing to built environments that reproduce and reinforce gender inequalities (Greed 2006:268). In the face of gendered power hierarchies (Cresswell and Uteng, 2008), studies on the intersections between gender and mobility unveil the profound impacts of cultural environment and gendered social position (Boyer & Spinney, 2016). Indeed a substantial body of research has shown that women suffer disadvantage within urban environments "…developed by men, primarily for other men…" (Aldred 2015; Bowlby 1990; Boyer & Spinney 2016; Dowling 2000; Greed 2005, 2006; Holdsworth 2013; Little 1994; Lucas 2012; McDowell et al 2006; Schwanen et al 2008; Yavuz & Welch 2009).

Gender differences with regard to mobility have been well rehearsed in the transport literature. In relation to cycling specifically, imbalance by gender is not a given but is well-documented. A number of studies suggest that whilst there is gender parity in some established cycling cultures, in many countries gender becomes a key indicator of differences in cycling levels (Krizek and Johnson, 2006; Cervero and Duncan 2003; Moudon et al, 2005; Emond et al, 2009; Winters et al, 2007). Dill and McNeil (2013) further point out that women are significantly underrepresented among more confident cyclists and those who currently cycle for transportation. In the UK, women's cycling levels are less than half that of men's (Gatersleben and Appleton, 2007; Melia, 2015). However, this does not make the UK unusual when compared to other countries with similarly under-developed cycling cultures. Typically, in car-oriented English-speaking cities with low cycling levels, women are less likely to use cycling for urban transport than men with the majority of cyclists being young to middle-aged men. However, much higher rates of female participation are witnessed where well established cycling cultures and facilities are the norm, most notably urbanised areas of Holland, Germany and Denmark (Pucher and Buehler, 2008). Here, cycling is a much more inclusive activity with

less dependence on the car as the primary source of transport and equal or even higher rates of cycling between men and women (Emond et al. 2009; Garrard et al. 2012). Female rates of cycling and total cycling mode share of transportation are so closely linked that Baker (2009) suggests gender equity in cycling is a key barometer of a cycling-friendly environment. (See for example figure 1).

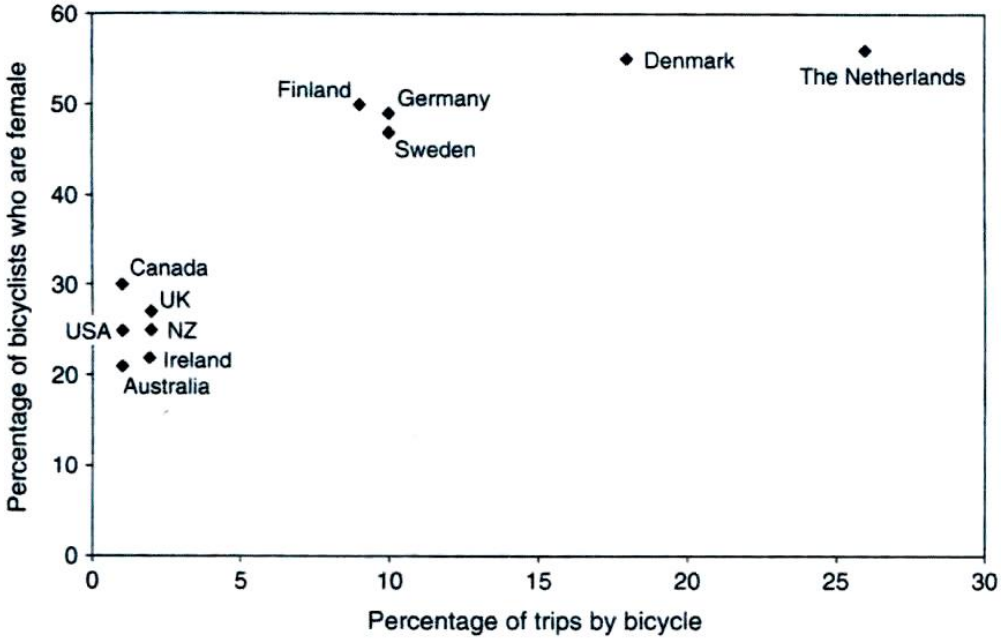


Figure 1 Bicycle mode share of trips and percentage of female cyclists (source: Pucher and Buehler, 2012).

A number of factors have been shown to explain gender discrepancies in places where cycling is a marginal activity. In particular, land use and transport planning have been critiqued for prioritising zoning and dispersed built forms that privilege the journeys of men in the form of car use and commuting; cycling infrastructure that ignores differences in safety concerns across genders (Greed 2006:268); and ignoring 'mobilities of care' (Madariga 2013) that shape women's mobility as primary caregivers, including differences in caring and household responsibilities, positions in the labour market, income and personal preference (e.g., Emond et al, 2009; Garrard et al, 2012; Krizek et al, 2005). It is argued that traditional social and domestic gendered divisions of labour mean women tend to carry a heavier mobility burden than men in the fulfilment of these roles.

The gendered nature of care-giving and the complex and fragmented mobilities it gives rise to, can make it harder for women to travel by bicycle. Research has demonstrated that tasks such

as child-care, school-runs and shopping, often alongside paid employment place significant limitation on women's ability to fulfil daily travel needs by bicycle (Emond et al. 2009; Garrard et al. 2012). Reeves & Greed (2003) for example illustrate that cycling becomes impractical for women trying to cover long distances with multiple stops in limited time frames (Reeves & Greed 2003:8 in Greed 2006:271). Countries that do see higher levels of women cycling (such as the Netherlands) tend to have higher quality, continuous and separated routes aimed at social cycling (rather than just commuting) that enable trip-chaining, cycling with children, and accommodate non-standard cycles.

Other barriers for women's participation in cycling identified in the literature include the physically strenuous nature of cycling, and in particular, non-identification with the prevailing masculine image of cycling in relation to maintenance and technology (Garrard et al. 2012). Social norms around appearance have also been shown to play out in women being less likely to cycle because of a lack of changing facilities in the workplace (Reeves & Greed 2003:8 in Greed 2006:271). Low levels of female cycling participation have even led to suggestions that women inherently dislike cycling, although current evidence provides little support of this possibility. It is much more likely as Cresswell and Uteng (2008) argue, that the masculine/ feminine coding of social norms intersect with narratives of mobility to fundamentally gender perceptions and practice, further contributing to striking gender differences in travel patterns. Safety concerns are identified as one of six latent variables in cycling (Munoz et al, 2016) known as a key deterrent factor that influences the likelihood of cycling (Handy and Xing, 2010; Winters et al, 2010; Teschke et al, 2012). Attempts to discover factors influencing perception of traffic safety unveil a set of common factors such as traffic speed, traffic volume, other road users (especially sharing roads with specific vehicles like HGVs or buses), and separation distance with other traffic (Christmas et al. 2010; Vandebona and Kiyota, 2001; Parkin, Wardman et al., 2007; Stone and Gosling, 2008). With regard to women, safety concerns are categorised in the literature in two ways: traffic safety concern and social safety concern.

Research on gendered variation with cycle safety for example, points out marked differences in traffic safety perception. For example, defined as a group of "easy riders" with less tolerance for traffic (Furth, 2008), female cyclists are more likely to be intimidated by sharing roads with vehicular traffic, and prefer separated bicycle facilities such as dedicated bike-only trails (Appleyard 2012, 2016; Emond et al, 2009; Garrard et al, 2008; Handy 2014; Krizek et al, 2005). In the UK context, Basford et al (2002) found that 72% of women who do not cycle characterised

the idea of cycling in traffic as frightening. Concern about safety is proven to have more significant influence on women's overall travel behaviour than men's (Schintler et al, 2000; Garrard et al, 2008; Twaddle et al. 2010; Yavuz & Welch 2010), and is deemed to be the most important factor preventing women from cycling (Emond et al, 2009; Twaddle et al. 2010).

In addition to being more reluctant to cycle in busy traffic environments and preferring separated cycling infrastructure, women are also found to be more concerned with social safety (Appleyard and Ferrell 2017). Research has shown that in general women tend to report higher fear of crime than men (Truman, 2005). Since those who are fearful of perceived danger may minimise their exposure to risk (Hough and Mayhew, 1983), women's widespread fear of physical and sexual violence is manifested in public places and has become a major constraint on their spatial behaviours and activities (Pain, 1997; Yavuz & Welch 2009). Accordingly, when compared to men, women place greater importance on cycling environments that ensure social safety. For example, a stated-preference survey in the US clearly showed that women are more likely to view lighting as a "very important" characteristic of a safe cycle route (68% versus 45%) (Krizek et al, 2005:36). Greed & Reeves have shown that in the UK women are less happy to cycle where cycle routes are separated and isolated (2003:8 in Greed 2006:271). Social safety concerns have also been highlighted in qualitative research carried out with cyclists and other road-users by Christmas et al. (2010). Similarly to Krizek et al (2005) they noted evidence of adaptive behaviours to protect against potential attack when cycling in deserted areas at night. However, although Christmas et al recognise that personal safety concerns could be more of an issue for female cyclists, they suggested it may be more "a special case of a more general barrier", which they cited as "the behaviour of other road users (ORUs)" (ibid, p.23).

Yavuz & Welch note a number of reasons why women consistently report higher fear of crime than men.[3] A particularly pertinent one is that women's greater physical and social vulnerability means that they have a greater sensitivity to risk (2010:2493). As Yavuz & Welch go on to state: "…women's susceptibility to sexual assault and frequent experiences of various forms of harassment make them feel more vulnerable and thus perceive risk more often than men" (ibid). Furthermore, knowledge of actual risk (for example male violence and aggression), and subordinate status of women in society are also known to contribute to women's

[3] This is not to say that fear of crime is only experienced by women; it has also been shown to restrict men's activities in public places. However, as Yavuz and Welch state, men's fear often goes unreported due to their relative lack of emotional articulation (2010:2492-3).

perception of risk (Pain, 1991). This entrenched perceived/ actual vulnerability and fear of violence help to explain women's stronger concern of cycling safety.

However it is important to note that such susceptibility to assault is the product of patriarchal power relations that construct the identity of women in specific ways. Feminists theorists argue that the masculine and heterosexual male gaze gives rise to a social coding of women's bodies that tends to pressure women to maintain certain standards of physical appearance deemed attractive by men (Law 1999: 580). This in turn constructs them as specifically vulnerable to sexual assault by men because of the disempowering lack of control that arises from becoming an 'object to be looked at'. Such subjection can generate fear and an associated set of norms of respectable and 'safe' behaviour (in order to alleviate that fear) that severely affect women's travel decisions and travel patterns.

To go further, and in line with a feminist epistemology, we also focus attention to the fact that it is (in part) through mobile experiences that women come to know themselves and define an identity as more or less 'feminine'. For example, inviting women to cycle in spaces where they feel unsafe (by for example including them on official cycle route maps), performs and constructs a 'vulnerable' and 'fearful' female identity. As Butler so eloquently puts it, it becomes, "…an expectation that ends up producing the very phenomenon that it anticipates" (1990:xiv). In the same way that Butler argues that one is not born a woman, one becomes a woman, women are not born vulnerable, they become vulnerable by being placed in specific contexts. Hence gendered 'essences' of fear and vulnerability arise through the reproduction of pre-existing patriarchal power-relations in and through space and mobility (Boyer & Spinney 2016).

Given the evident differences in how men and women respond to social and traffic safety, and the importance of space and infrastructures in reproducing these differences, it is perhaps surprising then that most towns and cities in the UK have few if any separated cycle lanes, and that many recommended cycle route maps utilise quiet and poorly lit streets and parks – Cardiff (the location of this study) is a case in point. Indeed when assessing the suitability of cycle infrastructure it would appear that priority is given to traffic-free routes even if they are isolated and may be perceived as unsafe from a social safety perspective. This leads us to question the assumptions underpinning the planning tools used to audit cycle infrastructure such as Cycling Level of Service. Indeed, both Law (1999) and Madariga (2013) argue that a better way to address 'gender and transport' is to look beyond gendered outcomes and instead

focus on a broader evaluation of the social, cultural, technological, and infrastructural, geographies of mobility.

Gender and the tools of planning

Whilst decisions around transport infrastructure and systems are made by a diverse and dynamic group of stakeholders, planners, designers and engineers form a core part of this network. In principle planning professionals should be fully capable of making decisions from the perspectives of those social and cultural groups they are not familiar with. However, research by Greed (2005, 2006) uncovered numerous reasons why gender remains a marginal concern in plan-making: In a UK based study Greed (2005) found that only 10 out of 450 Local Authorities were actively undertaking gender mainstreaming into planning processes (723). In trying to understand how to mainstream gender in planning processes, Greed (2005) found a variety of issues: that planning professionals lacked the time and resource to deal with a new 'minority' agenda; many felt they already had too many other similar agendas to accommodate; many felt that gender had already been adequately dealt with, or that gender inequality was not an issue; or in some cases were outright hostile that it was a problem. Greed also demonstrated that women planners were just as likely to be ignorant of the issues as men and did not necessarily know how to accommodate women's needs. As a result Greed concludes that, "…it is not gender but the professional cultures within which identities are fostered and decisions are made that are problematic" (Greed 2005:721).

One element of professional planning culture that contributes to such myopia are the tools and methods used to gather data on contexts and user experiences. Madariga (2013) for example provides a critique of planning and engineering tools and visual representations which she argues over-represent the importance of men's mobility and marginalise that of women – for example by placing more emphasis on the commute. Indeed, such tools may not only reflect gender inequalities but in so doing reproduce them by making them invisible. Accordingly, Madariga calls for the development of, "…new gender-aware policy tools such as Public Transport Gender Audit Tools which allow for the systematic identification of gender dimensions and provide measures throughout the policy planning and implementation cycle" (Madariga 2013:61).

Level of Service Audit Tools

As cycling has become increasingly important to transport policy agendas in countries across the globe (Aldred et al 2016; Spinney 2016), numerous assessment methods have been developed to evaluate the quality of cycle provision in a given location. Cycling Level of Service (CLoS), or Bicycle Level of Service (BLoS) tools which measure operational performance of bicycle facilities and local environments, are now common tools for transport planners, engineers and other practitioners to measure the quality of provision and identify areas for improvement. Here we review some of these CLoS tools with a particular focus on their safety-related components and the degree to which they account for different user perspectives.

Although some CLoS tools place particular emphasis on cyclist comfort (such as the Road Condition Index (RCI) developed by Epperson in 1994 and the Bicycle Suitability Rating (BSR) developed by Davis in 1995), cycling safety has long been the staple of the majority of CLoS tools. In 1987, Davis developed the Bicycle Safety Index Rating (BSIR) (Davis, 1987), which is deemed as the first systematic attempt to establish an evaluation method of bicycle facilities that highlights safety concern (Figliozzi and Blanc, 2015). In the BSIR, the safety evaluation focuses on the physical and contextual factors that are related to cyclists' travelling safety. Variables include: average motor vehicle traffic, number of travel lanes, speed limit, width of outside lane, and pavement condition. This exclusive concern over cycling collision risk is also found in subsequent CLoS. For instance, in the Bicycle Level of Service developed by Dixson (Dixson 1996), scoring incorporates variables like on-sight distance restriction, on-street parking presence, and "Barrier" presence (e.g. bikeway discontinuities); similarly, the Bicycle Level of Service developed by Jensen in 2009 (Jensen, 2009), uses measures of adjacent land use, buffer width, and presence of bus stops as indicators of safety.

More recent CLoS tools have begun to stress not only protection from physical harm, but also the emotional stress and anxiety that accompanies unsafe environments. Tools that highlight cyclist stress or their perceived hazard risk include Sorton and Walsh's (1994) Bicycle Stress Level (BSL); Lindis's (1994) Intersection Hazard Score (HIS); Harkey et al's (1998) Bicycle Compatibility Index (BCI); and the Level of Traffic Stress (LTS) developed by Mekuria et al. in 2012. In these CLoS tools, the evaluation of cyclists' perceived safety is still largely associated with cycling collision risk or travelling safety, with variables like motor vehicle traffic, lane width, motor vehicle speed in the BSL; pavement condition, proportion of heavy vehicles land use density in the HIS; and the presence of parking lane and residential area in the BCI used as key

safety criteria. Therefore, although perceived cycling safety has been incorporated in some CLoS assessment tools, the majority of them measure cycling safety only with regard to predicted conflicts and roadway comfort.

With the aim of highlighting whether they account for collision risk, perceived safety, and social safety, Table 1 reviews some of the current CLoS tools in chronological order. As the table illustrates, most of the current CLoS have taken both cyclists' perceived safety and social safety into consideration. However, social safety has not yet been regarded as a critical factor in any existing CLoS tools, and thus its significance in affecting propensity to cycle (especially for women) may be undervalued. For instance, in the welsh Cycle Route Audit Tool (CRAT) of the "Active travel: Design Guidance", (the focus of this study), perceived safety and social safety are not regarded as part of the safety measurement. Rather, they are deemed as elements that influence the attractiveness of cycling. This is also the case for the much-lauded Dutch CROW Manual where differential experiences of social safety are barely mentioned. Accordingly this review demonstrates that issues of social safety - which are demonstrably felt more strongly by women - are either not systematically included or are deemed relatively unimportant when measuring the quality of a cycle route.

In a (2031) review of Level of Service tools, Asadi-Shekari et al state that a comprehensive and objective assessment tool should consider the full range of cycling needs and experiences to contribute to the formulation of an inclusive and sustainable bicycle environment. However, reviews of existing bicycle assessment models show that most of them view cyclists as a homogenous population, failing to adequately consider the diverse needs of those wishing to cycle (Asadi-Shekari et al 2013). Although a small number of CLoS tools account for the capabilities, needs and perceptions of different cycle user groups (such as the BSL and LTS, which segment the bicycling population primarily by age and cycling experience), gender is not considered as a classification criteria. As Asadi-Shekari et al conclude, "the challenge is to construct an assessment model that considers the full range of cyclists…" including women, children, the elderly and disabled (2013:186).

The absence of difference in CLoS tools may be symptomatic of a professional ethnocentrism related to the overwhelming male domination of transport engineering, design and planning professions in the UK. By way of example, in Europe, most transportation committees and advisory boards have less than 15% women (Motherwell 2018:4) whilst in the UK only one third of Royal Town Planning Institute (RTPI) members are female (RTPI, 2015:n.p). In the public

sector, transport has the lowest proportion of women in senior positions at 6.25% (Motherwell 2018:5). Whilst we are certainly not saying that men do not have the ability to accommodate the perspectives of other social groups, there is evidence that the relative absence of women (amongst others) in these professional contexts may lead to certain perspectives being marginalised (Motherwell 2018:5). As (Greed 1994) demonstrated in the context of planning, professionals tend to subscribe to their own subculture which they draw upon to define "…what is 'normal' and 'obvious' and therefore are likely to plan for the needs of 'people like themselves'" (Greed 1999 in Greed 2006:269). This point is exemplified in a recent study utilising CLoS by Hull & O'Holleran (2014). This study used CLoS to assess routes in British and Dutch cities and discusses traffic safety at length. However the study fails to mention social safety as an issue, possibly because those conducting the assessment were men and were looking at cycling with an implicitly gendered perspective[4], but most likely because the audit tool used in this instance renders the category of social safety relatively invisible. As Butler (1999:5) has argued, any system that presumes or produces a masculine subject is problematic. Indeed, the power of such tools as Butler goes on to argue is that "subjects are invariably produced through certain exclusionary practices that do not "show" once the juridical structure of politics has been established" (1999:5). Hence the problem we highlight in relation to CLoS is that whilst they play a key role in reproducing gendered subjectivities, the presences and absences within them remain unquestioned because their objective status elides the politics that underpin them.

To combat such implicit gender politics, Greed argues that "…gender mainstreaming is essential to enable planners to 'make the familiar strange' to stand back and appreciate the needs of 'the other' and thus to evaluate the appropriateness of their policies for both women and men in society" (Greed 2006: 269-270). Accordingly, through utilisation of the Welsh CLoS tool (CRAT), the main aims of this paper are to determine the extent of gendered differences in social safety perception, and to evaluate the extent to which the CRAT reflects these potentially substantial gendered differences. As such, the study reported here can best be described as a form of 'gender audit' (Beveridge et al 2000 in Greed 2006:269) because our goal is to test a tool that has already been developed. Ultimately we hope that by uncovering gendered

[4] Whilst one of the authors of the paper is a woman, it is unclear which of the authors undertook the CLoS audits or whether the inexperienced cyclist accompanying them was male or female.

assumptions we can contribute to, "…developing data collection techniques and data sets that better describe both women's and men's mobility and gender issues in transport" (Madariga 2013:50).

Table 1: A review of recent and current CLoS safety criteria

A review of recent and current CLoS models' safety criteria									
CLoS tools	Country/Region/City	Promulgator (year)	Collision risk		Perceived safety		Social safety		Notes
			Included	Critical	Included	Critical	Included	Critical	
Highway Capacity Manual (HCM 2000)	The US	Transportation Research Board (TRB) (2000)	X	N/A	_	_	_	_	Critiqued for treating bicyclists and pedestrians as if they are cars.
Guidelines for Assessing Cycling Level of Service	Western Australia	The Government of Western Australia (2006)	X	X	X	X	_	_	Although it explicitly measures the level of lighting on the road in terms of lux, the intention is to ensure travelling safety, and the lighting criteria has been given the lowest weight in the measurement.
Bicycle Environment Quality Index (BEQI)	The US	San Francisco Department of Public Health (2009)	X	N/A	X	N/A	_	_	Although it includes criteria of "Bicycle Scale Lighting", this is also not out of the social safety concern.
Highway Capacity Manual (HCM 2010)	The US	TRB (2010)	X	N/A	X	N/A	_	_	It takes into consideration the perspectives of bicycles on different types of transportation facilities including intersections and urban streets (TRB 2010).
Cycle Route Audit Tool (CRAT) of the "Active travel: design guidance"	Wales	Welsh Government (2014)	X	X	X-	_	X-	_	"Social safety and perceived vulnerability of user" is placed under the criteria of "Attractiveness" instead of "Safety" category, and it is not attached with "critical" value.
Level of Service Metrics (for Network Operations Planning)	Australia and New Zealand	Austroads (2015)	X	N/A	X	N/A	X	N/A	Takes into consideration lighting and criminality or disturbance, and the number of cyclists.
Highway Capacity Manual (HCM 2016)	The US	TRB (2016)	X	N/A	X	N/A	_	_	
Design manual for bicycle traffic: Bicycle Balance Tool	The Netherlands	Dutch CROW (2007)	X	_	X	_	X	_	The CROW Manual includes 'cyclist road safety' and 'social safety' under the aspect of 'Cyclist Satisfaction' in the Bicycle Balance benchmarking tool (CROW, 2007:367) but no indicators have 'critical' status. The main discussion implies that non-isolated routes are desirable but not mandatory (p319). In the main discussion of CROW, social safety is included under the principle of 'Attractiveness' with virtually no discussion of how differently it maybe experienced (p105).
Cycling Level of Service (CLoS) of the London Cycling Design Standards (LCDS)	England	Transport for London (2017)	X	X	X	X	X	_	Explciitly categorised the safety element of CLoS into "collision risk", "feeling of safety", and "social safety". However, there is no critical value being attached to "social safety".
Healthy Streets Check	England	Transport for London (2017)	X	N/A	X	N/A	X	N/A	The Healthy Streets Check looks at 'liveability' more generally and therefore is not cycle-specific. As such it does not include critical factors and leaves this decision to the discretion of the assessor.
1. "X" - affirmative. "X-" - partly included or vaguely referred; "-" - negative; "N/A" - not applicable. 2. "Critical" refers to a pass-fail criterion discussed in more detail on page 19.									

3. Research Design

In order to investigate the extent to which CLoS accounts for gendered perceptions of safety, the research employed a range of qualitative methods including observation, semi-structured interviews, and go-alongs with 18 participants. Participants were randomly recruited in the city with no regard for whether they were regular cyclists or not. In total, 9 male and 9 female interviewees participated. The location for the study was Cardiff, the capital city of Wales in

the UK, population (Unitary Authority area) 361,000. All primary data collection, including CLoS assessment was undertaken by the female author of the paper.

According to the CRAT guidance notes, it can be used for both existing and proposed routes, and if on existing routes, the current conditions should be audited. This study selected three different cycle routes in central Cardiff on the basis that they would exhibit different levels of traffic and social safety when subject to CRAT. This was confirmed by conducting the CRAT on these routes. The routes used were a section of the Bute Park cycle path, the North Road, and the Colum Road cycle lane (as shown in figure 3). All three are designated as recommended cycle paths on the Cardiff Cycling Map (Cardiff Council 2016).

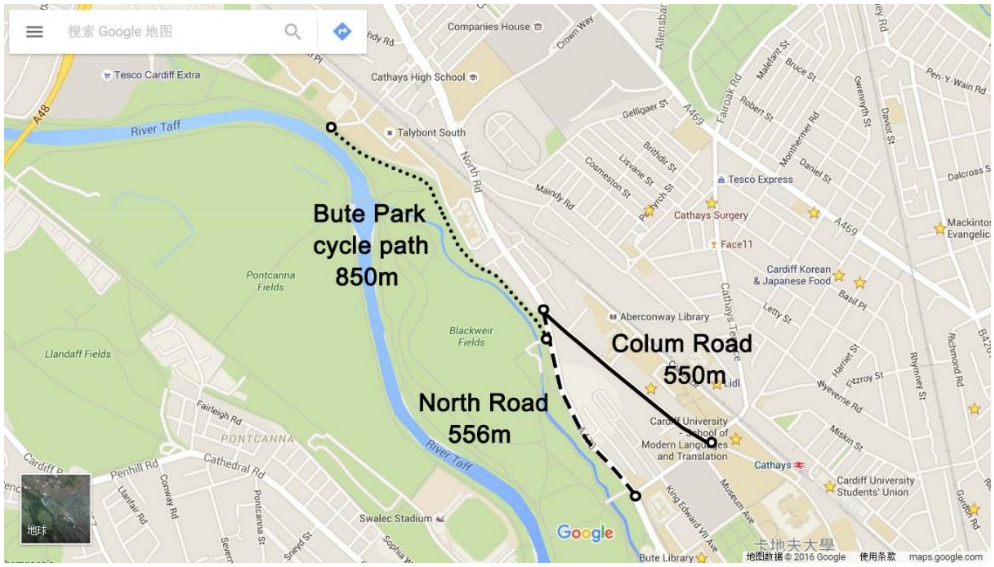


Figure 3: Location of the three cycle routes in the study (Source: https://www.google.co.uk/maps/)

The Bute Park cycle lane is an off-carriageway route, where a 2-metre wide lane is separated from a 1.5-metre pedestrian route by a white line (Figure 4). The lane is located on the North edge of the Bute Park, separated from the city main road – North Road – by dense planting and a brick wall for much of its length. As a result the path is visually screened from the North Road and other open areas.

Figure 4 - Study route 1: The Bute Park cycle path (Source: Author)

The North Road cycle lane is a fully separated cycle lane protected by physical installations such as guardrails, parapet, kerb, and plantings (Figure 5). It is approximately 1.8-metres wide. The section subject to CRAT runs largely along the Bute Park car parks starting from its intersection with Corbett Road and ends at the junction with the Colum Road.

Figure 5 - Study route 2: The North Road cycle lane (Source: Author)

The Colum Road cycle lane is an advisory cycle lane that is “intended for, but not legally restricted to, cyclists’ use” (TfL, 2014:69). The cycle lane is embedded between a carriageway

and a parking strip on both sides on the road (figure 6). It connects Park Place and North Road, with mainly student residences and some university buildings alongside.

Figure 6 - Study route 3: The Colum Road cycle lane (Source: Author)

Sampling and Methods

Before involving participants in assessing study routes, the researcher initially evaluated the safety performance of the three cycle lanes according to the CRAT. Following this, 18 semi-structured interview participants were recruited opportunistically resulting in a non-stratified sample. Of these, 12 took part in 'static' interviews (six men, six women; nine regular cyclists, three non cyclists) and 6 in mobile interviews (three men, three women; four cyclists, two non-cyclists). Before being instructed to comment on specific aspects corresponding to the CRAT safety criteria, participants were encouraged to report general evaluations on each route's safety level. Following these participants were invited to rank the three routes in terms of their safety levels.

Mobile methodologies are described by Coe & Smyth (2010, p.129) as those that, "seek to capture the ways in which being 'in motion' produces different kinds of experience in place and, therefore, different kinds of understanding of the world". As Anderson (2004) & Spinney (2015) amongst others have noted, conversations 'in place' – such as 'talking whilst walking', can harness the affective nature of place as an active trigger to prompt knowledge recollection and production. Given the significance of first-hand experience of place to feelings of safety, this

study ‘mobilised’ some of its semi-structured interviews, conducting them as walk-alongs (Kusenbach 2003; Lorimer & Lund 2003). All mobile interviews were conducted twice: in the daytime (between 15:30-18:30) and at night (between 21:30-22:30) to get a sense of both spatial and temporal context.

The efficacy of this approach for this research was borne out in the difference in participant responses before and whilst visiting locations. By way of example, one female interviewee initially expressed no sense of insecurity towards cycling on isolated cycle routes stating that, “it is not a big deal. I think I can cycle on an isolated road”. However, during the go-along interview she changed her view completely stating: “I won’t cycle on a route like this. I don’t think I fully understood what isolation meant before. I think I have to change my answer.” Such comments demonstrate the often very real differences between what we say and what we feel, and underline the importance of mobilising our methods.

For those participants who were not able to take part in the go-alongs, static interviews were used. In order to try and bring a greater sense of the routes to the participants, methods were mobilised (Spinney, 2015) with pictures and videos of the study routes (in both day and night time) shown to participants before asking them to assess the routes’ safety levels.

Following full transcription of all interviews, transcripts were coded using the safety criteria of the CRAT as a guide to categorise respondents’ answers into “perception of collision risk” and “perception of social safety” which correspond to “feeling of safety” and “social safety” factors in the CRAT safety matrix. The responses of both male and female participants were then analysed to explore the existence of any internal disparities/ similarities and subsequently in relation to the results of the CRAT.

4. Use of the CRAT to assess cycle routes

Transport – and particularly active travel – has become a central policy focus in Wales. Welsh Government has recently received additional devolved powers to promote active travel in the form of ‘The active travel Wales Act (2013)’ (which came into force in September 2014) and the ‘Wellbeing of Future Generations (Wales) Act 2015’. The latter is concerned with improving the long-term health of the Welsh population whilst the former complements this goal by placing

a statutory duty on the Welsh Government to boost levels of walking and cycling. As part of this commitment Ministers are required to 'make and publish annual reports on the extent to which walkers and cyclists make active travel journeys in Wales' (Active Travel Annual Report, 2017:5). Accordingly, all Local Authorities in Wales were required to submit maps of their existing cycle routes in January 2016 as a basis for development of future Integrated Network Maps (Active Travel Annual Report, 2017:7). One of the key duties under the act is to set a quality standard so that, "…routes on the network are: safe, comfortable, continuous and direct" (Sustrans 2017:2).

In order to facilitate this, the Welsh Government has introduced a Cycle Route Audit Tool (CRAT) as part of its 'Design Guidance: Active Travel Wales Act (2013)' to "assist local authorities in the auditing of routes" (Welsh Government, 2014: 396). By framing the discussion around design options, CLoS is expected to enable improvement of existing road layouts by defining which elements of a given route give the lowest level of service. A points system is adopted in the CRAT to evaluate the level of safety. Each indicator has a set of descriptions guiding assessment, and has three or four classification categories depending on the indicator.

The CRAT is based on and categorised into five design outcomes of cohesion, directness, safety, comfort and attractiveness, and each of them is broken down into specific factors with detailed indicators to measure performance. Among them, the 'safety' principle is comprised of six main factors: traffic speed, traffic volume, collision risk, street design, kerbside activity and evasion area. Notably, the 'social safety' and 'perceived vulnerability of users', factors (comprised of "lighting" and "isolation" indicators) are placed under the category of "Attractiveness", but in order to aid our comparison, here we incorporate it in the safety measurement of the three study routes.

As is common in CLoS, some of the criteria have been given a "critical" rating. Out of a total of 25 indicators in the CRAT, five can score a critical, and they are all found in the 'safety' requirement. An understanding of the Critical score and its selective use in the CLoS is central to the findings and argument of this paper. The CRAT guidance states that, "Routes which fail to pass any of the critical factors require further development and should not be included on the Existing or Integrated Network Maps." (Welsh Government, 2014: 396). Accordingly, a Critical score on any factor means that regardless of how high the overall score for the principle in question, a route effectively cannot 'pass' the level of service assessment and will require remedial action with regard to that factor. Importantly, *no matter how low a social safety score*

may be, it cannot be assigned a Critical score. This is a point that we return to later in relation to our research findings. Full results of the CRAT assessment of the three studied routes are presented in the Appendix 1.

4.1 Bute Park cycle path

Since the Bute Park cycle path is a traffic-free path with no kerbside activities, all collision risk–related scores in this path, namely the indicators of traffic speed, traffic volume, collision risk, street design, kerbside activity and buffer area, are in the highest category. However, since it is alongside dense greenery that blocks vision from the outside (Figure 8), it poses potential risk/fear of crime. Moreover, it is dimly lit at night (Figure 9) and has no exits along the whole route except the beginning and the end. Consequently, it receives low marks in the "lighting" and "isolation" criteria. Overall, the Bute Park cycle path scored 16 (out of 20) in total CRAT safety assessment.

Figure 7 (left) The Bute Park cycle path in the daytime; Figure 8 (right) The Bute Park cycle path at night (Source: author)

4.2 North Road cycle lane

Marked with red painting on the surface and protected by buffering facilities (Figure 8), the North Road cycle lane also performs well in collision risk-related assessment, with the exception of the intersection of the route with a car park exit where right of way is given to cars. The route is located in an open area where it can be seen from the main road. Due to the

variable proximity of nearby activities, the lane is not always overlooked and can in part feel isolated particularly at night. At night, the route is lit by street lamps (Figure 11) although for a short section trees block the light impacting negatively on visibility. Table 3 below presents its results in the CRAT safety assessment. With a total score of 16 (out of 20), the North Road cycle lane also has a generally good performance in meeting safety standards set in the CRAT.

Figure 9 (left): The North Road cycle lane at daytime; Figure 10 (right): The North Road cycle lane at night (Source: author)

4.3 Colum Road cycle lane

The Colum Road cycle lane is a "shared" lane that is intended for, but not legally restricted to, cyclists' use. In the middle section, the track passes through a designated parking strip, which is set between the cycle lane and the pavement (Figure 12). Empirical observation when conducting the CRAT found that more than half of motorised vehicles (28 out of 50) drove into the cycle lane.

The overall traffic speeds[5] in the Colum Road should be relatively low due to a 30mph speed limit; traffic calming measures and its situation between two main signal controlled junctions. However, even at peak time (8.30am) with heavier (and therefore in theory slower) traffic, we

[5] Traffic speeds were recorded using a smartphone 'speed gun' app over a 1 hour period in the morning peak between 8am and 9am. Accordingly there is a margin of error in the data recorded. Counting was done manually. Scores shown are for both sides of the carriageway and for all four junction directions.

found that whilst 90% of vehicles were travelling below 30mph on the carriageway, only 73% were travelling below 30mph across the main Colum/ Corbett Road junction. The 'Instance of Lowest Indicator' rule states that, "when assessing the links and junctions on a route the assessor should always look for an instance of the lowest indicated range. This will be the score of the entire section studied. The assessor should not make an overall assessment but look for the weakest point where the standard is not met. This is the point at which issues may occur and the aim of the CLoS is to reduce the number of these issues present in designs" (WG Design Guidance 2014: Appendix B). With this in mind, the route failed the 85th percentile test at the junction, scoring just 1 out of 4 on the 'Reduce Differential Speeds' factor.

With regard to the 'motor traffic volume' factor, Colum Road itself had a relatively low flow with 710 Vehicles per peak hour on the busier inbound carriageway, only 1.4% of which were HGVs. Despite the Colum/Corbett Road 4-way junction recording flows of 1540 Vehicles per peak hour, 6.5% of which were classed as HGVs, there is no critical factor available but the route still scores 0 in relation to this factor.

There are two T-junctions on the north side of the Colum Road with no traffic lights. Since they all lead to university car parks, the traffic volumes at these two junctions are relatively low. However, conflicting movements between bicycle traffic and car traffic in these two junctions were observed. At night, the cycle track is well lit by street lamps (Figure 13). Since Colum Road is heavily used by students living alongside, and car drivers heading towards the university and city centre, it is always busy resulting in much reduced risk/fear of crime reflected in higher scores for social safety. Colum Road cycle lane scored a total of 8 (out of 20) with a Critical for the 'Motor vehicle Volumes' factor.

Figure 11 (left) The Colum Road cycle lane in the daytime; Figure 12 (right) The Colum Road cycle lane at night (Source: author)

4.4 Discussion of CRAT scores

According to the CRAT assessment of the three study routes, the Bute Park cycling lane and the North Road cycle lane achieved the same score (total=16), while the Colum Road cycle lane received a relatively low score of 8. Most notably, whilst the Bute Park cycling lane scores highly for safety, it has the lowest scores for "social safety" (not included in the "safety" category of the CRAT) due to its isolation from activity and poor lighting at night. With dedicated and protected facilities but also openness to street activity, the North Road cycle lane has a generally good performance in both traffic safety and social safety categories, scoring well on the latter due to the constant presence of human activity. Despite high vehicle volumes and speeds at the busy Colum/ Corbett Road junction at one end, the Colum Road route did not score any Criticals for safety. Indeed, no factors on any of the studied routes scored 'Critical' meaning that given their satisfactory scores as a whole and despite any shortcomings, according to CRAT all the studied routes are fit for cycling with no immediate mandatory remedial action required.

5. Participants' evaluations on cycling safety of study routes

This section thematically documents the empirical data obtained from the analysis of six mobile semi-structured interviews and 12 'static' semi-structured interviews. Since this paper aims to compare CLoS safety criteria in relation to individual safety concerns, comments from

respondents have been categorised into two themes – “perception of traffic safety” and “perception of social safety” which correspond to factors within the safety requirements and attractiveness of the CRAT. Each theme has been further divided into different topics based on respondent descriptions.

5.1 Subjective Assessment of Study Route Safety levels

Perception of Traffic Safety

The results show that whilst there are significant differences between male and female participants’ perceptions towards traffic safety for the three study routes, the CRAT accurately reflected the experiences of women. All male and female interviewees praised the off-road nature of the Bute Park cycle path and protected dedicated cycle lane in the North Road, which separated them from motorised traffic. In contrast, both gender groups expressed great concern over traffic safety in the Colum Road because it forced them to ride alongside cars. However, this concern appears to be greater for female participants with 7 out of 9 stating they would rather choose another road to cycle, contrasting with only 1 out of 9 male participants stating the same. However, despite these differences, the traffic criteria of the CRAT would appear to correspond closely to the stated views of our women cyclists as Colum Road received a low 7/20 in total for safety (4/16 if only traffic safety is taken into account).

Perception of social safety

Our main findings are centred on the two “Social safety and perceived vulnerability of user” factors of CRAT that are applicable to the routes, split into indicators of (1) Lighting; and (2) Isolation. The data suggests that when people perceive a risk or fear of crime of the cycling route, both the route’s lighting and isolation condition play a significant part in their assessment. Accordingly, we further explore the theme of risk/fear of crime after the discussion of lighting and isolation in the following presentation of interview results.

(1) Lighting

The light levels on the North Road cycle lane and the Colum Road are satisfactory to both male and female respondents. Respondents noted that being well lit at night made the cycling route feel safe:

> *"Lighting is essential at night, so I can see the road, and other people can see me riding through. The lighting is good here (on the North Road cycle lane). I don't need to worry about any hidden danger that is out of my sight."*
> *(female D, cyclist, aged 21, static interview)*

As this participant attests, it is being visible to others, and knowing that any hazards in the environment are visible that allays fears and ensures a feeling of safety. However, during mobile interviews, two female cyclists pointed out that in some sections of the North Road cycle lane, street trees have blocked the light and thus posed a risk because hazards might not be visible:

> *"Overall, the lighting is great. But in here (a stretch where lighting has been blocked by street trees), it is difficult to see the lane. I might get off the track and hit on the railings, or I could trip on a stone."*
> *(female C, cyclist, aged 27, mobile interview)*

In comparison, the Bute Park cycle lane was criticized by both male and female participants for its unsatisfactorily dim lighting at night:

> *"The light can be brighter. I mean, it does look a little bit creepy, especially on a rainy night."*
> *(male A, cyclist, aged 26, mobile interview)*

Use of the word 'creepy' by this participant conjures up images of horror films where danger could be lurking unseen. This reading of the place was reinforced by female participants who pointed out that inadequate lighting was central to producing the place as fearful:

> *"I do not think I would ever go there at night. I doubt anybody would. It looks like the lighting is not bright enough. I would feel safer if the lighting was improved."*
> *(female E, cyclist, aged 34, static interview)*

(2) Isolation

Isolation was also a prominent issue on the Bute Park cycle path. Our data suggests no significant gender difference in attitudes to cycling on this route in the daytime. Both gender groups regard this separated and green environment as a positive factor for riding:

> *(At daytime) "It is right next to the Bute Park. It is not really isolated for me. So, it will not be a problem. In fact, I am quite enjoying it. Being apart from the noisy main road, the quiet atmosphere here is pretty enjoyable. Overall, it is a nice place to cycle. Green scenes, and fresh air."*
> *(male B, cyclist, aged 32, mobile interview).*

> *"I usually cycle here for exercise. It is quiet here, and I enjoy those trees and fresh air."*
> *(female A, non-cyclist, aged 32, mobile interview)*

As these accounts suggest, there can be real benefit to opening up parks and green spaces to cycling (CROW 2007:320). In contrast, all male and female interviewees agreed that the route's isolation from activity makes it feel unsafe at night. However, there were very clear differences regarding the extent to which this affected cycling behaviour. Crucially, male participant responses from mobile and static interviews stated clearly that a feeling of isolation would not be a critical issue in deterring them from using this route:

> *"Well, it did look a little bit scary (at night). But it is the same (as during the day). There is no problem for me at all."*
> *(male B, cyclist, aged 32, mobile interview)*

> *"I agree it would be a criminal's favourite spot, (since) no one can see what happens here. (But) I think it is fine for me. I can ride fast."*
> *(male C, cyclist, aged 29, mobile interview)*

As these comments attest, whilst Bute Park was perceived as unsafe by men, this perception was not enough to deter them from using it. The second comment in particular also points to the fact that in this instance, the lack of fear is not solely a product of a masculine gender, but also because as a 'fast' cyclist, the participant feels that they retain some control to escape any

negative situation and would not become a victim. This contrasted significantly with women who expressed strong concerns that the route would feel so unsafe it would be enough to deter them from using it at night:

> *"I think it is quite dangerous to ride a bike here at night. It is a secluded place separated from the outside world. I do not like being somewhere nobody can see me and I can't see anybody. I bet the criminals would love this place."*
> *(female A, non-cyclist, aged 32, mobile interview)*

> *"I would not cycle here at night. It would be so scary. Nobody will be here at night. It is dangerous to be here alone."*
> *(female C, cyclist, aged 27, mobile interview)*

These accounts contrast markedly with those given by men, using language – separation, scary, dangerous, secluded, alone - that positions them as fearful and vulnerable. Notably, the first account implies that this fearful subjectivity is not only the product of gender. Rather the status of non or inexperienced cyclist and the lack of speed and control that entails compounds a feeling that any potential negative situation could not be controlled or escaped.

(3) Risk/fear of crime

It is evident that women's perception of risk/fear of crime is closely linked to the environment of the route, including lighting, location, street setting, and the level of activity. On the Bute Park cycle lane, some female interviewees expressed their concerns regarding the dense plantings alongside the route and how they could conceal potential attackers:

> *"I would worry about my own safety. Some guy might be hidden in the bushes and waiting for targets. It would be a perfect place for criminals at night. So no, I won't choose this route."*
> *(female C, cyclist, aged 27, mobile interview)*

"Although it is natural and peaceful, I would feel unsafe walking or cycling there, especially at night. I guess those plantings make me think of those crime scenes on TV."
(female F, cyclist, aged 22, static interview)

In contrast, the well-illuminated North Road cycle lane with open surroundings constantly overlooked by passers-by and nearby residents made participants feel safe to cycle day and night:

"Although it is a little bit noisy, the busy main road by the side actually makes me feel safer."
(female B, cyclist, aged 25, mobile interview)

"There are always people on this road, so I don't worry about being attacked here."
(male B, cyclist, aged 32, mobile interview)

Similarly, investigation shows that all respondents are pleased with the social safety on Colum Road. The liveliness of the road and the lighting at night are the most common stated reasons:

"It seems to be a safe road to cycle at night. The street light is bright, and the street is lively."
(female A, non-cyclist, aged 32, mobile interview)

"Good. It is similar in the daytime or at night. It is busy as usual, and it is well lit up by those street lamps."
(male cyclist B, aged 32)

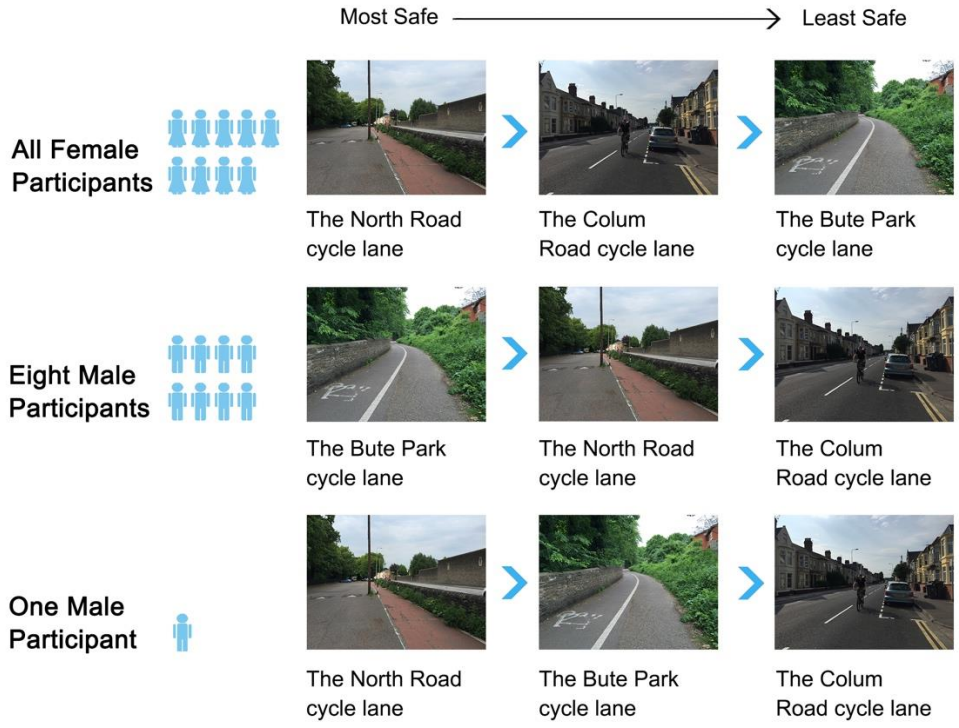
As these accounts attest, busyness, liveliness, noise and presence of people all contribute to a feeling of safety that translates into a willingness to cycle in such places for both men and women. However, our results overall reinforce the findings of other studies in that whilst isolation and lighting are relevant for both men and women, their effect on cycling behaviour is very different with men experiencing isolation and lack of visibility relatively benignly in contrast to women where these experiences were translated into a strong deterrent to cycle because of the loss of control they represented. Additionally, these gendered experiences of

social safety were shown in some instances to be cut across by cycling identities which further shaped behaviours.

5.2 Rating the Safety level of Three Study routes

After assessing the three study routes, all interviewees were asked to rank the level of safety of the routes. Figure 13 below displays the results. All nine female interviewees stated that the North Road cycle lane is the safest of the three routes, while the Bute Park cycle track is deemed to be least safe. In marked contrast, eight out of nine male interviewees state that Bute Park cycle path is ranked as the safest, with the Colum Road cycle lane perceived as the least safe route. Only one male interviewee believed that the North Road cycle lane was safer than the Bute Park cycle path and the Colum Road cycle lane. This distinct ranking result provides empirical evidence of significant gender discrepancy in perceptions of cycling safety.

Figure 13. Ranked safety perception of the three routes



6. Comparison between CRAT safety assessment results and interview findings

The comparative analyses between the CRAT safety assessment and interview findings serves two key purposes: the first is to establish whether the CRAT scores accurately reflect the

perceptions of cyclists in relation to the different factors and can therefore considered to be 'unbiased' in this regard; the second is to establish whether or not the CRAT assessment tool is sensitive to any differences between men and women's perception of safety factors.

Our first observation is that with regard to collision risk the CRAT can be said to be unbiased in that the scores arrived at by the researcher conducting the CRAT closely reflect those gathered from men and women in the study. For example, with regard to the 'collision risk' factor there is broad agreement between all participants regarding the Level of Service provided by all three routes with Bute Park regarded as providing the highest LoS and Colum Road providing the lowest LoS.

Our second observation is that there is also broad agreement with regard to social safety with both men and women giving Bute Park lower scores for 'social safety' indicators than either North Road or Colum Road. However, it is with regard to the significance attached to these and how this translates into behaviour where scores for men and women diverged significantly from the scores obtained using the CRAT. Eight out of nine women outright rejected riding on a route with a high perception of risk or isolated from other activity, and all female participants stated they would not cycle on a route without lighting. This demonstrates that "risk/fear of crime", "lighting", and "isolation" are critical factors for women because they are significant enough to deter them from cycling on routes where conditions are unsatisfactory. This contrasts markedly with male participants who gave Bute park similarly low scores for social safety at night but stated it would not stop them cycling there.

These findings enable us to conclude that for men, low scores for social safety indicators do not require the possibility of a 'Critical' score that can veto the route: this is reflected in the current CRAT where no Critical scores are obtainable for any of the two social safety indicators. However, for women, very low scores for social safety indicators *do* require the possibility that these factors can be scored as 'Critical' because they are enough to stop the route being used at all and should trigger remedial action regardless of the overall score. Accordingly, we conclude that the CRAT tool in its current form does not adequately reflect gendered differences in perception of social safety. Indeed in its current form the CRAT allows routes considered to be unrideable for women to be passed as rideable precisely because there is no requirement to take mandatory remedial action regarding what we have shown to be critically

low scores on indicators of social safety. These findings further affirm that the safety assessment matrix of the CLoS assessment tool is only objective from a male perspective and insufficiently considers the views and needs of women.

The implications of this for understanding the current low levels of women's participation in cycling are significant. Welsh Government CRAT guidance states that, "If the route is assessed as suitable in its current condition according to the network requirements and design standards it can be included in the Existing Routes Map" (WGDG, 2014: Appendix B). Whilst on the one hand engineers and planners using CLoS tools to measure route quality may deem routes to be satisfactory and therefore include them as part of a core cycling network (for example including them on official cycle maps of an area as is the case for the Bute Park route in Cardiff), female cyclists are likely to perceive them as unsafe and ultimately unrideable. This may lead them to seek alternative routes (possibly with more traffic) or lead to 'aversion behaviours' (Markovich and Lucas 2011) where journeys are either not made at all or made by another mode perceived to be offer greater social safety. Either scenario is less than ideal as women may expose themselves to greater traffic risk, increase their journey times or make journeys by modes deemed safer although less sustainable (e.g by car). In addition, the presence of socially unsafe routes means that the connectivity of a cycle network will appear different for men and women. This is because sections deemed unrideable (such as Bute Park in this study) effectively mean that there are missing segments in the network for some users, making the whole network seem less attractive for cycling. With these considerations in mind it is imperative that CLoS tools adequately account for women's perspectives on safety to increase participation and ensure that cycle route maps only include routes that are suitable for a range of genders, ages and abilities. Whilst we do not have data to show how many socially unsafe routes appear on official cycle maps in the UK, our study suggests that such maps may need revising from a gender perspective – a topic worthy of further study.

7. Recommendations for future CLoS assessment

Based on the findings of this study, there are several improvements that should be made in order for CLoS to more accurately reflect the views of a wider range of users. Firstly, with regard to the general conduct of CLoS assessment, besides performing CLoS assessment at peak times during the day, it should be mandatory that measurement is conducted at night to access

reliable information on the social safety factors of study routes. WG CRAT guidance goes some way to recognising the importance of temporality when it states, “social safety particularly during hours of darkness can strongly affect the choice to cycle. Many greenways suffer from poor social safety and so efforts should be focussed on overcoming these concerns” (WGDG 2014: Appendix B). However, the guidance needs to be more explicit that conducting CLoS at night is vital to obtain a full understanding of what a route feels like.

Secondly, according to our experience of conducting CLoS, it is recommended that criteria adopted in the CLoS should be measured in ways that leave them less open to interpretation. For example, under the “lighting” indicator, instead of subjectively judging the length of stretches of darkness as “short” or “long”, CLoS could define the tolerance range by a specific length. For example, less than 10m as a short stretch of darkness that might receive a Good CLoS (score = 1) while more than 10m as a long stretch of darkness that should receive a Basic CLoS (score = 0). Such detailed guidance would greatly reduce the subjective judgement of the assessor and help make the tool more robust. Moreover, poor levels of lighting could be scored as critical dependent on location, for example if the lack of lighting is at an intersection, underpass or tunnel where people are more likely to feel isolated (AASHTO, 1999). Doing so would enable a more objective, sensitive and comprehensive CLoS assessment matrix to be achieved.

Thirdly, and in light of the fact that low social safety scores act as an absolute deterrent to cycling for women, *we suggest that CLoS assessment tools should include the potential for “Critical” scores for the social safety factor, particularly in relation to, “risk/fear of crime”, “lighting” and “isolation” indicators*. By acknowledging that low scores in these factors are fundamental deterrents to women using these routes, existing and potential female cyclists’ personal safety concerns could be addressed as a priority through revision of the LoS. At present WG guidance simply states that, “…social safety particularly during hours of darkness can strongly affect the choice to cycle” (WDG, 2014:Appendix B) with no recognition that this is heavily gendered, not to mention cut across by age, ability, ethnicity etc. Explicit acknowledgement that social safety is a concern for everyone, but critical for specific groups would potentially have the benefit of creating routes where cyclists of all abilities, genders and ages (including men) feel safer by creating a more pleasant cycling experience for all. Related

to this, we also suggest that social safety factors should not be placed under requirements of 'Attractiveness' as they are in the WG CRAT as this sends out the wrong message that social safety is an issue of aesthetics and is somehow less important (Madariga 2013). Rather, to put it on an equal footing, social safety should be included alongside traffic safety factors as it is with some other CLoS tools such as that developed by Transport for London.

We would draw attention to the fact that these failings are not specific to the WG CRAT. Design Guidance that we would expect to be much more gender aware such as the Dutch CROW Design Manual for Bicycle Traffic repeat these mistakes. The CROW Manual for example also discursively marginalises social safety under the umbrella of 'Attractiveness' and says nothing about gender differences in experiences of social safety, stating simply that, "…social unsafety is not the same for everyone". The CROW manual goes on to warn against discouraging designation of routes because of poor social safety because "…some categories of people are not at any great risk on a socially unsafe connection" (2007:320). Whilst this may be true, it suggests a real lack of consideration for those who do experience such routes negatively. It would appear that even guidance held up as International best practice is failing to take gender seriously.

Fourth, it is recommended that women are included as a matter of course when conducting CLoS. Hull and O'Holleran (2014) in their use of CLoS to study cycle routes point to the importance of widening the user group by having routes assessed by both a more and less experienced cyclist. As they state, "…by pairing an experienced cyclist with a novice, the limitation of considering one perspective and ability of cyclist is partially overcome" (2014:374). However, despite this emphasis on different perspectives, gender, disability and age are notable absences in their study of CLoS. Based on our findings we suggest that involving women in conducting CLoS assessment can provide alternative gender perspectives on evaluating bicycle schemes or current cycle route conditions, and in doing so help to obtain results that reflect multiple perspectives. In line with Asadi-Shekari, et al (2013) we would also extend this suggestion to other social groups including the young, old, transgender, and those with physical impairments, particularly those who may use non-standard cycles. The key reason for this is that because gender in relation to social safety is cut across by other social and cultural factors,

it is likely to be experienced differently by (for example) an experienced young female cyclist to an older and inexperienced transgender cyclist.

Finally and perhaps most importantly, our findings support the case for not only involving women in conducting CLoS, but increasing women's participation in engineering, design and planning roles in order that tools and methods like CLoS are designed from the outset with a more heterogeneous user in mind. As Greed (2006) has demonstrated, "…individuals inevitably bring their own personal life experiences and 'world view' of what is 'normal' and 'average' to the policy-making process" (Greed 2006:270) and these views become embedded in particular tools and methods. The benefit of gender analysis is that it, "…provides the tools for highlighting possible limitations, biases or omissions, and for suggesting new conceptual frameworks, research priorities, questions, reference models, terms and visual representations that do take in to account gendered dimensions" (Madariga 2013:50). Supporting the contention made by the Women's Engineering Society that more gender diverse workforces can facilitate "…different perspectives and ideas that drive innovation" (2016:3), only if women (and other social groups) are fully involved in producing CLoS criteria and standards can CLoS adequately consider and present their needs regarding cycling infrastructure and services. To clarify, this does not mean that we think men are incapable of taking on board and materialising insights from perspectives other than their own: they evidently are. Rather as Greed states in relation to the RTPI gender mainstreaming toolkit – which aims to have gender considered at the earliest stages of planning - when making policy, tools and plans, a series of gender-sensitive (and age, ability, ethnicity etc) questions must be asked in the early stages in order to ensure a broad range of views is considered. It would appear that this has not occurred in the development of current CLoS tools.

Ultimately we make a call for multiple perspectives to be embedded in the tools of planning because of the epistemological role they play in shaping urban environments and 'making up' those users who are included or excluded from them by design. In this sense we echo Butler's assertion that gender is performative, emphasising "…that what we take to be an internal essence of gender is manufactured through a sustained set of acts" (xv). As such the fact that social safety fears are more acutely felt by women cyclists is partly a product of the fact that current cycle route guidance encourages women to engage in acts of cycling in places that make them fearful, thus bringing into being a vulnerable subjectivity that reproduces the original

essence: as Butler states, “juridical power inevitably “produces” what it claims merely to represent” (1999:5). CLoS tools are performative in that they are integral to encouraging women cyclists to repeat such identity-forming acts, but moreover that such acts are manifested precisely because of absent or inadequate gender considerations in the design of the tools that are used to assess these spaces in the first place. By contrast, if women only ever cycle in places where they feel empowered and in control, such a gendered subjectivity will to some extent recede because it will no longer be performed. Such an enlightened spatial politics will require a more enlightened gender politics to be present in the tools that shape these spaces.

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Appendix 1

Key re-quriment	Factor	Indicators	Critical	Score Index	Case cycle routes		
					Bute Park	North Road	Colum Road
Safety	**Reduce/remove speed differences where cyclists are sharing the carriageway**	Motor traffic speed on approach and through junctions where cyclists are sharing the carriageway through the junction	85th percentile >37mph (60kph)	0 - 85th percentile >30mph 1 - 85th percentile 20mph-30mph 2 - 85th percentile <20mph	2 Not shared with motor traffic	2 Not shared with motor traffic	**0 85% are not travelling below 30mph (72.7%) Junction total VRU/h=1540 Percentage >30mph=(420) 27.3% Percentage 20-30mph=(780) 50.1% Percentage <20mph=(340) 22.6%**
		Motor traffic speed on sections of shared carriageway	85th percentile >37mph (60kph)	0 - 85th percentile >30mph 1 - 85th percentile 20mph-30mph 2 - 85th percentile <20mph	2 (separated from motor vehicles) separated	2 (separated from motor vehicles) separated	**1 85% are travelling less than 30mph (90%) Carriageway total VRU/h=880 Percentage >30mph=(90) 10% Percentage 20-30mph=(260) 29.5% Percentage <20mph= (530) 60.5%**
	Avoid high motor traffic volumes where cyclists are sharing the carriageway	Motor traffic volume on sections of shared car-riageway, expressed as vehicles per peak hour	>1000vph, or >5% HGV	0 - 500-1000vph and 2-5%HGV 1- 100-500vph and <2% HGV 2 - 30-100vph	2 (separated from motor vehicles) separated	2 (separated from motor vehicles) separated	0 Carriageway total VRU/h = 710 Percentage HGVs: 1.4% Inbound carriageway.
	Risk of Collision	Segregation to reduce risk of collision alongside or from behind	Cyclists sharing carriageway-nearside lane in critical range between 3.2m and 3.9m wide and traffic volumes prevent motor vehicles moving easily into opposite lane to pass cyclists	0 - Cyclists in unrestricted traffic lanes outside critical range (3.2m to 3.9m) or in cycle lanes less than 1.8m wide. 1 - Cyclists in cycle lanes at least 1.8m wide on carriageway; 85th percentile motor traffic speed max 30mph. 2 - Cyclists on route away from motor traffic (off road provision) or in off-carriageway cycle track. Cyclists in hybrid/light segregated track; 85th percentile motor traffic speed max 30mph.	2	2	0 - Cyclists in unrestricted traffic lanes outside critical range (3.2m to 3.9m) or in cycle lanes less than 1.8m wide.
		Conflicting movements at junctions		0 - Side road junctions frequent and/or untreated. Major junctions, conflicting cycle/motor traffic movements not separated 1 - Side road junctions infrequent and with effective entry treatments. Major junctions, principal conflicting cycle/motor traffic movements separated. 2 - Side roads closed or treated to blend in with footway. Major junctions, all conflicting cycle/motor traffic streams separated.	2	1 (there is a conflicting point of car traffic and bicycle traffic at the exit of the car parks where right of way is given to cars)	0 - Side road junctions frequent and/or untreated. Major junctions, conflicting cycle/motor traffic movements not separated

	Avoid complex design	Legible road markings and road layout		0 - Faded, old, unclear, complex road markings/unclear or unfamiliar road layout 1 - Generally legible road markings and road layout but some elements could be improved 2 - Clear, understandable, simple road markings and road layout	2	2	2
	Consider and reduce risk from kerbside activity	Conflict with kerbside activity	Narrow cycle lanes < 1.5m alongside parking/loading	0 - Significant conflict with kerbside activity (eg nearside cycle lane < 2m wide alongside kerbside parking) 1 - Some conflict with kerbside activity - eg less frequent activity on nearside of cyclists, min 2m cycle lanes or buffer. 2 - No/very limited conflict with kerbside activity	2	2	0
	Reduce severity of collisions where they do occur	Evasion room and unnecessary hazards		0 - Cyclists at risk of being trapped by physical hazards along more than half of the route. 1 - The number of physical hazards could be further reduced 2 - The route includes evasion room and avoids any physical hazards.	2	1	0
Attractiveness	**Social safety and perceived vulnerability of user**	Lighting		0 - Most or all of route is unlit 1 - Short and in-frequent un-lit/poorly lit sections 2 - Route is lit to highway standards throughout	0	1	2
		Isolation		0 - Route is generally away from activity 1 - Route is mainly overlooked and is not far from activity throughout its length 2 - Route is overlooked throughout its length	0	1	2
Total score					16	16	7

https://beta.gov.wales/sites/default/files/publications/2017-09/active-travel-design-guidance.pdf