

Examining Ways to Enhance Active Transportation and the Impact on Commuters' Health, Wellbeing and Sustainable Development

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ABSTRACT

Active transportation and physical activity is a major remedy to health-related problems in our society. According to the World Health Organization the lack of physical activity is one of the leading risk factors for global mortality as well as health problems such as diabetes, cardiovascular complications and other diseases that are threatening public health. To reduce the health risks of physical inactivity, active transportation and generally physical activity have recently gained great interest in our modern societies. This paper investigates ways to enhance active transportation and the impact on commuters' health, wellbeing and urban sustainability. As a result, a theoretical framework is developed that explores the relevant variables that influence commuter's willingness for active mobility.

INTRODUCTION

Nowadays, with the development of smart cities, multiple transportation modes are available to citizens in almost every country around the world. The technological advancement of the last century led to the massive production of cars, buses, trains and metro lines, that made the transportation of people easier. This is especially important for commuters, which travel every day to work and then back home. However, this had also negative consequences not only for the natural environment, as a result of CO_2 emissions, but also for the health and well-being of people as a result of physical inactivity.

Since the appearance of many vehicle-based transportation modes, active transportation, such as walking, running, cycling, etc., has significantly been reduced. This is due to the general belief that walking, running and cycling is more tiresome and time consuming for someone to reach their destination (Yang et al., 2012). The reason behind this belief is also the lack of appropriate conditions and infrastructure that contribute to a high-quality pedestrian network.

Physical inactivity is being correlated with sedentary life, which can lead to many health issues for people, minor or major ones. For instance, obesity, depression and anxiety (Humphreys et al., 2013) are some of these health outcomes. Further, due to an inactive lifestyle, people might not be able to work effectively, as job satisfaction and productivity can be decreased (Loong et al., 2017). This is due to the fact that physical activity is associated with physical and mental wellbeing, emotions and moods (Humphreys et al., 2013). The lack of physical activity is one of the leading risk factors for global mortality as well as different diseases that are threatening public health. According to the World Health Organization (2017) physical inactivity has been identified as the fourth leading risk factor for global mortality causing an estimated 3.2 million deaths globally. Furthermore, the lack of physical activity has clearly been shown to be a risk factor for cardiovascular diseases.

Further, physical activity can reduce morbidity and mortality (Sahlqvist et al., 2012). In a study by the US Physical Activity Guidelines Advisory Committee (2015) it is reported that physical activity

44 contributes to better health through its direct effects on decreasing disease risk as well as its indirect effects
45 on losing weight and reducing obesity. Further, physical activity and active transportation can contribute
46 to reduce chronic health conditions. There is a growing awareness that significant benefits for health and
47 the natural environment could be achieved by reducing the use of cars and shifting to active transport, such
48 as walking and bicycling. By being active people can stay healthy. They can reduce obesity, can lower the
49 risk of heart disease, diabetes, stroke, high blood pressure and osteoporosis. Also, active transportation
50 can prevent the appearance of some chronic diseases like musculoskeletal and cardiovascular or even
51 prevent certain cancers (Yang et al., 2012). Additionally, active transportation can lead to congestion
52 reduction, cost-effective travel and reduction of noise and air pollution (Lawson et al., 2013).

53 Unfortunately, nowadays many people are relying on their private cars as a major means of transporta-
54 tion. Instead, people could be more physically active and thereby more healthy and happy if they choose
55 to walk or use their bikes or even choose the public transport mode in their daily life. Also, there are
56 major health and environmental benefits from physical activity. We need to reverse the trend of people
57 engaging in less and less mobility at work, at home, and as they move from place to place.

58 Based on the above problem definition, this paper examines the variables that influence active
59 transportation particularly by the provision of relevant information on conditions of the pedestrian
60 network, such as connectivity, safety, comfortable mobility as well as feedback on the people's physical
61 condition. The level of active transportation of commuters as well as their willingness to exercise in their
62 everyday life are examined. Further this study aims to identify the relationship of some factors explored
63 through an extensive literature review with the willingness of commuters for active transportation, as well
64 as the impact on commuters' health, wellbeing and sustainable development. In more detail, we present a
65 framework to explore the role of information, walkability conditions, culture, individual characteristics
66 and health problems to commuters' willingness for active transportation in relation with wellbeing at
67 work, productivity, job satisfaction and obesity. By carrying out an extensive literature review on the topic
68 of active transportation and physical activity a conceptual framework is developed and presented in this
69 paper. The framework is useful for visualizing the most important parameters that will influence active
70 mobility.

71 **METHODOLOGY**

72 An extensive literature review was conducted on relevant studies that examine the variables that influence
73 and enhance active transportation as well as the impact on commuters' health and wellbeing. For the
74 choice of articles, we have followed a process identification screening eligibility and inclusion. The
75 relevant articles were identified by searching multiple databases. Search terms included walking, cycling,
76 active transport, physical activity, active commuting and impacts on health and wellbeing.

77 In the literature review that follows, factors influencing active transportation and physical activity
78 came in the form of variables that were tested for a significant association with active transportation and
79 physical activity. Then variables were grouped into a conceptual framework exploring what leads to
80 the "Willingness for Active Transportation", "wellbeing at work", "job satisfaction", and "productivity",
81 which is presented in a later section of this paper.

82 **LITERATURE REVIEW**

83 As we see below, there are many studies that explore the variables that influence active transportation and
84 physical activity. Also, the various studies show the benefits of active transportation and the necessary
85 prerequisites for engaging commuters in active modes of transport. The literature review that follows goes
86 through the latest studies carried out in a variety of cities around the world. As it is revealed further on
87 these show consistency in the fact that active transportation and physical activity positively contribute to
88 health and to a higher quality of life.

89 Many of the studies are investigating the different levels of satisfaction of adults from the use of
90 different transportation modes as well as the factors that affect their choice for a transportation mode.
91 As shown in one particular study on commuter satisfaction, there is a higher level of satisfaction for
92 pedestrians and cyclists but also train commuters are significantly more satisfied than drivers and bus
93 and metro users (St-Louis et al., 2014). Also, the choice of transportation mode is depended on the
94 weather conditions. When weather conditions are good people prefer to walk or to bike, but when weather
95 conditions are adverse then people tend to use their cars or the public transport (St-Louis et al., 2014).

96 Except from weather, other factors that affect the choice of the transportation mode is efficiency and
97 flexibility (Nordfjærn et al., 2014). The ones who want to be more efficient and flexible choose to commute
98 by car. On the other hand, those who prioritized safety and comfort prefer to use the public transport.
99 Also, high risk perception is related to car use. Further, Loong et al. (2017), shows that commuters who
100 use their car should revisit their choice as they bound to experience low levels of punctuality. This is
101 contrary to their intuition that car mode of transport will give them higher efficiency. Furthermore, the
102 choice and decisions of commuters is shaped by the constantly changing and fluid nature of commuters'
103 social activity (Guell et al., 2012).

104 Demographic, socioeconomic, household and trip specific characteristics are also influencing the
105 choice of transportation modes and active traveling. More specifically, this literature review reveals
106 that gender, car ownership and journey distance have the largest effect on the use of non-motorized
107 transport, while manual related professions and families with children experience the lowest likelihood
108 of non-motorized commuting. Also, cycling is the most preferable commuting mode and specifically
109 three times more likely to be chosen by males (Lawson et al., 2013). Another factor that influences active
110 transportation is the population-level patterns (Hankey et al., 2017). Based on spatial estimates of bicycle
111 and pedestrian traffic it has been shown that travel correlates with street functional class and proximity to
112 high traffic roads. Also, it is seen that the highest rates of active travel are in neighborhoods with high
113 levels of population density, land use mix, open space, and retail area Hankey et al. (2017). Similarly,
114 Mathews et al. Mathews et al. (2009) supports that there are significant differences among race, sex
115 and age when it comes to be physically active as well as the type, location, and purpose of activity. In
116 their study, they concluded that men engage in pedestrian activity for going to work while women were
117 more likely to walk for escorting their children to school and running errands. Whites primarily engage
118 in leisure-time pedestrian activity, and non-whites are more likely to engage in pedestrian activity for
119 transportation. On the other hand, older adults were less active than their younger counterparts. Further,
120 Yang et al., Yang et al. (2012) through their study for identifying the association between time spent in
121 active commuting, support that men are using bicycles more than women while women prefer to walk to
122 work, walk when they take the children to school and walk to the shops. Also, greater active commuting
123 leads to higher levels of moderate to vigorous physical activity mostly for women. Age also plays an
124 important role for being active (Sener and Lee 2017) since young people tend to walk more and use their
125 bikes more than older people. Therefore, it is recommended that walking and bicycling can be enhanced
126 through infrastructures development and built environment enhancements as well as workplace programs.
127 A study by Hallal et al. 2012 shows that a large percentage of 95% of adults are physically inactive.
128 Women and boys are more active than men and girls. Also, inactivity rises with age and is increased in
129 high-income countries.

130 In this literature review we also vividly see that physical activity affects health. More specifically, the
131 relationship between active commuting and physical and mental wellbeing was examined by Humphreys
132 et al. (2013). Their results showed that active commuting is associated with high levels of physical
133 wellbeing. The relationship between active travel and psychological wellbeing has also been examined by
134 Martin et al., Martin et al. (2014). With the use of fixed effects regression models, they investigated how
135 travel mode choice, commuting time, and switching to active travel impacted the overall psychological
136 wellbeing. Also, they investigated how travel mode choice impacted the specific psychological symptoms.
137 Their results showed that there is strong relationship between overall psychological wellbeing and active
138 travel and public transport when compared to car travel, time spent for walking and driving, and switching
139 from car travel to active travel. Additionally, active travel was associated with reductions in the likelihood
140 of experiencing some specific psychological symptoms when compared to car travel. Based on their
141 results we can say that positive psychological wellbeing effects should be considered in interventions
142 seeking to promote active travel. Furthermore, Mulley et al., Mulley et al. (2013) supports that there
143 are important health benefits from active transport modes. Each additional hour spent in a car per day
144 was associated with a 6% increase in the likelihood of obesity. On the other hand, each additional hour
145 spent on walking per day was associated with a 4% decrease in the chance of obesity. Also, there is an
146 association between active travel, recreational and total physical activity. Sahlqvist et al. (Sahlqvist et al.,
147 2012) found, that adults who used active travel report significantly higher total physical activity and more
148 healthy and happier compare to those who did not. Based on this study substantial physical activity can
149 be accumulated through active travel. This also shows that active travel is very much associated with
150 pre-determined factors such as the willingness of people to be physically active.

151 Many studies are focusing on children's commuting to school and the effects that this has on their
152 body weight and physical condition. Studies such as those of Faulker et al.(2008) showed that children
153 who walk or bike to school have better physical condition and healthier body weights. Also, Schoeppe et
154 al., (2015) investigated the associations of children's active travel to school and non- school destinations.
155 According to the findings, active travel to non-school destinations was positively related with children's
156 daily moderate-to-vigorous physical activity, in contrast to active travel to school. Furthermore, active
157 travel modes were not associated with children's sedentary behavior levels. Regarding the gender, there
158 were not any significant differences.

159 Moreover, an interesting study was conducted for analyzing commuters' punctuality and energy levels
160 at work and school (Sahlqvist et al., 2012). Ten multilevel mixed-effect logistic regressions were used to
161 determine the factors that impact the commuter's feeling of being energized when they arrive at work
162 or school and their punctuality. Results showed that weather conditions and mode of transportation
163 have significant impact on an individual's energy at work and punctuality. It is important to note that
164 drivers have the lowest likelihoods of being energized and the highest likelihoods of arriving late for
165 work. Meanwhile, cyclists have the highest likelihoods of feeling energized and being punctual. As a
166 conclusion, this study suggests that satisfaction with travel mode is associated with higher likelihoods of
167 feeling energized and being punctual. This study clearly shows the potential of active commuting and the
168 benefits that can be gained.

169 Built environment and street connectivity also affects active transportation and physical activity. Some
170 studies showed that street connectivity is statistically significantly correlated with active transportation
171 Berrigan et al. (2010). More specifically, an explicitly geographic approach can strengthen studies of the
172 built environment and physical activity and specifically active transportation. This shows that connectivity
173 is a major factor for walkability. Connectivity can be enhanced by providing the necessary information
174 to travelers and this can be achieved by an appropriate smart phone application. Also, green space and
175 living in different travel-related urban zones can contribute to active transportation. Mäki-Opa et al.
176 (Tomi E. et al., 2016) suggest that a good pedestrian and cycling infrastructure can play an important role
177 in promoting active transportation regardless of educational background, leisure-time and occupational
178 physical activity. The benefits of pedestrianizing an area are very significant and were identified by a
179 study from Soni and Soni 2016. The benefits were divided into five categories, that is transportation
180 related, social, environmental, economic and health related. Some of the transportation related benefits
181 are mobility and accessibility improvement, reduction in car use, congestion and parking need, road
182 crashed and injury reduction. The social category includes social interactions and relations and security
183 and safety increase. Air pollution and noise reduction are some of the environmental benefits and fuel and
184 land saving are economic benefits. According to the health benefits, unpolluted air intake in respiration,
185 exercise, fat loss and fitness, improvement in psychological health and metabolism and digestion are
186 some of the factors. Another study that supports the fact that the built environment contributes positively
187 to physical activity is the study by Carlin et al., 2017. In their research it was shown that pedestrian
188 and cyclist safety structure were positively correlated with physical activity, while lack of sidewalks
189 and streetlights were negatively correlated with physical activity. Finally, Schwartz (2008), examines
190 associations of the built environment surrounding worksites and of work policies with walking behaviors.
191 The results showed that when locating sites for work premises that are walkable and when also applying
192 some policies at the same areas, then the employees become influenced to actively commute to their work
193 more often. Also, Yu, 2015 examined pedestrian injury severity indicating that individual characteristics,
194 road environments and area characteristics around the crash location affect positively the pedestrian injury.
195 Further, Zuniga-Teran et al. 2017 suggest a "Walkability Framework" to be used as a model to measure
196 interactions between built environment and physical activity. The study integrates walkability categories
197 with the two main purposes of walking, that is pleasure and transportation.

198 Another study that explores the benefits of active transportation is that of Olabarria et al., 2014, that
199 took into consideration socio-demographic, mobility, road safety and environmental characteristics of
200 the neighborhoods for walking and motorized trips. The results showed that motorization negatively
201 affects walking, as walking rates fall when motorization rises. The suggestion is that motorization is a
202 factor that should be considered when promoting safe active travel. Ding et al., 2016, with their work
203 aim to a better understanding of the economic burden to increase physical activity levels all over the
204 world. Using available data from countries representing 93% of the worlds' population, direct health-care
205 costs, productivity losses and disability-adjusted life-years were estimated. The claim here is that physical

206 inactivity leads to a significant economic burden. The results showed that promotion of regular physical
 207 activity should be prioritized to reduce non-communicable diseases. Based on the above the next section
 208 presents a conceptual framework for analyzing the prospect of active transportation. As we see later
 209 on independent, mediating and moderating variables are identified with more focus on the potential of
 210 information in the context of a smart city.

211 DEVELOPMENT OF A CONCEPTUAL FRAMEWORK ON ACTIVE TRANS- 212 PORTATION

213 By identifying the variables that promote and influence the commuter's willingness for active trans-
 214 portation as well as the positive impact on the natural environment, on health and the quality of life,
 215 a conceptual framework is developed and presented in this section. Variables were grouped into this
 216 conceptual framework based on the relationship between the independent variable "Information" and the
 217 depended variable "Commuters' Willingness for Active Transportation" as shown in Figure 1. Within this
 218 relationship we have three sets of moderating variables that affect the decision for active transportation.
 219 The first set of moderating variables is the "Individual Characteristics" such as demographic character-
 220 istics (age, sex, weight, level of education) and socioeconomic characteristics (profession, car ownership,
 221 family with children). The second set of moderating variables is health problems that are caused by
 222 not being active such as high blood pressure, diabetes, cardiovascular complications and other diseases
 223 that are threatening the public health. The third set of variables is "Culture/ Mindset". An opportunity
 224 exists here to change the mindset of people in order to add active transportation into their daily routine.
 225 Further, we have three mediating variables in our theoretical framework, namely wellbeing at work,
 226 obesity and municipality decision making for improving pedestrian conditions. Specifically, municipality
 227 decision making mediates between information and the pedestrian condition index; obesity mediates low
 228 active transportation and health problems; and finally wellbeing at work mediates between commuters
 229 willingness for active transportation and job satisfaction/ productivity.

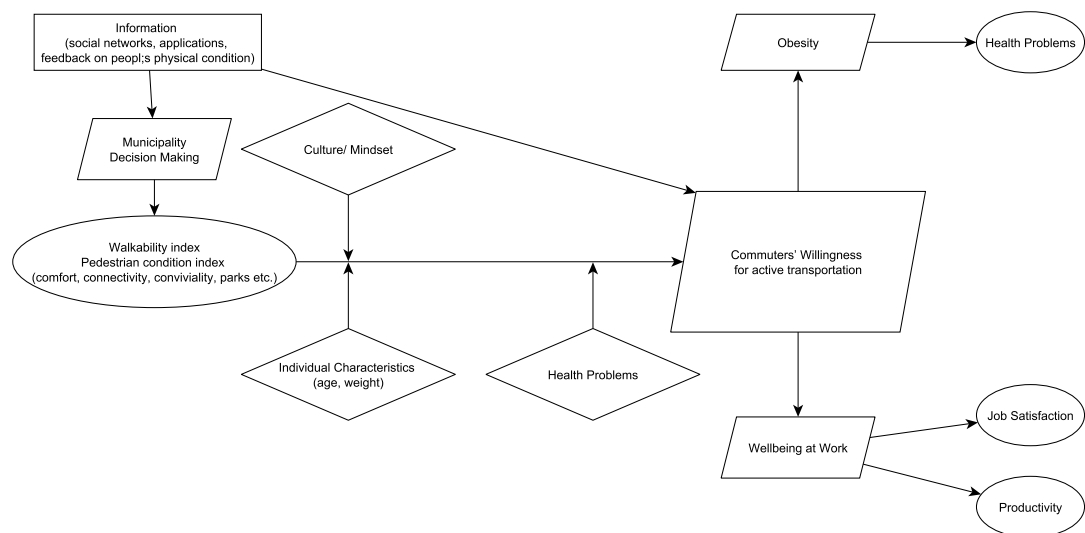


Figure 1. Theoretical framework

230 As a result of the above theoretical framework (Figure 1) a number of research questions need to be
 231 answered such as:

- 232 • 'How does the necessary information about the pedestrian and cyclist network affect the willingness
 233 of the commuters for active transportation?'
- 234 • 'Are commuters willing to be more active under certain conditions in the pedestrian infrastructure?'
- 235 • 'How does culture influence the commuters' willingness for AT?'

- 236 • 'Are individual characteristics and willingness for AT correlated?'
- 237 • 'How do health problems influence commuters' willingness?'
- 238 • 'Does the commuters' willingness to actively transport lead to increased wellbeing at work?'
- 239 • 'How does AT influence productivity and job satisfaction?'
- 240 • 'Does the willingness for AT reduce obesity?'

241 Further, a number of hypotheses to be tested include the following:

- 242 1. H0: There is no correlation between the information about the pedestrian and cyclist infrastructure
243 and the commuters' willingness for active transportation. H1: With the appropriate information
244 about the pedestrian and cyclist infrastructure, the willingness of commuters' will increased.
- 245 2. H0: The conditions of the infrastructure are not related to the willingness for active transportation.
246 H1: The conditions of the walkability infrastructure are related to the willingness for active
247 transportation.
- 248 3. H0: There is no correlation between them. H1: There is a correlation between people's culture and
249 their willingness to AT.
- 250 4. H0: There is no correlation between individual characteristics and willingness for AT. H1: Individual
251 characteristics are related to willingness for AT.
- 252 5. H0: Health issues are not correlated to willingness for AT. H1: Health issues are correlated to
253 commuters' willingness to actively transport.
- 254 6. H0: There is no relationship between willingness for AT and wellbeing at work, productivity and
255 job satisfaction. H1: Willingness for AT is related to wellbeing at work, productivity and job
256 satisfaction.
- 257 7. H0: Commuters' willingness to actively transport and obesity are not correlated. H1: Commuters'
258 willingness to actively transport is correlated to obesity.

259 CONCLUSIONS

260 This paper explored the variables that positively influence active transportation of modern commuters.
261 As a result, a theoretical framework is developed that identifies independent, mediating, and moderating
262 variables that influence commuter's willingness for active mobility. Further, the relationships among
263 the identified variables were drawn on an integrated conceptual model. This was achieved based on an
264 extensive literature review on active transportation and the benefits on commuter's health and wellbeing.
265 Knowledge from the literature review was synthesized into a holistic model for commuter's active
266 transportation.

267 Based on the model, clear research questions to be explored were derived and a number of formal
268 hypotheses were developed. The next step is to carry out a survey study on the topic of commuter's
269 active transportation which will provide us with the necessary data in order to develop a multidimensional
270 predictive model on active mobility for commuters.

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