

Four wheels could be two too many

Can the bicycle itself influence our choice of transport mode?

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ABSTRACT

Governments worldwide are increasingly becoming aware of the rapid and unsustainable growth in the amounts of travels. Car driving accounts for most of the growth and the society are already confronted with serious problems connected to congestion. Bicycling is seen upon as part of the solution, however, bicycling as a portion of all travels is in decline. By a targeted literature search this paper tries to highlight bicycling as a sustainable transport mode. It was found that there is little focus, if any, on the bicycle and how itself, as a design product, can contribute to increase bicycling as a mode of transport. In addition, only recently there has been a shift of focus towards the bicyclist, and really what makes people choose to bicycle. Thus, it is concluded that future research need to do a more holistic approach to understand what really makes people bicycle; the bicyclist needs to be in the centre of the main focus and the bicycle should be included as one of the many choice of transport mode determinants.

KEYWORDS: Bicycle design, bicycling, influence, relevant factors, transport, commuting, city, urban areas, congestion, environment, health, bicyclist, Norway, mode of transport

When I see an adult on a bicycle, I do not despair for the future of the human race.

~H.G. Wells

1. INTRODUCTION

An early morning or evening, on a perfectly normal weekday in Trondheim, the third largest city in Norway, numerous people are travelling to work by various forms of transport modes. Bicyclists hurtle off on their superlight racing or mountain bikes in their Tour de France tricots looking like they are participating in a race. Numerous vehicles stack up and pestle in traffic jams, in fact, caused by themselves. Public travellers stand as herrings in a barrel and suffer from the same congestion as the motor vehicles cause. From the author's point of view, this, some peculiar, incident is happening every weekday all year round, not only in Trondheim and Norway, but also everywhere else, in every city and urban area in the rest of the world. Most remarkable though, is that Mr. Anybody seems to think this is fine, or at least, a necessary part of life.

1.1 Preliminary search

Globally, as more and more people become increasingly mobile, travelling is growing rapidly. Motoring by car causes a large part of it. In Mexico, the motorization growth over 50 years from 1980 to 2030 has been from 1-2 million motor vehicles in 1980 to a forecast of 70 million vehicles in 2030, and the growth is increasing (Lobo, 2011). It certainly seems inconceivable that China, with currently around two cars for every hundred people, could ever attain levels of car ownership now found in the USA (some 78 cars per hundred people). (De Boom et al., 2001, Horton et al., 2007, Smith, 1995)

Motorization growth, local as global, needs to be addressed. According to Norway's National Transportation Plan 2010 – 2019, secondary objective F4, the government aims to ensure that bicycle share will be increased from the current 4-5 percent to 8 percent in the plan period. It is further an objective that cities and towns establish coherent main bicycle traffic. Norwegian Public Roads Administration will work to ensure that 50 percent of all cities and towns with over 5,000 inhabitants should have adopted a plan for a primary bicycle network

by 2010. There are approximately 100 such cities and towns in Norway today' (Samferdselsdepartementet, 2008-2009).

Similar objectives have been set in many western countries all around the world; among them is USA, one of the most car-friendly countries in the world. According to Pucher and Buehler (2006) the stated goal of U.S. Department of Transportation is to double the bike share of urban travel in American cities.

The reasons for objectives, as exemplified by Norway and USA, are mainly the profound issues linked to motorized transportation all over the world, especially in cities and urban areas. Issues related to the rapidly motorized transport and congestion are health issues like obesity and cardiovascular disease (Hamer and Chida, 2008), time (Börjesson and Eliasson, 2012), economical issues and advantages (Vågane et al., 2009a, Krizec, 2007), and environmental issues (Bopp et al., 2012).

Regarding an increase in bicycling some promising signs can be seen certain places, especially in Europe, which has cities that set the standard for bicycle use. Some good examples of heavy investments and commitments are worth mentioning.

In Copenhagen, 36 percent of commuters bike to work. The city plans to invest more than \$200 million in bike facilities between 2006 and 2024 and estimates that by 2015 half its residents will bike to work or school. In Amsterdam, cycling accounts for 55 percent of journeys to jobs that are less than 7.5 kilometres (4.7 miles) from home. The government has pledged to spend \$160 million from 2006 to 2010 on bicycle paths, parking, and safety. And Freiburg, Germany, a city with 218,000 people, has allocated roughly \$1.3 million annually for cycling since 1976; now some 70 percent of local trips there are made by bike, on foot, or by public transit. (Roney, 2008)

Even China's central government has according to (Roney, 2008) an increasingly concern about traffic congestion, energy consumption, and

people's health. In June 2006, Deputy Minister of Construction, Qiu Baoxing ordered cities that narrowed or removed bike lanes to restore them.

When it comes to the bicycle itself, in terms of bicycle production, there are more bicycles made and sold than ever before. Globally, the volume of bicycles produced, owned and ridden vastly outnumbers cars (Huwert, 2000, Horton et al., 2007). In 2000, over 100 million cycles were produced globally, against about 40 million cars.

In addition people state that they think of cycling as a nice experience and they have a positive image of it (Smith et al., 2011, Daley and Rissel, 2011). Even in the scientific literature there seem to be a common agreement on that increased bicycling is part of the solution to many of the issues mentioned earlier in this section (Pucher et al., 2011, Winters et al., 2010, Smith et al., 2011, Pucher and Buehler, 2006, Lobo, 2011).

However, despite all the good intentions, plans and obvious positive effects of bicycling mentioned earlier, globally it seems to be a proportional decline in bicycling as a transport mode. There is little evidence of a widespread growth and, in fact, in a world in which more and more people are increasingly mobile, the total amount of bicycling trips is probably on the rise, but the proportion of all journeys made by bicycle almost certainly is in decline. (Horton et al., 2007, Pucher and Buehler, 2006)

In Britain bicycling has fallen from accounting for some 37 per cent of all journeys in 1949, to 1 per cent of all journeys today according to the Department for Transport in 2002 (Horton et al., 2007) and in Norway transport by bicycle has decreased from 7% of all journeys in 1992 to a steadily 4-5% in the first decade in the 21st century. Transport by car has maintained a level between 63 and 66 per cent in the same period (Table 1). (Vågane et al., 2009a)

Transport	1992	2001	2005	2009
Bicycle	7	4	5	4
By car ¹	63	64	66	63

Table 1²: Daily trips by mode of transport in Norway 1992-2009 in percent. (Vågane et al., 2009a)

Two of the world's currently most mobilised societies, China and India, appear to be following the same path, cycling accounted for some 40 per cent of journeys in Beijing in 2002, but a decade earlier this figure was 60 per cent (Horton et al., 2007, Larsen, 2002).

As pointed out earlier there seems to be a mismatch between what governments plan for and what actually happens in real life. The preliminary research also shows that within the scientific environment there might be a lower focus on the bicycle itself as one of the means to influence people to bicycle more. Would it not be one of the easiest solutions to increase bicycling if people themselves had a desire to ride by bicycle because of the product itself, be it caused by, for example, its aesthetics, solid engineered machinery or the sense of freedom when riding it?

Thus, given this starting point, it seems important to focus on the bicycle as a product and Mr. Anybody who is going to ride it.

1.2 Review objective

The paper aims to highlight the bicycle itself and bicycling as a transport mode. In its search it tries to clarify if the bicycle, as a designed and engineered product, can contribute to increase one of the most sustainable ways of travelling for people.

1.3 Structure of the paper

The paper has five sections; the first section is an introduction to the topic and gives the reader some background. Second section describes the research methodology used and

¹ The category "By car" consists of two merged categories; 'As car driver' and 'As car passenger'

² The table is an excerpts of a table found in VÅGANE, L., BRECHAN, I. & HJORTHOL, R. 2009a. Den nasjonale reisevaneundersøkelsen 2009 - nøkkelrapport.

the third section follows up with an overview over the findings. In the fourth section the discussion part is presented and in the last and remaining fifth section the article rounds off with some conclusions and proposes a further ride.

2. RESEARCH METHODOLOGY

The research done has been a targeted literature review. Books, journal articles, government reports and other documents reviewed were obtained in the following ways:

- Web search within scientific databases such as Compendex (Ei Village 2), Science Direct (Elsevier), SpringerLink eContent, Transport (Ovid), Wiley Online Library, Springer, Scopus (Elsevier) and Google Scholar.
- Web search within governments' official report databases and official departments
- Library search at NTNU Library and BIBSYS.

Mainly the research has focused on the latest published scientific material available, typically between year 2000 and 2013, however, some earlier and essential scientific books and papers have been reviewed where it has been appropriate. Most of the review is based on papers written by authors originating from the western world, in particular USA. The remaining authors come from Europe and Australia although a few originate in China and elsewhere in Asia.

The topic proved to be quite complex, therefore a diverse field of expertise has been relevant, primarily transport, medicine, engineering, environment, urban design, and sports.

2.1 Search keywords

Keywords that has been used to search for relevant information in the scientific databases, not limited to, are: 'influence', 'determinants', 'motivators', 'deterrents', 'design', 'utility', 'engineering', 'ergonomics', 'mechanics', 'relevant factors', 'commuting', and many more. The keywords were combined in different varieties with each other and variations of the words 'bicycle' and 'bicyclist'.

2.2 Terminology used in the paper

The phrase 'bicycling' or 'cycling' in this paper is referring to bicycling as a utilitarian mode of transport or non-recreational bicycling. Bicycling/cycling is defined as transport to some other activity and not solely for recreation. Other interpretations of bicycling, such as leisure and sports bicycling, or recreational cycling is not a topic in this paper and the reader will be notified.

2.3 Limitations of topic

The topic is in general bicycling as a transport mode, included commuting, and the connection to the bicycle itself, as a product. Hence, leisure and sports bicycling is not discussed. Research of other forms of transportation, like car driving and public traffic, are left out due to the length of the paper.

2.4 Attention in the literature

When it comes to attention of bicycles and bicycling in the literature (Table 2), much of the material found focus on biomechanics/ergonomics, determinants in bicycle commuting and on safety and accidents. It is interesting to see that the search criteria related to 'Bicycle' and 'Bicyclist' seem to have little attention in the literature, although many of the articles included in 'Determinants in bicycle commuting' examine psychological factors³ as one of several determinants.

An overweight of the articles is aimed at the sports segment, especially within the fields of biomechanics, mechanics and medicine⁴. Bicycling as recovery training for patients within the fields of medicine is also notable. As a notice to the reader the overview may be inadequate and probably more articles can be found as well as more search criteria.

³ Behaviour, attitude, habit and norms

⁴ Not included in the table, see footnote 5

Search criteria ⁵	Articles ⁶
Bicycle as a determinant	1
Bicycle as a product ⁷	6 ⁸
Bicyclist category ⁹	2
Bicyclist psychology (behaviour etc)	8
Biomechanics, ergonomics	20
Build environment	11
Determinants in bicycle commuting	27
Mechanics	13
Politics	9
Safety and accidents	21
Weather and climate	5

Table 2: Number of scientific articles found with relevance to selected search criteria, most of them combined with bicycle or bicycling. Mainly published between 2000-2013.

Given the challenge of finding articles relevant to the topic to show how the interest in the scientific environment has developed through the last years, it is squinted to the most nearby category 'Determinants in bicycle commuting'.

In the beginning of the 21st century it was, according to the review of the literature by Heinen et al (2009), written less than five articles a year about what determinants make people bicycle. Nevertheless, since then the number has increased steadily and 2007 seems to be the top year with 22 articles written (Table 3).

⁵ The attentive reader notifies that environment and health (medicine) are excluded from the search criteria. There are two reasons: 1) It is a vast amount of literature that considers these two topics, and 2) The criteria are not the main focus in this article.

⁶ Some articles can be sorted under different search criteria due to several criteria in one paper.

⁷ Bicycle history, production, evolvement

⁸ Including a book HERLIHY, D. V. 2004. *Bicycle : the history*, New Haven, Yale University Press.

⁹ Many of the articles included in 'Determinants in bicycle commuting' review this topic, thus, the actual number is higher.

Year	2005	2006	2007	2008
Articles	10	11	21	7

Table 3: Number of relevant, scientifically approved, articles concerning determinants in bicycle commuting, per year 2005 - 2008. (Heinen et al., 2009)

Although Heinen et al (2009) for unknown reasons have left out some literature, (e.g. Shannon et al (2005) and Steer Davies Gleaves (2008)), still it is possible to say that it has been increasing in recent years. The trend seems to go on this decade as well (Table 4). Although the search has been somewhat brief, the author of this paper has found 11 scientifically approved articles in 2010 and 22 articles in 2011 (14 articles in the first six months of 2012).

Year	2009	2010	2011	2012 ¹⁰
Articles	3	11	22	14

Table 4: Number of relevant, scientifically approved articles concerning determinants in bicycle commuting, per year, 2009 - 2012.

As Heinen et al (2009) put it in their extensive review of the literature concerning commuting by bicycle 'It is nevertheless striking that, despite policy and academic interest in cycling, little attention has been paid to cycling compared with other modes of transport' (Heinen et al., 2009). (p.60)

3. FINDINGS

3.1 Little focus on the bicycle – the product

As shown in Table 2 there are few articles that emphasize the bicycle as a product in itself. They see the bicycle from a historical point (Herlihy, 2004, Weinert et al., 2007) or see at the production side of bicycles (Larsen, 2002, Roney, 2008).

Nevertheless, it is within the scientific fields of mechanics (Wilson and Papadopoulos, 2004) and biomechanics (ergonomics) most papers

¹⁰ The first six months of 2012

regarding the bicycle as a mechanical device are found.

The bicycle as a determinant in the choice of transport mode has had little focus in the literature, however, it is worth mentioning a report of New Zealand Transport Agency, 'I'll just take the car.' Improving bicycle transportation to encourage its use on short trips. The report is authored by (Smith et al., 2011), and approaches the issue from a novel perspective by making use of what is called affective design methodology.¹¹ The report describes the results of an extensive project investigating bicycling in New Zealand.

In the second half of the first of three recommendations in the report (Smith et al., 2011) states the following, accountable for New Zealand:

The design and availability of products, services and facilities suitable for encouraging practical cycling receives little attention from local authorities, cycling advocacy groups, or the cycling industry (which is focused on recreation) (Smith et al., 2011).

Further, they claim that in New Zealand, cycling culture is almost exclusively focused on recreation. This undoubtedly leads to products and services aimed at the recreational cyclist: road racing, mountain and BMX bikes and associated accessories and clothing. (Smith et al., 2011)

It is encouraging that many of the reasons could be minimised through good design of products, services and facilities, and that so many non-riders have access to a bicycle although they choose not to use it. (Smith et al., 2011)

There are, however, parts of the experience that can be influenced to a greater or lesser extent. It is essential that the tools available are suitable for longer-term use, and that the individual can easily include the opportunity to cycle within their daily activities (for example

¹¹ Affective design maintains focus on the user and the project had a core focus on desirability, experience and appreciation of products.

this could be a choice between bicycle ownership or convenient availability of workplace or public bicycles). (Smith et al., 2011)

Smith et al. (2011) also highlights that there is little mention¹² of the cycling industry, either in its role as provider of products, services and facilities, or as a beneficiary of increased cycling. (Smith et al., 2011)

However, (Smith et al., 2011) conclude in their report, regarding bicycling in New Zealand, that focus on the design of isolated products and services was unlikely to have significant effect on the goal of encouraging more practical cycling for short trips. Further on, they claim that it became apparent that the focus needed to be more holistic and describe a complex, multi-layered system. (Smith et al., 2011)

Next to the research report written by Smith et al. (2011) it is possible though, with an exploratory search, to find dispersed opinions and fragments of what can be traced to the bicycle itself and eventually if it might encourage more bicycling. The information is more or less implicit in a number of articles, put under the search criteria 'Determinants in bicycle commuting' in Table 2, but it is seldom more than fragments and rarely highlighted by the author.

(Heinen, 2011, Winters et al., 2010) tell, among other things, that the weather conditions largely influence the choice to cycle, but can hardly be changed by humankind.

(Lobo, 2011) mention in an his article that this dimension¹³ is nevertheless important, but the point being that it is only one in several components to be considered, and not necessarily the most crucial one in order to achieve success.

¹² ... in the New Zealand cycling strategy documents.

¹³ The technical dimension, also known as the choice of mode technology. LOBO, A. Perspectives from Mexico to Achieve More with Less, Alternative Transport Modes and their Social and Environmental Benefits. Transport for Society, 2011 Leipzig, Germany.

Manufacturers of cars and public transport vehicles go to great lengths to create an appropriate indoor environment for travellers, and the nature of the vehicle is an important further consideration in transport demand modelling because the perceived quality of the in-vehicle environment on a journey will affect choices amongst modes. Similarly, the comfort, aesthetics, luggage handling and gearing of the bicycle are all important. (Parkin et al., 2007)

3.2 Evolvement of the bicycle - stagnated

Several authors argue that the evolvement of the everyday or traditional bicycle, as they call it, has stagnated, or even has gone backwards.

Oddy (2007) argues that falling prices and mass uptake of the bicycle by the working class contributed, during this era¹⁴, to a decline in the previously high status of the bicycle, and thus to a climate hostile to innovation in the cycling industry (Horton et al., 2007). Burke and Bonham (2010) tell that while considerable research effort has gone into sport and leisure bikes in terms of materials for lightness, etc. Leon Arundel (2010) has suggested that the quality of everyday bikes is one of the few areas to have gone backwards. Weinert et al. (2007) say that traditional bicycles also have become less and less suited for travel as trips lengths extend and households demand fast, flexible, load carrying modes.

Further on, (Cox and Van De Walle, 2007) argue that the success of the diamond frame is at least partly attributable to its manufacturing simplicity and the opportunity to mass-produce in feasible sizes. They believe that the tacit implication of Herlihy's¹⁵ historical narrative is that the development of the bicycle reached its fulfilment during the 1890s, when the basic principles of the pneumatic-tyred safety was established.

Although several authors argue that the ordinary bicycle has stagnated one of the promising 'new' modes is the electrical bicycle.

¹⁴ The early decades of the twentieth century

¹⁵ HERLIHY, D. V. 2004. *Bicycle : the history*, New Haven, Yale University Press.

This 'bicycle' offers its users additional benefits as it reduces the necessary physical effort. The increase in the usage of electric bikes could result in an increase in the cycling distance and more frequent bicycle use by people in non-optimal physical condition or in a hilly surrounding. On the other hand, as cycling on an electric bicycle is less healthy than on a regular bike, this trend could affect societies negatively. (Heinen, 2011)

Electric bikes are also not the most efficient users of scarce road space. While e-bikes can move more people per lane than cars, buses move more people per lane than e-bikes (Cherry and Cervero 2006, (Weinert et al., 2007)). Safety is the most commonly cited concern due to their silent nature and increasing speed and weight. While e-bikes provide zero tail-pipe emissions, they do emit pollution from power plants, which are mostly coal fired in China. Lead emissions from batteries production and recycling also have serious health implications due to high lead loss rates in the Chinese lead and battery industries. (Weinert et al., 2007)

3.3 The bicycle's position in the vehicular hierarchy is unclear

Both Forsyth and Krizek (2011) and Daley and Rissel (2011) argue that the bicycle's position in the vehicular hierarchy often is unclear in most part of the world, despite that it is legally recognized as a vehicle.

Forsyth and Krizek (2011) propose that cyclists have needs from the standpoint of urban design that substantially differ from pedestrians, motorists or transit users. Furthermore, it is contended that full provision for their needs is unlikely to come to fruition until their perspective is more formally acknowledged in research and through design guidelines. (Forsyth and Krizek, 2011)

In the Handbook of transportation engineering (Kutz, 2011) it is referred to a transport model originally proposed by Keegan (2001). She calls the model for The Green transport hierarchy (Figure 1) and the point is that the hierarchy gives pedestrians and bicyclists highest priority because of their low cost and non-

environmental impacts, and low space efficiency.

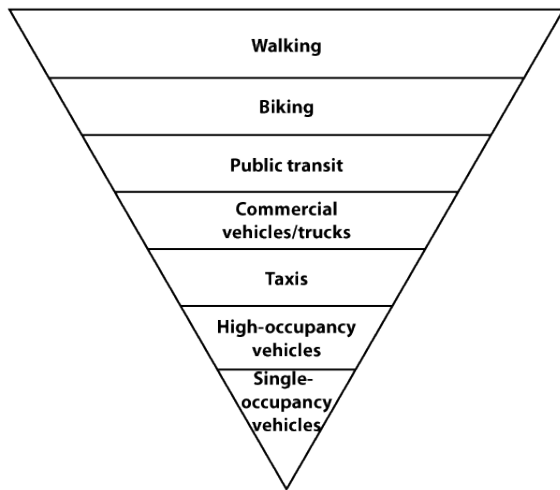


Figure 1: Green transportation hierarchy (Keegan, 2001)¹⁶

3.4 Growing attention on the bicyclist

Recent years there has been a growing focus on psychological factors as part of the research on determinants for commuters by bicycle (Stangeby, 1997, Gatersleben et al., 2002, Shannon et al., 2006, Gatersleben and Appleton, 2007, Guell et al., 2012), yet, according to (Heinen and Handy, 2012) there is no international comparative research that has focused on attitudes, beliefs, and social norms.

In addition there are differences in whom the studies include, how extensive they are, how many participants, and what the research emphasizes.

Steer Davies Gleave (2008) claims in the Caps public and stakeholder consultation facilitation report that there is no definitive model or theory of behaviour and that there is a wide range of models describing decision-making and behaviour with varying degrees of complexity. Some key theories are highlighted and provide a context for interpreting the reasons why people do and do not cycle. In the brief survey it is considered two broad theories of behaviour; expectancy-value and integrative behaviour. Further on, the report links these

¹⁶ The essence of the green transportation hierarchy is that higher occupied vehicles enjoy higher priority.

theories to the factors that affect people's propensity to bicycle.

There is also a diversified classification of the bicyclists in the literature. Winters et al (2011) divide the bicyclists into following cyclist types:

- Potential cyclists (never in past year)
- Occasional cyclists (1-11 one-way trips/year)
- Frequent cyclists (12-51 one-way trips/year)
- Regular cyclists (52 or more one-way trips/year).

Gatersleben and Appleton (2007) base their user classifications on the stages of change in Prochaska et al's (1884, 1994) transactional mode of behaviour change:

- Precontemplation
- Contemplation
- Prepared for action
- Action and maintenance

Heinen (2011) proposes three transitions to target more correctly the different groups of cyclists, namely from non-cyclist to cyclist, from occasional to frequent cyclist and from part-time to full-time cyclist.

Winters et al (2011) talk about a so-called psychologically tipping point when it comes to increase the amount of bicyclists. They tell that when the riders grow in numbers, eventually it will come to a point where more and more people want to bicycle because 'everybody' else do. Further, Gatersleben and Appleton (2007) claim that it is easier to target those people that are in the 'Prepared for action' phase than those in the 'Contemplation' phase, and the more phases a person has to go through, the harder it is and the longer time will be spent in convincing them to become bicyclists.

3.5 Complex reality and lack of literature and surveys

There seem to have become a common agreement in the literature that what really makes people to bicycle is a complex and challenging task.

There is not one simple solution to transport related problems. Not for all people the same mode will be a useful alternative and those who choose the same mode do so for different reasons. It is important to try and find out what motivates different mode users to satisfy as many of them as possible. (Gatersleben and Appleton, 2007, Steer Davies Gleave, 2008)

Parkin et al (2007) call for a deeper understanding of why people do or do not cycle and point out two main issues that need to be addressed in quantitative research. First, the range and type of data collected and analyzed needs to be broader than what is deemed adequate for other modes transport. Second, the choice mechanisms that ought to be considered in relation to cycling may be more involved.

Quantitative and quasi-quantitative models are according to Parkin et al (2007) often required as a precursor to the implementation of quantitative models and help determine the range of parameters that need to be analysed.

To the author's knowledge only Heinen et al. (2009) have given a comprehensive literature overview of papers that focus on the dominant factors regarding bicycling as a utilitarian mode of choice. Heinen et al. (2009) subdivide the determinants into 5 categories. Natural environment, build environment, socio-economic factors, psychological factors and in addition they add a section of aspects related to cost, time and effort.

4. DISCUSSION

The main findings in the literature study is the following items:

- Little focus in the literature on the bicycle as a product and how it might increase bicycling as a transport mode
- The bicycle has not evolved
- The bicycle's position in the hierarchy is unclear
- There has been little focus on the bicyclist earlier, but the focus is increasing

- The reality is complex and there is a vast amount of factors that influence the choice of transport mode
- The literature calls for a broader approach, a more comprehensive overview and more profound surveys

4.1 Bicycle – the product

Strangely there has been little focus in the literature on the bicycle and how itself, as a design product, can increase bicycling as a transport mode.

However, in Smith et al (2011) the report's conclusion may be interpreted in such a way that it is a possibility that the bicycle itself, by its appearance and technological features, can influence and contribute to the rise of bicycling as an essential mode of transportation. However, the main conclusion is that it is necessary to look at the topic more holistically and it is proposed a practical model where the bicycle is part of a larger whole.

Nevertheless, few other authors emphasize the bicycle itself and ask themselves if it could influence the choice of transport mode as a product. To the contrary, the literature focus on what can be done with the surrounding factors.

As Cox and Van De Walle (2007) put it, there is a duplex issue, which this article emphasizes, they tell that technologies not only have an enormous impact on societies; they are themselves also significantly shaped by social, political and economic factors.

Most of the research and studies found in the literature address the duplex issue from the social, political and economical point of view. This, somewhat unilateral, angle might have been caused by lack of expertise included in the research. As earlier mentioned there are a diverse field of scientists involved in the literature, however, there seem to be little expertise from the field of affective design and other adjacent areas. One of the cornerstones within the design field is to maintain focus on the user, thus, naturally, the product or in this case, the bicycle also should be drawn in from the periphery. It is possible to speculate in that

one of the reasons might be that design as a scientific field is fairly young and simply, there are still not enough scientists within the field.

The lack of focus from the technological side of the duplex issue in literature also might have been caused by a lack of focus on bicycling in the reality. Simple put, low focus on bicycling in real life may have caused a low focus in the scientific fields.

Several authors argue that the bicycle has not evolved and that over time, the bicycle, as a transport mode, has become maladapted and does not fit what people needs are of today. Given that this appealing assumption is true, it is imaginable that it could be one of the easiest and even least expensive ways to boost bicycling. As the investments, mentioned in section one, made by Copenhagen and other bicycle friendly cities implies, it is large sums of money that is spent on a wide range of objectives. Perhaps, by spending only a fraction of these investments, supporting research on bicycling and bicycles would have resulted in a new and innovative bicycle. It is a possibility for a whole new era of the bicycle and maybe even new employment could have been created.

Even if the bicycle is legally listed as a vehicle in most countries, there is a mismatch between the build environment and cyclists. Motorized traffic has its apparent space, the pedestrians likewise, but bicycles have an unclear role in the hierarchy and most places bicyclists legally can travel in both places. Speed, safety and space are quite different for the three road users and are a source of conflict. The bicyclists need their own space and environments adapted to them like in Copenhagen and Amsterdam. Most likely the bicycle friendly environment is a contributor to the high levels of bicycling. However, other cities, which do not have had many decades of focus on bicycling, certainly can have difficulties in making a shift from a car-based society to a bicycle-based society, both mentally and physically. Certainly it is difficult to establish a bicycling lane substituting a road lane if there are a lot of motorists and few bicyclists.

4.2 Bicyclists – the users

The literature does not have a clear opinion of how to classify the bicyclists. There has been conducted several surveys regarding bicycling, mostly with respect to commuting, however, they are undertaken different places around the world, meaning that long distances can prevent sharing of experiences and information. Certainly, a common understanding of how to classify the bicyclists and an opportunity to make similar surveys could contribute to understand differences and similarities better. However, at the same time, there could be profound issues that make it difficult to compare different cultures, people, geography and other. There could also be that if the surveys become to general, local subtleties are missed out.

Ultimately, it seems like humans and the psychological part of humans are essential to understand the 'secret' of convincing more people bicycle.

4.3 Complexity

The investigation has revealed that there are many uncertainties regarding the determinants of bicycling, and there are a lot of factors that possibly can influence the rider's choice of transportation. More importantly, deciding and finding the dominant determinants and barriers is a highly complex and a profound task that depends on a variety of factors. The literature

It seems like bicycling as a mode of transport and what factors that trigger people to bicycle are a more complex problem than assumed and that is first until now the literature has begun to realise how complex and profound it is to exactly pinpoint what is the answers. There are a vast amount of variables.

Winters et al (2011) certainly are right when they claim that items such as flat terrain, darkness, or poor weather seem difficult to modify, but indirectly the items may be modifiable by the bicycle itself; certainly an electrical bicycle would help a lot of potential bicyclists to overcome their resistance against hilliness. Perhaps better protection on the bicycle against rain and water splashes would

be a solution for people's aversion towards bad weather. There are many uncovered solutions

With a holistic viewpoint there are several actors that have the opportunity to affect the outcome of a global problem like this. Some actors are addressing the issue, others could do better, and still others could initiate a start.

4.4 Limitations which could have affected the study

The search within databases have been thorough, yet it is possible that several articles have been overlooked, either due to closed databases and unavailable full text documents or in the end, the author's human limitations and time constraints.

This article has been limited to look at the bicycle itself and the bicyclists. That means all other transport forms mainly are left out in the research, hence, insights from adjacent areas could have been drawn into the article. However, transport, as a research theme in general is a huge subject.

In addition, more profound research could have been done within the psychological part, but due to the complexity it seemed best to provide a short overview and rather suggest the topic as a future research.

It has been a diversified amount of scientific literature available, dependent on how specific the search has been. Little information about the main topic means that there are higher uncertainties, however, the topic has been mentioned in other ways in related subjects in many articles regarding exemplified by commuting by bicycle.

As Winters et al. (2011), Bergström and Magnusson (2003) state, there is always a discrepancy between intentions revealed and actual behaviour and of course this indirectly could have affected this paper. It is advisable to always have this in mind when reviewing surveys.

Despite the above-mentioned limitations, it should be, in the author's opinion, still possible to draw the conclusions from the material collected.

5. CONCLUSION

As described earlier in this article, among governments worldwide there are a growing awareness of congestion and the rapid growth in car travels, as well as the severe problems that follows. In addition, it seems to be an increasing agreement that bicycling could be one of the solutions to stop the unsustainable way of travelling. Some cities, especially in Europe have come a long way, however, most of the world is struggling and as a portion of all travels, bicycling is in decline.

This article highlights bicycling as a transport mode and asks if the bicycle itself can influence the choice of transport mode.

Through an extended review of scientific literature it is not possible to say if the bicycle itself can influence the choice of transport mode. Little material has been found about the topic and most of the papers focus on surrounding factors. However, according to Smith et al. (2011), it may be a possibility that the bicycle can influence our choice of transport mode, however it is more likely to be as a part of several other factors.

It is not possible to confirm if the evolvement of the bicycle has stagnated or gone backwards. Too little literature has been found of the subject, and it is necessary to investigate the topic further. It is possible to imagine a link between an undeveloped bicycle and a low bicycling share. Given that this is true it is interesting to investigate if this could be one of the least challenging and economically methods to increase bicycling in the society.

The bicycle is neglected as a means of transport and should neither be categorized in the same category as motor vehicles nor pedestrians. It seems likely that the bicycle's position in the vehicular hierarchy is unclear in most of the world, there are several articles addressing this issue in addition to the real life experience done in Copenhagen, Amsterdam and other cities. It is likely that the bicycle friendly environments in these cities have led the bicycle to a more certain position in the hierarchy as it should have.

It is surprising that, in the context of how old the common bicycle and bicycling is, there has been somewhat little research on what really makes us ride, especially when it comes to commuting and what factors that influence humans to chose the bicycle as a mode of transport.

There has to be conducted more quantitative studies to explore and decide on which factors that influence the decision. Especially there is a lack of research within areas, which Heinen et al (2009) calls, psychological and socio-economic factors, or the user, as it is called it in affective design.

However, recent years there has been a shift towards these areas, the bicyclists and the psychological factors. It seems essential that the focus should be aimed at the bicyclist.

It has been a unilateral focus in the literature regarding the duplicity mentioned earlier. It is needed more attention on the technological part and from the bicycle and bicyclists point of view. There seem to be a lack of expertise within the scientific field when it comes to product design, hence, more research are needed to reveal the opportunities the bicycle as a product has, and what the user needs, to affect bicycling as a transport mode in a positive manner.

5.1 Further work/ research

Further research should put the user in centre of the analyses.

It is suggested that to know what factors that are relevant when it comes to the bicycle as a product, it is first necessary to know what factors are relevant in general.

Thus, some questions that could be asked for future research would be:

- What factors are most relevant to increase bicycling as a transport mode in general?

And then:

- What factors are most likely to be influenced by a new and innovative utility bicycle?

Other questions could be:

- What is the most simple and easy way to increase bicycling as a transport mode?
- Is it possible to increase bicycling by doing it fashionable and a desirable product?

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