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Khatun E Zannat

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# **AN ANALYSIS OF ACTIVE TRANSPORT TRAVEL BEHAVIOR OF YOUNG ADULT**

A CASE STUDY OF UNIVERSITY STUDENTS OF GRENOBLE

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**KHATUN E ZANNAT**

June, 2017

**SUPERVISOR: DR. KAMILA TABAKA**

# **AN ANALYSIS OF ACTIVE TRANSPORT TRAVEL BEHAVIOR OF YOUNG ADULT**

**A CASE STUDY OF UNIVERSITY STUDENTS OF GRENOBLE**

This thesis report has been submitted to the Institut d'Urbanisme de Grenoble, France in partial fulfillment of the requirements for the Erasmus Mundus double degree master's program on International Cooperation in Urban Development & Master of International Cooperation in Urban Planning.

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June, 2017

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## Abstract

Physical activity in any means is important for all, irrespective of age and gender, however, shift from the adolescence to adulthood is considered to be more susceptible to gain obesity and health risks. It is agreed that physical activity patterns, established in young adult life stage, are likely to endure for a long time. So, to promote active travel behavior and improve health condition of the future adults, young adult is an important life stage to intervene. The purpose of this study is to explore how individual, social, and environmental factors do influence the commuting behavior of emerging adults primarily. Grenoble city is selected as a case for the study. Two institutions (Institut d'Urbanisme de Grenoble (IUG) and Institut de géographie alpine (IGA)) of Université Grenoble Alpes and École nationale supérieure d'architecture de Grenoble (ENSAG) are selected to study the students aged 18 to 25. The association between different factors and active travel behavior of the students are analyzed using both spatial and statistical analysis techniques. For spatial analysis, a face to face interview is conducted through spatial mapping (geocoding) and three spatial attributes (land use, land use mix and public transport service area) are considered as the basis for the analysis. For statistical analysis, in addition with the face to face interview, an online questionnaire survey is conducted, focused on three types of factors (socio-demographic, travel, and environmental factors) associated with the active travel behavior of young adults. Both descriptive statistics and binary logit model are used for this purpose. The findings from these two analyses reveal that there are significant relationships exist between different socio-demographic, travel and environmental factors and students' active travel behaviors. Besides, this study also explores the potentiality of different alternative strategies adopted in the city of Grenoble and gaps of these interventions from the perspective of students. Therefore, this research justifies the importance of young adult life stage for the promotion of active transportation and potentiality of their participation in research works.

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# 1. Chapter: Introduction

## 1.1 Background

In the contemporary global pace of urbanization, urban transportation is in the limelight for its impacts on health and environment (Black, 2010, Winters et al., 2007). It is estimated that transport sector alone is responsible for 25% of world's greenhouse gas emission that is responsible for global climate change. In addition to this, since the beginning of 21<sup>st</sup> century, the rate of carbon dioxide emission from transport sector is augmenting on an average rate of 1.5% annually (Black, 2010). Conspicuously, the preeminent victims of these pollutions are those who are directly exposed to the pollution, specially the road users and people living or working near the busy urban roads (Wee, 2007). Meanwhile, thriving dependency on automobile both in the developed and developing countries, irrespective of the wealth of these countries, are apparent in several studies, reports and statistics (Kenworthy and Laube, 1999, Clark, 2009), which exacerbate the environmental problems within the society. However, it is conceivably true that modern urban life without transportation is unimaginable and transportation is considered to be the skeleton that socially and economically affords complex urban fabric (Moore and Pulidindi, 2013). Therefore, planners and transport engineers are working hard to find innovative solutions to combat these problems (Baltes, 1996).

In order to combat the negative consequences, engendering from the transport sector and to achieve sustainable urban transport, significant researches and studies have been carried out to rethink about urban transportation and elicit the appropriate strategies and measures in this regard (Black, 2010, Oswald Beiler, 2016, White, 2016). In the midst of debate pertinent to measures more oriented towards sustainable transport; generally, there is a consensus that public transport as well as active travel enhance sustainability (Santos et al., 2013, Bjørnarå et al., 2017, Pucher et al., 2010a). Moreover, promotion of public transport and active travel increase physical activities (Ermagun and Levinson, 2017), reduce car uses, pollution and congestions (Lachapelle et al., 2011, Pérez et al., 2017, Bopp et al., 2015). Here, active travel, referred to the human powered mode of travel, involves different modes and methods to travel such as walking, cycling, skating, skateboarding, skiing etc.

For the promotion of public transport, it is quintessential to think about active travel particularly walking and cycling, since the use the public transport also involve certain degree of active travel (10 minute walk) (Cohen et al., 2014, Djurhuus et al., 2014, Rissel et al., 2012, Frank et al., 2004). The strong association between access to public transport and active commuting is proved by Djurhuus et al. (2014), from the study of Denmark. Apart from active travel required to use public transport, walking and cycling have been used independently for utilitarian as well as for recreational purpose (Djurhuus et al., 2014). For instance, in Denmark almost 70% people use cycle to go to work in summer, which is on an average 46% throughout the year (Andersen et al., 2000).

It is widely acknowledged that active travel is the most environmental friendly mode of transport (Litman, 2013). The importance of active transport is not merely confined to its environmental benefits. It is also widely conceived as a type of physical activity (Pucher et al., 2010a, Bopp et al., 2015, Cohen et al., 2014, Djurhuus et al., 2014, Sahlqvist et al., 2012), as, 30 minutes of recommended physical activity for adult is equivalent to walk 2 miles briskly (Booth and Chakravarthy, 2002) or 2-3 miles cycling (Cohen et al., 2014). Furthermore, it is empirically proven through several studies that active travel has crucial relationship with physical activity, obesity and coronary diseases (Pucher et al., 2010a, Bopp et al., 2015, Wang et al., 2005, Jones and Eaton, 1994). Like health and environmental benefit, economic benefit associated with active travel is also worthwhile; this statement is reinforced through several cost-benefit analyses of investment that is spend for the construction of infrastructures (e.g. walking and cycling track,

walking and cycling facilities) required to facilitate active travel (Davis, 2010, Gotschi, 2011, Wang et al., 2005, Sælensminde, 2004). Therefore, the potentiality of investment for walking and cycling is worthwhile for the society compared to other transport investments (Sælensminde, 2004), which would further increase the future number of cyclists and pedestrians. Apart from this economic, environmental and health benefits, active transportation, particularly walking and cycling in transport purposes entail indirect benefit of better quality of life and psychological well-being to the personnel as well as to the community (Wang et al., 2005). Furthermore, when active transportation is used alone (not in the intermodal way), it decongests other infrastructures (e.g. motor way and public transportation) in the peak hour, enabling and regulating a balanced urban system.

Despite of having several direct and indirect benefits of active travel, unfortunately active commuting comprises a very small proportion of total trip in different countries (e.g. 3% of total trip in U.S.) (Bopp et al., 2015, Baltés, 1996, Kaczynski et al., 2010), and is marginalized compared to other modes of transport (Gouda and Masoumi, 2017). Even though the amount of active travel in European cities are 3 to 5 times higher than the US (Pucher et al., 2010a), yet in UK 25% people do not even walk for 20 minutes in a year (Cohen et al., 2014). Moreover, there is a still decreasing trend of active travel which is replaced by increasing trend of car uses (Caspersen et al., 2000, Cohen et al., 2014, Gordon-Larsen et al., 2005, Davis, 2010), as, it is indisputable fact that to overcome the health and environment related problems associated with urban transportation, a shift from car use to active travel is imperative (Rabl and De Nazelle, 2012). This trend imports physical inactivity notably among children, adolescence, and adult.

Even though physical activity in any means is important for all, irrespective of age and gender, shift from the adolescence to adulthood is considered to be more susceptible to gain obesity and health risk. The reason why this life stage (18-25) is more prone to health risk, is several life events incurred in this time like change in food pattern, physical activity, way of living etc. (Nelson et al., 2008, Kwan et al., 2012). Also, this is the time period when people are more occupied with sedentary way of working and studying with their compact time schedules. These changes in life course often results in decreasing level of physical activity (Allender et al., 2008). This trend of declining physical activity is well documented in several researches (Dowda et al., 2003, Buckworth and Nigg, 2004, Keating et al., 2005, Sisson and Tudor-Locke, 2008). This transitional age (18-25) is termed as “*emerging adult*” by Arnett (2000), is an important life stage. According to Arnett (2000), huge diversity of activities are apparent in this life stage those are not even possible in the adolescence stage or in adulthood. Even though a century before, in this stage people thought about marriage and settled life, however, now from the beginning of twentieth they are thinking about higher education, better career and exploration of identity for future.

Meanwhile, it is ascertained in several studies that physical activity pattern establishes in young adults (18-25) are likely to endure for long time. Hence, they are likely to maintain the habit throughout their adulthood that they have developed during this emerging adulthood time period (Keating et al., 2005, Sparling and Snow, 2002, Fish, 1996, Corbin, 2002). Furthermore, within this time period a particular group of people is working, studying, or doing both of those activities. Therefore, this group of people is the future adult and forerunner of the society. So, to promote active travel behavior and improve health condition of the future adult, young adult is an important life stage to intervene. In these circumstances, the purpose of this study is to explore how individual, social and environmental factors influence the commuting behavior of emerging adult primarily. Recent research by Simons et al. (2017) covered the part of working young adult whereas this research is focusing on those who are studying in University. The outcome of this study will show that a number of personal, social and environmental variables are associated with active travel behavior of young adult going to university for higher education.

## **1.2 Research question**

Therefore, from the above synthesis, this research will try to answer the following research questions:-

- What are the socio-demographic and environmental factors affecting the use of active transport of young adults?
- How these factors are influencing the use of active transport among the young adults?
- What are potential solutions to improve future active transport use from the perspective of young adults?

## **1.3 Hypothesis**

The above mentioned research questions are fixed based on the following hypothesis:-

Active travel behavior developed in the time of emerging adulthood will increase the future active as well as public transport uses that will ensure future sustainable urban transportation.

## **1.4 Objectives**

Therefore, in light of above mentioned research questions and hypothesis, this research will try to fulfill the following objectives:-

1. To analyze the travel behavior of active transport users going to university as well as in the stage of emerging adulthood through spatial mapping and statistical analysis
2. To analyze the potentiality of alternative improvement measures through the development of a comprehensive framework to augment future active transport use in case of Grenoble including the perspective of young adult

## **1.5 Scope of the study**

This study explores the active travel behavior of emerging (18-25) adults who are studying in university. However, there are enormous activities like part time or full time job, vocational training, and involvement in volunteer work after higher secondary school apart from studying in university in which people from early twentieth are engaging themselves in order to get practical experiences before starting higher studies. This study does not cover other fields of activities related to part time or full time job of the students and does not count people's active travel behavior related to those activities. Also, the research framework is developed based on the theory of Triadic influence developed by Flay and Petraitis (1994) which is explained in the literature review chapter, therefore, this study focus more on distal determinants (demographic, social-cultural and environmental factors) rather than on proximal determinates (attitude, subjective norms and perceived behavior) pertinent to active travel. Future research can be done combining both proximal and distal determinants to elucidate the active travel behavior of emerging adult. Also, the cross sectional analysis of this research does not provide any causal relationship.

## **1.5 Organization of the thesis**

The thesis has been started with background information regarding the major challenges facing by planners and decision makers in achieving sustainable urban transportation. Meanwhile, it exhibits the importance of active transportation in order to attain our desired goals to have healthy, sustainable society. Furthermore, it reveals the ongoing figures of active transportation to understand the reason to think about this issue and apprehend the necessities to do this research in the field of transportation related to active transportation. Then, a brief explanation is given on the intention of this research work. In the next section that means in the chapter 2, where the outcome of literature review is summarized. That chapter is organized in the same way as this research is progressed. Each section of that chapter has clarified different concepts and pointed out the research gap which has helped to develop the methodology for this study. In chapter 3 a brief discussion on methodological framework is

given. It contains stepwise methodology with justification for every step. Chapter 4 contains the general understanding about the case study and rationality behind selecting Grenoble city as a case. Chapter 5 and 6 are two analysis chapters. Chapter 5 contains the spatial analysis and chapter 6 the statistical analysis with an aim to achieve the first objective that will answer the first and second research questions. Chapter 7 is illustration about the framework developed to promote active travel behavior based on the review of ongoing measures taken to facilitate active transportation in different cases around the world and analysis of the case study based on the framework and solutions suggested by the young adults in this study which helps to fulfill the second objective. Finally in the chapter 8 all findings from the analysis are summarized and a brief conclusion has been given to check whether the stated objectives of this study are achieved or not.

## 2. Chapter: Literature review

### 2.1 Implication of active travel

It is widely acknowledged and proved that physical activity is imperative for healthy life as well as act as a catalyst for reduced mortality and morbidity rate. According to Andersen et al. (2000), the rate of mortality among physically inactive person is apparently double compared to those who are active and participate in sports and leisure time physical activities. Now, the importance of physical activity has got such an attention that researchers are now looking for sustainable physical activities (Bjørnarå et al., 2017). However, no matter the context or the environment, all of the ongoing researches related to health or physical activity are putting more light on walking and cycling, as, these activities achieve higher health benefits using less equipment and transport intensive endeavors (Saunders et al., 2013, Sahlqvist et al., 2012). Also, in this competitive world when it is difficult to find out time for recreational activity and physical fitness, it is more uncomplicated to utilize walking and cycling to work as an alternative of physical exercise (Kaczynski et al., 2010). In this regard, Andersen et al. (2000) examined that cycling to work has positive benefits, similar to leisure time physical activities. Furthermore, Oja et al. (1998) illustrated the importance of daily walking and cycling to work as an important form of health-enhancing activity.

When it is agreed in the health science that cycling and walking is a good form of physical activity, now, in the field of sustainable mobility more heed is imposed on active travel as a sustainable means of transportation (Oswald Beiler, 2016). According to Gouda and Masoumi (2017), “*Sustainable transportation is a main subset of urban sustainability and Urban sustainability certification (USC) supports six components of sustainable transportation: active transportation, public transportation, carpooling, car-sharing, alternative transportation, and sustainable management of freight transportation*”. Therefore, it is avowed that active transport is an imperative means of urban sustainable transportation and it is compulsory with other alternative facilities to ensure urban sustainability.

Besides ensuring sustainability, active transport has been considered as a quintessential intervention in developing healthy city and in improving the quality of life (Pucher et al., 2010a, De Geus et al., 2008, Hart and Parkhurst, 2011). For example, Hendriksen et al. (2010) have practically gauged through a study of working people in Netherlands that those who are using cycle to work have less amount of sickness report compared to non-cyclists. Furthermore, increasing level of walking and cycling to work place is a kind of active living style. Moreover, it is empirically appraised by Edwards (2008) that apart from the solitary walking and cycling activity, additional walking required to avail public transport could save \$5500 per person through the reduction of medical expenses. In another study, it is enumerated that if 10% adult started to walk, it would save in U.S. \$5.6 billion from heart disease cost (Jones and Eaton, 1994). This savings from medical expenses is an indication of palpable health benefits, associated with walking and cycling. Nevertheless, the contribution of active transportation in developing healthy city is not merely confined to the development of physically healthy people rather it has a contribution in reducing pollutions, congestions, and other externalities, associated with other mode of transportation. It is estimated by Rabl and De Nazelle (2012) that in a large city ( 4,500,000 population) if one person choose bicycling instead of car to commute for 5km (one way) in 5 working day per year, the health benefit from the physical activity is valued about 1300 Euro/year and the value of the reduced air pollution is 30 Euro/year. It is also worthwhile to mention that active transport benefits are no longer confined with the passenger transportation, it has been using for goods movement in Paris and an estimated amount of annual savings 0.8 M Euro found from transport externality savings (Koning and Conway, 2016).



From the above discussion, it is quite clear that research related to active transportation is important for both the field of health and transportation. As, level of physical activity is not only linked with physical exercise, it varies depending on the selected means of transportation also (Craig et al., 2002). According to Wen et al. (2006), based on their research on working population in Australia, people who use car to go to work are experiencing inadequate levels of physical activities compared to non-users. Furthermore, it is identified by Wener and Evans (2007) that train commuters reported 30% more steps per day which is four times higher than car commuters. Also, Rissel et al. (2012) have acknowledged through systematic review of ongoing researches related to adult using public transport that substantial increased use of public transportation will transform physically inactive adult into an active one. However, not only the mode choice, traffic speed as well as traffic volume is associated with the physical activity and development of social relation in a community (Mindell and Karlsen, 2012, Hart and Parkhurst, 2011). Theoretically, it is proven by Bopp et al. (2011b) and Brown et al. (2016b) that transport intervention can be effective from the perspective of obesity prevention and promising strategy for improving physical activity. Therefore, it can be inferred that active commuting is an important intervention to ensure health benefits as well as sustainable mobility.

However, though it is easy to say about the importance of active transportation, in the meantime, hard to increase the number of active commuting for transport purpose because of the competing popularity of other modes (Privately own vehicles). But, the reason behind the popularity of automobile compare to other available modes is not the high number of car availability in the market compared to other modes. Rather, it is more embedded to the offered facilities afforded or declined by different available modes (Baltes, 1996). Hence, to promote a particular mode uses, it is imperative to think about the offered facilities of that mode and the actual requirement of the users. In this regard, there are several challenges identified by several researchers in terms of promoting active transportation (Hamann and Peek-Asa, 2017, Nilsson et al., 2017). Handy et al. (2014) have well documented the challenges regarding the promotion of cycling for transport purpose in a nutshell. According to them, identification of the actual number of cycle users (transport or recreational purpose), effective interventions among different possibilities to promote number of cycle users for transport purposes and potential evidence to reinforce the decision behind investment in cycling infrastructures are the major challenges. In order to overcome these challenges, potential factor identification could be significant in promoting cycle users as well as empirical evidence to ensure optimum utilization could be more constructive and advantageous (Handy et al., 2014).

## **2.2 Theory related to travel behavior**

In order to understand the active travel behavior, several researchers working in the field of health and transport have been using different theories developed in the field of psychology, social science and urban studies. Among them, theory of planned behavior by Ajzen (1991), theory of Triadic influence by Flay and Petraitis (1994), ecological model of health behavior by Sallis et al (1996), Richard et al (2011), McLeroy (1988), social ecology model by Stokols (1992), social cognitive theory by Bandura (1999) are widely used model to understand and elucidate the active transport behavior and associated physical activity.

### **2.2.1 Theory of planned behavior and Theory of Triadic influence**

Theory of planned behavior is the extension of Theory of reasoned action. In the light of Theory of Planned behavior, general disposition to predict a particular behavior is a poor endeavor, since it is empirically proved that traits and attitude have a poor relationship with behavior in a specific situation. According to this theory, to understand a specific behavior it is imperative to combine occasion, situation

and forms of action. The central factor of Theory of Planned behavior is one's intention to perform a behavior. It is assumed that when the intention is strong, people are more likely to engage in that behavior. Along with this intention, in this model the new addition is the perceived behavioral control from Bandura's concept of perceived self-efficacy (1977) i.e. one's perception of performing a particular behavior (confidence in their ability). According to the Theory of Planned behavior, perceived behavioral control, in addition to behavioral intention, can explain directly the behavioral achievement; however, depending on the situation either intention or behavioral control could be more imperative than the other. Meanwhile, the behavioral intention is dependent on three independent determinates: attitude towards that behavior, subjective norm and perceived control behavior. In this regards, the relative importance of each of the independent variables depend on the behavior and situation (Ajzen, 1991).

Theory of Triadic influence is developed by Flay and Petraitis (1994) to understand the health behavior in a more comprehensive way. Alike the theory of planned behavior, this theory also considers personal behavioral intention (Proximal factors) as an important determinant of behavior, however the underlying fact is, a person's attitude, social norm and self-efficacy towards a particular behavior is also dependent or bound respectively on his/her cultural origin, social situation and inherited disposition. Hence, Theory of Triadic influence additionally considers the background factors such as socio-cultural-environmental factors (Distal factors) as ultimate causes of behavior. The hypothesis behind this is behavior is deeply rooted in a person's general cultural environment, current social situation, and personal characteristics.

Several researchers have used these conceptual frameworks in explaining the active travel behavior of different samples, in different situation and in distinct context (de Bruijn et al., 2005, Chaney et al., 2014, Muñoz et al., 2016). de Bruijn et al. (2005), have used the Theory of Planned Behavior in addition with Theory of Triadic Influence to custom their conceptual model for identifying determinants of adolescents' bicycle use for transportation and snacking behavior. From their findings it is observed that adolescents snacking behavior is more intentional than bicycle use. In case of bicycle use it is more dependent on other **external determinants** rather than on attitude, subjective norm, and perceived behavioral control. On the other research by Chaney et al. (2014), perceived norms and the level of control students had regarding their method of transportation were important contributions to AT use.

### **2.2.2 Ecologic model**

Even though, the term 'ecology' is rooted in biology, it has been developed in several disciplines like sociology, ecology, public health, behavioral science (Stokols, 1992). The core concept of ecological model is, behavior is not only influenced by a single homogenous factor rather more by intrapersonal (biological, psychological), interpersonal (social, cultural), structural, communal and physical environmental factors, and policies (Sallis et al., 2008). The forerunner of this model is Urie Brofenbrenner. According to Brofenbrenner's model, behavior is affecting as well as affected by multiple levels of influence (McLeroy et al., 1988). From the perspective of social ecology, well-being of people is more dependent on social as well as physical environment along with their personal attributes. Therefore, unlike the behavioral model focused more on individual and social factors, from the view of ecological model, it reinforces the important to understand the complex nature of environment encompassing the community and incorporate multiple level of analysis to understand its dynamic interrelations between people and environment (Sallis et al., 2008).

Moreover, along with several applications of this ecologic theory in health, social science, the fundamental principles of this theory have been used to understand different social and environmental impacts in physical activity (Sallis and Glanz, 2006, Sallis et al., 1997) as well as active transport behavior (Saelens et al., 2003, Hess et al., 2017). It is found from the study of Saelens et al. (2003) that

how environmental factors are responsible in promoting or restricting physical activity as well as active lifestyle. Furthermore, based on ecological approach, Cerin et al. (2006) have identified potential individual and community level predictors have influence on selecting walking as a mode of transport. Furthermore, based on the socio-ecologic model of health behavior Feuillet et al. (2015) have postulated the importance of local built environment on individual's active transport behavior and significance of context specific environmental factors in elucidating human travel behavior. Therefore, all these researches intended to describe active transport behavior support the conceptual approach of ecologic model i.e. to observe behavior considering several aspects extended from individual to social and physical environmental factors.

### **2.3 Factors affecting active travel behavior**

It is necessary to identify potential factors affecting people's preference for active transportation in order to identify suitable interventions to promote active transportation. It is considered to be the first step before explaining the nature and pattern of active travel behavior in any particular place. Even though, it is agreed that active travel behavior depends on multiple aspects, however, there is no common consensus about the correlates and magnitude of these aspects. Different researchers have identified different personal, psychological, social, environmental factors which are either affording or restricting the active travel. Some authors have focused more on the physical environment rather than on individual factors affecting active travel with a hypothesis that change in built environment has long term benefit compared to individual targeted intervention (Craig et al., 2002, Feuillet et al., 2015, Frank et al., 2004). Meanwhile, some authors are focused on both social and physical environment with an assumption that their influence type is different depending on the purpose of active travel (Hess et al., 2017, Hoehner et al., 2005). According to their findings, in terms of utilitarian purpose, active transport is highly influenced by physical environment. On the other hand, for recreational purposes, along with physical environment, social environment has substantial influence in motivating people for walking or cycling.

However, the environment, which is on discussion, is also a matter of fact. It could be the environment of neighborhood, or the place where students study, people work or the city as a whole. Neighborhood environment and its importance on active travel is revealed in some researches (Jun and Hur, 2015, Cerin et al., 2006, Turrell et al., 2014, Simons et al., 2017). Also, the importance of workplace environment is justified, where it is more important to think about the social environment to inspire the employees to avail active travel to work (Handy and Xing, 2011). In the same way, for university students and school going children, the physical environment of the campus/school precinct is important to think about its influence on student's active movement (Handy and Xing, 2011, Bopp et al., 2011a). Apart from the importance of environment, the perceptions of individual as well as their psychological and biological factors are prioritized in several researches (Lemieux and Godin, 2009, Simons et al., 2017, Bopp et al., 2011b). Therefore, clearly there are different factors associated with active travel, however, these factors are not static and do not have similar influence in different local and global contexts. As a result, before defining an intervention to promote active travel, it is necessary to explore potential factors, which are influential in a context to make the investment worthwhile.

However, it is agreed that active transportation is important for all age group people, either to have healthy way of living or to have sustainable means of transportation, from the perspective of environment. Major researches related to active travel are more often focused on adults (Handy and Xing, 2011, Merom et al., 2008, Kaczynski et al., 2010, Ogilvie et al., 2008, Bopp et al., 2011b), child (Babey et al., 2009, Carlson et al., 2014, Bringolf-Isler et al., 2008, McMillan, 2005, McMillan, 2007, Pont et al., 2013, Schoeppe et al., 2013, Timperio et al., 2004, Witten et al., 2013) or adolescences (de Bruijn et al., 2005).

In the meantime, young adults, an important life stage, are often overlooked or in infancy in the research fields. Recent research related to young adult is done by Simons et al. (2017), focusing only on working young adults, where a huge proportion of young adults involve themselves in study and exploration of their future career. Meanwhile, some studies related to university students have been conducted when they are either compared with faculties and staffs (Bopp et al., 2011a) or focused on only bicycling (Titze et al., 2007) or focused more on individual factors affecting active commuting (Lemieux and Godin, 2009). Therefore, a little investigation is done to explore the perceived and objective physical environmental factors affecting young adult's active travel behavior while they are involved in study. It is important to explore this case, because they are on a verge to enter the professional sectors. Therefore, the behavior that they will adopt will continue throughout their adulthood. Table 1 includes the important literatures related to factors affecting the travel behavior of different aged people along with the significant findings of those researches.

#### **2.4 Active transportation and University students**

Universities are unique places of complex functionalities and logistics. Universities have massive impacts on the cities where are located and viz-a-viz (Tolley, 1996, Balsas, 2003). To make a university functional, it requires housing facilities, transportation, health, sports, energy etc. Among these facilities, transportation is the crucial one. However, the transportation, along with the universities, is simultaneously important for corresponding cities, as universities are major trip generators and cities have to afford this trips which is never confined within the campus (Shannon et al., 2006). On the hand, it is undeniable fact that trend of motorization culture in the university campus, parallel to society, is apparent and the movements of students and staffs are also associated with transportation externalities. It is estimated from the study of University of Central Lancashire that for 33m km per annum commuting of 13,000 students and 13,000 staff, the amount of carbon dioxide emission is 6.6m kg (Tolley, 1996). Therefore, like the city dwellers, travel behavior of the university students is also affecting the environment of the city, creating congestion and decreasing quality of life.

Meanwhile, it is found from an empirical study that only a few proportions of university students meet the recommended level of physical activity (34.3%) and engaged in active movement pattern (19.5%) (Sparling and Snow, 2002). In this regard, a shift from car to any kind of active movement could be an effective intervention to reduce the negative externalities associated with transportation and enhance the physical activity level among the students, faculty and staff (Shannon et al., 2006). Furthermore, it is empirically proven that the university students, who have been using public transport, are more likely to achieve the recommended level of physical activity compared to the car users (Villanueva et al., 2008). For this reason, it is high time to think about university campus and college students' mobility pattern to find out effective interventions that would have positive impacts on the city as well as university.

In the meantime, it is demonstrated by Balsas (2003) that a college campus could be a suitable model of sustainable transportation system that will ensure better mobility with minimum externalities. The reason is, university campus has been playing an important role for shifting modal choice from car to other alternative mode choices. It is proved that a significant shift from car to active transport will incur if there is available alternative modal options and reduced number of barriers to avail those alternatives (Shannon et al., 2006). Also, it is providing unique opportunities for the student to shape a healthy life through education and its physical environment (Sparling and Snow, 2002, Fish, 1996). However, it is often overlooked in the current literature that universities are not only affecting the current travel behavior of students; these are developing the future habit of the students, who would be the future forerunner of the nation (Balsas, 2003). Also, these behaviors develop during the college age become a part of their

lifestyle in adulthood (Fish, 1996). Therefore, the life experience during the university periods is quite important and university settings play an important role in this regard.

On the other hand, universities are working in different transport related research projects in collaboration with transit agencies to provide innovative transit pass programs (Balsas, 2003). So, universities have the higher possibilities to explore several innovative strategies to solve transport related problems and disseminate their knowledge to the decision makers with acceptable evidences. For example, “Unlimited access” is such a joint venture between university and transit agency, where university is paying a lump sum amount for student’s free access to public transport which in return increases transit ridership, student’s access to campus and reduces automobile dependency among the students (Brown et al., 2001). Along with identification and evaluation of innovative solutions, in the contemporary researches related to the active travel behavior of college student encompasses different strands of identification of several predictors associated with active travel, evaluation of physical activity level among different types of active travel users and so on (Sisson and Tudor-Locke, 2008, Chaney et al., 2014, Van Dyck et al., 2015). This contemporary researches further call for more in-depth understanding about college students travel behavior among young adults, in different location and university settings.

### **2.5 Chapter conclusion**

From this chapter, it is found that active travel is a concern of several disciplines and it is important for health, social, urban and transport studies. Therefore, it is demanding for more researches through the combined effort of different disciplines. Furthermore, this chapter shows the potential gap of the existing researches where this study is intended to contribute. In this regards, young adult group studying in university has been chosen for this study depending on the gap found in the literatures. Along with the gap, this chapter stipulates the necessities to think about the university students who are often marginalized in the researches as well as reinforce the inclusion of the students in the research.

Table 2-1: Major researches related to active travel

Author	Study Area	Focus	Age group	Main Argument	Factors considered for analysis	Statistical analysis	Findings
(Baltes , 1996)	MSAs of U.S	Factors influencing travel to work by bicycle	Different age cohort	Use of bicycle for work trip or any other purpose is a matter of personal preference and dependent on many factors that are within or outside of individual's control	Climatic condition, availability of bicycle amenities, parking cost and availability, topography, traffic levels, and other important factors like population, land area, age, education level, college and high school enrolment, population density, ethnicity, income, mode choice, poverty level choice, total worker in a family, mode choice, travel time to work, place of work, vehicle ownership, labor force participation, manufacturing employment, armed force to population ratio, owner occupied housing unit, worker density.	Multiple Regression model	High percentage of bicycling to work is found in the age from 18 to 24 enrolled in college. Also, this result is apparent in MSAs having major universities within their boundaries. Also, negative relationship found between vehicle available and bicycling to work
(de Bruijn et al., 2005)	Netherlands	Factors affecting the use of bicycle and snacking tendency of adolescent	Adolescence going to secondary school (mean age 14.8)	The intention can be best predicted by the consideration of both proximal and distal factors like attitude, subjective norms and perceived behavioral control	<b>Proximal factors:</b> Attitude, subjective norms, perceived behavior control, <b>Distal Factors:</b> ethnicity, home situation, degree of urbanization, school type, social environment, age, gender, perseverance, self-esteem and relation with parents	Bivariate correlation, multiple linear and binary logistic regression	Interventions aimed to change the behavior directly are not as efficient as those which are more focused on influencing distal factors.
(Bopp et al., 2011a)	Manhattan, Kansas, US	Factors affecting the active travel behavior in an university campus	Students and Faculty Staff of Kansas State University	Factors related to both individual as well as environmental level are important in association with active commuting among students and faculty members university	Demographic factor , psychological and environmental factor. Psychological influence (self-efficacy, environmental concern, health benefit, time constraint), Environmental influence (availability of sidewalks, preferences of traveling companions, terrain, safety from traffic or crime, and parking cost and availability, time required to come in campus through walking and cycling), frequency of trip per week by each mode of transport	Hierarchical regression analyses	Students actively commuted to campus more often than faculty/staff and walking was more common than biking. Finding highlights the importance of addressing a wide range of influences within a social ecological framework and simple environmental changes may not be enough to result in an increase in AC behavior.

Author	Study Area	Focus	Age group	Main Argument	Factors considered for analysis	Statistical analysis	Findings
(Handy and Xing, 2011)	U.S.	Factors related to bicycle commuting	Adult	Along with physical environment, social environment of the workplace is also important factor to influence bicycle trip beside other socio-demographic and individual factors.	Socio-demographic factors, individual attitudes (Self efficacy, ecological economic awareness), the built environment (availability of transport infrastructure, safety, land use, neighborhood type), natural environment and social environments (support from relatives, social influence and norms related to cycling)	Binary logit model	Residential environment with supporting facilities for cycling, physical distance of different destinations, safety on the street, and social environment in the workplace has significant influence on promoting cycling behavior.
(Simons et al., 2017)	US	Psychosocial and environmental factors in association with walking, cycling, public transport and car use.	Working young adult (18-26) both college and non-college	Both psychosocial and environmental variables are related to the four transport modes in college and non-college educated working young adults.	Socio-demographic factors, general transport data (driving license, ownership of moped, car/motorcycle and bicycle, pass ownership for public transport), transport to work and other destination (frequency, duration, combination of mode), psychosocial factors (self-efficacy, social norm, modeling, social support, perceived benefits and perceived barriers), perceived environmental benefits (residential density, land use mix diversity, land use mix access, street connectivity, walking and cycling facilities, aesthetics, safety from traffic, safety from crime, distance to work)	Binomial regression models	More college educated compared to non-college educated young adults participated in cycling and public transport. Psychosocial variables are more important than environmental variables for transport to destinations other than work.
(Singh, 2016)	New Delhi, India	Factors affecting urban walkability	Inhabitants of neighborhood	Several morphology of urban design either affords or restricts the walkability of neighborhood.	Factors supporting and restricting the walkability of street located in neighborhood (Street enclosure, block length, street vitality, factors making people uncomfortable)	Qualitative	Most important factors affecting pedestrians' perception of walkability is related to build envelop on either side of the streets. Enclosure, block length and edge conditions were found crucial in creating the perception of a walkable neighborhood.

Author	Study Area	Focus	Age group	Main Argument	Factors considered for analysis	Statistical analysis	Findings
(Mero m et al., 2008)	Australia	Predictors for initiating and maintaining active commuting	Working age (18-65)	To make the promotional intervention for active commuting more effective, it is important to identify the determinants of such behavior from transport as well as health perspective	Independent measures (self-efficacy, physical activity level, outcome expectation covering both health and transport benefit, physical activity participation in terms of time and duration, socio-demographic factors, distance from home to workplace, body mass index, mode used in a particular day at pre and post campaign, daily amount of walking/cycling to and from work, regularity of this behavior.	Pearson's chi-square, McNamara's chi-square, bivariate and multivariate.	Inactive individuals were the least likely to adopt or maintain AC, even in the single day (WTWD). A single day active travel is not associated with health concern. Avoiding the stress of driving and the hassle of parking were the only significant predictors of AC on WTWD.
(Muñoz et al., 2016)	Spain	Latent variables affecting bicycle commuting	Employees and students making commuting trip	In order to develop effective cycling policies it is essential to understand the key factors influencing bicycle commuting	Objective factors: Socio-economic and household characteristics, mode availability, trip characteristics Subjective factors: Cycling indicators.	Exploratory factor analysis (EFA)	Lifestyle, safety and comfort, awareness, direct disadvantages, subjective norm, and individual capabilities are six latent variables associated with active commuting.
(Kaczynski et al., 2010)	Manhattan, Kansas	Institutional factors influencing active commuting	Employees more than 18 year old	People with a workplace environment having cultural and physical supports are more likely to walk or bicycle to work.	Socio-demographic factor, walking time to work, employer's encouragement for active commuting, perceived number of coworkers actively commute to work, availability of bicycle facilities a, number of times per week walked and bicycled to or from work	Chi-square tests, Binomial logistic regression	The presence of workplace physical and cultural supports is related to more active commuting behavior and may especially encourage active commuting among women.
(Ogilvie et al., 2008)	Glasgow, Scotland	Personal and environmental correlates of active travel and physical activity	Resident of a household aged 16 or over	Perceived characteristics of local environment and objectively assessed proximity transport facilities are important along with socioeconomic and demographic factor to define the level of active travel	Socioeconomic status, perceptions of the local environment, travel behavior, physical activity and general health and wellbeing	multivariate logistic regression	After demographic and socioeconomic characteristics were taken into account, neither perceptions of the local environment nor objective proximity to major road infrastructure appeared to explain much of the variance in active travel or overall physical activity in this study



Author	Study Area	Focus	Age group	Main Argument	Factors considered for analysis	Statistical analysis	Findings
(De Geus et al., 2008)	Belgium	Psychosocial and environmental predictors of cycling	Working adult (18-65)	To influence commuter cycling, it is necessary to identify the factors that can be changed, so that relevant policies and effective interventions can be developed	Self-report measures of cycling, demographic variables (Age, gender, BMI, the highest level of education, working situation, distance and frequency of traveling to work and living area), psychosocial variables, self-efficacy, perceived benefits and barriers and environmental attributes (destination, traffic variables and facilities at the work place) of cycling for transport	t-tests, Chi-Square, logistic regression	The findings suggest that when people live in place with adequate cycling facilities, individual determinants outperform the role of environmental determinants. Promotional campaign should have an aim to create social support by decreasing social barriers and increasing awareness and self-efficacy
(Titze et al., 2007)	University of North Carolina	Environmental, social, and personal factors and cycling for transportation	University students	To better understand the determinant of cycling it is necessary to explore the different correlates of cycling behavior in general and for transportation in particular.	Socio-demographic aspects (Gender, age, BMI. Economic status, exercise level) and cycling behavior, and perceived environmental, social, and personal attributes of cycling for transportation	Multi-nominal regression analysis	Regular cycling was negatively associated with the perception of traffic safety and positively associated with high safety from bicycle theft, many friends cycling to the university, high emotional satisfaction, little physiological effort, and high mobility. Irregular cycling was positively related with environmental attractiveness and little physiological effort.
(Van Cauwenberg et al., 2012)	Belgium	Physical environment and walking for transportation	Older adults ( $\geq 65$ years)	A well perceived environment with objectively identifiable facilities is suitable in encouraging more walk trip for transportation.	Access to facilities (shops & services, public transit, connectivity), walking facilities (sidewalk quality, crossings, legibility, benches), traffic safety (busy traffic, behavior of other road users), familiarity, safety from crime (physical factors, other persons), social contacts, aesthetics (buildings, natural elements, noise & smell, openness, decay) and weather	Content analysis	To promote walking for transportation a neighborhood should provide good access to shops and services, well-maintained walking facilities, aesthetically appealing places, streets with little traffic and places for social interaction. In addition, the neighborhood environment should evoke feelings of familiarity and safety from crime.

Author	Study Area	Focus	Age group	Main Argument	Factors considered for analysis	Statistical analysis	Findings
(Craig et al., 2002)	Canada	Physical activity and physical environment	All inhabitants	Physical activity particularly walking to work and the physical environment of the neighborhood is correlated to each other	Neighborhood characteristics, socio-demographic information (income, university education, poverty, and degree of urbanization), mode of transport to work	Hierarchical linear modeling	A positive association found between environment and walk for work, that reinforce the ongoing movement of integrated communities for residential and other non-residential activities
(Bopp et al., 2011b)	Manhattan, Kansas, US	Eco-friendly attitude in adopting walking and cycling to work	Employed young to middle aged adults	Attitude towards environment has significant potentiality to predict likelihood to promote active transportation and discourage car use.	EFA (Individual's overall behavior toward ecology-related issues), AC patterns, motivators and barriers for AC, and demographics (Age, Gender, Ethnicity, education, type of employment), commuting pattern (number of times per week that they walked, biked, and drove to and from work)	t-tests and analyses of variance	Individuals in the top quartile of EFA scores were more likely to actively commute and less likely to drive and reported more self-efficacy, fewer barriers, and more motivators for AC.
(Feuill et al., 2015)	Paris, France	Built environmental factors and walking for commuting and leisure	Adult (18 or more than 18)	Places with contrasting local context in terms of built environment is associated with the level of walking,	Time spent walking for errands and for leisure, 19 built and socioeconomic environmental features.	Geographically weighted regression models	Spatial heterogeneity of relationships between walking and the built environment occurred across the entire studied area
(Frank et al., 2004)	Atlanta, Georgia, US	Built environment at local level, travel pattern, physical activity and obesity	Adult	The walkability of a neighborhood is not equal everywhere, hence more localized observation of relation between urban form, transport activity and obesity is necessary	BMI, gender, Ethnicity, age, education, income, time spent in car and distance walked, built environmental measures(land use, street network, connectivity and mixed use)	Logistic regression	Land-use mix had the strongest association with obesity and each additional kilometer walked per day was associated with a 4.8% reduction in the likelihood of obesity.

Author	Study Area	Focus	Age group	Main Argument	Factors considered for analysis	Statistical analysis	Findings
(Hess et al., 2017)	France	Active Mobility and Environment	Adult more than 18	Even though there are intention in the contemporary researches to explore the factors affecting the active travel behavior, still there are novel factors not yet studied for this purpose	Factors already used (built or physical environment factors including land use, accessibility to shops and green space, transportation systems and networks, architecture, sidewalks, traffic, street lightning, and crime rate. Social environment factors include income, education and social characteristics)and new factors are considered for the new questionnaire development	content analysis, scoping review and cross tabulation	The under explored factors are: housing situation within the urban structure, overall consideration of the activity space beyond the limits of the residential neighborhood, the perception of all the transportation modes, and the time scheduling impacting the modes actually used.
(Hoehner et al., 2005)	US	Perceived and Objective Environmental Measures and physical activity (walking & cycling )	Aged 18 to 96 years)	The environmental characteristics of neighborhood has significant influence not only on leisure time physical activity as well as transport related physical activity	Physical activity behavior (including both transportation and recreation based physical activity level), environmental measure both physical and social environmental variables, perceived environmental measures.	Chi-square and logistic regression	This study of urban environments supports some direct relationships between the environment and physical activity behavior. Availability of potential destinations within walking distances have influence in the level of recreation and transportation related physical activity. However, in case of recreational physical activity along with built environment social environment is also dominant.
(Jun and Hur, 2015)	Ohio, US	Physical and perceived walkability and neighborhood social environment	Adult	Neighborhood social environment is associated with both physical and perceived walkability of the neighborhood.	Neighborhood social environments (social interaction, sense of community), physical walkability of the neighborhood, residents' perceived neighborhood walkability regarding factors selected in the measuring physical walkability, and demographic characteristics.	Ordinary least square regression, Structural equation modeling	Perceived walkability has a positive effect on neighborhood social environment, whereas physical walkability is not relevant to social interaction and has a negative relationship with sense of community because physical walkability and perceived walkability do not correlate into the same direction

Author	Study Area	Focus	Age group	Main Argument	Factors considered for analysis	Statistical analysis	Findings
(Lemieux and Godin, 2009)	Quebec, Canada	Cognitive and environmental variables, and active commuting	Undergraduate and graduate students	Along with environmental variables, individual perceived behavioral control and attitude towards active commuting, are also need to be considered in describing active commuting behavior	Neighborhood environment, physical activity habits, variables from the theory of planned behavior (TPB) and related cognitions, habit of using active commuting, socio-demographic variables	Hierarchical multiple regression	People who are in the habit of using active commuting do so more often. Cognitive variables play a more important role than environmental variables in predicting and explaining active commuting. When environmental variables were significant, they were mediated by cognitive variables.
(Cerin et al., 2006)	US	Neighborhood environmental walkability	Adult (20–65)	The relationship between environmental factors and physical activity particularly of walking for transportation and recreational purpose is under studied.	Residential density, proximity to nonresidential land uses, ease of access to nonresidential uses, street connectivity; walking/cycling facilities, pedestrian traffic safety, and crime safety, weekly minutes of walking for transport and walking for recreation, socio-demographic characteristics,	Multilevel confirmatory factor analysis was	Presence of diversified destinations, residential density, walking infrastructure, aesthetics, traffic safety, and crime were positively related to walking for transport; whereas, aesthetics, mixed destinations, and residential density were associated with walking for recreation.
(Owen et al., 2004)		Environmental attributes and walking	Adult	Both perceived and objectively assessed environmental attributes are associated with walking behaviors of adults as well as physical activity.	Environmental attributes related to the walking behavior of adults were identified from a previous literature review	Quantitative studies	Aesthetic attributes, convenience of facilities for walking, accessibility of destinations and perceptions about traffic and busy roads were found to be associated with walking for particular purposes. Attributes associated with walking for exercise were different from those associated with walking to get to and from places.

Author	Study Area	Focus	Age group	Main Argument	Factors considered for analysis	Statistical analysis	Findings
(Saenens et al., 2003)		Environmental correlates of walking and cycling		Neighborhood environmental characteristics is relevant to walking and cycling for transport	Outcomes from the studies pertinent to neighborhood correlates with no motorized transport are considered for analysis.	Review based analysis	Residents living in a neighborhood having higher density, greater connectivity, more land use mix exhibit higher walking and cycling for transport purpose compared to those who are living in low density, poorly connected and homogeneous land use neighborhood.
(Sundquist et al., 2011)	Sweden	Neighborhood walkability, physical activity, and walking behavior	Adult aged (20-65)	The associations between neighborhood walkability and walking for active transportation or leisure, and moderate-to-vigorous physical activity require further verification of its association from global and local perspective.	Age, gender, income, marital status and neighborhood-level socioeconomic status, residential density, street connectivity, land use mix, individual's level of physical activity by accelerometer, Self-reported measures of physical activity	Multilevel linear as well as logistic models	A positive association between objectively measured neighborhood walkability and physical activity and walking behavior is found in the European context. No significant differences in minutes/week of walking for leisure were found between highly walk able and less walk able neighborhoods
(Rind et al., 2015)	UK	Built environment, socioeconomic inequality and active travel	Adults aged 16+	Physical environment affects socioeconomic inequality in active travel behavior.	Socio-economic, demographic and travel-related characteristics of participants, physical environmental characteristics both detrimental and beneficial to health	Chi-square, Binary logistic regression	The active travel pattern among the lowest income group is less affected by physical environmental deprivation. Socio-economic gradient in active travel appears to be independent of physical environmental characteristics

Author	Study Area	Focus	Age group	Main Argument	Factors considered for analysis	Statistical analysis	Findings
(Turrell et al., 2013)	Brisbane, Australia	Built environment and health inequality	Mid-aged adult (40–65 years)	The disadvantaged neighborhood and its built environment, access to motor vehicle and walking for transport are interrelated.	Neighborhood disadvantage (socioeconomic score), built environment measures (street connectivity, density, and land use mix), socio demographic characteristics, participation in physical activity, activity pattern, access to motor vehicle	Multilevel multinomial logistic regression	Higher levels of walking for transport in disadvantaged neighborhoods was associated with living in a built environment more conducive to walking and residents of these neighborhoods having limited access to a motor vehicle
(Turrell et al., 2014)	Brisbane, Australia	Socio-economic factor, neighborhood and walking for transportation	Mid- and early old-age (40 – 70 years)	Neighborhood disadvantage, individual-level socioeconomic position and walking for transport are associated to each other	Neighborhood disadvantage (socioeconomic score), Education, employment status, and occupation, household income, walking for transport	linear regression model, logistic modeling	The number of never walker is low in the disadvantage neighborhood and the walking for transport decreases over time.
(Babey et al., 2009)	California	Socio-demographic, Family, and Environmental Factors	Adolescence age (12-17)	Socio-demographic, family and environmental factors are associated with active commuting to and from school	Socio-demographic information of adolescence and parents, how often adult present after school, how much parent new about that, name of the school, parents walking for transportation, perception about neighborhood	Logistic Regression	Child's active mobility does not depend on single factor. It depends on the individual factors of children and parents, family structure, income, environmental factors and adult's supervision. Without Parents supervision, adolescent are more likely to actively commute, even though it depends on age of the child and parental condition
(Bringolf-Isler et al., 2008)	Switzerland	Personal and environmental factors associated	Children of different age	Active commuting to school varies across communities	Main mode of children, frequency to accompany children, child's gender, nationality, maternal education, family structure, child's height and weight, day care attendance after school, number of car in the household, perception about way to school, license for child's independent mobility, distance to school, altitude different between school and home, density around home	Multivariate regression models	Parent's perception about safety in child's way to school influence active commuting. Children from urban area and dense are involved in active commuting. Possibility of socialization increase safety perception, there are also variety of factors affect parental behavior like child's age, availability of car, safety concern, maternal status. Distance

Author	Study Area	Focus	Age group	Main Argument	Factors considered for analysis	Statistical analysis	Findings
							between home and school should be short
(Witton et al., 2013)	New Zealand	Parents perception and child's active travel	Children	Children have less freedom than their parents	Parents were initially asked about their play, active travel and neighborhood experiences while they were children themselves and their children's play and mobility behaviors that differed from their own at the same age.	Descriptive analysis	Changes in social policies, life style have impact on community and family life. Insecure employment, diminishing role of the school as the heart of the community and demographic change is also affecting child's independent active mobility
(Carlson et al., 2014)	USA	Active movement of Adolescent	Adolescence	Individual, social environment, built environment and policy factors work together to influence active travel of youth	Number of day travelled to and from school using active travel, perception about neighborhood, self-efficacy for physical activity, parent's support for physical activity, decisional balance for physical activity, perceived barrier for active travel, socio-demographic information of both parents and kids, education, marital status, work status, vehicle ownership, parent's active travel pattern, perception about neighborhood around home and school	Multinomial regression models	Kids who live near the school, parents perception about active travel and neighborhood safety living in dense area, street connectivity, pedestrian safety are important for active transport
(Pont et al., 2013)	Australia	Urban design, family decision and child's travel from home to school	Children age 9 to 12	Participation in active travel during the school journey is associated with the relative influence of environmental and personal factors	Child, parent and family characteristics, child's and parents' weekly time spent being physically active, parents' estimate and evaluation of their child and parents' attitudes about physical activity, parents' estimate and evaluation of the environment, travel outcomes (how his or her child travelled to and/or from school)	Pearson's Chi-square, t-test and regression analysis	The proportion of children who used AT at least once in the previous week was greater for those living in areas of relatively high environmental supportiveness for AT. Parents' estimates of these variables were more effective in predicting AT status than those measured objectively.

Author	Study Area	Focus	Age group	Main Argument	Factors considered for analysis	Statistical analysis	Findings
(Timperio et al., 2004)	Australia	Neighborhood environment and active transport	Children	Perception (Parent's and Children) about neighborhood has significant influence in child's active travel	Socio-demographic information, child's usual walking or cycling to local destinations, types of destination walk able distance, and their perceptions of their, child's perceptions of traffic, strangers, road safety and sporting venues, and their perceptions of their parent's views (traffic, strangers and road safety).	Description statistics and analysis of variance	Parent's perception about traffic in the neighborhood, provision of public transport, car ownership rate, road pattern, available sports facilities, safe pedestrian and cycling facilities and child's perception about available public spaces near to home are significant predictor in defining child's likelihood to use walking or cycling.
(McMillan, 2005, McMillan, 2007)	US	Built environment and child's active travel	Children	Non-urban form factors are often overlooked in defining travel behavior where they might have greater or similar influence over urban forms factors.	Child's travel pattern to and from school, parents travel pattern to school, perception about safety and traffic, perception about neighborhood design feature, perception about driving behavior in neighborhood around school, attitude towards active transport, perception about social and cultural norms to AT, self-report of their own AT, demographic question about household.	Binomial logit regression	The opportunity for "eyes on the street" may increase a caregiver's level of comfort about a child traveling by non-motorized means to school. Surprisingly, the proportion of street segments with a complete sidewalk system showed no relationship to travel behavior to school.
(Schoeppe et al., 2013)		Child's independent mobility and active travel	Children	There is associations of independent mobility and active travel to various destinations with physical activity, sedentary behaviour and weight status	Search for paper was done with the following term: child, adolescent, adolescence, youth, kids, independent mobility, active travel, active commuting, active transport, walk, cycle, cycling, physical activity, active, sedentary, sitting, weight, body composition, body mass index (BMI), overweight, obese, obesity, and adiposity.	Literature review	Most studies focused solely on active travel to and/or from school, and showed significant positive associations with physical activity. The same relationship was detected for active travel to leisure-related places and independent mobility with physical activity. An inverse relationship between active travel to school and weight status was evident but findings were inconsistent.



### **3. Chapter: Methodology**

The methodology part of this study is organized according to the specified objectives of the research. Therefore, the research has two distinct stages. The first part is the statistical analysis and spatial analysis to find out the association between demographic, socioeconomic, trip and environmental factors and active mode choice, as a means of commuting purposes. The second section is to understand the case of Grenoble and students' perspective with respect to the developed framework based on ongoing literatures pertinent to active transport improvement measures. Therefore, the research is based on both secondary as well as primary data. Secondary data has been collected from the published journal articles and recommended reports of the international organizations working in the field of active transportation particularly walking and cycling. Besides, university website, website of SMTC (Syndicat Mixte des Transports en Commun), website of INSEE (Institut National de la Statistique et des Etudes Economiques) and Grenoble Alpes Métropole (2009) have been used to get general information about the university, Grenoble metropolitan area, Grenoble City as well as public transport condition in Grenoble. Besides, the primary data is collected from online as well as face to face interview from university students. A brief discussion of the selected methodology is given below

#### **3.1 Problem definition and objective formulation**

The ongoing researches about active travel often oversight the factors affecting the mode choice behavior of emerging adults (18-25), whereas it is agreed that behavior that established at this age, endure throughout the adulthood (Nelson, 2008). Also, it is worth to mention that at this stage of life, a growing tendency to receive higher education after high school is quite obvious because of the competitive contemporary world's economic situation (Arnett, 2000). Hence, the aim of this study is to incorporate, within the ongoing researches, the importance of emerging adults (18-25), who are attending university, to identify the association between socio-demographic, travel related and environmental factors and active travel behavior. Therefore, two objectives are fixed for this research. First, it is intended to find out the potential factors and their association with active travel behavior of emerging adult. Second, it is aimed to analyze the potentiality of alternative improvement measures, through the development of a comprehensive framework to augment the future active transport uses, in case of Grenoble, incorporating the perceptions of young adults.

#### **3.2 Study area**

Since, among the post industrialized cities, European cities exhibits 3 to 5 times higher walking and cycling trip compared to the cities from the U.S. (Pucher et al., 2010a). The Grenoble city, which is also renowned as an important European scientific center, is selected as a case for this study. Two higher education institutions: Institut d'Urbanisme de Grenoble (IUG) and Institut de géographie alpine (IGA) of Université Grenoble Alpes as well as the architecture school: École nationale supérieure d'architecture de Grenoble (ENSAG) are selected to study on the students, aged 18 to 25. The main campus of the university is located in Saint-Martin-d'Hères, which is another city of Grenoble metropolitan area (direct neighboring city of Grenoble city). Here, Grenoble city is selected instead of Saint-Martin-d'Hères because, Grenoble city is the center of Grenoble metropolitan area and center of investments. Therefore, students from the main campus are not included in the study. Another reason to exclude the other students from different scientific departments is to include the perception of future geographers, architects, and planners in the study (cf. Map 4-4).

### 3.3. Data collection

#### 3.3.1. Primary data

As, the idea is to incorporate the perspectives of emerging adults, attending university, in understanding their travel behavior, thus, a cross sectional questionnaire survey has been carried out in the selected institutes and school to collect the primary data. At the beginning of April, 2017, an **online questionnaire** was randomly distributed among the students, aged 18 to 25 from IUG, ENSAG and IGA. The questionnaire was both in English and French. Each year 300 students are enrolled in IUG Institute, 600 students in IGA (UGA, nd-a, UGA, nd-b) and 1000 students in the ENSAG (ENSAG, 2013). **58 students responded** among the randomly selected students from the selected institutes.

In the online questionnaire, major questions were asked about four distinct types of journeys, such as, journey to university, grocery, office, and leisure. Student responded to the questions related to the primary mode that they use in an ordinary week to accomplish the selected four types of journeys. There were also some questions in the questionnaire to explicate the reason for choosing a particular mode, for a particular journey. Moreover, to understand the other trip factors, respondents were asked about the availability of alternative modes, as well as their preferred mode of travel. Additionally, there were questions regards to the trip frequency, time required for each trip. Besides, using the questionnaire survey, it was also investigated the difficulties that respondents face during their trip through active mode (e.g. walking and cycling).

Other than the trip information, some questions were related to demographic and socio-economic factors like age, gender, height, weight, housing type, income, study level, car ownership, bicycle ownership, driving license and nationality. Furthermore, to elicit the information related to the association between active travel behavior and environmental factors, some questions, on the available facilities in respondent's neighborhood, using a Likert scale (Not satisfied, moderately satisfied and very satisfied), were incorporated. Facilities included in the questionnaire were related to the pedestrian, cycling and public transport, driving facilities, available green and open spaces, crime safety, traffic safety measures, available non-residential facilities, aesthetics, and interactions with the neighbor in their neighborhood. The online questionnaire is available in Appendix B.

For the construction of the questionnaire, a broad review of published literatures related to active travel was carried out to find out the selected list of potential demographic, socio-economic, trip and environmental factors associated with active travel (cf. Table 2-1). A pilot survey was conducted before circulating the online questionnaire to make the questionnaire more precise, logical and clear. Furthermore, through the pilot survey unnecessary questions were omitted which were quite personal (e.g. marital status) and were not important to the context of the study, e.g., information related to journey to work.

Along with the online questionnaire, **35 face to face interviews** with the same questionnaire were conducted. Before doing the face to face interview, it was ensured that selected students did not participate on the online survey to avoid the duplication. Apart from the questionnaire, in the face to face interview students were asked to drop the pin in the Google map showing the approximate places where they live (home in Grenoble), do shopping (grocery), go for administrative works (Bank, post, and insurance office), go to meet friends and do sports activities. Additionally, students were also asked to elucidate their responses in order to dig deeper into their perception, emotion and feelings (Additional questions asked in face to face interview available Appendix C). Furthermore, a ground level observation was carried out by the author to validate the information provided in the face to face interview. Therefore,

data provided in the spatial mapping was utilized for the ground observation of those area marked by the students in the Google map (cf. Map 5-7).

### **3.3.2 Secondary Data**

For the purpose of this study, different authentic sources are used to collect secondary data. First of all, to understand the land use pattern of Grenoble, land use data is collected from Ministère-de-la-Transition-Écologique-et-Solidaire (2015) which is the provider of Corin Land Cover (CLC). CLC contains five broad land use types (artificial territories, agricultural territories, forests and semi-natural habitats, wet area, water surfaces) comprised of 44 different types of component. For this study, urbanized areas (continuous urban fabric, discontinuous urban fabric), industrial or commercial areas and communication networks (industrial or commercial areas and public facilities, road and railway network and associated area, airport), mines, landfills and construction sites, forest areas, agricultural land, vegetation areas among the 44 components of CLC are selected for spatial analysis (cf. **Map 4-2**).

Furthermore, the walk Score values (walk score is a walkability index), which reflect the land use mix and density of particular area, is collected from the official website of Walk Score® (www.walkscore.com). From this website the walkability of an area is explicated by a number ranged 0-100 where the value '100' reflects highest walkability and '0' reflects lowest walkability. Walk score uses Google map to identify nearby restaurants, coffee shop, bars, groceries, parks, schools, entertainment and errands located within 1 mile buffer from the selected position. The detail description of walk score is explained in chapter 5. Apart from these two official websites, other websites of selected institutes and school (IUG, IGA, ENSAG, UGA), and organizations (SMTC, ADTC, INSEE, Grenoble-Alpes-Métropole, Transdev, SEMITAG) are also selected for the secondary data resources.

Furthermore, to develop the online questionnaire, the factors having potentiality to influence active travel behavior, of young adult, have been elicited from the published journal papers, related to active transportation and socio-economic, demographic, physical and environmental attributes (cf. Table 2-1). Moreover, the framework consists of major strategic interventions successfully adopted in different countries to promote active travel, is developed based on an extensive literature review of published journal, article and report (cf. Table 7-1).

### **3.4. Data Analysis**

For the analysis of the obtained data at the very beginning, respondents which were not aged 18 to 25 were excluded for the further analysis. As a result, from the total 58 online responses, 49 responses are only selected for further analysis. Two kinds of analysis, to understand the association between different factors selected from the literatures and active travel, have been conducted: Statistical and spatial analysis. In the spatial analysis, information obtained only from the face to face interview is selected. But, in the statistical analysis responses from both online and face to face questionnaire survey is selected (49 online and 35 face to face interview).

#### **3.4.1. Achieving the 1<sup>st</sup> objective**

##### **3.4.1.1 Spatial analysis**

To understand the factors affecting the active travel behavior of young adult from the spatial perspective, a spatial mapping exercise was conducted with the university students during the time of face to face interview. In this exercise, randomly students from the selected institutes were asked to drop a pin on Google map showing the nearby<sup>1</sup> plot/road of their home and other potential places where they go in an ordinary week (like to shop, to leisure activity or in administrative office). A base map is prepared based

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<sup>1</sup> To ensure the confidentiality exact date and address was not asked voluntarily

on the latitude and longitude obtained from the dropped pin exercise of the students. The obtained geocodes are then projected in the Lambert Conformal Conical Projection system for further analysis. For the purpose of this study, home is considered to be the origin of all trips. The prepared base map of origin and destination of different types of trips are then analyzed separately based on three spatial attributes: aggregate land use pattern, land use mix (walk score) and service area of public transportation system. From this analysis, potential land use-transport interaction in describing young adult's active travel behavior is elicited. From the spatial analysis, the influence of environmental factors associated with the active travel pattern as well as their destination choice is demonstrated through maps prepared in ArcGIS 10.1.

#### **3.4.1.2 Statistical Analysis**

To understand the active travel behavior of the target group statistically, a conceptual framework is developed based on the Theory of Triadic influence developed by Flay and Petraitis (1994). The assumption of this conceptual model is that, young adults' travel behavior is influenced by several distal factors which further affect their personal factor to select a mode for particular purpose. Here, cultural, personal, socio-economic, environmental and trip factors are considered as potential distal factors, assume to have influence on students' active mode choice behavior. Data from the questionnaire (49 responses) and face to face interview (35 responses) is analyzed based on the conceptual model through descriptive statistics and binary logit model, using SPSS version 24.0 for Windows. As, student's active mode choices (walking, cycle and public transport) for different journey purposes is recoded in a dichotomous format (0, 1: 1 means use that particular mode and 0 means do not use that particular mode for that particular trip), therefore, binary logit model fits perfectly under this circumstance to predict individual decision in choosing particular mode compared to other possible options available to them.

Binary logit model is a logistic regression model that provides a best fitting equation or function using the maximum likelihood method, which maximizes the probability of classifying the observed data into the appropriate category, given by the regression coefficients. Logistic regression gives each predictor a coefficient 'b' which measures its independent contribution to the variations in the dependent variable. The dependent variable can only take on one of the two values: 0 or 1. At the same time, the regression gives a log distribution which is also called logit. Logit is normally explained by the odds ratio which means the likelihood of an independent variable to be the member of a target group of dependent variable (Hilbe, 2016).

First and probably the most important step of running the binary logistic model is to determine the variables that can explain and predict the decision making process. These variables are usually called as 'explanatory variables'. For this study, these explanatory variables are grouped into three sub categories: socio-demographic, trip and environmental factor. Next, explanatory variables are refined and for that purpose a correlation matrix has been formed among the explanatory variables to check the multicollinearity. If explanatory variables are highly correlated to each other, then the model might become biased towards some variables. The idea is, if the correlation coefficient between two explanatory variables is larger than 0.8 then those will be excluded from the model.

Depending on the trip purpose and mode choice, variables of each subcategory pertinent to that particular trip is used to run the model. The list of key explanatory variables and coding are given in Appendix D. At the same time, dependent variables i.e. mode choice is divided depending on the trip purpose. Therefore, 36 different models have been developed to explicate the association between 'explanatory' and 'exploratory' variables. In each model, it has been assessed that how a particular mode choice for a given purpose is influenced by several distal factors, considered in this study. The list of variables is

shown in the Table 3-1. Here, socio-demographic variables, those contain both cultural and personal information, are fixed for models (12 models). Furthermore, models developed by travel factors contain 4 types of variable that contain travel information about that particular trip purpose (12 models). Similarly, model developed on environmental factors contain the perception about neighborhood for all types of trips (12 models). Within the scope of this study, the final model combining all factors (socio-demographic, travel and environmental) for each trip is not developed.

Table 3-1: List of explanatory and exploratory variables used for developing model

Explanatory variables Exploratory' variables	Socio-demographic factor	Travel factor	Environmental factor
Mode used for the trip to University (Walk, Cycle, Public Transport)	<ul style="list-style-type: none"> <li>•Present study level</li> <li>•Affiliation with the university</li> </ul>	<ul style="list-style-type: none"> <li>•Other available mode for trip to particular purpose</li> </ul>	<ul style="list-style-type: none"> <li>•Perception about the neighborhood where students live (Available pedestrian facilities, cycling facilities, public transport facilities, driving facilities, green spaces and park, crime safety, traffic safety, non-residential facilities, beautification and social interaction with the neighbor)</li> </ul>
Mode used for the trip to Grocery (Walk, Cycle, Public Transport)	<ul style="list-style-type: none"> <li>•Age</li> <li>•Height</li> <li>•Weight</li> </ul>	<ul style="list-style-type: none"> <li>•Preferred mode among all the alternative</li> </ul>	
Mode used for the trip administrative work (Walk, Cycle, Public Transport)	<ul style="list-style-type: none"> <li>•Gender</li> <li>•Current income status</li> <li>•Housing type</li> <li>•Nationality</li> </ul>	<ul style="list-style-type: none"> <li>•Trip frequency</li> <li>•Trip duration</li> </ul>	
Mode used for the trip to leisure activity (Walk, Cycle, Public Transport)	<ul style="list-style-type: none"> <li>•Car ownership</li> <li>•Bicycle ownership</li> <li>•Driving license</li> </ul>		

Source: Prepared by author, 2017

### 3.4.2 Attaining second objective

To fulfill the second objective, a comprehensive framework containing potential interventions taken in different countries to promote active transport use, is developed through extensive literature review of journal articles (cf. Table 7-1). Based on this framework, the situation in Grenoble is analyzed through the information from ground observation (2017), published reports, and web sites of concerned authorities. Furthermore, the perceptions young adults related to those interventions is also included to justify the analysis of the case.

### 3.5 Findings and recommendation

Finally, major findings from the statistical and spatial analysis as well as the analysis of the case with respect to different types of interventions are summarized to give recommendations related to the promotion of active transportation in Grenoble.

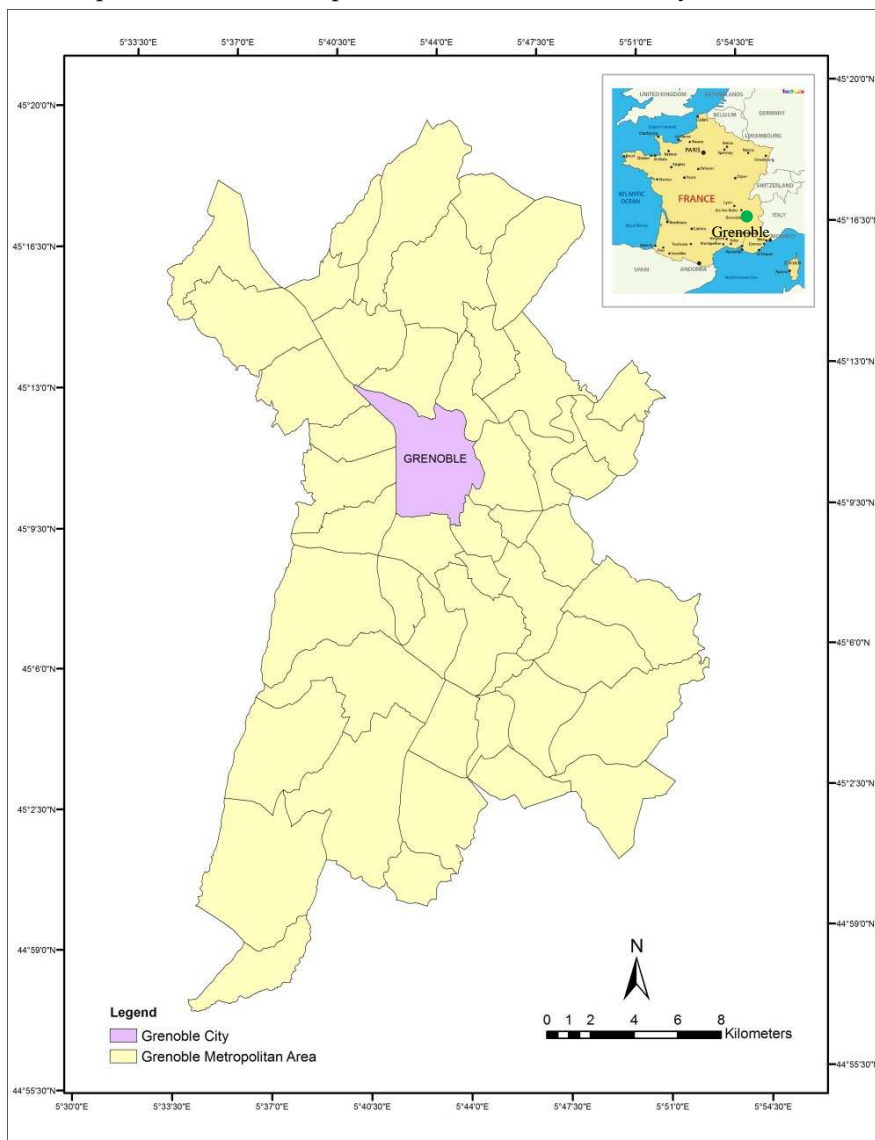
### 3.6 Chapter conclusion

In this chapter the detail methodology of this study is given. The coordination schema of the methodology is attached in Appendix A. Depending on this methodology the following chapters of this thesis is organized. However, in the following chapters, before starting a particular analysis, detail explanation of methodological approach has been provided.

#### 4. Chapter: Case study

Active travel tendency varies from place to place. For this study to understand factors affecting active travel pattern, Grenoble city situated in the southern part of France is selected as case study (cf. Map 4-1). Grenoble City is the center of Grenoble Metropolitan Area which is the Second Rhône-Alpes agglomeration specialized in scientific activities. Grenoble metropolitan area is composed of 49 municipalities and it is placed in the middle of Alps (3 massifs), about 100 km. southern from Lyon and 150 km. south-western from Geneva. In order to understand the case properly, briefing of Grenoble Metropolitan Area and Grenoble city will be done in this chapter in a parallel. The main contents of this chapter are general socio-economic information, land use and public transportation condition of the Grenoble City and Grenoble Metropolitan Area. Also, a brief overview of Université Grenoble Alpes will be discussed here, as the main target group of this study is composed of the students from this university.

Map 4-1: Location map of Grenoble Metropolitan Area and Grenoble City



Source: Prepared by author, 2017

### 3.1 Socio-demographic condition of Grenoble

The Grenoble city is the highly populated municipality among the total 49 municipalities of Grenoble agglomeration (36% of the total population of Metropolitan Area), though the area of the city is only 3.3% of the total metropolitan land area. Also, it is the highly dense area, comprising almost half of the dwelling and employment within this small area (INSEE, 2014). Moreover, it is the economic growth engines of metropolitan area. General information about Grenoble Metropolitan Area and Grenoble City is given in Table 4-1.

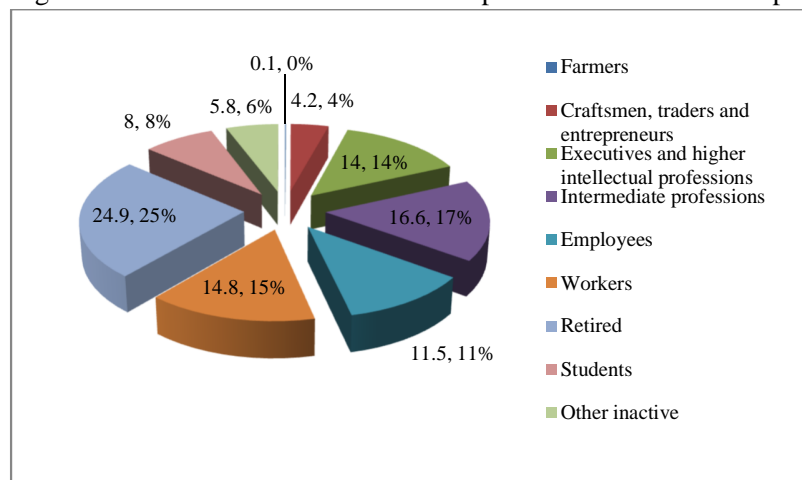
Table 4-1: Socio-demographic profile of Grenoble Metropolitan Area and Grenoble City

	Grenoble Metropolitan area	Grenoble city
Number of population	442,772	160,215
Density (number of inhabitants per km <sup>2</sup> )	811.6	8,837
Area (km <sup>2</sup> )	545.5	18.1
Population growth rate between 2008 to 2013 (%)	0.5	0.4
Number of households in 2013	203114	83394
Total number of dwellings in 2013	224,220	95,333
Total employment (employed and self-employed) at the place of work in 2013	221,402	94,645
Labor force participation rate for 15-64 year olds in 2013	71.9	70.1
Unemployment rate for 15-64 year olds in 2013	12.4	15.2

Source: (INSEE, 2014)

Beside the importance of the Grenoble city, the metropolitan area is correspondingly important for its spatial location which is a unique balance between natural environment and urban development. Since 1<sup>st</sup> January 2015, this area of 49 municipalities got its French “Metropole” status (Grenoble-Alpes-Métropole, 2009b). Apart from its touristic attraction and according to its scientific structural importance, the metropolitan area is also important for students, as the total number of students in the metropolitan area is almost 8.8% of the total population (INSEE, 2014). Besides student’s assembly in this area, there are also other diversified professionals working here extended from farmers to higher intellectual professionals. Therefore, the metropolitan area exhibits diverse socio-economic profile, cultural status and mixed of different nationality (cf. Figure 4-1).

Figure 4-1: Distribution of different occupation in Grenoble Metropolitan Area



Source: (INSEE, 2014)

As a consequence of the university activities (studies and research), the population of this metropolis is rather young. Half of the population is under the age of 35; a quarter is between 15 and 29 (INSEE, 2014).

### 3.2 Land use pattern

Grenoble metropolitan area is surrounded by three mountain ranges, to the north the Chartreuse, to the south and west the Vercors, and to the east the Belledonne range. Grenoble is also famous as the “Capital of the French Alps”. Therefore, the dominant land use type is the forest area covering the mountain. This forest area includes hardwood forest, coniferous forest as well as other types of mixed forest (cf. **Map 4-2**). Beside forest, dominance land use category is agricultural land that is scattered in all the suburban areas. Apart from this, the flat land contains the major urban fabric, commercial, industrial and public facilities those are extended in the east-west and southern direction. It is apparent that the continuous urban fabric (80% of the surface is impermeable) is limited only in the Grenoble city. The other cities contain continuous urban fabric (30 to 80% of the surface is impermeable) (Ministere-de-la-Transition-Écologique-et-Solidaire, 2015). Both, continuous and discontinuous urban fabric contains buildings, roads, vegetation and artificially covered surfaces. Also, a significant amount of water body is available, as, it is the area where the river Drac joins the Isère. Since, Grenoble city is located almost at the center of the metropolitan area, the dominant land use type in this area is urban fabric (Both continuous and discontinuous) along with prominent industrial, commercial, public facilities.

However, the closest neighbor cities of the Grenoble city, are Saint Egrève, Fontaine, Saint-Martin-d'Hères, Échirolles, Eybens, Meylan, Pont-de-Claix, also containing important urban status for the metropolitan area as a whole. In these cities, the land use is especially continuous urban fabric where industrial, commercial and public facilities are prominent. The only airport of this metropolitan area has a leisure vocation and it is located in the boarder of Domène city which is located in the north-eastern part of the metropolitan area (10km from Grenoble). The Grenoble civil and commercial airport is placed much more northern: at Saint-Geoire-en-Valdenne, 40km north from Grenoble city.

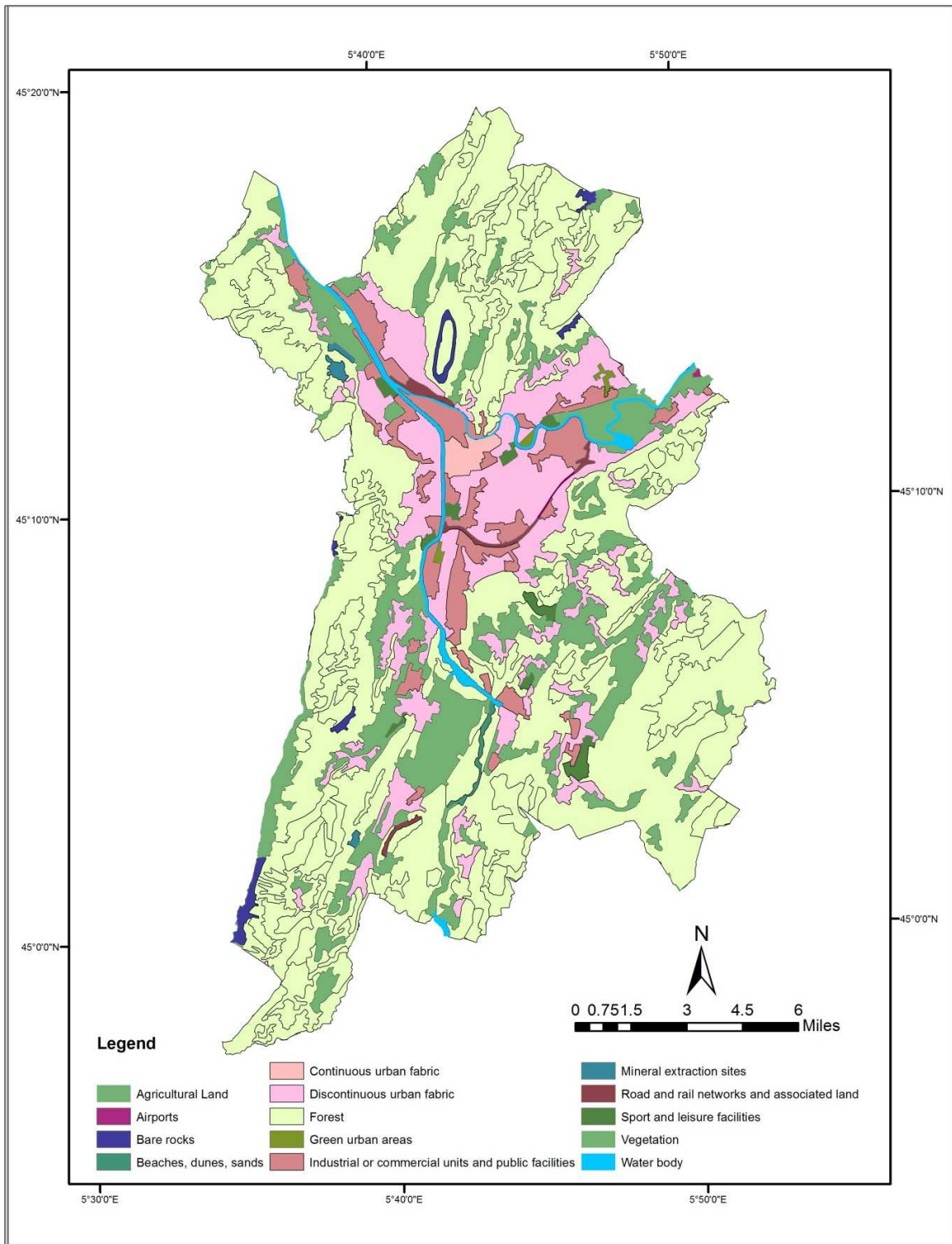
Table 4-2: Land use distribution in Grenoble Metropolitan Area

Land use	Percentage of total area
Agricultural Land	8.61
Vegetation	3.68
Water body	5.95
Sports and Leisure facilities	0.41
Road and Rail network	0.25
Mineral extraction site	0.11
Industrial, commercial, public facilities	2.99
Green urban area	0.09
Forest	68.32
Discontinuous urban fabric	8.48
Continuous urban fabric	0.29
Beaches, dunes, sands	0.09
Bare rocks	0.67
Airport	0.05

Source: (Ministere-de-la-Transition-Écologique-et-Solidaire, 2015)



Map 4-2: Land use map of Grenoble Metropolitan Area



Source: Prepared by author, 2017 (Data: Ministère-de-la-Transition-Écologique-et-Solidaire (2015))

### 3.3 Transportation

The hierarchical order in Grenoble in making trip and transport decisions follows ascending order-communes, Grenoble Alpes Métropole, Conseil Départemental de l'Isère, Conseil Regional Auvergne Rhône-Alpes, Etablissement Public Foncier Local-EPFL-RG (land supply structure), and State. In Grenoble Metropolitan area, the organizing authority of mobility is the Syndicat Mixte des Transports en Commun (SMTC). Transdev Group is the public transport operator in France whereas SEMITAG is a semi- public company partner of the Transdev Group, ensures on behalf of SMTC the management of the entire tram and bus network in this metropolitan area and recently taking care of bike rent (Transdev, nd). Therefore, it can be stated that the public transport system in Grenoble is running through the joint venture of public-semi private partnership. It is approved that Grenoble Metropolis has one of the best transport network in France. A brief summary of the type of transport services is given in Table 4-3.

Table 4-3: Public transport service in Grenoble Metropolitan area

<b>Public transportation</b>	Tram <ul style="list-style-type: none"> <li>▪ 5 tram lines (A/B/C/D/E)</li> </ul>
	Bus <ul style="list-style-type: none"> <li>▪ 66 lines CHRONO: C1/C2/C3/C4/C5/C6</li> </ul> <p>The Chrono lines offer direct access to the city center, connections to busy areas and the tram. The service of this line is equivalent to that of the tramway in terms of frequency and amplitude</p> <ul style="list-style-type: none"> <li>▪ 12 lines PROXIMO: 11/12/13/14/15/16/17/18/19/20/21/22</li> </ul> <p>These lines serve the dense areas of the conurbation while favoring a connection with the tram lines and the Chronos lines. This line has a frequency more precisely of 7 to 15 minutes during peak hours.</p> <ul style="list-style-type: none"> <li>▪ 28 FLEXO lines: numbered from 40 to 69</li> </ul> <p>These lines provide local access to the less dense areas of the agglomeration and are connected to the main trading centers and to the other lines of the Tag network. They operate on regular service during peak hours and on reservation in off-peak hours (reservation at least 2 hours before travel).</p>
	<ul style="list-style-type: none"> <li>▪ 18 parking-relay</li> </ul>
<b>Bicycle</b>	<ul style="list-style-type: none"> <li>▪ 320 km of cycle tracks</li> <li>▪ 5000 Métrovélos for hire (3 € per day)</li> <li>▪ 12,000 bicycle parking spaces</li> </ul>

Source: (Grenoble-Alpes-Métropole, 2009c)

This urban network is complemented through inter-urban car managed by Isère General Council Network, the Trans'Isère network and Rhône-Alpes regional train network called TER in France: Trains Express Régionaux.

There are also different pricing options within the metropolitan system. Inside the communes of the Grenoble metropolis, one can travel with:

- 1 Trip €1.50  
The ticket is valid for one hour; connecting and return trips are allowed. The use of other transports than metropolitan buses and tramways are allowed with the same ticket: inter-urban bus (TransIsère) and trains (TER), if this use is inside the metropolitan area .one can buy tickets from the bus driver (2€)
- 10 trips for €13.40 or 30 trips for €36.50

Tickets can be used by several people to travel together using the same ticket, which has to be stamped each time by all travellers.

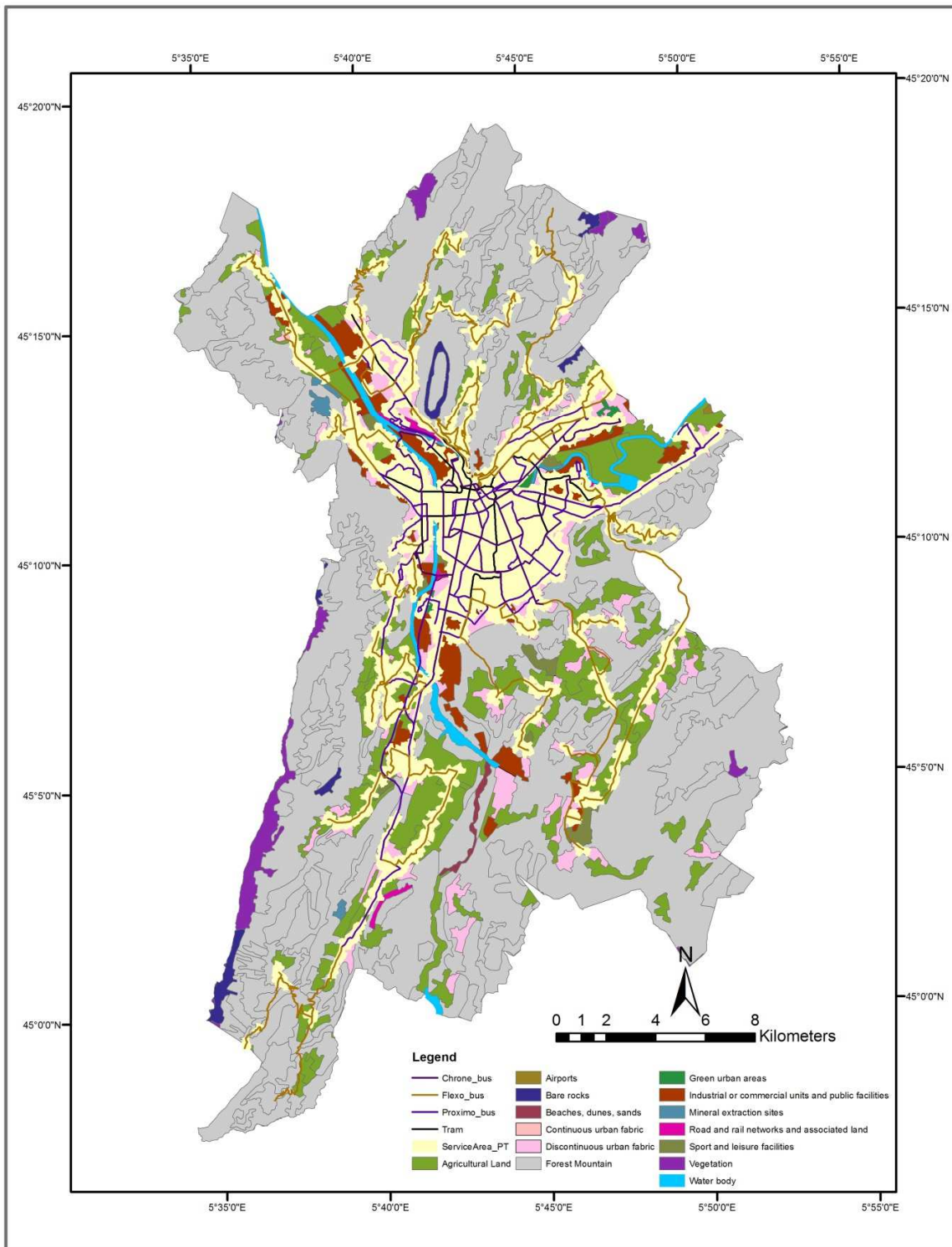
- Trip - Group Rate 10.50 €  
This ticket is reserved for groups of 10 to 30 persons. One can ask this ticket by making the authorization request at least 48 hours in advance from AlloTAG
- 1-day Visitag ticket €5.00  
This ticket enables users to travel freely all around the network during one day.
- 3-day Visitag ticket €12.00  
This ticket enables users to travel freely all around the network during three days starting the day of the first stamp.
- 10 trips at a discounted rate of €10.50  
This ticket is reserved for people who are disabled and/or aged over 65 on presentation of their disability card or of an identity document.
- TRIBU €5.00  
The ticket is valid for one calendar day across the entire network for a family of between two and five people, who must travel together. A family means one adult accompanied by one, two, three or four children, or two adults accompanied by one, two or three children. The children must be under 18 years of age.
- There are also the encouraged prices to let the people leave their car at Park and Ride (P+R), and take the bus or tramway. Usually they pay for the parking place for a day at the price of TAG transportation tickets, and they have the possibility to make back and forth ride with this parking bill.
- Monthly subscriptions on OÙRA card allow one to travel freely on the TAG network (metropolitan area) and on a TER-SNCF route whose station of origin or destination is Grenoble, Gières, Saint-Egrève, Pont-de - Claix or Echirolles (metropolitan municipalities). For students less than 25 year old, this card can be recharged for 1 month with 15€ only. Also, for the students who is eligible to get social security and more than 25 year old, payment is only 2.5€ per month. For the rest of the age group and nonstudents this monthly card 55€ per month.

Source: (Grenoble-Alpes-Métropole, 2009c)

#### Service area of Tram and Bus

In order to make the public transport more accessible, 103 trams are running on 4 lines with 63 station and 300 buses are running on 21 regular lines with 950 bus stoppages (Grenoble-Alpes-Métropole, 2009c). Approximately, all settlements located in Grenoble Metropolitan Area have access to public transport system. Total service area of public transport is about 10,720.5 Hectares whereas total land area with settlement is about 13,016.2 Hectares (including continuous and discontinuous urban fabric, sports and leisure facilities, road and railroad network site, mineral extraction site, industrial, commercial and public facilities, green urban area and airport). The service area of the public transport network from each stoppage within 400m covers almost 89.5% area (16.18 sq. km) of the total land area of the Grenoble city. Therefore, it can be inferred that almost 89.5% area of Grenoble city is commutable by public transport system. Here, area accessible within 400m from each public transport stoppage is considered to be under the service area of public transportation as this distance is considered as standard maximum walking distance for transit stoppage (Rattan et al., 2012). Also, it is apparent in the Table 4-3 that Grenoble city is the nerve center of the metropolitan area that is well connected with the other 48 communes through public transport network.

Map 4-3: Service Area of Public Transportation in Grenoble Metropolitan Area



Source: Prepared by author, 2017 (Data: Ministère-de-la-Transition-Écologique-et-Solidaire (2015))

### 3.4 Université Grenoble Alpes

The Université Grenoble Alpes (UGA) plays an important role in higher education and research in France. UGA competes with the other best universities worldwide for its research and educational innovations. It has almost 45,000 students, 5,500 staffs including 3,000 teachers and lecturers and 2,500 administrative and technical staff. These huge human resources are part of 24 faculties, schools or institutes and 80 laboratories of this university (UGA, nd-c). The main campus is located in Saint-Martin-d'Hères- at the east of Grenoble (cf. Map 4-4). Besides, there are other 15 locations of the university outside the main campus. Among these 15 places, 11 places are located in Grenoble Metropolitan Area and the others are in Valence, Ardèche (Pradel), Vienne, Villar-d'Arène and Montmaur, France (the last two places are mountain research station). However, within the metropolitan area, 10 places are in Grenoble city and the other one is in Echirolles. As, there are 10 institutions within Grenoble city and they are almost evenly distributed from north to south part of the city, a special character of these locations is apparent (UGA, nd-d). Among these 10 locations, for this thesis 2 locations where 3 institutions located are selected to catch the potential students i.e. young adults aged between 18 to 25 years old to do this study. These three institutions are

- Institut d'Urbanisme de Grenoble (IUG)
- Institut de géographie alpine (IGA)
- École nationale supérieure d'architecture de Grenoble (ENSAG) (cf. Map 4-4 &Map 4-5).

The reason to select these institutions is to take into account the perspective of future architect, geographer and planner. It is worth to mention that, even though the main campus is located in Saint-Martin-d'Hères city, Grenoble city is selected for this study as the case. This is because, the main campus is entirely residential and compare to Saint-Martin-d'Hères city, Grenoble city is more important as an economic and historic center of the metropolitan area. Moreover, it offers more activities and opportunities, especially cultural, social and leisure activities.

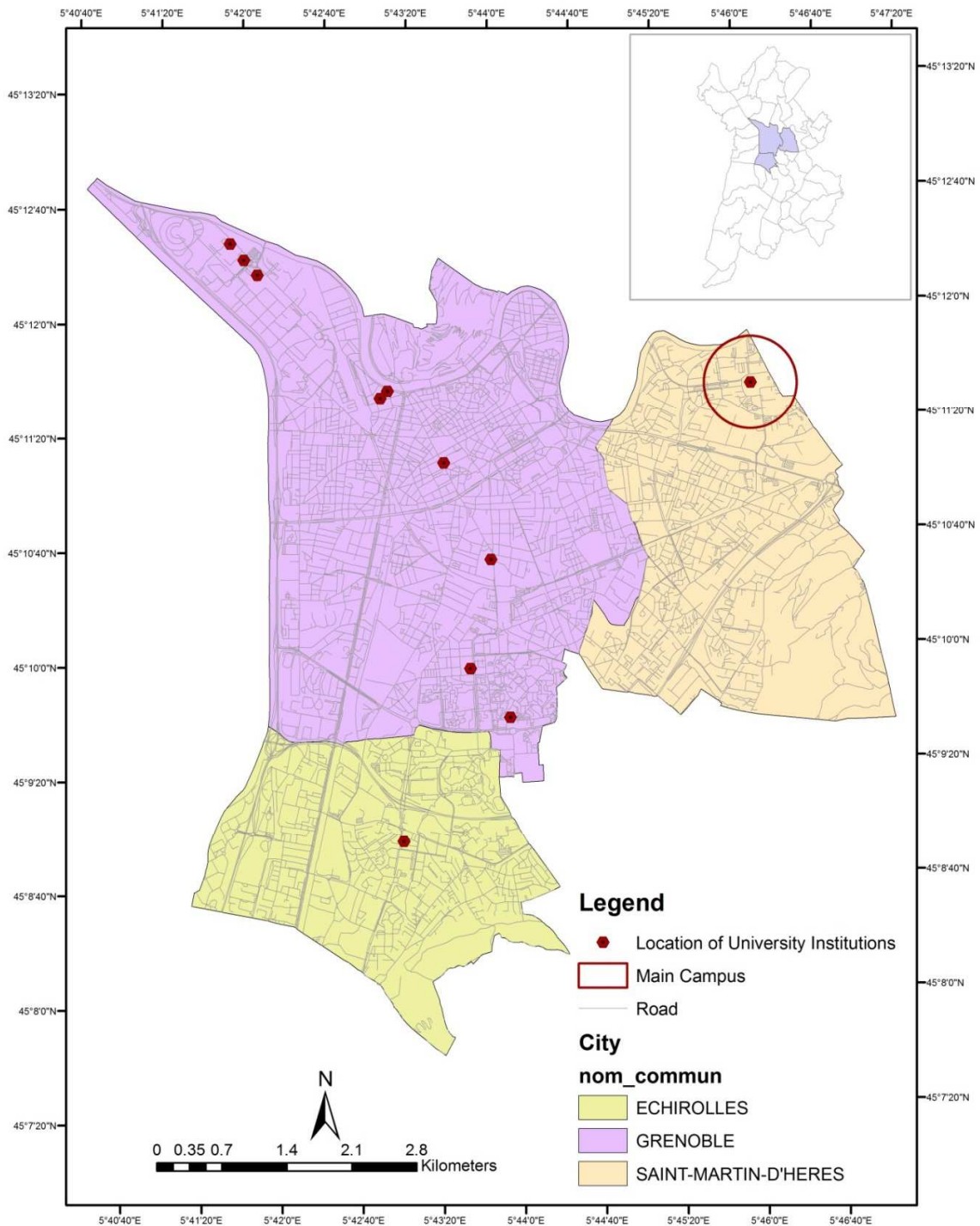
Among these three institutions, IUG offers multi-disciplinary and international courses, with an aim to prepare students for careers in town planning. The IUG provides students the opportunity to explore the modern city and the tools essential for studying, developing and managing a city. Total number of students enrolled in this institution is almost 300, registered in Bachelor, Master degree or Doctoral programs. This institution also runs Erasmus Mundus Masters of Sciences program in English with several European partners entitled as Mudus Urbano. IUG is also affiliated with PACTE – Public Policies, Policy Actions, Territories (UMR CNRS) laboratories and Federated Research Structure in Networked Territories (SFR Territoire en réseaux) (UGA, nd-a).

On the other hand, IGA is one of the largest and oldest institutions for geography in France, providing Bachelor, Master and Doctoral degree. Around 600 students are enrolled in 6 Bachelor and 7 Master's program. At the IGA, around 50 lecturers and researchers along with 100 non-university professionals support the students for careers related to geography in the fields of planning, the environment and sustainable development. This institution is affiliated with different research laboratories: UMR ESPACE, UMR LIG, UMR LTHE and UMR PACTE (UGA, nd-b).

Moreover, ENSAG is concerned with both complex and positive training to prepare the future architects in diversity of practicing modes and contemporary social and environmental issues. The school uses different virtual and analogical approaches as well as experimentation in technical and academic workshops. The school has four research units: Centre for research on sound space and urban environment (CRESSON), Careers in the history of Architecture, building, cities, territory (MHA-evt),

Architecture, Landscape, Mountain (APM), the CRAterre - ENSAG and Cultures Constructive lab (ENSAG, 2010).

Map 4-4: The geographical location of the Université Grenoble Alpes

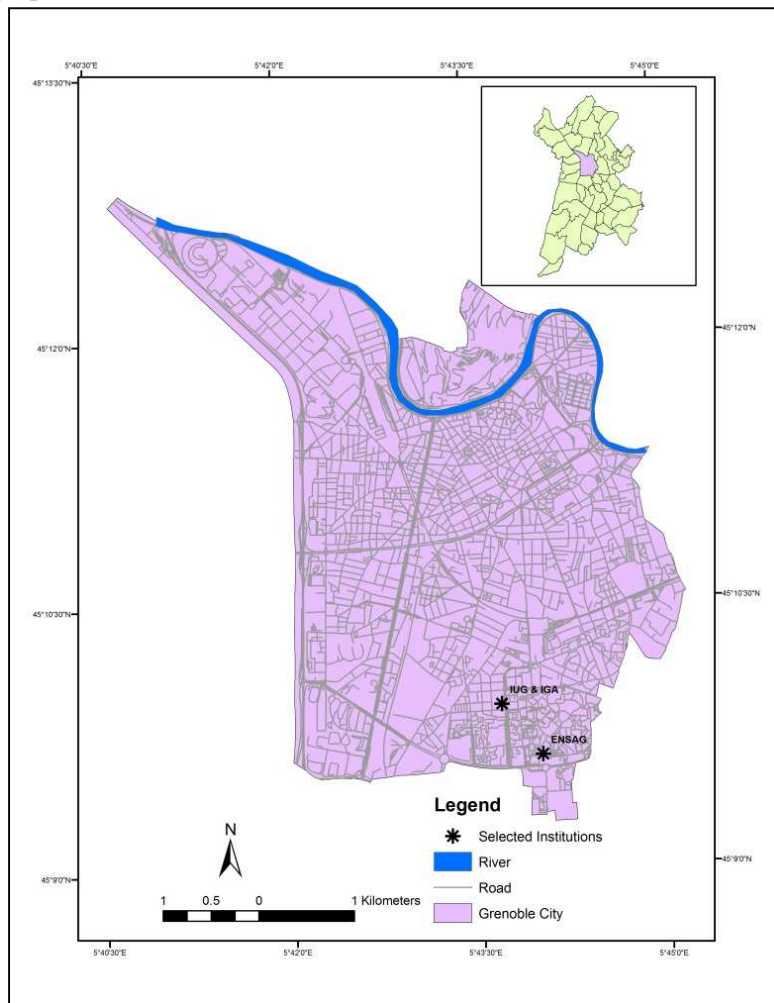


Source: Prepared by author, 2017

### 3.5 Why Grenoble City?

The rationality for selecting Grenoble City as case study is three folds. First, several faculties and institutions of Université Grenoble Alpes are located in this city which has huge impact on city's housing, transportation as well as on the overall planning of the city. Second, the city is characterized by diverse population from different nationality, different socio-demographic and cultural status. Also, a high variety of spatial variation in development is apparent like high density and mix development in the northern part and comparatively less dense and homogenous land use pattern in the southern part. Apart from the density and land use type, the northern part exhibits the history and culture of the city whereas the southern part more modern development.

Map 4-5: The geographical location of selected Institutions



Source: Prepared by author, 2017

### 3.6 Conclusion

Therefore, from this chapter a general understanding about Grenoble Metropolitan Area and Grenoble City is found. The importance of Grenoble city within the metropolitan is justifiable from the demographic, land use and transportation connectivity profile. Furthermore, the reason to select Grenoble city as case study is completely rational after considering the threefold justifications behind the case selection.

## 5. Chapter: Spatial Analysis

In this chapter, factors affecting the active travel behavior of young adults studying in university are analyzed from spatial point of view. To do so, data collected from the face to face interview is used along with aggregate land use, public transport service area and land use mix information of Grenoble. For better understanding, the analysis is done for both origin and destination of student's trip for different trip purposes. As mentioned in the methodology, four particular types of trips (trip to university, trip to shop, trip to administrative office, and trip to leisure activity) are considered in this analysis.

### 5.1 Basis of analysis

#### 5.1.1 Land use

It is agreed that transport is a derived demand and problems associated with it can be solved by other fields apart from transportation. In this regard, in the contemporary researches, it is prescribed that spatial arrangement of different types of uses and activities could be potential solution to reduce congestion and pollution (Buliung and Rimmel, 2008). Keeping in mind this premise, land use pattern has been successfully used by researchers like Handy and Xing (2011), Hess et al. (2017), Saelens et al. (2003) and Sundquist et al. (2011) as a substantial factor of built environment which is considered to be a significant component of encompassing spatial environment. Therefore, for this study land use is contemplated as a significant factor with a hypothesis that it might have significant impacts on young adult's active transport behavior.

In this study, aggregate land use pattern of Grenoble city is collected from Ministere-de-la-Transition-Écologique-et-Solidaire (2015) (cf. Map 5-1). Primary focus regarding land use pattern and active transportation is to understand the type of land use more supportive or restrictive to active transport behavior from the perspective of both origin and destination. The percentage of different land use pattern in Grenoble is given in Table 5-1.

Table 5-1: Area wise land use distribution in Grenoble

Land use type	Area in sq. km	Percentage of total land area
Continuous Urban Fabric	3	16.57
Discontinuous urban fabric	10	55.25
Commercial unit and public facilities	3.9	21.55
Forest	0.6	3.31
Sports and leisure facilities	0.5	3.31

Source: (Ministere-de-la-Transition-Écologique-et-Solidaire, 2015)

#### 5.1.2 Walk score

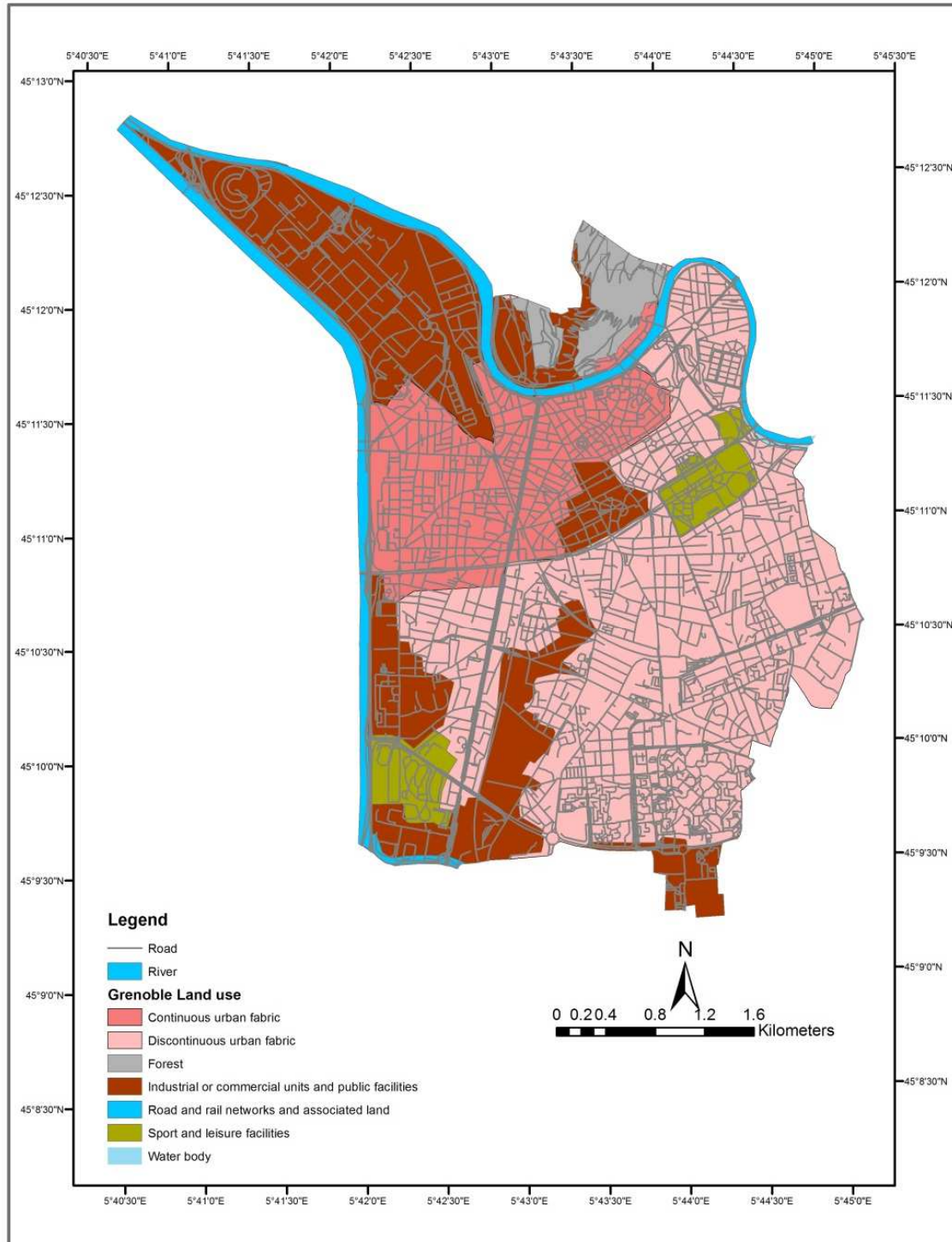
To gauge the walkability of a particular area or built environment, there are different Walkability indices like pedshed, walk opportunities index, walk score etc. (Manaugh and El-Geneydy, 2011). Among these different indices, walk Score is one of the recognized and valid measurement tools of estimating neighborhood walkability in different geographic locations and at distinct spatial scales (Duncan et al., 2011). To measure the walkability depending on proximity and density of different types of amenities, it is developed by Frontlane in association with other academics such as Larry Frank and Reid Ewing (Gilderbloom et al., 2015).

The data source for walk score are Google, Education.com, Open Street Map, the U.S. Census, location and places added by the Walk Score users community. It uses algorithm to catch different types of uses within 1 mile radius of a particular spatial point. Scores of different resources are then summed and weighted by their distances from that address, and normalized to 100. Resources include grocery stores,



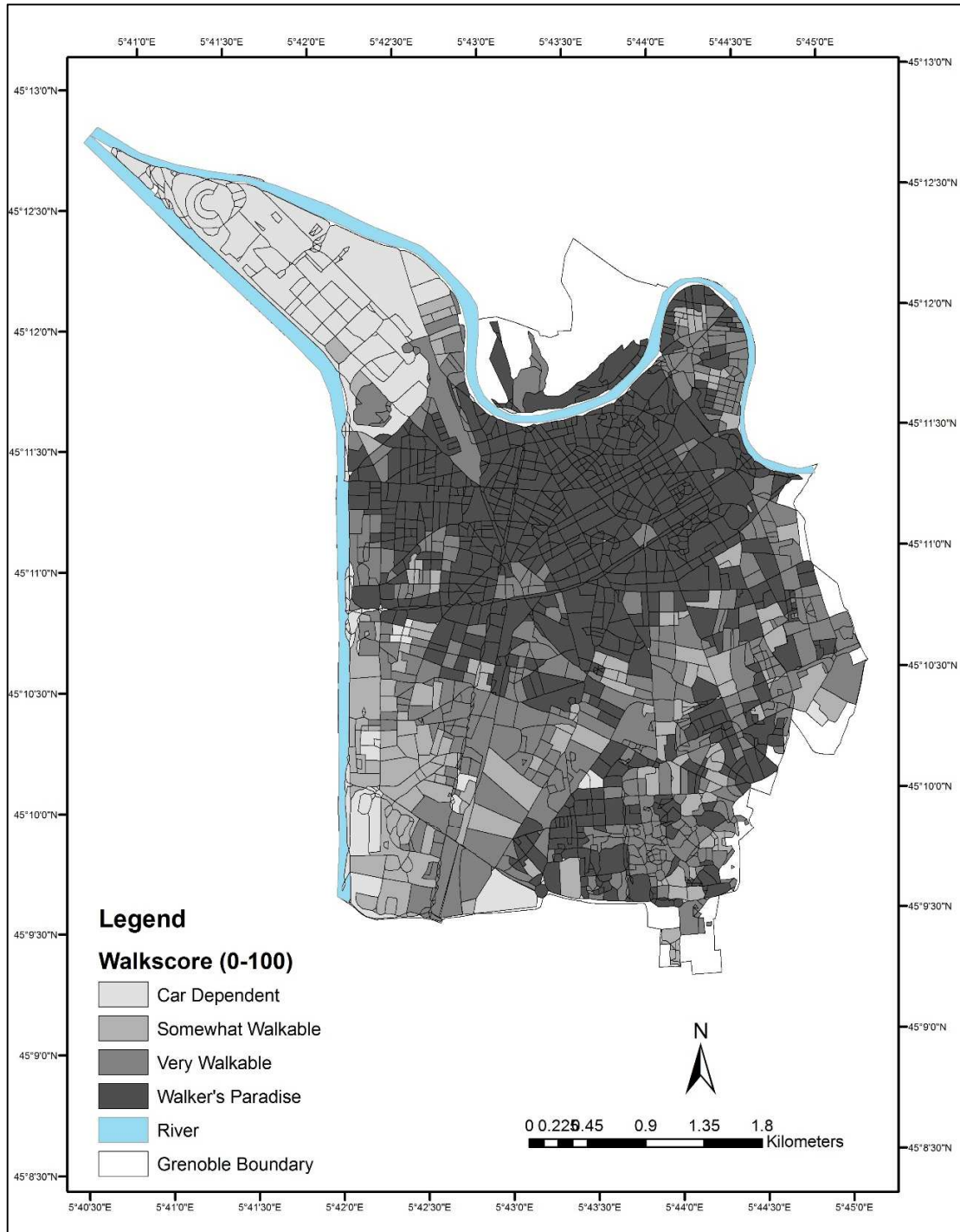
bars, movie theaters, libraries, schools, and more. Scores do not distinguish “health-friendly” resources from other types, and do not incorporate aspects like area crime or sidewalk quality.

Map 5-1: Land use pattern of Grenoble



Source: Prepared by author (Data: Ministère-de-la-Transition-Écologique-et-Solidaire (2015))

Map 5-2: Walkability map of Grenoble using walk score



Source: Prepared by author, 2017 (Data: [www.walkscore.com](http://www.walkscore.com))

Moreover, land use mix and density is considered as important factors of built environment affecting active travel behavior and used by different researcher in their study related to travel behavior analysis (Simons et al., 2017, Frank et al., 2004, Cerin et al., 2006, Saelens et al., 2003, Sundquist et al., 2011). In this study to incorporate these two factors, it took the advantage of walk score walkability measurement

index. Data is obtained from the web site of Walk Score®. Manually data is collected for each building then plotted using ArcGIS 10.1 and open street map. In the preparation of walk score map, forest area is not included. It is found from the walk score map that more than 70% area of Grenoble is in a very good walking condition in terms of land use mix and density (cf. Table 5-2 and Map 5-2). This walk score map is used as a base map to understand the influences of land use mix and densities in availing active transport as a means of transportation among the university going young adult group.

Table 5-2: Walk score distribution in Grenoble

Walk score	Explication	Area of Grenoble under (sq. km)	Percentage of total area
90-100	Walker's Paradise Daily movement do not require a car	7.19884	41.14
70-89	Very walkable Most of the movement can be accomplished using foot	5.657288	32.33
50-69	Somewhat walkable Some movement can be possible on foot	2.227233	12.73
0-49	Car dependent Most of the movement require a car	2.416086	13.81

Source: Walkability map of Grenoble using walk score (cf. Map 5-2)

### 5.1.3 Public transport service area

Along with land use mix and density, access to public transport facilities is also recognized as a noteworthy factor in understanding people's inclination for either car or other environment friendly available modes of choice (Handy et al., 2005). Therefore, in this study the public transport service area of Grenoble is selected as third strands for analysis. As mentioned in the study area chapter (cf. Chapter: Case study), the public transport service is planned in Grenoble by tram and bus, where there are different combinations of buses (chrono, proximo, flexo) depending on the type of route it's covering. The frequency of tram, chrono and proximo is almost same in the pick time. Besides, flexo is more frequent only in the pick time. The service area of these transport facilities is calculated using Network Analysis tool of ArcGIS 10.1. This service area is different from Euclidean distance based on buffer area, as service area takes into account all accessible streets (that is, streets that are within specified impedance). Here, service area is calculated for a distance of 400 meter ( $\leq 400$  meters) from each transit stoppage, since, from each transit stoppage this is the maximum walk able area (Rattan et al., 2012). To identify the transit stoppage, open street map, website of metromobilite (<http://www.metromobilite.fr>) and personal observation is used to cross check the information. In the meantime, any change/diversion in tram/bus route for construction and maintenance is not taken into account in this study. General information about public transport service area of Grenoble is shown in

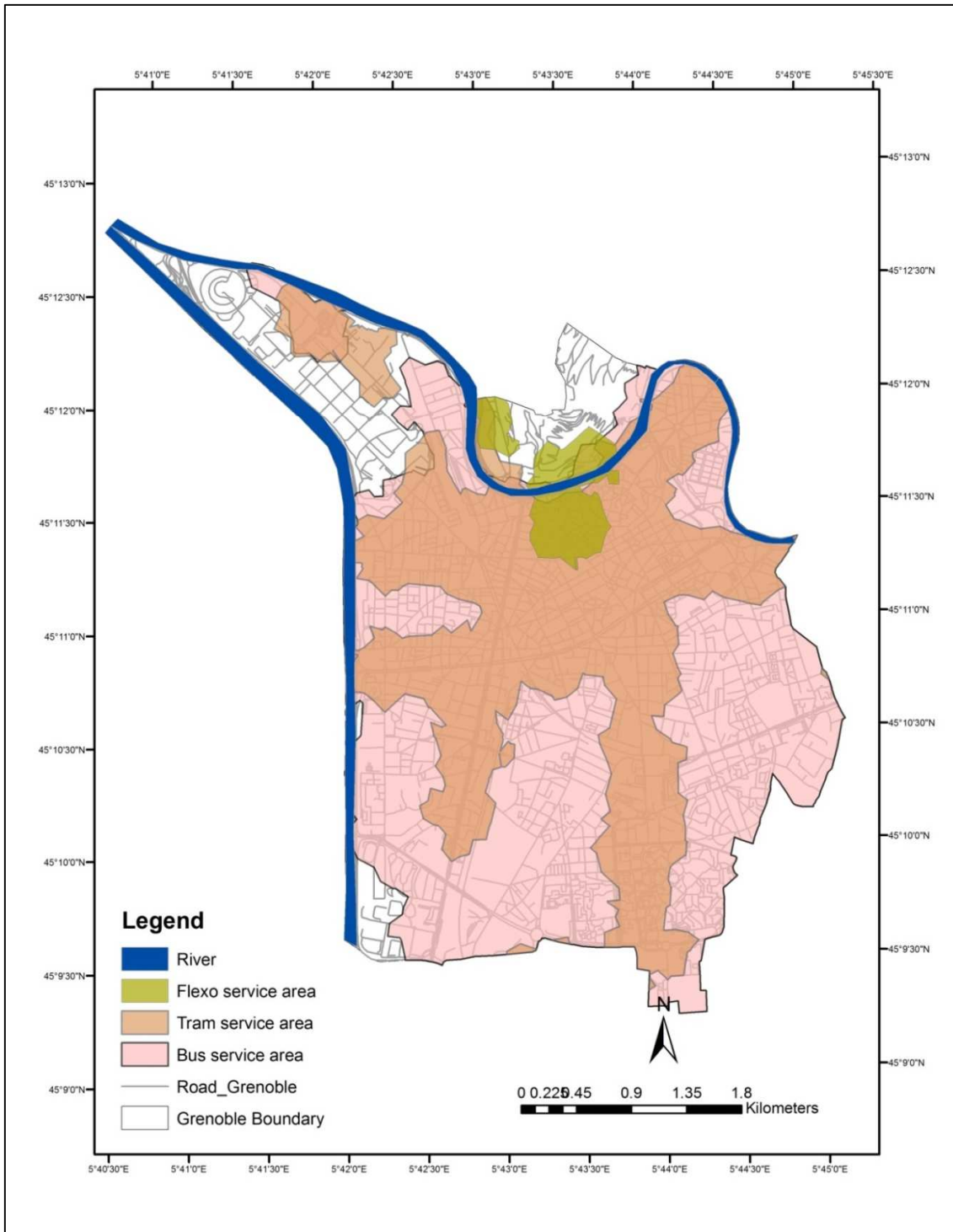
Map 5-3 and Table 5-3.

Table 5-3: Public transportation Service area of Grenoble

Name of the service	Service area (sq km)	Percentage of service area compared to the total area of Grenoble
Tram	7.8269	43.24254
Bus (Chrono and Proximo)	15.1897	83.92099
Flexo	0.730742	4.037249

Source: Public transport service area map of Grenoble (Map 5.3)

Map 5-3: Public transport service area map of Grenoble



Source: Prepared by author, 2017 (Data: open street map, [www.metromobilite.fr](http://www.metromobilite.fr))

## **5.2 Analysis of Origin-Destination**

For the purpose of this study, the influence of different spatial attributes on determining the mode choice is investigated from the perspective of both origin and destination of a single trip. Here, to simplify the complex daily trip pattern of young adult and for better clarification, the origin of each trip is considered as home. In the face to face interview, students were involved in a spatial mapping process. During this process, they dropped pin in the Google map showing approximately the nearby street where they lived and made other trips. The geocode of those points is used in this chapter for spatial analysis. Almost 35 students were involved in the mapping process from three different institutes (IUG, IGA and ENSAG); however, data from 31 students are used in this chapter for analysis. The reason is, other students lived in the nearby city of Grenoble and in the Google map the boundary of Grenoble was not clarified very well to exclude those students before the mapping.

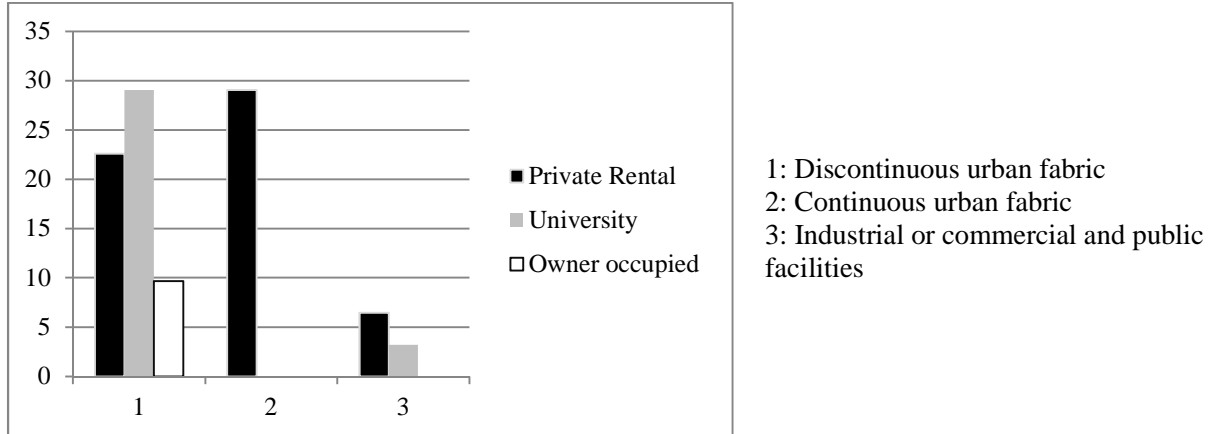
Among these 31 students, 35.5% students are from IUG, 25.8% from IGA and 38.7 % from ENSAG. As in the online questionnaire, greater amount of response was found from IGA; therefore in the face to face interview higher proportion of students were selected from the other two institutions. During the interview, there was an attempt to select equal number of master's and bachelor students as well as native and non-native students. Hence, 51.6% students among the selected 31 students are studying in a Bachelor program, whereas 48.4% students in a master's program. Moreover, 45.2% among the 31 students are non-native (13 different nationality) and 54.8% are native students. Mean age of these students is  $22.35 \pm 2.074$ Std. During the face to face interview, along with the geocode information of origin-destination of different trips, they were also asked questions similar to the online questionnaire (about socio-demographic, environmental as well as travel factors) associated with their movement in an ordinary week. Different combinations of income sources and housing types are found within this small sample. Almost, 35.5% students were entirely dependent on their parents, whereas the rest of the students holding the possession of different income sources like scholarship, part time job, full time job, internship etc. Among these students, 61.3% students have their driving license, 25.8% have their own car and 41.9% have their own bicycle. In terms of housing, 32.3% students are living in university provided dormitory, 58.1% in private rental housing and almost 9.7% in owner occupied housing.

### **5.2.1 Analysis of origin (Home)**

It is obvious from the Map 5-4 that the spatial distribution of student's home is not consolidated in a particular area, rather scattered all around Grenoble. Almost 61% students (among the 31) have been living in the discontinuous urban fabric area, whereas 29% in the continuous urban fabric and almost 10% in the aggregate zone of commercial and public facilities area (cf. Map 5-4). However, in the continuous urban fabric, the housing type of the students' home is private rental which is expensive compared to university dormitory and almost 77% of those students are native students. Meanwhile, students residing in the discontinuous urban fabric are either living in university dormitories (29.03%), in private rental housing (22.53%) or in owner occupied housing (9.68%). Among them, almost 61% students (among 19 students residing in discontinuous are) are non-native students. It is also noteworthy to mention that university dormitories are scattered at the periphery of the city; either located in the discontinuous urban fabric or in the aggregated industrial and commercial units and public facilities area. Students who are living in these dormitory, 90% of them are non-native students. Therefore, a significant spatial difference is found among the students in terms of their location of home and type of housing between native and non-native students. Moreover, students residing in the owner occupied houses are only available in the discontinuous urban fabric and they are all native students. From this figure, it is

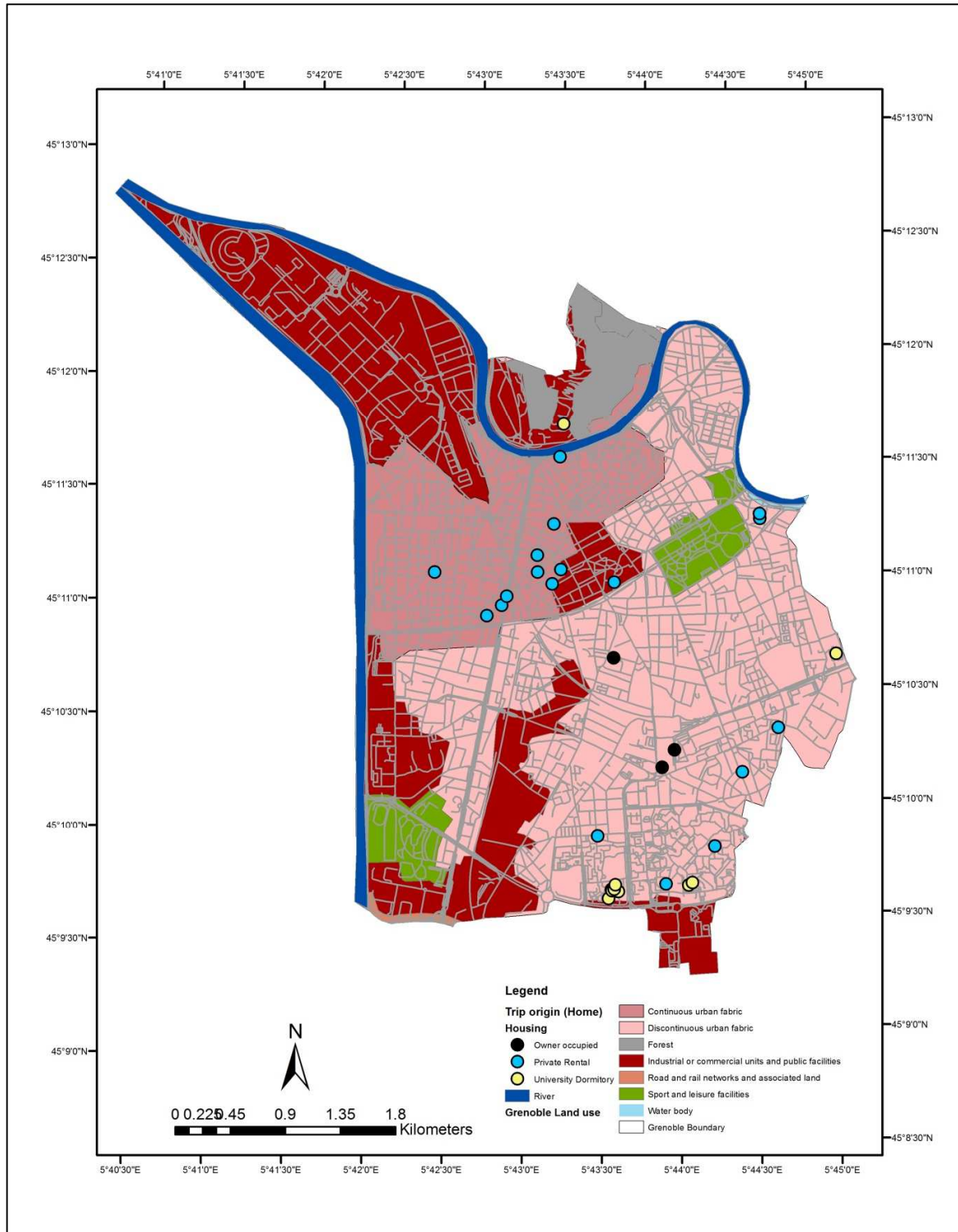
prescribing people's preference to buy their houses near the periphery or suburban area compared to city center (that is continuous urban fabric) (cf. Figure 5-1).

Figure 5-1: Housing type and distribution in different urban fabric



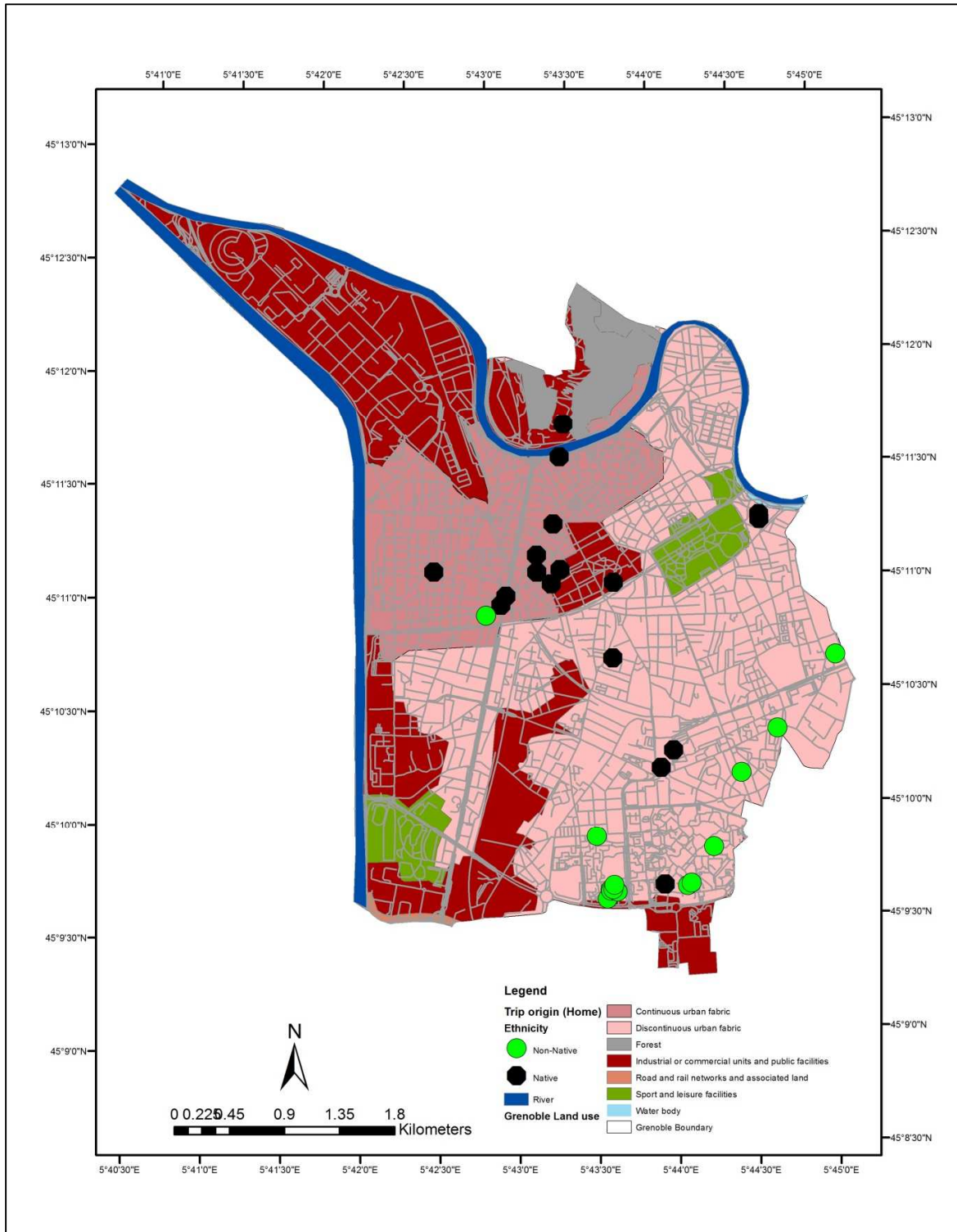
Source: Face to face interview 2017 and Ministère-de-la-Transition-Écologique-et-Solidaire (2015)

Map 5-4: Origin map of you adult showing the distribution of housing type



Source: Prepared by author, 2017 (Data: Face to face interview 2017 and Ministère-de-la-Transition-Écologique-et-Solidaire (2015))

Map 5-5: Origin map of young adult showing the distribution of native and non-native students

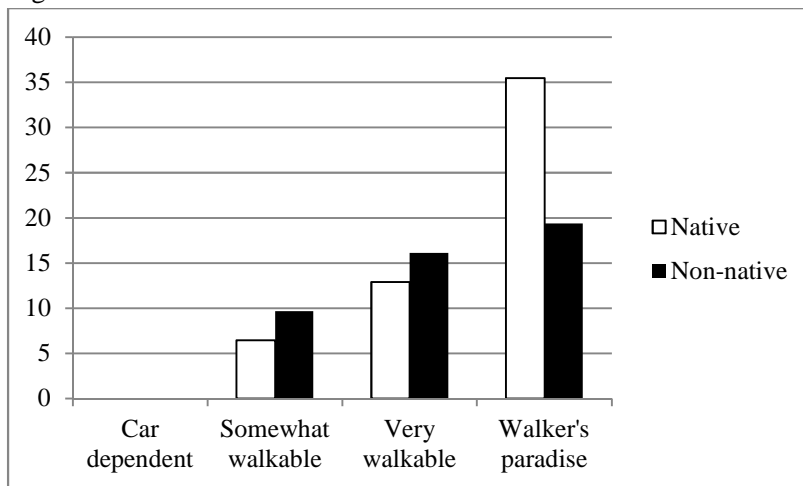


Source: Prepared by author, 2017 (Data: Face to face interview, 2017 and Ministère-de-la-Transition-Écologique-et-Solidaire (2015))



From the perspective of land use mix and density, in the walk score map, it is apparent that none of the students are living in the car dependent areas; no matter either the student is native or non-native. Even though, most of the areas in Grenoble under the category of walker's paradise (more than one third of the total area), which are consolidated around the center (continuous urban fabric) and scattered in the discontinuous urban fabric area. Almost 55% (among the 31 students) students are living in this walker's paradise zone. Therefore, an indirect preference among the students for different types of land use mix is plausible. Besides, 29% students are living in the very walkable area whereas only 16% students are living in the area called somewhat walkable. Among the 55% students living in the walker's paradise, about 64% students are native. On the other hand, in the comparatively less walkable area (somewhat walkable) almost 60% students are non-native (cf. Figure 5-2). Like the land use distribution, in terms of density and land use mix a spatial difference between native and non-native students are observable. This difference could be an indirect reference of affordability among native and non-native students.

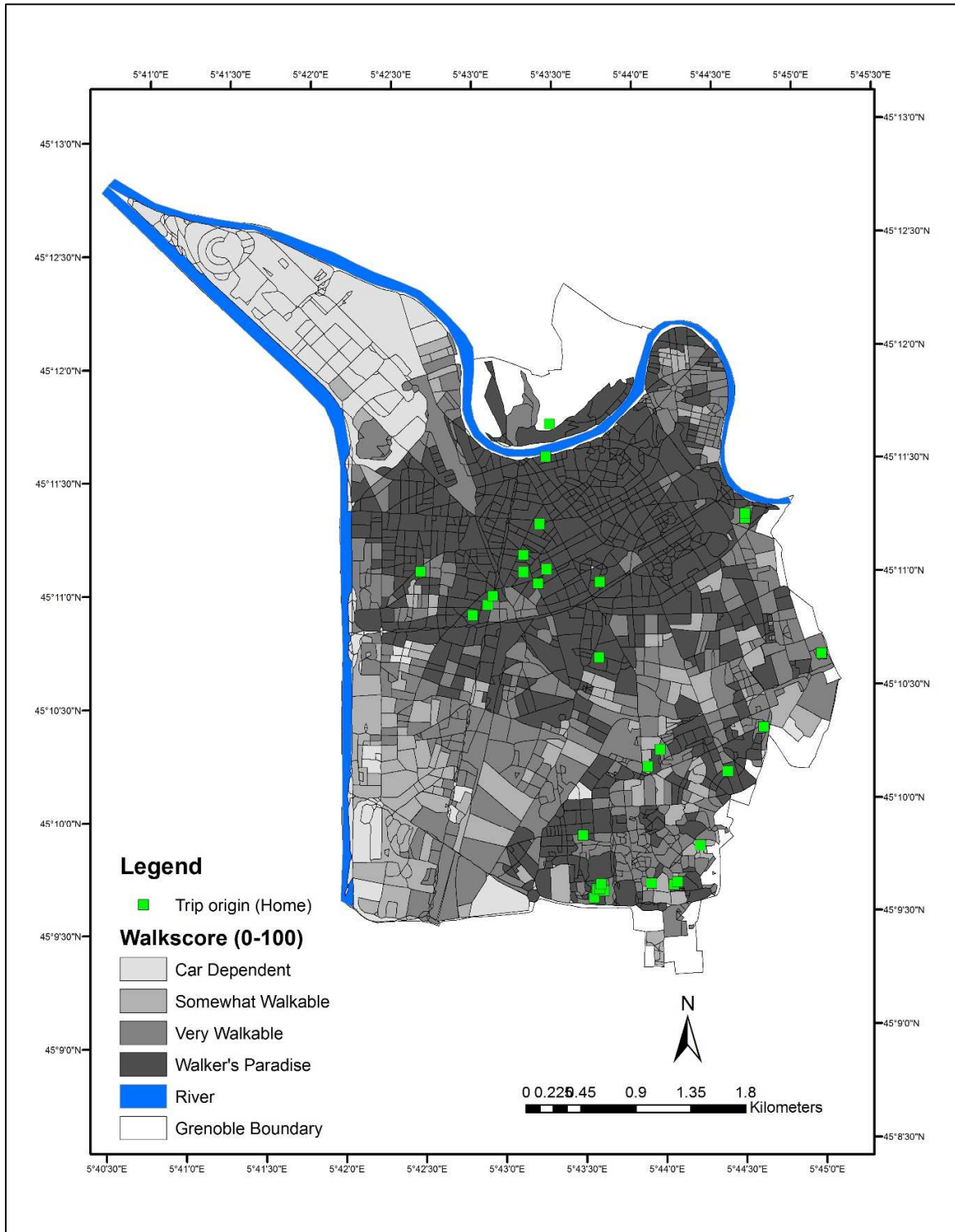
Figure 5-2: Distribution of native and non-native students in different walkable area



Source: Walk score map (cf. Map 5-6)

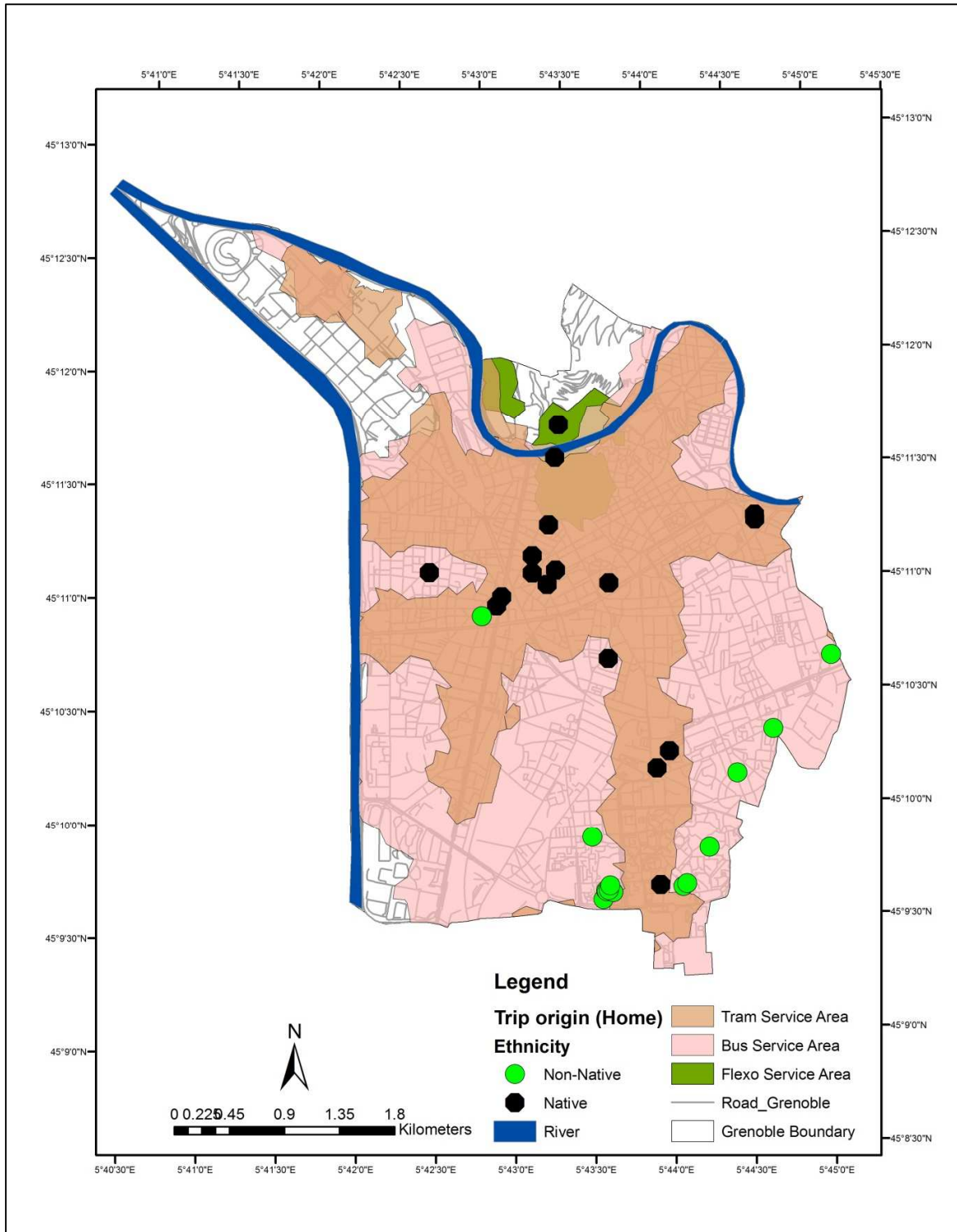
Along with land use pattern and land use mix, service area of public transportation is considered as an important built environment attribute in this study with an assumption that provision of public transport service could be substantially associated with the promotion of active transport behavior. The reason is public transport use also involves a mentionable amount of active movement like walking. In case of Grenoble, the city has very good public transportation service provision. Almost, 89.5% area (16.18 sq. km) of Grenoble is under the service of public transportation. However, the entire Grenoble area is not under the service of all available public transport modes like tram and bus. Some area is covered by both tram and bus, whereas some with either only tram or bus. Additionally, flexo is covering a very small portion of area on a demand basis requirement. Statistically, area served by both bus and tram is 43.5% of the total service area whereas bus alone is serving 47.5% of the service area. Meanwhile, among the students participated in face to face interview, 45% of them are living in the area served by both bus and tram and 48% of them under the service area of bus. None of them are living in the area which is not covered by the public transport services (cf. Map 5-7). Therefore, it can be argued that to live near the transit services could be a priority choice for the young adult students to adjust their time and resources within their affordability. Even though, to be near the public transport service is a common observation for all students, however, higher propensity to live near multiple modal coverage is apparent among the native students compared to non-native students.

Map 5-6: Walk score map of Grenoble



Source: Prepared by author, 2017 (Data: face to face interview, 2017 and [www.walkscore.com](http://www.walkscore.com))

Map 5-7: Origin map of young adult exposed to the service area of public transport



Source: Prepared by author, 2017 (Data: face to face interview, 2017, open street map, [www.metromobilite.fr](http://www.metromobilite.fr))

### 5.3 Analysis of destination

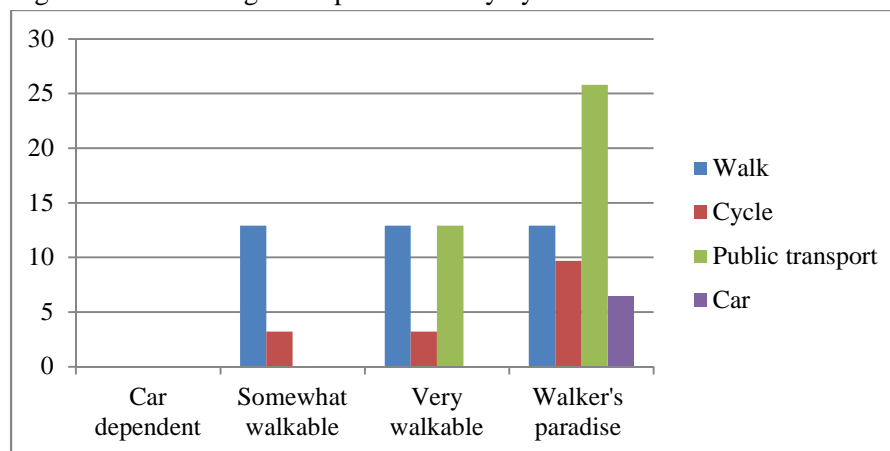
For the analysis of destination, destinations of four different types of trips (trip to university, trip to shop/grocery, trip to administrative office and trip to leisure activity) are considered separately, as it is assumed that mode choice and pattern of movement vary depending on the type of purposes.

#### 5.3.1 Trip to University and travel behavior

In case of trip to university, it is found that higher percentage of students use public transport (38.71% of the 31 students) or walk as a means (38.71% of the 31 students) to come to university. Even though, the service area of Grenoble public transportation covered 89.5% (16.18 sq. km) area of Grenoble and student's trip origins are located within the public transport service area, almost 6.45% students use car to go to university and all of them are native students. However, it is apparent in the map as well as in the figure that those who are living in high walkable area have higher tendency to use public transport or cycle rather walking (cf. Map 5-8 and Figure 5-3). Also, the percentage of students walk to university is nearly same in different walkable condition of their origin. Now, the question is whether walkability in terms of land use mix has any influence in adopting walking/cycling as a mode of transport for the particular trip to university. This situation can be explained using the map of university service area (cf. Map 5-9).

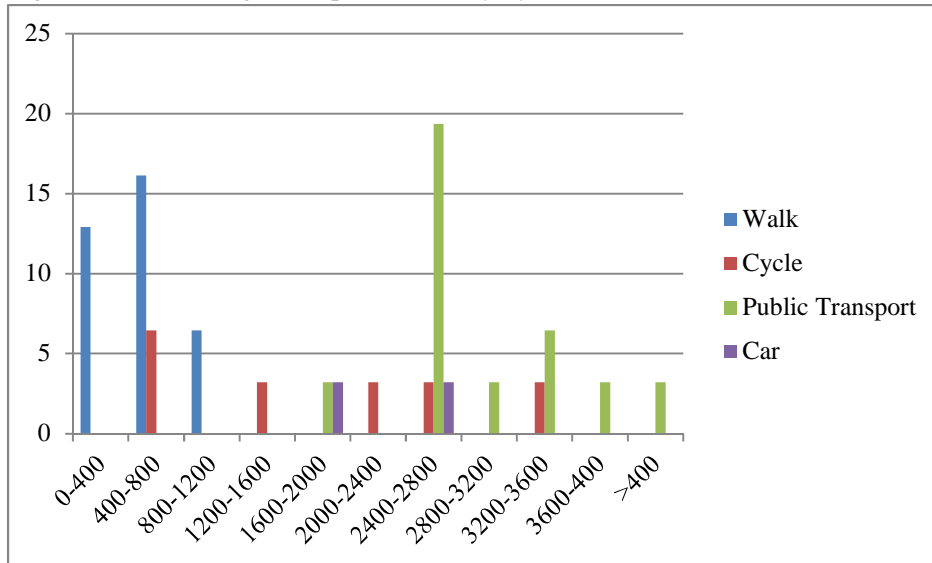
When the destination point is university, it is apparent in the Map 5-9 that those who are living within 0-1.2km service area of the university, are using walking as mode of transport to go to university which is irrespective of their origin's walkability index. It should be kept in mind that here the distance is not the Euclidean distance from the origin rather calculated based on available roads and junction to reach the destination. On the other hand, those who are living in the highly walkable area (walk score 90-100) are using public transport or cycle, because those places are located near the city center (continuous urban fabric) and in the service area of university ranged from 2.8-3.2km which is not within the walking distance. Therefore, it can be inferred that for this particular purpose (trip to university), walkability in terms of density or land use mix is not that much influential to promote walking how the distance from the university (service area of the university) is. Therefore, we cannot generalize that land use mix always plays significant role in increasing active travel. It also depends on the distance to destination and purpose of the trip. Here, in case of trip to university placement of the students' accommodation nearby the campus is a significant factor in increasing more walk trip to university. Modal distribution of students in different service area of university is shown in Figure 5-4.

Figure 5-3: Percentage of trip to university by different modes from different walkable area



Source: Origin destination map for trip to university and corresponding walkability (cf. Map 5-8)

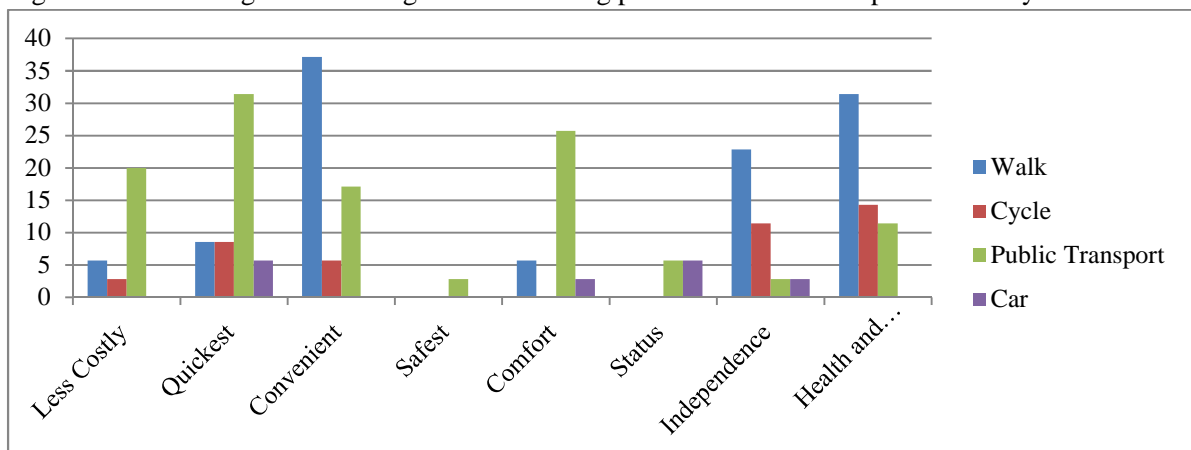
Figure 5-4: Percentage of trip to university by different modes from different service area of university



Source: University service area map and trip flow for trip to university (cf. Map 5-9)

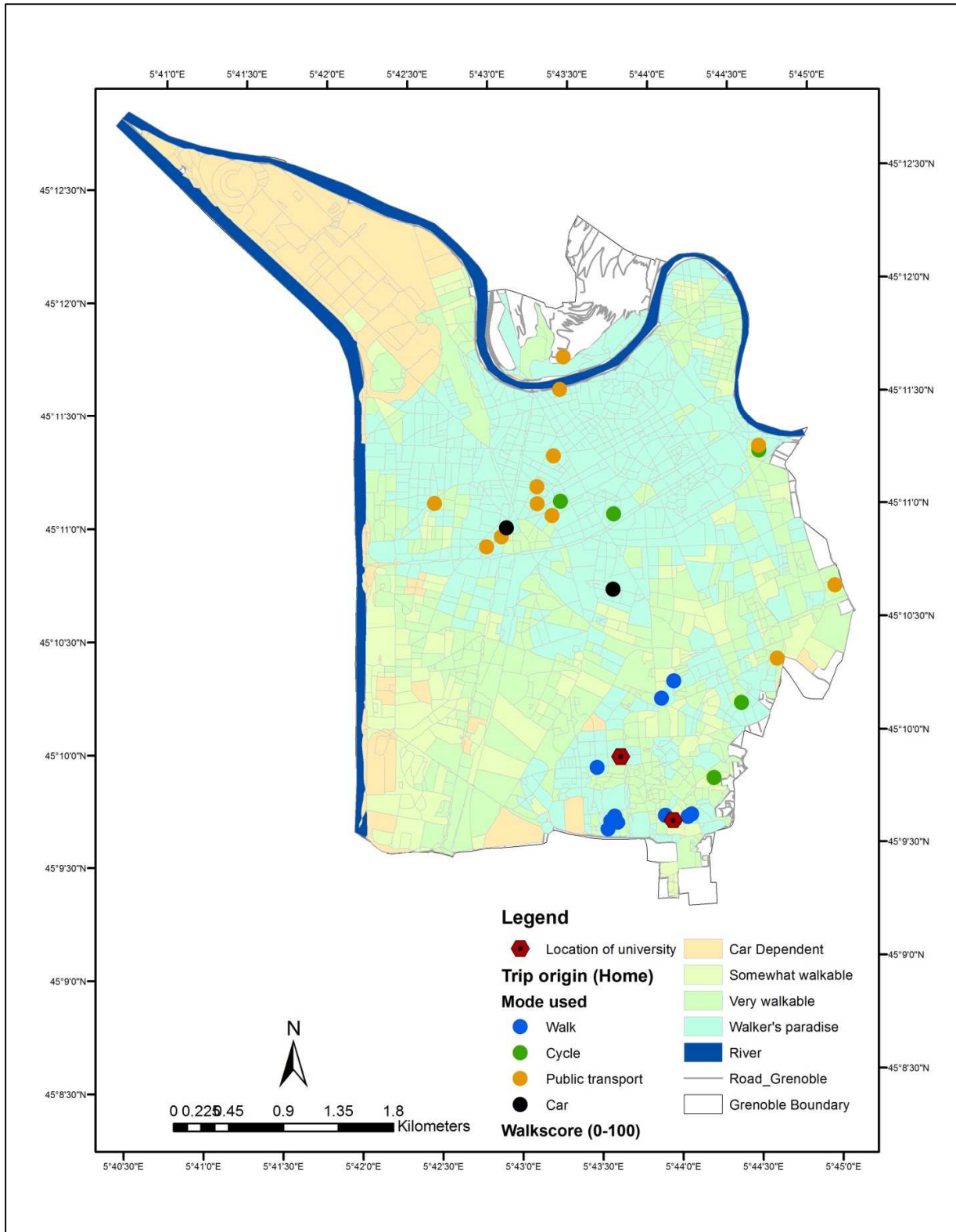
In the face to face interview, students had elucidated the reason for selecting the particular mode (walk, cycle, public transport and car) as a means to go to university. Among the walkers, all of them said that their place is very nearby to school which support the observation from spatial mapping. They also liked to walk because of their **personal independence** (61.5% among 13 students) and **benefit for health and environment** (84.6% among 13 students). In the same way, for cycle users, their personal independence and health and environmental concern are prime reasons to use cycle to commute to university (80% and 100% respectively among 5 cycle users). Unlike the walkers and cycle users, for the public transport users, it is all about **comfort, cost and time**. It is worth to mention that in Grenoble special facilities (15€ per month) for below 25 year old students also inspire the students to use public transport instead of other available alternatives and increase their frequency of mobility (cf. Figure 5-5).

Figure 5-5: Percentage of reasoning behind selecting particular mode for trip to university



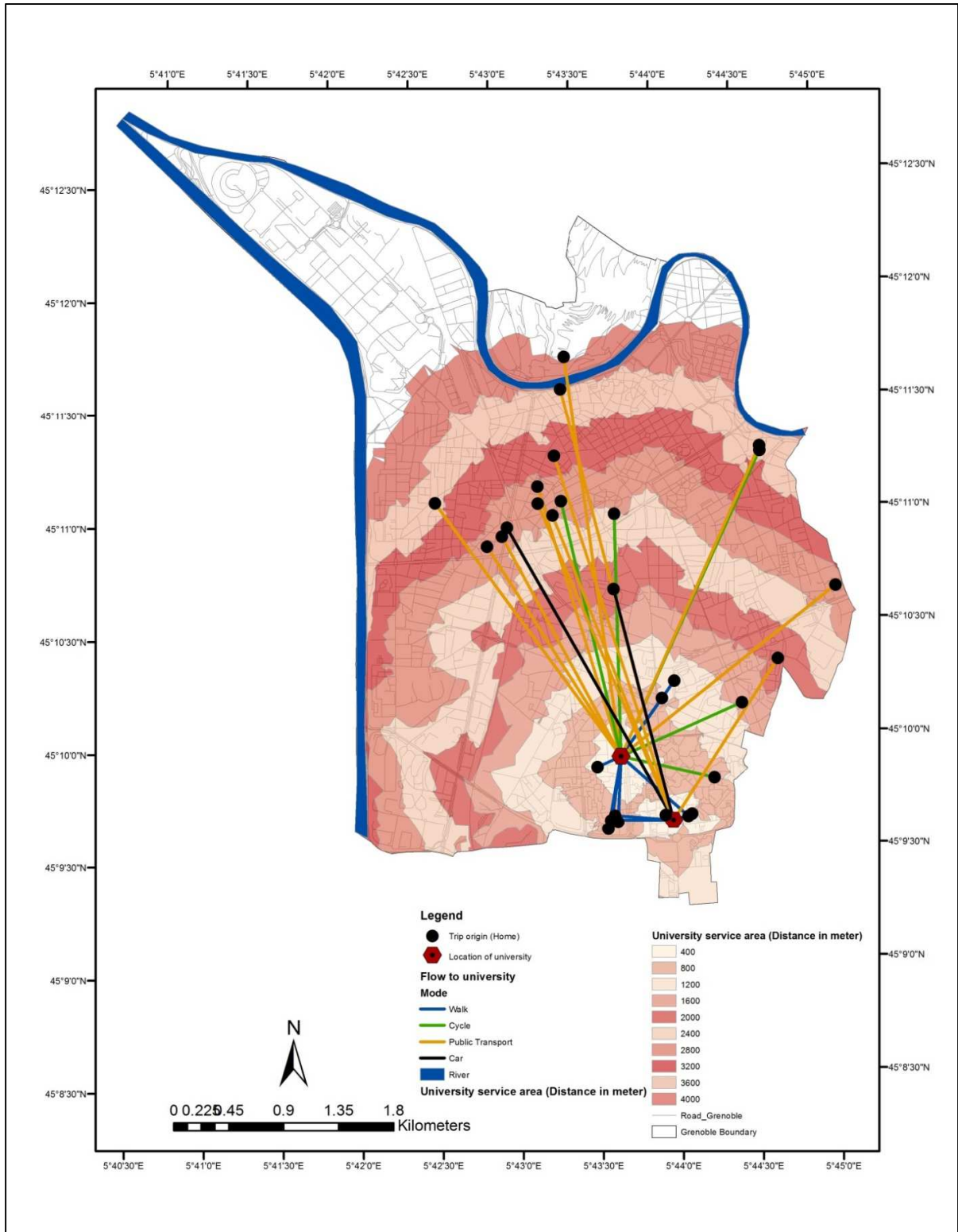
Source: Face to face interview, 2017

Map 5-8: Origin destination map for trip to university and corresponding walkability



Source: Prepared by author, 2017 (Data: face to face interview, 2017, www.walkscore.com)

Map 5-9: University service area map and trip flow for trip to university



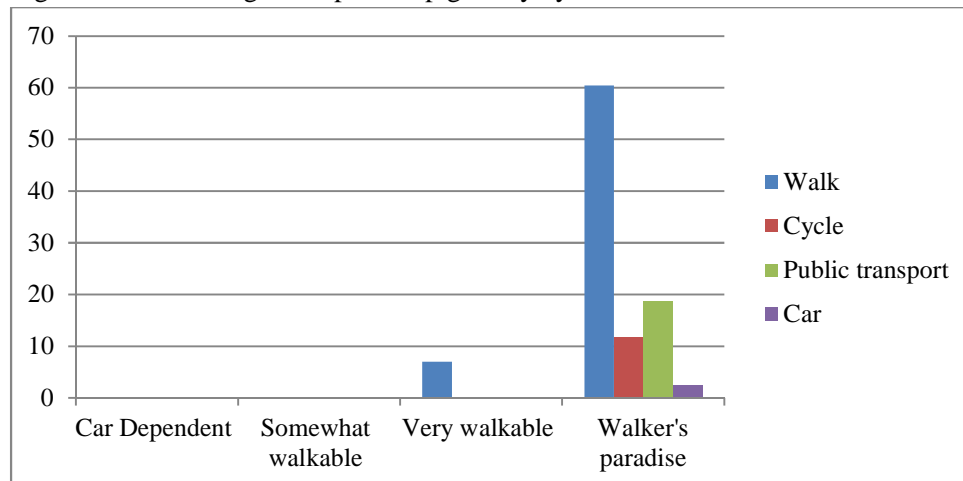
Source: Prepared by author (Data: face to face interview, 2017)

### 5.3.2. Trip to shop/grocery and travel behavior

To analyze the trip to shop/grocery, destinations within Grenoble is considered for spatial analysis. Total 70 trip destinations were observed in the spatial mapping exercise among which 43 trips are considered for the further analysis, those who have both origin and destination located within Grenoble. In the spatial mapping exercise, in case of trip to shop students had option to put multiple places where they go for grocery in an ordinary week. For the purpose of trip to shop/grocery, higher percentage of trip involving walking, public transport or cycling is evident in the highly walkable area (cf. Figure 5-6). Apparently, highest percentage of trip is made by walking (67%) and public transport (19%). The spatial distribution of origin (home) and destination (shop/grocery) of trip for shopping is shown in Map 5-10. It is clear in the map that walkability of both origin and destination has influence in selecting destinations to go for shopping. In the discontinuous urban fabric, where there is scattered walkable area, attracting less number of trips for shopping because of lack of land use mix. On the other hand, at the center where there are walkable places and land use mix attracts more trips for shopping/grocery.

However, all the trips towards the city center by public transport are not generated by those who are living in the center and similarly, all the walk trips near the university are not made by those who are living nearby the university. This complexity of the movement can be explained using trip flow connecting origin (home) and destination places. It is obvious in the Map 5-11 that those who have their home at city center are also doing their grocery from the nearby shops of university through walking and those who are living nearby the university, are also rushing to the center by public transport. Hence, it can be construed that, student's choice of destinations and mode for shop/grocery are dependent on the walkability i.e. land use mix and density of the places. It is also obvious that the percentage of walk trip is higher nearby the university as well as in the center; because these walk trips are parts of trip chain students are involved in throughout the day to adjust their time and resource constraint. On the way back from university, students are making their walk trip to go to grocery shops located near the university, even though they are living near the city center.

Figure 5-6: Percentage of trip to shop/grocery by different modes from different walkable area

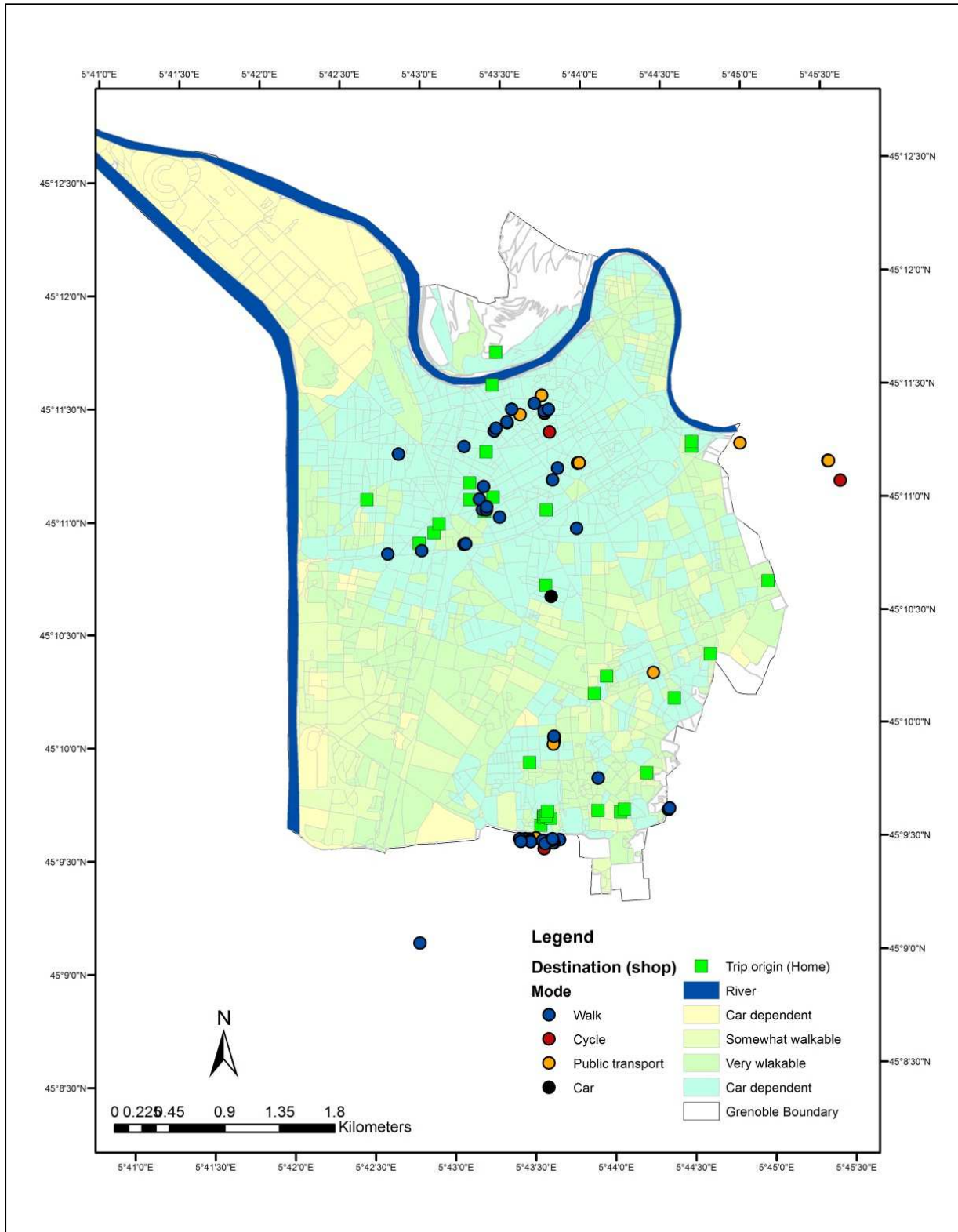


Source: Origin-destination map of trip to shop/grocery and modal distribution (cf. Map 5-10)

Therefore, walkability in terms of land use mix and density is an important factor influencing the students active travel behavior when it is about trip to shop/grocery. It is apparently suggesting that for the promotion of active travel behavior of the students, it is important to think about land use mix and density around the university campus that will be supportive to make the trip chain through walking/cycling.

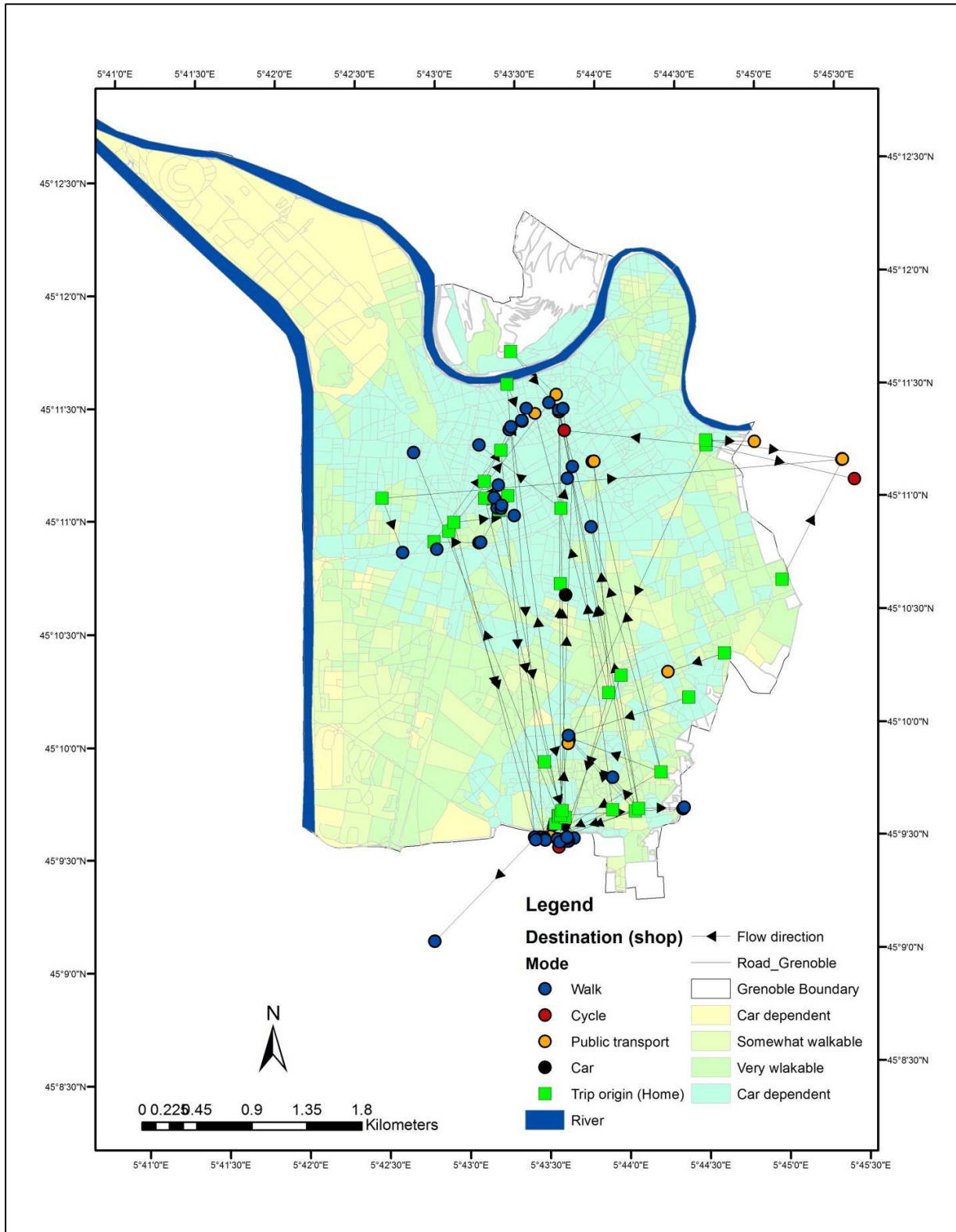


Map 5-10: Origin-destination map of trip to shop/grocery and walkability



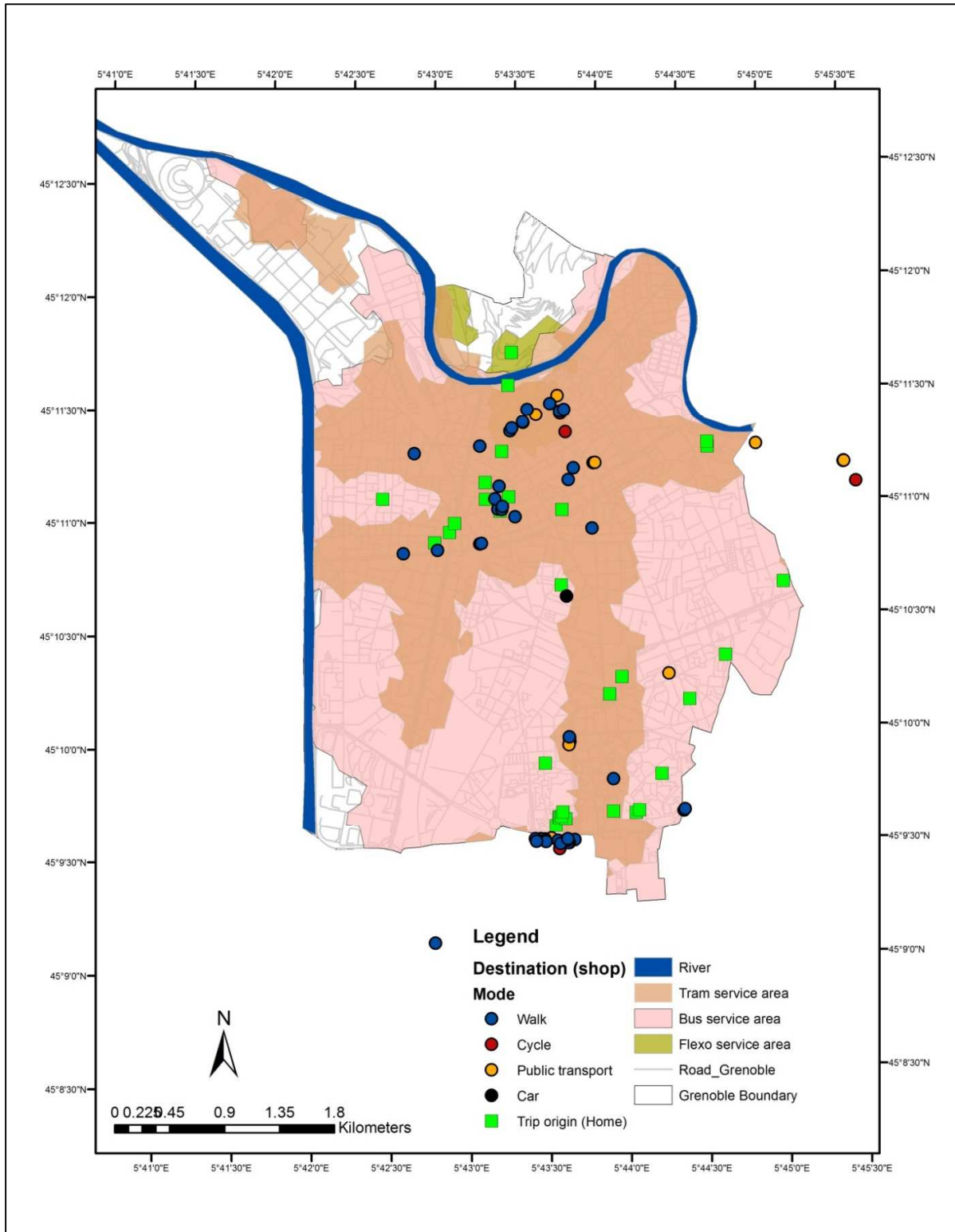
Source: Prepared by author, 2017 (Data: face to face interview, 2017 and [www.walkscore.com](http://www.walkscore.com))

Map 5-11: Trip flow map of origin and destination for trip to shop/grocery and modal distribution



Source: Prepared by author, 2017 (Data: face to face interview, 2017 and [www.walkscore.com](http://www.walkscore.com))

Map 5-12: Origin-destination map of trip to shop/grocery and public transport service area

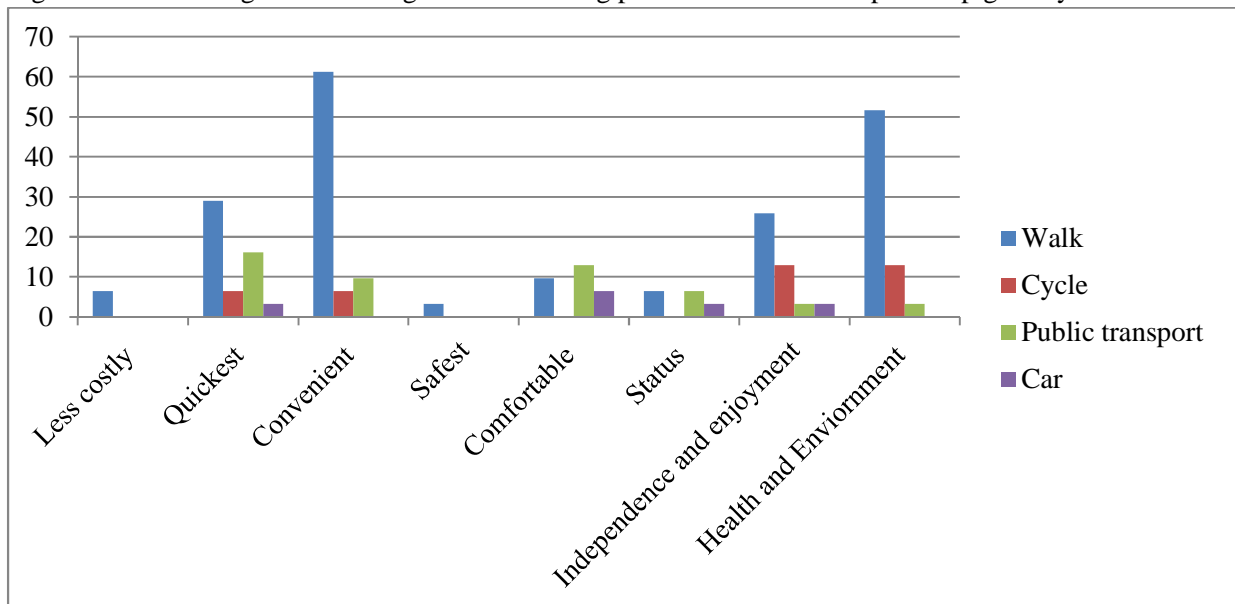


Source: Prepared by author, 2017 (Data: Face to face interview (2017), open street map, [www.metromobilite.fr](http://www.metromobilite.fr))

Meanwhile, it is distinctive in the public transport service area Map 5-12 that student's choices of destinations are also dependent on the available public transport facilities available to reach the destinations. Apart from the destinations located outside of Grenoble, among 43 destinations, 60% of them have good connectivity with both bus and tram and almost 35% area is connected by bus, tram as well as flexo. Therefore, it's a clear indication that greater access to public transport is giving higher mobility among the young adults and better opportunity of exploration.

Also, from the face to face interview, it is confirmed by the students (61.29%) that they chose walking to go to shop/grocery because walking was convenient for them, since, the shops are either very nearby to their university campus or to their home. Like the trip to university, students also chose walking for their concern about health and environment as well as for their personal enjoyment (cf. Figure 5-7).

Figure 5-7: Percentage of reasoning behind selecting particular mode for trip to shop/grocery



Source: Face to face interview, 2017

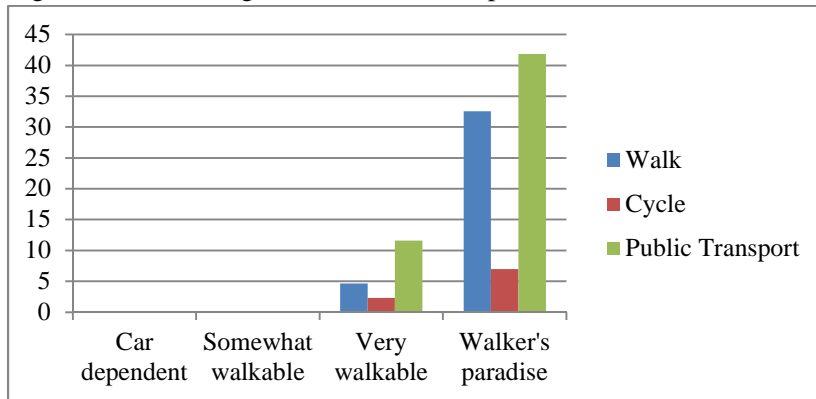
### 5.3.3 Trip to administrative office

In case of trip for bank or post office or any other kind of administrative office work, the concentration of movement is found at the continuous urban fabric i.e. the city center of Grenoble. There are also some trips having destination outside of Grenoble which are not considered here for analysis. The total number of trips having destination in Grenoble is 43. Among these 43 trips, 67% have their destinations in the continuous urban fabric and commercial and public facilities area (cf. Map 5-13). This movement pattern can be better explicated by using flow map (Map 5-14 and Figure 5-8). It shows that majority of the trips for the purpose of office is attracted to the areas which are highly walkable i.e. having land use mix and higher density. Also, from the flow map it is apparent that majority of direction for these trips are towards city center. This pattern of movement is suggesting that major offices those might be in necessities of students are located in the highly walkable area. Unlike the trip for shopping, here public transport use is more dominant than walking. Hence, it is an indication that students prefer to be in high walkable area for administrative purpose, however, as those places with administrative offices are not located nearby their home they still prefer to use those facilities convenient to go by public transport. It is worth to mention that in case of bank often students are bound to choose some specific bank, as all available banks do not have provision for students. However, for the other office work like post/social security/insurance,

students are going to the nearby offices or branch that is reachable by walk as well as public transport. This aspect is also visible in the flow Map 5-14 and public transport service )

Map 5-15, where students are heading towards those places nearby the university or city center, which are accessible by walk or public transport. Also, those places more attractive for students are having good connectivity by bus as well as tram. Therefore, walkability and better access to public transport are important attributes for trip to office for the students.

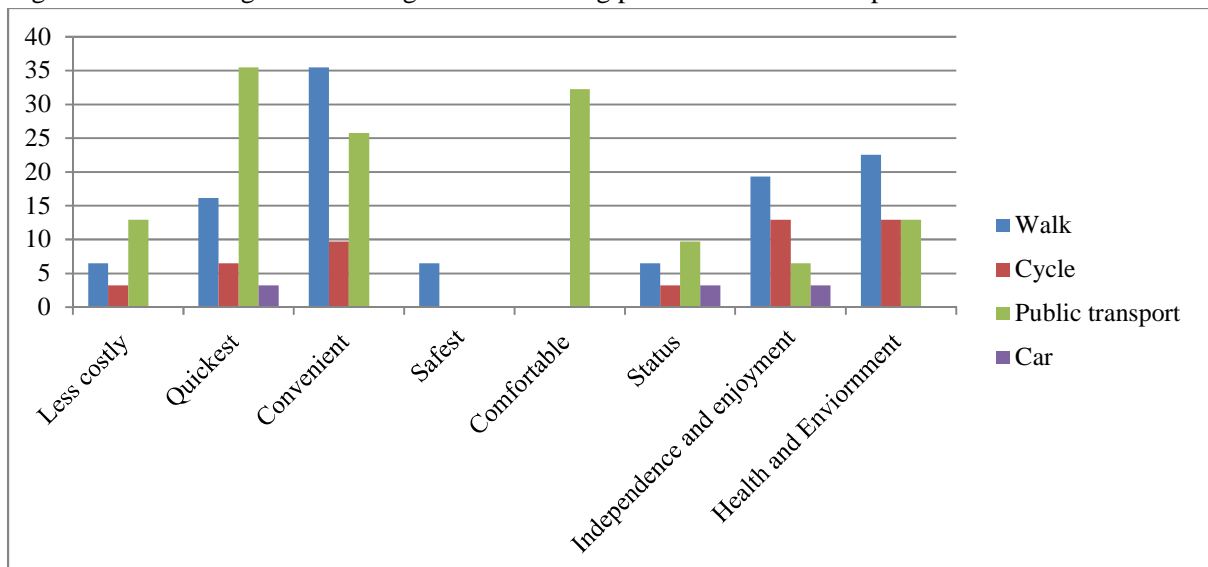
Figure 5-8: Percentage of mode use for trip to administrative office in different walkable area



Source: Origin-destination map for the trip to office and corresponding land use (cf. Map 5-13)

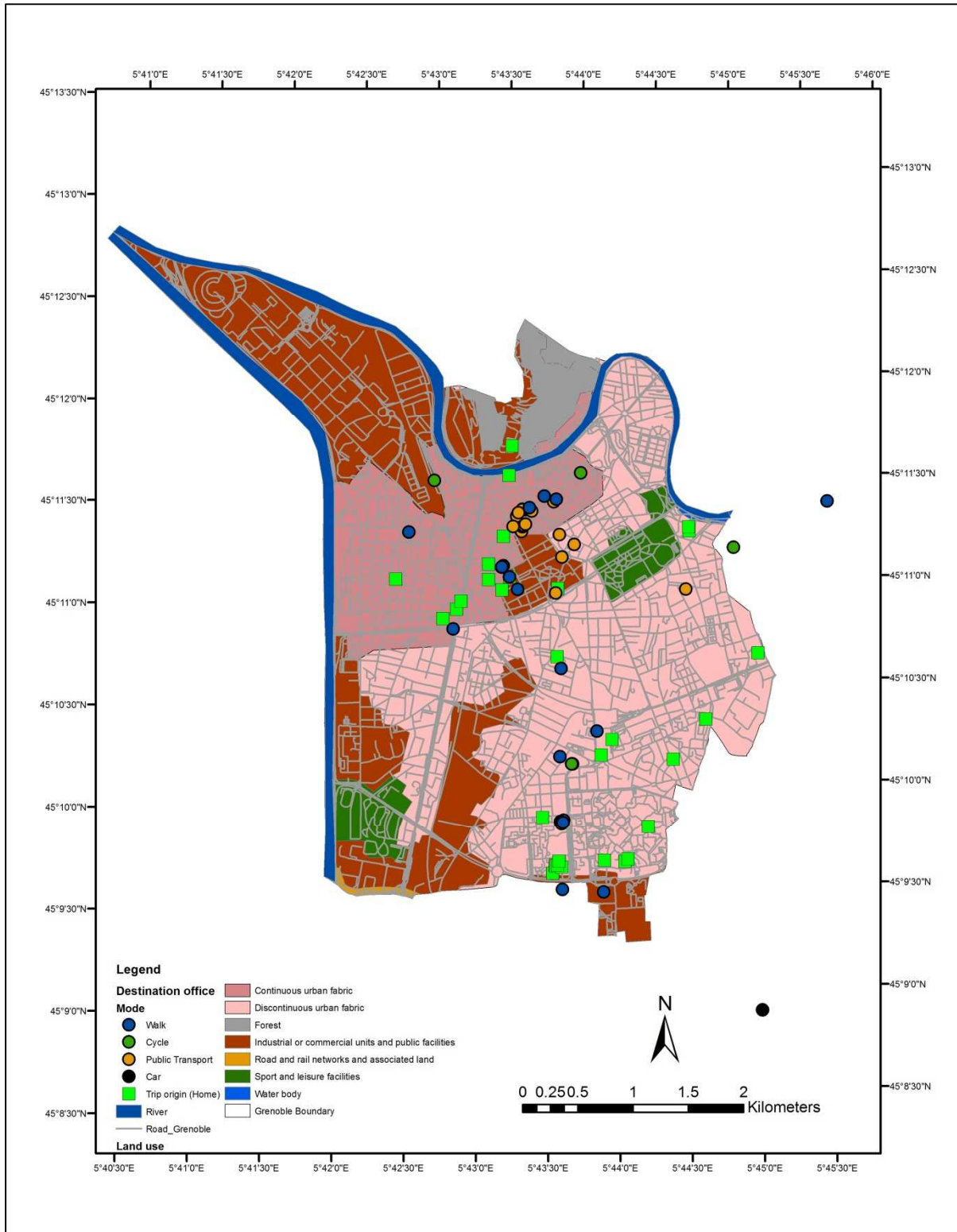
In the face to face interview, students also clarified their reasons behind selecting public transport and walking for the purpose of trip to office. For both walking and public transport it is about time and convenience. When it is very nearby from origin then walking is most convenient and when it is far, public transport is more convenient as it is quicker than walking to go there (cf. Figure 5-9). This is also showing how better access to public transport can influence the students to be actively mobile.

Figure 5-9: Percentage of reasoning behind selecting particular mode for trip to office



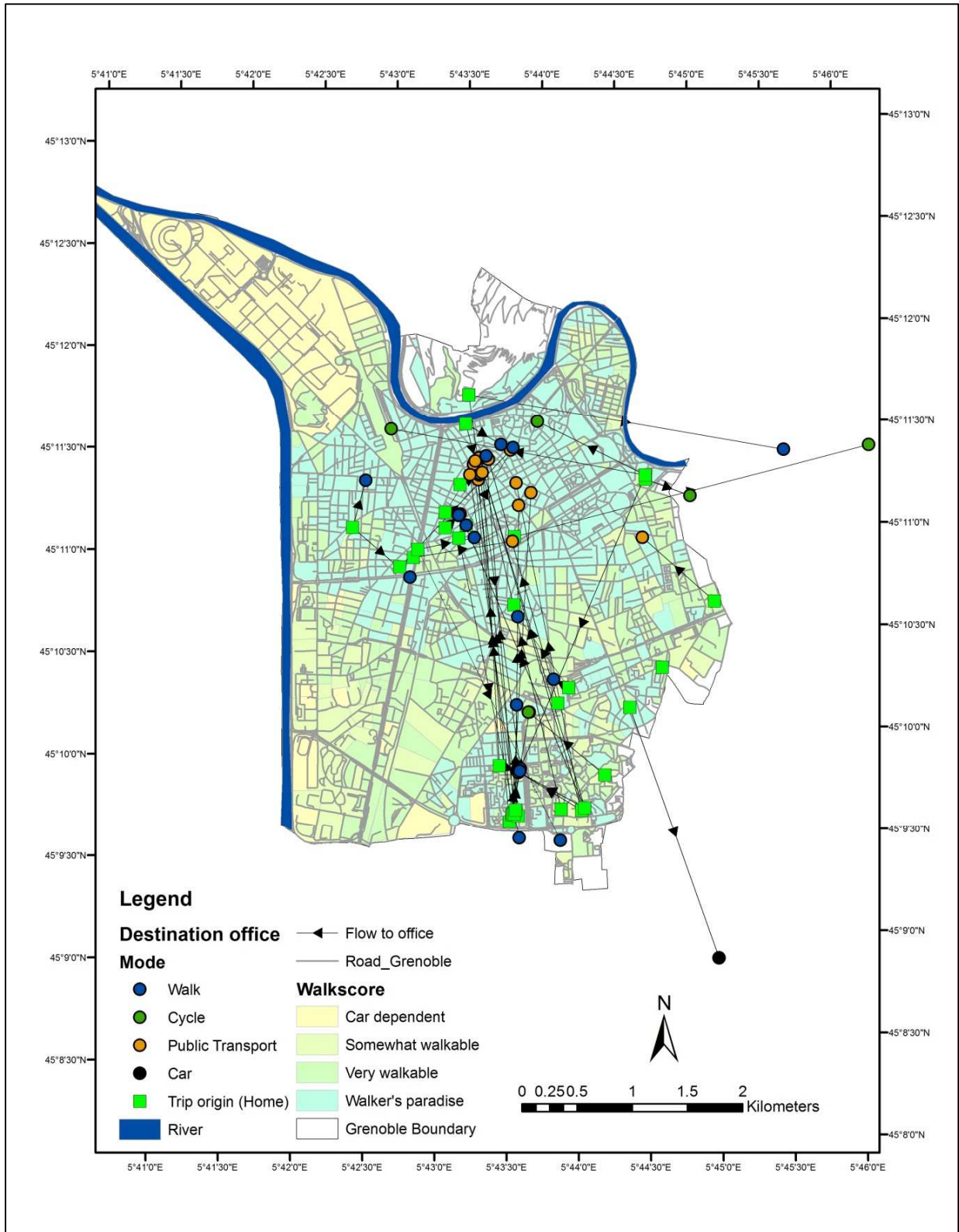
Source: Face to face interview, 2017

Map 5-13: Origin-destination map for the trip to office and corresponding land use



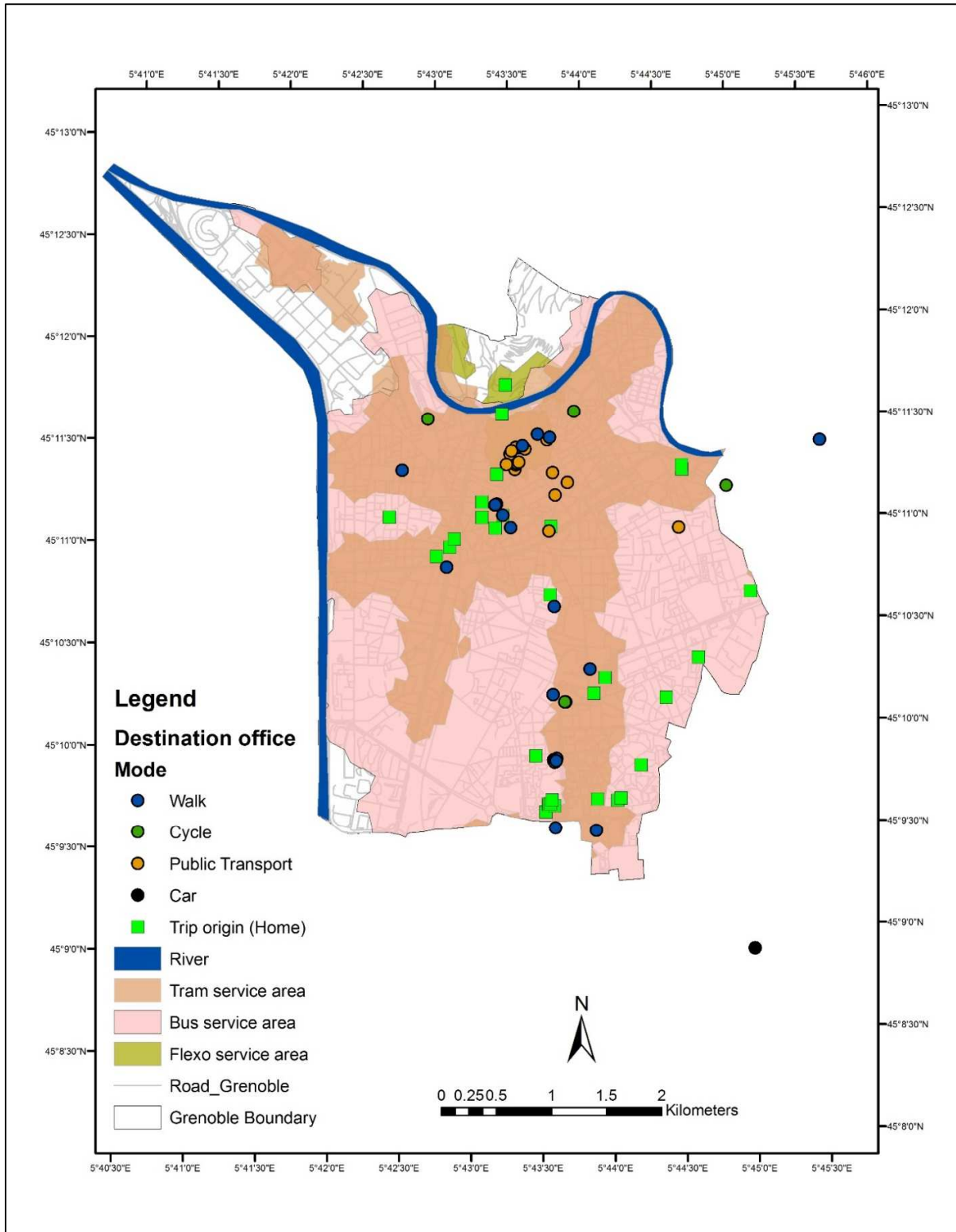
Source: Prepared by author, 2017 (Data: face to face interview, 2017 and Ministère-de-la-Transition-Écologique-et-Solidaire (2015))

Map 5-14: Trip flow map of origin and destination for trip to office and modal distribution



Source: Prepared by author, 2017 (Data: face to face interview, 2017 and [www.walkscore.com](http://www.walkscore.com))

Map 5-15: Origin-destination map of trip to office covered by public transport service area



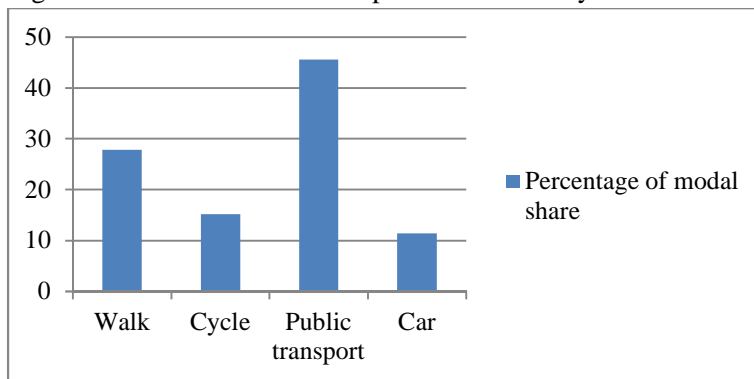
Source: Prepared by author, 2017 (Data: Face to face interview (2017), open street map, [www.metromobilite.fr](http://www.metromobilite.fr))



### 5.3.4. Trip to leisure activity

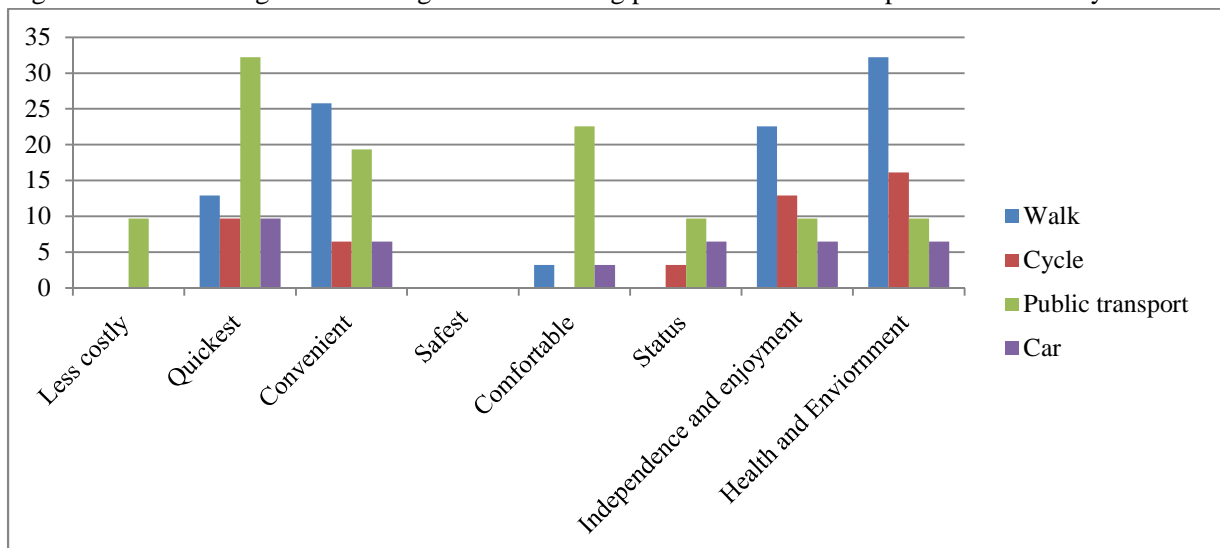
For the purpose of leisure activity, trips are not confined more often within the territory of the city. Students were asked in the face to face interview about where they go in an ordinary week for leisure activity. During the exercise, 31 students marked 79 point showing where they go in an ordinary week in different frequency for leisure activities. Among this 79 point, 62 points are located within Grenoble and others outside of Grenoble (cf. Map 5-16). The motivation for this outskirts trip is the surrounded mountains and other touristic places, where students prefer to go for hiking, bike racing as well as for running. Moreover, it is found in the transport service map that most of the places where students are making their leisure trips are within the service area of public transportation of Grenoble metropolitan area (cf. Map 5-17). This is also evident in Figure 5-10 made by considering all the trips marked by the students for leisure activities that highest percentage of leisure trip is made by public transport, even though car use rate is also higher for leisure trip (cf. Figure 5-10).

Figure 5-10: Modal share for trip to leisure activity



Source: Origin-destination map for the trip to leisure activity (cf. Map 5-16)

Figure 5-11: Percentage of reasoning behind selecting particular mode for trip to leisure activity



Source: Face to face interview, 2017

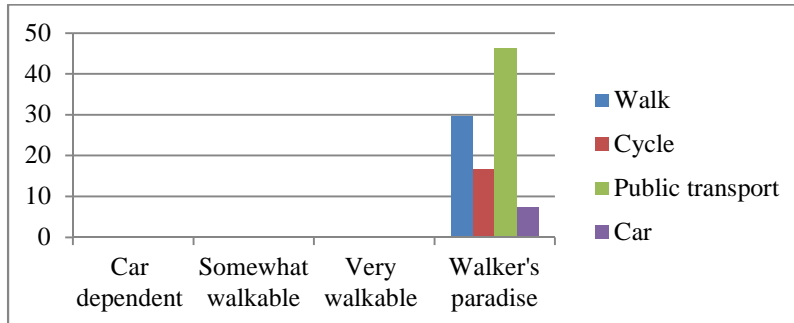
Besides, from the interview it is also found that higher percentage of walk trip, bike trip as well as public transport trip is generated for the purpose of leisure activities. The reason for selecting walking/cycling as a means to go for leisure activities is students' health and environmental concern as well as personal

independence and convenience. Therefore, students prefer active means of transportation when it is convenient for them. Meanwhile, for public transport users, they are selecting public transportation because it is quickest and convenient (cf. Figure 5-11). This reasoning is supporting the findings from spatial mapping that all those places far from their origin are well served by the public transport service area. However, some places well covered by public transport service area are also attracting car trip. In the interview, students explicated the reason of car use for leisure trip by saying that in the weekend to have car shared by group of students is more convenient, quickest and enjoyable compare to other modes. This is prescribing the car sharing provision and resources utilization tendencies of the students. Furthermore, it can be brought in light that student are not more concern about the distance for leisure trips, rather about the facilities and their convenience to avail those places.

Furthermore, in a micro-scale, trips attracted within Grenoble for leisure activities, are concentrated in the highly walkable areas (walker’s paradise: 90-100), where there are higher land use mix and multiple destination options (cf. Figure 5-12). Likely to the macro scale, even within the city higher percentage of leisure trip is made by public transport. Apparently, in the Map 5-18 it is quite visible that all the leisure trip destinations are concentrated in the city center i.e. the area under continuous urban fabric. In the discontinuous urban fabric particularly near the home of students, leisure trips are almost zero. Furthermore, higher percentages of trips are attracted by those areas served either by both bus and tram (more frequent and available option) or by three of the available option (tram, bus and flexo) (cf.

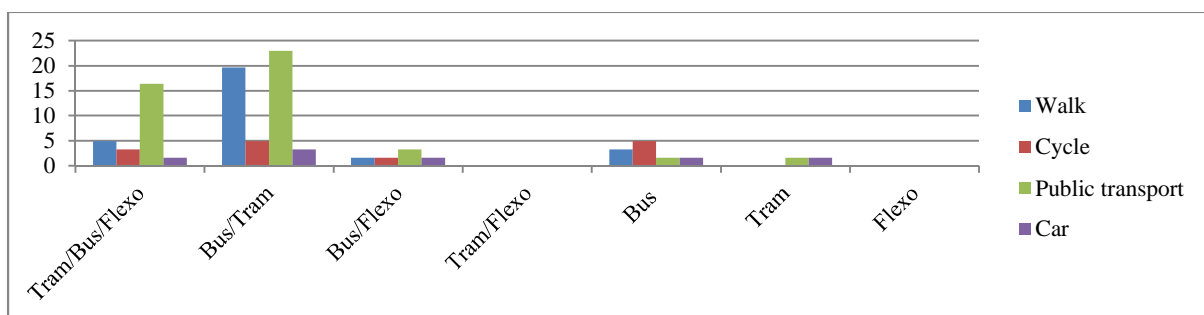
Figure 5-13). Therefore, within the city land use mix i.e. walkability is an important attribute to make the students more mobile and activite, where access to good public transport facilities is prerequisite.

Figure 5-12: Percentage of mode use for trip to leisure activity in different walkable area



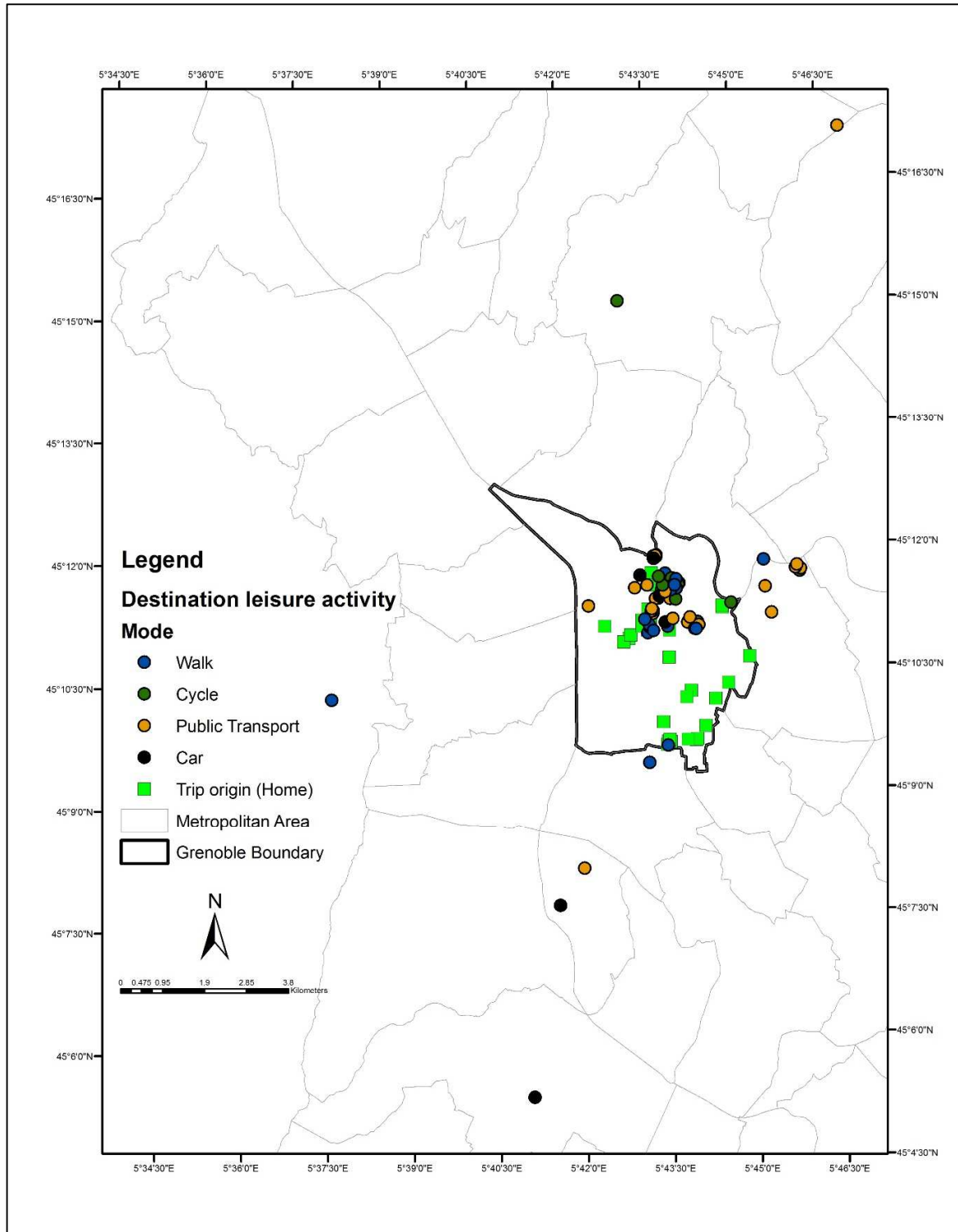
Source: Origin-destination map of trip to leisure activity (cf. Map 5-18)

Figure 5-13: Modal share within Grenoble in different public transport coverage area



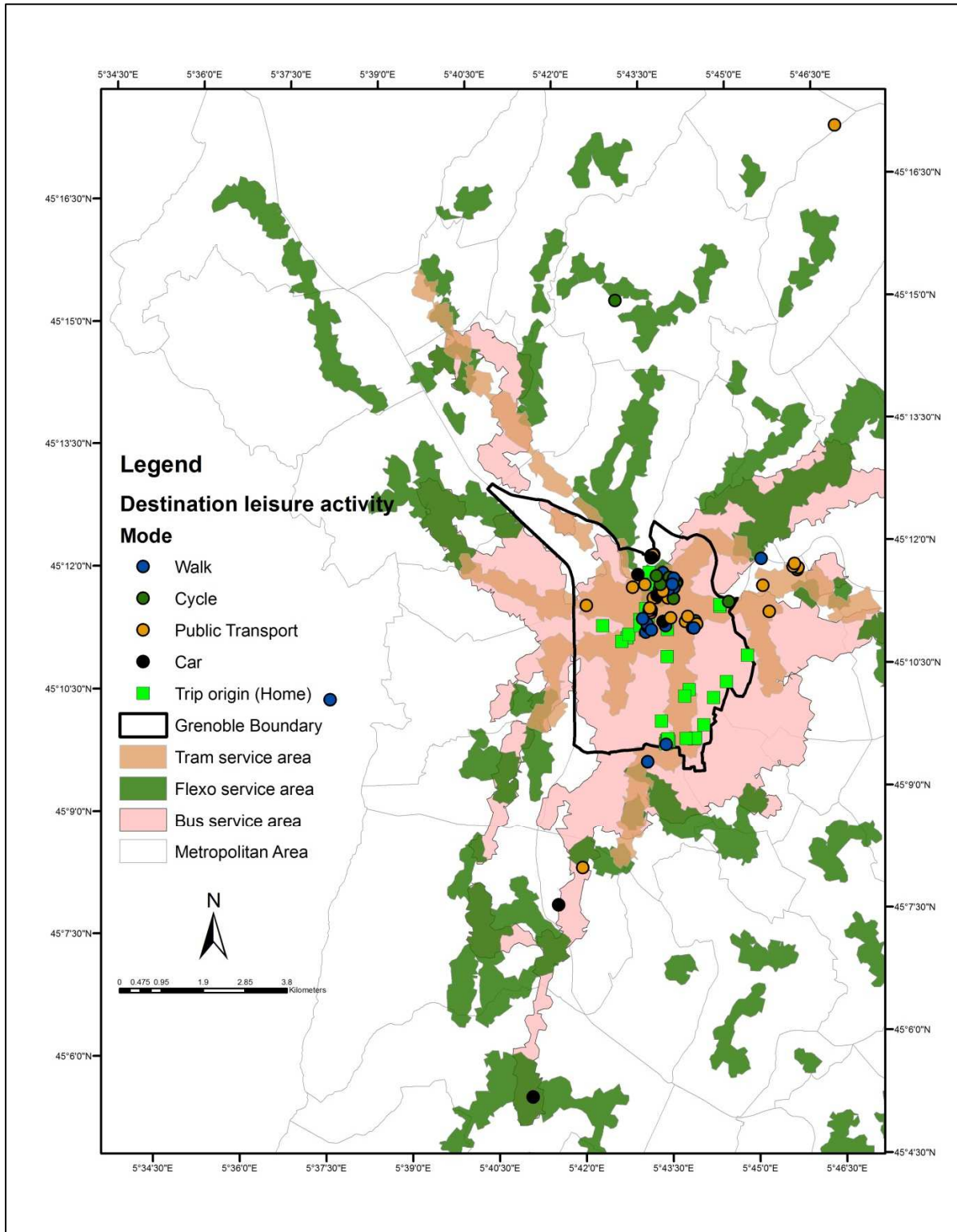
Source: Origin-destination map of trip to leisure activity covered by public transport service area (Map 5.17)

Map 5-16: Origin-destination map for the trip to leisure activity



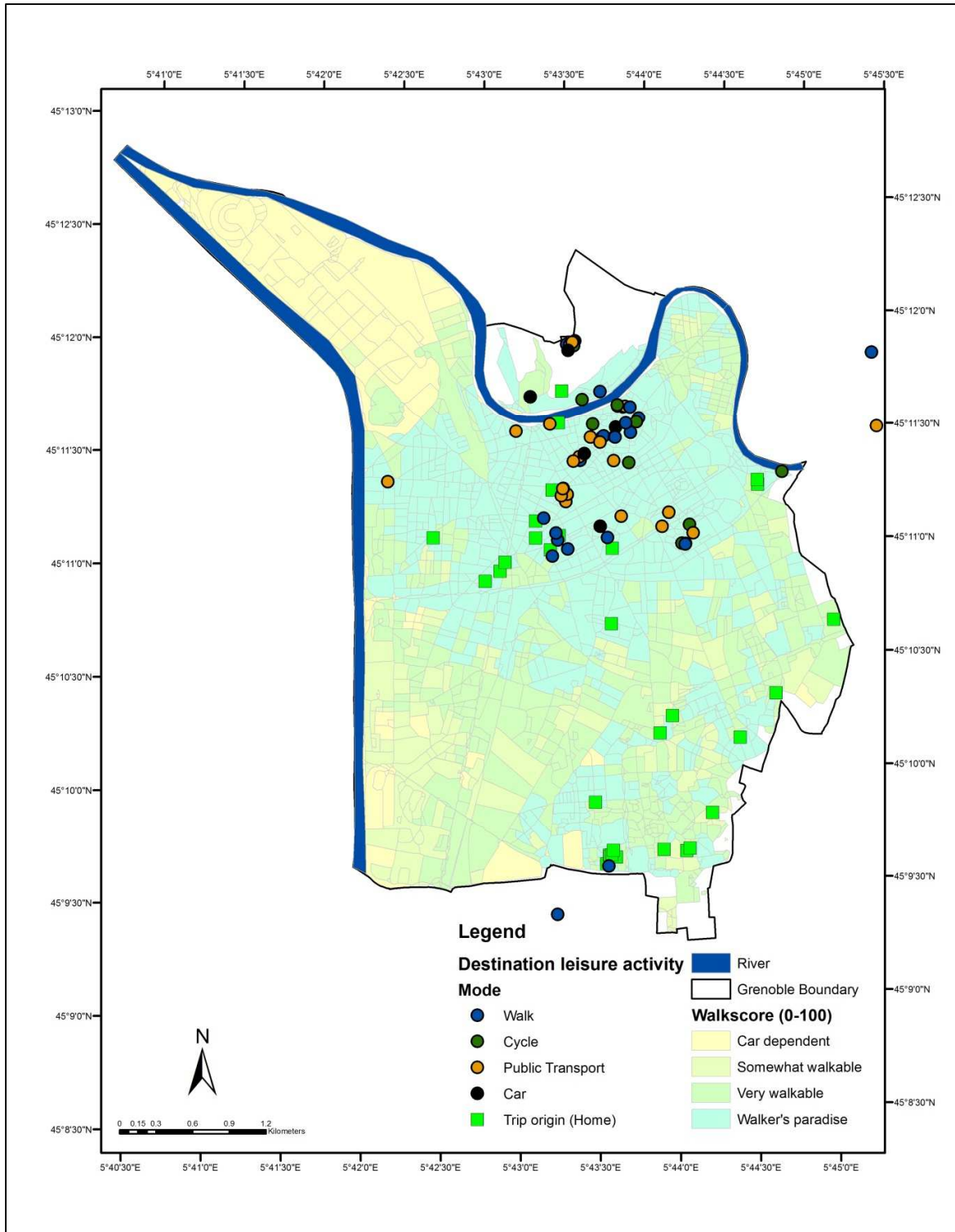
Source: Map prepared by author, 2017 (Data: face to face interview, 2017)

Map 5-17: Origin-destination map of trip to leisure activity covered by public transport service area



Source: Prepared by author, 2017 (Data: face to face interview, open street map, [www.metromobilite.fr](http://www.metromobilite.fr))

Map 5-18: Origin-destination map of trip to leisure activity



Source: Prepared by author, 2017 (Data: face to face interview, 2017 and [www.walkscore.com](http://www.walkscore.com))

#### **5.4. Conclusion**

Form the above analysis, it can be inferred that depending on trip purpose spatial attributes affecting people's mode choice behavior differ. Some factors which are dominant for one purpose might not have same impact for other purposes. In case of trip to university, distance from origin is more substantial factor in defining student's mode choice behavior than walkability (land use mix/density) of origin and destination which is unlikely for the trip to shop. For shopping purpose land use mix and density of both origin and destinations become more fundamental. In contrast, for leisure trip not only the land use mix of destination is important, availability of public transport services to reach those places is also essential. Therefore, the analysis is signifying to contemplate about different trip purposes and their associated spatial attributes more precisely to understand the active travel behavior of young adults studying in university. Also, it is pointing to think about different trip purposes simultaneously to understand the holistic pattern of active travel behavior and associated factors.

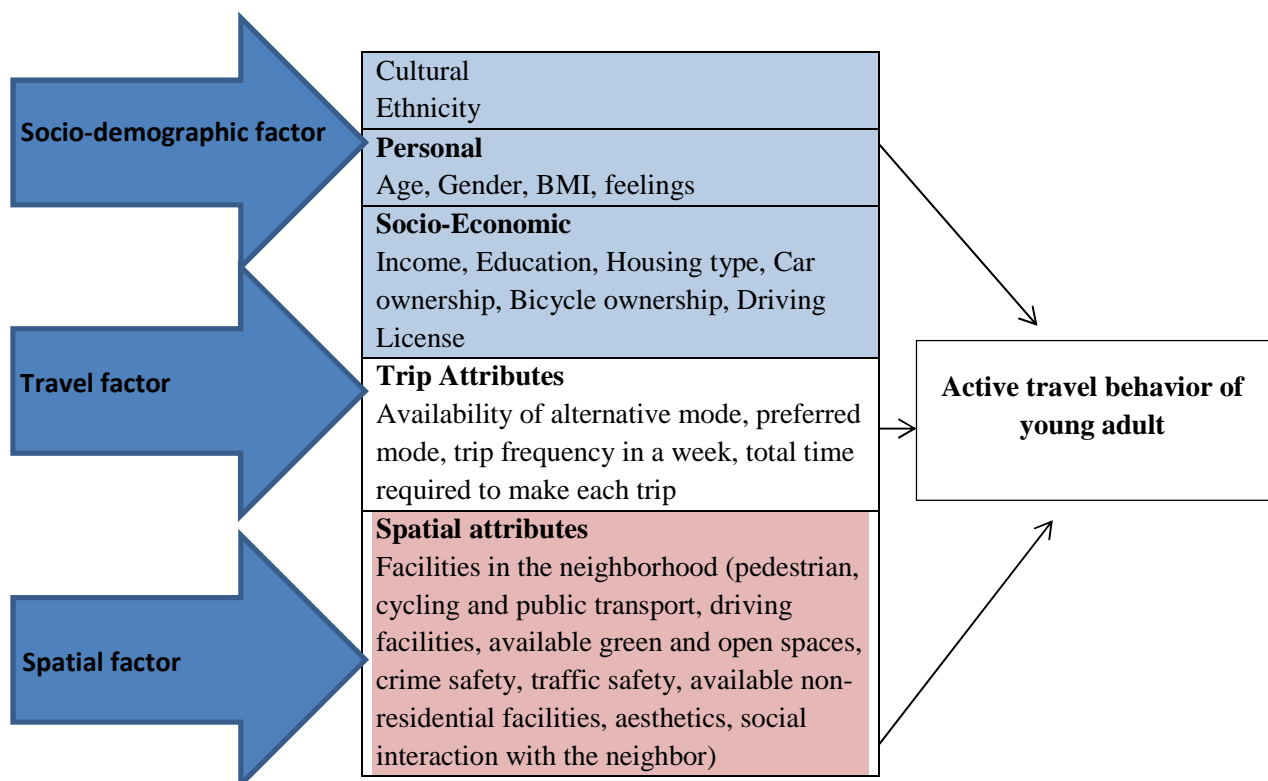
## 6. Chapter: Statistical analysis

In this chapter factors affecting the active travel behavior of young adult will be analyzed statistically. To do so, a conceptual model is developed based on the Theory of Triadic influence. Then, potential factors affecting the active travel behavior of young adult is elicited based on the conceptual model through binary logistic regression. Here, data from both online questionnaire and face to face interview is used. All the variables are grouped for better understanding in three sub-categories: socio-demographic, trip and environmental factors. Each sub-category is comprised of several variables that better represent the holistic picture of that sub-category. However, as the number of sample size is 84 only, model combined with three sub-categories are not within the scope of this study. Therefore, separate model for each sub-category is the final outcome of this chapter.

### 6.1. Conceptual model

Based on the Theory of Triadic influence developed by Flay & Petraitis (1994) and to understand the active travel behavior of young adult in a more comprehensive way, a conceptual framework is developed (cf. Figure 6-1). Major distal factors considered in this study are cultural, personal, socio-economic, travel and environmental factors. All these factors are categorized in three sub category. Here, the assumption of this conceptual model is, there are different socio-demographic, travel as well as environmental factors significantly associated in defining active travel behavior of young adults studying in university. All the factors included in the conceptual model are determined from the literature review of already published journal paper. The summary of this review is given in Table 2.1.

Figure 6-1: Conceptual model based on the theory of Triadic influence



## 6.2 Descriptive statistics

For the statistical analysis, responses from both online questionnaire (49 students) as well as face to face interviews (35 students) are used. Students from three institutes (IUG, IGA and ENSAG) participated in the survey. As it is mentioned that the target group of this study is young adult aged 18 to 25, hence the average age of the students is  $22.07 \pm 2.076$  Std. Within this sample, the percentage of students enrolled in a bachelor program is 54.8, whereas the rest of the students (45.2%) are enrolled in a master's program. Also, among the participants 45.2% students are male and 54.8% students are female. Therefore, a good composition between male and female respondents is apparent in the sample. Moreover, among the 84 students, 36.9% students are non-native and 63.1% native. Almost, students from 22 nationalities have participated in the survey. As a result, the study incorporates the views of both native and non-native students. In terms of current income status, 45.4% students are entirely dependent on their parents, whereas the rest of the students have either scholarship (21.4%) or part time job (13.1%) or have full time job (1.2%) or having financial sources in combination of these mentioned financial sources (16.7%).

In terms of having car or bicycle as privately owned motorized or non-motorized vehicle, almost 50% students have bicycle and 31% students have their own car, however, 69% students have their driving license. It indicates that even through very few students have their own car, but they can rent car to drive from one place to another. Apart from this, three types of accommodation found where students reside: 13.1% in owner occupied house, 67.9% in private rental housing and 19% in university dormitory. Among the students living in student's dormitory, 75% of them are non-native whereas in the private rental housing 68% students are native students.

## 6.3 Regression analysis

Binary logistic regression analysis is used to elicit significant factors affecting the mode choice behavior of young adult. Here, the focus is to understand the factors affecting walking, cycling and public transport use as means of transportation. Public transportation is also counted in as a type of mode involving active movement as it requires a minimum amount of walking to reach the transit stoppage. The Key explanatory variables and corresponding coding is given in Appendix D.

### 6.3.1. Socio demographic factors affecting mode choice of young adult

Socio-demographic factors affecting students walking, cycling and public transport use behaviour is summarized in Table 6.1, Table 6.2 and Table 6.3 based on the values in equation obtained from the logistic regression model. In this regard, which factors are significant and having positive and negative influence in selecting particular mode can be explicated by  $p$  value ( $p \leq 0.05$  significant factor and  $p > 0.05$  insignificant factor), co-efficient value (+ value denotes positive influence and - value denotes negative influence) and odds ratio (odds ratio =1: the probability of an event occurring between two situation is same, odds ratio  $> 1$  : the probability of an event occurring is higher between two situations with one unit increase of the target value, odds ratio  $< 1$ : the probability of an event occurring is lower between two situations with one unit increase of the target value). Using the  $p$ -value limit 5% i.e. the significance level, it is found that for the trip to university by walking, ethnicity and housing type have significant contribution in the model. Among them, housing type is positively and ethnicity is negatively affecting the mode choice behaviour. For more detail, the odds of selecting walking as a means of transport among the native students for the trip to university is lower compared with non-native students as the odds ratio is **0.158**. In the same way, those who are living in the university dormitory compared to other housing option (private rental/owner occupied) have higher chance to select walking for this purpose (**OR 4.807**). The reason is the locational importance of university provided dormitory. As, the dormitories are located nearby the university, could be significant reason to influence the students residing in the university



dormitory, in selecting walking as a means of transportation for trip to university. Also, in the descriptive statistics, it is found that higher percentage of native students are living in the private rental places and those places are located around the city center (not within walking distance from the university), influences the students in selecting other modes compared to walking. The similar result is found, in terms of trip to shop/grocery and influence of housing type in selecting walking as a means of transport compared to other available means (*OR* 2.992). Unlike the trip to university, in case of trip to shop, gender and present study level have significant contribution in the model. Here, compared to female students, male students have higher odds (*OR* **2.897**) of selecting walking as a means of transport for this particular trip. Safety and security or concern about quality of product could be important reason for choosing other alternative options. Also, compared to bachelor students, master's students have less propensity to select walking for trip to shop/grocery (*OR* **0.194**), which shows that higher level of education is associated with sedentary behavior. Moreover, for the trip to administrative office, among the selected factors present study level, age and gender have significant contribution in the model, whereas present study level is negatively affecting the model like the previous trip to shop model and gender and age has positive influence. However, in case of recreational trip, it only depends on bicycle ownership i.e. those who have their own bicycle has less chance to use walking for leisure activity trip purpose.

In terms of selecting cycle as a means of transport for different trip purposes (cf. Table 6.2), gender, bicycle ownership and car ownership have significant contribution like the same effects for all trip purposes considered in this study except trip to leisure purposes. This means that those who have their own bicycle has higher odds to select bicycle for trip to university, shops or grocery or trip to office compared to those who does not have their own bicycle. Therefore, bicycle ownership is an important factor in defining the choice of young adult of selecting cycle as a means of transport. In contrast to this, those who have their own car have less chance to select cycle as a means of transport, since, the model exhibits lower odds ratio for trip to university, shop and administrative office. However, compared to female students, male students have fewer propensities to select cycle as a means of transport. It is also found from the descriptive statistics that among the 50% students who have their own bicycle more than half of them are female. Therefore, higher bicycle ownership among the female students could be significant reason for lower propensity of cycle use among the male students.

In terms of use of public transportation among the students, some important factors are worth to mention. Among them, age is an important factor. It is found that higher the age, there is lower odds of selecting public transport as a means of transport for the purpose of shop, office or leisure activity. This could be the reason of facilities provided by Tag (Transports de l'Agglomération Grenoblois) for the students below 25 (15€ per month) years old. In the meantime compared to female students, male students have higher odds of selecting public transportation for trip to office (*OR* **3.391**) and for trip to leisure activity (*OR* **3.107**). Furthermore, students who are residing in student dormitory have higher propensity to select public transportation as most of the dormitories are located in the periphery of the city and not well facilitated with leisure activities. Furthermore, in accordance with the trip to university using cycle (Table 6.2), those who have their own bicycle has lower odds of selecting public transport for their trip to university (*OR* **.07**). Also, students studying in master's program have higher odds of choosing public transport for their shopping or grocery purpose, which is also supporting their fewer tendencies for walking and cycling for this particular purpose and reinforces their sedentary behavior. Moreover, compared to those who are studying in IUG or IGA compared to ENSAG has lower odds of choosing public transport among the other available modes (walking or cycling). Therefore, a lower walking and cycling tendency and higher public transport use is apparent for the students from ENSAG.

Table 6-1: A comparison of walking behavior of young adult in terms of various socio-demographic explanatory variables depending on different trip purpose (with respect to significance level, co-efficient and odds ratio)

Socio-demographic factor	Mode: Walk											
	Trip to university			Trip to shop			Trip to office			Trip to leisure activity		
	B	P value	Odds ratio	B	P value	Odds ratio	B	P value	Odds ratio	B	P value	Odds ratio
Affiliation with the university				0.328	0.386	1.388	0.274	0.586	1.316			
Present study level	-0.719	0.439	0.487	<b>-1.639</b>	<b>0.017</b>	<b>0.194</b>	<b>-3.368</b>	<b>0.002</b>	<b>0.034</b>	-0.281	0.7	0.755
Age	-0.03	0.887	0.97	0.315	0.08	1.37	<b>0.616</b>	<b>0.015</b>	<b>1.852</b>	0.31	0.14	1.364
Gender	0.932	0.198	2.54	<b>1.064</b>	<b>0.044</b>	<b>2.897</b>	<b>2.469</b>	<b>0.006</b>	<b>11.814</b>	0.621	0.296	1.861
Ethnicity	<b>-1.848</b>	<b>.044*</b>	<b>0.158</b>	0.454	0.5	1.574	1.833	0.096	6.254	1.061	0.168	2.888
Housing type	<b>1.57</b>	<b>.021*</b>	<b>4.807</b>	<b>1.096</b>	<b>0.043</b>	<b>2.992</b>	0.604	0.399	1.83	-0.096	0.883	0.908
Bicycle ownership							0.266	0.711	1.304	<b>-1.676</b>	<b>0.012</b>	<b>0.187</b>
Car ownership	0.014	0.989	1.014	-0.108	0.867	0.897	0.648	0.453	1.911	-0.256	0.754	0.774
Driving license	-0.451	0.564	0.637	-0.036	0.952	0.965	-1.177	0.196	0.308	-0.85	0.245	0.427
Current income status	-0.823	0.251	0.439	0.42	0.405	1.522	0.937	0.197	2.552	0.697	256	2.007
BMI	-0.211	0.025	0.81	0.013	0.839	1.013	<b>0.396</b>	<b>0.006</b>	<b>1.486</b>	<b>0.214</b>	<b>0.047</b>	<b>1.238</b>

$p$ -Value  $\leq$  .05 (significant value)

Table 6-2: A comparison of cycling behavior of young adult in terms of various socio-demographic explanatory variables depending on different trip purpose (with respect to significance level, co-efficient and odds ratio)

Socio-demographic factor	Mode: Cycle											
	Trip to university			Trip to shop			Trip to office			Trip to leisure activity		
	B	P value	Odds ratio	B	P value	Odds ratio	B	P value	Odds ratio	B	P value	Odds ratio
Affiliation with the university	0.693	0.262	2	0.817	0.337	2.263	0.277	0.739	1.32	1.140	0.105	3.126
Present study level	1.057	0.21	2.878	0.782	0.424	2.186	1.636	0.159	5.135	1.003	0.286	2.726
Age	0.268	0.239	1.308	-0.072	0.792	0.93	0.004	0.991	1.004	-0.140	0.585	0.869
Gender	<b>-1.735</b>	<b>0.016</b>	<b>0.176</b>	<b>-4.177</b>	<b>0.002</b>	<b>0.015</b>	<b>-4.127</b>	<b>0.002</b>	<b>0.016</b>	-1.881	0.033	0.152
Ethnicity	1.673	0.105	5.326	-1.36	0.253	0.257	0.676	0.628	1.965	0.072	0.946	1.075
Housing type	-0.751	0.321	0.472	<b>-2.105</b>	<b>0.033</b>	<b>0.122</b>	-1.637	0.101	0.195	-1.015	0.242	0.362

Bicycle ownership	<b>3.526</b>	<b>0.000</b>	<b>33.991</b>	<b>4.486</b>	<b>0.003</b>	<b>88.793</b>	<b>4.477</b>	<b>0.002</b>	<b>87.933</b>	3.401	0.002	29.986
Car ownership	<b>-2.109</b>	<b>0.048</b>	<b>0.121</b>	<b>-4.127</b>	<b>0.009</b>	<b>0.016</b>	<b>-5.33</b>	<b>0.005</b>	<b>0.005</b>	-4.517	0.004	0.011
Driving license	1.172	0.223	3.229	2.201	0.062	9.036	0.323	0.771	1.381	0.723	0.421	2.060
Current income status	-0.557	0.432	0.573	-1.368	0.133	0.255	-1.93	0.072	0.145	-1.138	0.176	0.321
BMI	0.05	0.577	1.051	0.115	0.334	1.122	-0.035	0.735	0.966	-0.018	0.862	0.982

*p-Value* ≤ .05 (significant value)

Table 6-3: A comparison of public transport use of young adult in terms of various socio-demographic explanatory variables depending on different trip purpose (with respect to significance level, co-efficient and odds ratio)

Socio-demographic factor	Mode: Public transportation											
	Trip to university			Trip to shop			Trip to office			Trip to leisure activity		
	B	<i>P</i> value	Odds ratio	B	<i>P</i> value	Odds ratio	B	<i>P</i> value	Odds ratio	B	<i>P</i> value	Odds ratio
Affiliation with the university	<b>-1.221</b>	<b>0.007</b>	<b>0.295</b>	-0.349	0.409	0.706						
Present study level	-0.003	0.997	0.997	<b>1.563</b>	<b>0.041</b>	<b>4.775</b>	1.255	0.122	3.509			
Age	-0.22	0.26	0.803	<b>-0.413</b>	<b>0.04</b>	<b>0.662</b>	<b>-0.455</b>	<b>0.03</b>	<b>0.635</b>	<b>-0.313</b>	<b>0.049</b>	<b>0.731</b>
Gender	0.778	0.161	2.177				<b>1.221</b>	<b>0.037</b>	<b>3.391</b>	<b>1.134</b>	<b>0.04</b>	<b>3.107</b>
Ethnicity	0.005	0.995	1.005	0.064	0.924	1.066	-0.973	0.154	0.378	-0.684	0.311	0.505
Housing type	-0.693	0.247	0.5	0.418	0.485	1.518	0.712	0.234	2.039	<b>1.192</b>	<b>0.037</b>	<b>3.294</b>
Bicycle ownership	<b>-2.657</b>	<b>0.000</b>	<b>0.07</b>	-0.403	0.517	0.668	-1.084	0.073	0.338	-0.584	0.311	0.558
Car ownership	0.662	0.386	1.939	0.395	0.599	1.484	-0.431	0.526	0.65	0.091	0.893	1.095
Driving license	-0.394	0.58	0.674	-0.216	0.758	0.806	1.458	0.043	4.299	0.706	0.303	2.025
Current income status	0.667	0.242	1.949	-0.139	0.804	0.87				-0.477	0.391	0.621
BMI	0.11	0.114	1.116							-0.059	0.417	0.943

*p-Value* ≤ .05 (significant value)

Table 6-4: A comparison of walking behavior of young adult in terms of various travel related explanatory variables depending on different trip purpose (with respect to significance level, co-efficient and odds ratio)

Travel factors	Mode: Walk											
	Trip to university			Trip to shop			Trip to office			Trip to leisure activity		
	B	<i>P</i> value	Odds ratio	B	<i>P</i> value	Odds ratio	B	<i>P</i> value	Odds ratio	B	<i>P</i> value	Odds ratio
Other alternative mode available	0.088	0.956	1.092	0.550	0.473	1.734	0.861	0.390	2.365	-0.729	0.452	0.482

Preferred mode for particular purpose	<b>-3.511</b>	<b>0.001</b>	<b>0.030</b>	<b>-1.202</b>	<b>0.000</b>	<b>0.301</b>	<b>-1.748</b>	<b>0.001</b>	<b>0.174</b>	<b>-1.789</b>	<b>0.000</b>	<b>0.17</b>
Trip frequency (in a week)	0.200	0.509	1.222	0.383	0.124	1.467	0.222	0.701	1.249	-0.218	0.319	0.80
Trip duration (per trip)	<b>-0.311</b>	<b>0.048</b>	<b>0.733</b>	-0.038	0.386	0.963	<b>-0.147</b>	<b>0.021</b>	<b>0.863</b>	0.006	0.840	1.01

*p-Value* ≤ .05 (significant value)

Table 6-5: A comparison of cycling behavior of young adult in terms of various travel related explanatory variables depending on different trip purpose (with respect to significance level, co-efficient and odds ratio)

Travel factors	Mode: Cycle											
	Trip to university			Trip to shop			Trip to office			Trip to leisure activity		
	B	<i>P</i> value	Odds ratio	B	<i>P</i> value	Odds ratio	B	<i>P</i> value	Odds ratio	B	<i>P</i> value	Odds ratio
Other alternative mode available	0.640	0.447	1.897	0.487	0.560	1.627	0.183	0.806	1.201	0.145	0.875	1.156
Preferred mode for particular purpose	-0.125	0.695	0.882	0.001	0.997	1.001	-0.321	0.327	0.726	-0.339	0.290	0.713
Trip frequency (in a week)	-0.136	0.322	0.873	-0.271	0.281	0.763	-0.590	0.306	0.554	0.139	0.453	1.15
Trip duration (per trip)	-0.050	0.111	0.951	-0.056	0.226	0.946	0.002	0.959	1.002	-0.011	0.647	0.989

*p-Value* ≤ .05 (significant value)

Table 6-6: A comparison of public transport use of young adult in terms of various travel related explanatory variables depending on different trip purpose (with respect to significance level, co-efficient and odds ratio)

Travel factors	Mode: Public transport											
	Trip to university			Trip to shop			Trip to office			Trip to leisure activity		
	B	<i>P</i> value	Odds ratio	B	<i>P</i> value	Odds ratio	B	<i>P</i> value	Odds ratio	B	<i>P</i> value	Odds ratio
Other alternative mode available	-0.898	0.342	0.408	<b>-1.672</b>	<b>0.023</b>	<b>0.188</b>	-1.085	0.224	0.338	0.926	0.443	2.525
Preferred mode for particular purpose	<b>0.859</b>	<b>0.028</b>	<b>2.360</b>	<b>0.539</b>	<b>0.049</b>	<b>1.714</b>	<b>1.295</b>	<b>0.001</b>	<b>3.652</b>	<b>0.870</b>	<b>0.005</b>	<b>2.386</b>
Trip frequency (in a week)	0.166	0.301	1.181	-0.186	0.469	0.830	0.534	0.393	1.705	0.045	0.805	1.046
Trip duration (per trip)	<b>0.175</b>	<b>0.000</b>	<b>1.191</b>	0.094	0.029	1.099	<b>0.184</b>	<b>0.001</b>	<b>1.202</b>	-0.003	0.883	0.997

*p-Value* ≤ .05 (significant value)

Table 6-7: A comparison of walking behavior of young adult in terms of various environmental explanatory variables depending on different trip purpose (with respect to significance level, co-efficient and odds ratio)

Environmental factor	Mode: Walk											
	Trip to university			Trip to shop			Trip to office			Trip to leisure activity		
	B	P value	Odds ratio	B	P value	Odds ratio	B	P value	Odds ratio	B	P value	Odds ratio
Perception about existing pedestrian facilities (in neighborhood) (1)	4.207	0.181	67.146	1.387	0.301	4.003	1.814	0.209	6.137	1.414	0.622	4.111
Perception about existing pedestrian facilities (in neighborhood) (2)	2.551	0.176	12.819	1.026	0.153	2.789	1.539	0.088	4.662	0.848	0.472	2.334
Perception about existing cycling facilities (in neighborhood) (1)	-4.773	0.138	0.008	-0.984	0.361	0.374	-1.321	0.303	0.267	0.176	0.920	1.193
Perception about existing cycling facilities (in neighborhood) (2)	0.250	0.832	1.284	-0.704	0.255	0.495	-1.079	0.179	0.34	-1.082	0.277	0.339
Perception about existing public transport facilities (In neighborhood) (1)	-16.241	0.999	0.000	-0.582	0.731	0.559	2.325	0.257	10.227	3.479	0.119	32.415
Perception about existing public transport facilities (In neighborhood) (2)	1.396	0.389	4.040	-0.297	0.731	0.743	-0.393	0.688	0.675	2.846	0.061	17.216
Perception about existing driving facilities (in neighborhood) (1)	-17.939	0.999	0.000	<b>2.021</b>	<b>0.043</b>	<b>7.546</b>	<b>2.564</b>	<b>0.014</b>	<b>12.991</b>	1.667	0.140	5.296
Perception about existing driving facilities (in neighborhood) (2)	-3.741	0.052	0.024	0.296	0.654	1.345	0.721	0.354	2.057	<b>2.674</b>	<b>0.010</b>	<b>14.496</b>
Perception about existing green spaces and park(in neighborhood) (1)	-0.654	0.754	0.520	-1.396	0.255	0.248	-1.386	0.365	0.25	-21.104	0.999	0.000
Perception about existing green spaces and park(in neighborhood) (2)	0.115	0.931	1.121	0.165	0.789	1.180	0.321	0.651	1.379	-1.319	0.126	0.267
Perception about existing crime safety (in neighborhood) (1)	<b>8.158</b>	<b>0.003</b>	<b>3492.495</b>	<b>1.901</b>	<b>0.02</b>	<b>6.693</b>	1.467	0.128	4.338	<b>-3.119</b>	<b>0.023</b>	<b>0.044</b>
Perception about existing crime safety (in neighborhood) (2)	4.207	0.071	67.156	1.425	0.062	4.158	0.875	0.339	2.398	1.112	0.220	3.042
Traffic safety (in neighborhood) (1)	<b>-4.432</b>	<b>0.050</b>	<b>0.012</b>	-1.543	0.107	0.214	-0.809	0.462	0.445	1.996	0.137	7.357
Traffic safety (in neighborhood) (2)	<b>-4.722</b>	<b>0.050</b>	<b>0.009</b>	-0.924	0.168	0.397	-0.761	0.321	0.467	0.399	0.649	1.490
Perception about existing available non-residential facilities (in neighborhood) (1)	1.365	0.283	3.916	-1.186	0.108	0.306	-1.132	0.194	0.323	<b>-3.286</b>	<b>0.010</b>	<b>0.037</b>

Perception about existing available non-residential facilities (in neighborhood) (2)	-0.669	0.738	0.512	-0.530	0.517	0.589	-1.150	0.271	0.317	-1.699	0.111	0.183
Perception about existing available beautification (in neighborhood) (1)	-1.338	0.397	0.262	0.120	0.876	1.127	-1.199	0.194	0.302	1.315	0.285	3.727
Perception about existing available beautification (in neighborhood) (2)	0.045	0.973	1.046	0.523	0.446	1.687	-1.032	0.185	0.356	<b>2.243</b>	<b>0.033</b>	<b>9.419</b>
Perception about existing social interaction with the neighbor(in neighborhood) (1)	-0.352	0.832	0.704	0.177	0.820	1.193	0.224	0.799	1.251	-1.640	0.160	0.194
Perception about existing social interaction with the neighbor(in neighborhood) (2)	-4.017	0.091	0.018	-0.460	0.542	0.631	-0.802	0.368	0.448	0.231	0.808	1.260

$p$ -Value  $\leq$  .05 (significant value)

Table 6-8: A comparison of cycling behavior of young adult in terms of various environmental explanatory variables depending on different trip purpose (with respect to significance level, co-efficient and odds ratio)

Environmental factor	Mode: Cycle											
	Trip to university			Trip to shop			Trip to office			Trip to recreational activity		
	B	P value	Odds ratio	B	P value	Odds ratio	B	P value	Odds ratio	B	P value	Odds ratio
Perception about existing pedestrian facilities (in neighborhood) (1)	<b>-6.043</b>	<b>0.017</b>	<b>0.002</b>	-6.984	0.151	0.001	-8.581	0.065	0.000	-5.086	0.089	0.006
Perception about existing pedestrian facilities (in neighborhood) (2)	<b>-2.724</b>	<b>0.012</b>	<b>0.066</b>	-1.922	0.091	0.146	<b>-3.603</b>	<b>0.021</b>	<b>0.027</b>	<b>-3.372</b>	<b>0.013</b>	<b>0.034</b>
Perception about existing cycling facilities (in neighborhood) (1)	<b>3.996</b>	<b>0.008</b>	<b>54.404</b>	<b>5.312</b>	<b>0.015</b>	<b>202.722</b>	<b>6.012</b>	<b>0.011</b>	<b>408.358</b>	<b>5.154</b>	<b>0.010</b>	<b>173.206</b>
Perception about existing cycling facilities (in neighborhood) (2)	0.925	0.241	2.523	1.417	0.195	4.124	<b>2.389</b>	<b>0.044</b>	<b>10.905</b>	<b>2.549</b>	<b>0.029</b>	<b>12.790</b>
Perception about existing public transport facilities (In neighborhood) (1)	-0.272	0.866	0.762	-22.331	0.999	0	-23.593	0.999	0	-21.071	0.999	0.000
Perception about existing public transport facilities (In neighborhood) (2)	-0.223	0.860	0.8	0.726	0.678	2.067	0.670	0.679	1.954	0.010	0.995	1.010
Perception about existing driving facilities (in neighborhood) (1)	-0.803	0.465	0.448	-20.374	0.998	0.000	-1.695	0.330	0.184	-2.208	0.308	0.110

Perception about existing driving facilities (in neighborhood) (2)	0.002	0.998	1.002	0.065	0.948	1.068	1.427	0.193	4.164	0.885	0.432	2.424
Perception about existing green spaces and park(in neighborhood) (1)	0.531	0.687	1.700	3.147	0.120	23.271	3.725	0.065	41.473	3.008	0.113	20.242
Perception about existing green spaces and park(in neighborhood) (2)	-0.494	0.543	0.610	-0.853	0.415	0.426	-0.747	0.452	0.474	0.029	0.978	1.030
Perception about existing crime safety (in neighborhood) (1)	<b>-2.521</b>	<b>0.025</b>	<b>0.080</b>	-2.06	0.094	0.128	<b>-3.716</b>	<b>0.012</b>	<b>0.024</b>	<b>-3.298</b>	<b>0.021</b>	<b>0.037</b>
Perception about existing crime safety (in neighborhood) (2)	-0.082	0.918	0.922	-1.456	0.241	0.233	-0.624	0.544	0.536	0.004	0.997	1.004
Traffic safety (in neighborhood) (1)	2.464	0.063	11.748	3.119	0.079	22.629	-3.716	0.096	28.389	2.812	0.077	16.645
Traffic safety (in neighborhood) (2)	1.229	0.111	3.418	<b>2.625</b>	<b>0.032</b>	<b>13.804</b>	<b>-0.624</b>	<b>0.022</b>	<b>13.114</b>	<b>2.633</b>	<b>0.020</b>	<b>13.915</b>
Perception about existing available non-residential facilities (in neighborhood) (1)	0.238	0.786	1.269	-0.939	0.457	0.391	-1.171	0.352	0.31	-0.301	0.792	0.74
Perception about existing available non-residential facilities (in neighborhood) (2)	1.538	0.103	4.654	-0.174	0.893	0.841	-0.554	0.66	0.575	-0.855	0.538	0.425
Perception about existing available beautification (in neighborhood) (1)	<b>1.860</b>	<b>0.037</b>	<b>6.427</b>	<b>4.565</b>	<b>0.004</b>	<b>96.093</b>	<b>4.503</b>	<b>0.003</b>	<b>90.254</b>	2.659	0.035	14.287
Perception about existing available beautification (in neighborhood) (2)	0.801	0.320	2.228	2.327	0.099	10.242	<b>3.836</b>	<b>0.009</b>	<b>46.339</b>	<b>3.327</b>	<b>0.008</b>	<b>27.858</b>
Perception about existing social interaction with the neighbor(in neighborhood) (1)	-0.680	0.473	0.507	-0.718	0.581	0.488	-0.521	0.643	0.594	-0.692	0.558	0.501
Perception about existing social interaction with the neighbor(in neighborhood) (2)	0.068	0.937	1.071	1.752	0.156	5.764	0.755	0.502	2.127	1.430	0.210	4.177

*p-Value* ≤ .05 (significant value)

Table 6-9: A comparison of public transport use of young adult in terms of various environmental explanatory variables depending on different trip purpose (with respect to significance level, co-efficient and odds ratio)

Environmental factor	Mode: Public transport											
	Trip to university			Trip to shop			Trip to office			Trip to leisure activity		
	B	<i>P</i> value	Odds ratio	B	<i>P</i> value	Odds ratio	B	<i>P</i> value	Odds ratio	B	<i>P</i> value	Odds ratio
Perception about existing pedestrian facilities (in neighborhood) (1)	2.46	0.080	11.709	1.199	0.435	3.316	2.046	0.206	7.734	<b>4.252</b>	<b>0.004</b>	<b>70.215</b>

Perception about existing pedestrian facilities (in neighborhood) (2)	<b>1.667</b>	<b>0.032</b>	<b>5.296</b>	-0.312	0.700	0.732	0.611	0.432	1.842	0.873	0.248	2.393
Perception about existing cycling facilities (in neighborhood) (1)	-2.201	0.069	0.111	-0.329	0.789	0.720	-1.342	0.300	0.261	<b>-3.461</b>	<b>0.009</b>	<b>0.031</b>
Perception about existing cycling facilities (in neighborhood) (2)	-1.292	0.053	0.275	0.313	0.665	1.368	-0.143	0.834	0.867	-0.808	0.285	0.446
Perception about existing public transport facilities (In neighborhood) (1)	1.872	0.229	6.499	1.347	0.443	3.847	-18.904	0.999	0.000			
Perception about existing public transport facilities (In neighborhood) (2)	0.058	0.947	1.060	1.148	0.241	3.151	0.146	0.877	1.157			
Perception about existing driving facilities (in neighborhood) (1)	0.532	0.534	1.703	-0.269	0.792	0.764	-20.394	0.999	0.000	-1.946	0.118	0.143
Perception about existing driving facilities (in neighborhood) (2)	0.778	0.256	2.178	-0.482	0.550	0.618	-0.590	0.402	0.555	-1.276	0.125	0.279
Perception about existing green spaces and park(in neighborhood) (1)	-0.106	0.926	0.900	-0.6	0.67	0.549	0.390	0.75	1.477			
Perception about existing green spaces and park(in neighborhood) (2)	-0.195	0.751	0.823	0.411	0.565	1.508	-0.352	0.609	0.703			
Perception about existing crime safety (in neighborhood) (1)	-1.330	0.101	0.265	-1.267	0.214	0.282	<b>1.645</b>	<b>0.05</b>	<b>5.179</b>	<b>2.865</b>	<b>0.002</b>	<b>17.542</b>
Perception about existing crime safety (in neighborhood) (2)	-0.304	0.674	0.738	0.159	0.846	1.173	1.543	0.054	4.677	-0.578	0.493	0.561
Traffic safety (in neighborhood) (1)	0.270	0.775	1.310	0.360	0.731	1.434	-0.639	0.508	0.528			
Traffic safety (in neighborhood) (2)	0.113	0.863	1.120	0.529	0.494	1.697	-0.807	0.291	0.446			
Perception about existing available non-residential facilities (in neighborhood) (1)	0.494	0.493	0.610	<b>2.043</b>	<b>0.014</b>	<b>7.716</b>	0.419	0.577	1.521			
Perception about existing available non-residential facilities (in neighborhood) (2)	0.599	0.464	0.549	0.506	0.592	1.658	-0.508	0.591	0.601			
Perception about existing available beautification (in neighborhood) (1)	-1.564	0.053	0.209	-2.215	0.056	0.109	0.237	0.764	1.267	<b>-2.511</b>	<b>0.023</b>	<b>0.081</b>
Perception about existing available beautification (in neighborhood) (2)	-0.453	0.495	0.636	-0.438	0.563	0.645	0.425	0.557	1.529	-0.850	0.275	0.428



Perception about existing social interaction with the neighbor(in neighborhood) (1)	0.073	0.927	1.076	0.447	0.629	1.563	-1.007	0.242	0.365	<b>2.104</b>	<b>0.027</b>	<b>8.196</b>
Perception about existing social interaction with the neighbor(in neighborhood) (2)	0.182	0.815	1.200	-0.311	0.727	0.733	-0.399	0.628	0.671	-0.069	0.939	0.934

*p-Value* ≤ .05 (significant value)

### **6.3.2. Travel factors affecting mode choice of young adult**

Among different travel factors considered in this study, students preferred mode has significant contribution almost in the entire models of walking and public transport use (Table 6.4, Table 6.6). In case of walking, for all trip purposes, students who exhibit variation between their preferred and selected mode have less odds of selecting walking as a means of transport (Table 6.4). This means, if students are walking and their preferred mode is also walking, then they have higher chance of selecting walking as a means for trip to university. In contrast to this, for those who exhibit variation between preferred and selected mode have higher odds to select public transport for all purposes (Table 6.6). This means that even if students have inclination for walking, cycling or for car, yet students are availing public transport for different purposes. Also, it is noteworthy that for walk trip, duration is an important factor. With the increase of distance, lower odds for selecting walk trip to university (*OR 0.733*) or for trip to administrative (*OR .863*) office is found (Table 6.4). Furthermore, in case of public transport use, where there are available alternative option to commute (walking or cycling), then there is less probability to select public transport for trip to shop (*OR 0.188*). Therefore, availability of walking and cycling opportunity is significantly contributing to select them as a means of transport. In contrast to trip through walking, in case of public transport higher odds are found for trip to university (*OR 1.191*) or office places (*OR 1.202*) when distance increases.

### **6.3.4. Environmental factors affecting mode choice of young adult**

To understand the environmental factors affecting the travel behavior of young adult, 10 factors related to the perception of social and physical environment of the neighborhoods, where students are living are considered in this study. The factors are analyzed in the same way like the other factors considered in this study. However, as these 10 factors are ordinal level data (recoded as 1. Not satisfied 2. Moderately satisfied 3. Very satisfied), very satisfied is considered as reference category for the analysis. From this analysis, it is also found that different neighborhood factors have substantial influence to motivate the students either to incline or restrict them from active transportation. Results from binary logistic regression in summarized in Table 6.7, 6.8, 6.9. For trip to university as well as trip to shop, compared with the students very satisfied with crime safety, those who are not satisfied exhibits higher odds of selecting walking as mode of transportation. The reason could be the rate of crime incurred in bus or tram stoppage or during cycle journey which are more prone to crime incidence than walking. Moreover, student's residential location could be another reason for this result, as they could be living in the vulnerable neighborhood but very closest to university and grocery where it is more convenient and safe to walk rather than to choose other mode. Also, often students prefer to walk in a group, if they are fearful about crime or incidence. Further evidence for such justification is the result for leisure trip. If students are not satisfied with crime safety they have lower odds of selecting walking for leisure trip (*OR 0.044*). On the other hand, students who are not satisfied or moderately satisfied with the traffic safety of their neighborhood compared to those very satisfied have lower odds of selecting walking as a means of transport. Therefore, perception about traffic safety in neighborhood is acting here as negatively influential factors for walk trip to university. In terms of driving facility, those are not satisfied with this facility or moderately satisfied shows higher odds for walking for shop or office trip. This gives intimation that having higher satisfaction about driving facilities in the neighborhood could motivate the students for using car instead of walk or other alternative available modes. Moreover, the importance of nonresidential facilities in the neighborhood to increase walk trip for leisure activity is found. Students who are not satisfied with non-residential facilities in their neighborhood compared to those who are very

satisfied, shows lower odds of walking for leisure activity (*OR 0.037*). This suggests that being unsatisfied with the neighborhood non-residential facilities; students are travelling further distance for leisure activities which are not located within walking distance. However, those who are moderately satisfied with the neighborhood beautification compared to those who are very satisfied shows higher walk trip for leisure activity. The potential reason could be student's diversified choice of leisure activities as well as places where they prefer to go. As, it is mentioned in chapter 4 that Grenoble is famous for its touristic attraction and mountain related leisure activity opportunities, therefore, after being satisfied with neighborhood beautification, students still prefer to go other places those might not be reachable through walking.

In terms of using cycle as a mode of transport for different purposes, cycling facilities available in the neighborhood is an important factor. Even though, it is found that those who are not satisfied or moderately satisfied with available cycling facilities in the neighborhood shows higher odds of selecting bicycle as a mode of transport for all the purposes selected in this study. This result exhibits that better perception often do not motivate people to avail a particular mode, also other motivations are required. Furthermore, this outcome could be the result of differences in perception between actual user and non-user. Besides, those who are moderately or less satisfied with pedestrian facilities shows lower propensity to use cycle compared to those who are very satisfied with such facilities. Therefore, availability of pedestrian facilities in a neighborhood is a complementary facility to promote cycling as well, because walkers and cyclists share the common facilities and amenities. Therefore, to promote walking and cycling, it is necessary to think about these two modes of transport together because of their common interest. Unlike the walk trip, those who are not satisfied with the existing crime safety in the neighborhood shown lower chance to use cycle for all the purposes considered in this study except trip to shop. Therefore, the premise in the trip to walk model of crime incidence with cycling or public transport could be a reason for such result. However, a contrasting result found from the model trip to cycle that those who are not satisfied or moderately satisfied with the neighborhood beautification shows higher odds of selecting cycle for different trip purpose. This means that better aesthetic perception even does not motivate certain satisfied students to avail cycle for different intended purposes. Moreover, traffic safety has both way effect depending on the purpose of the trip. Compare to those who are very satisfied with traffic safety of their neighborhood, moderately satisfied students show lower propensity to use cycle to make office trip whereas higher propensity for shop or leisure activity. This remarks the necessities of traffic safety in the neighborhood for the promotion of cycle use among the students.

In terms of public transport use, compared to the other modes different factors are more dominant. More interestingly, those who are not satisfied with neighborhood social interaction show higher odds for public transport use. It shows the importance of social interaction in case of motivating people to walk or use cycle, because this interaction also gives a sense of safety and security. It is justified with the factor of crime safety. Students who are not satisfied with crime safety shows higher propensity for public transport for office as well as leisure activity. Therefore, social interaction and sense of crime safety are related to each other. Even though from the model of cycle use, neighborhood beautification does not impact the cycle use, however, in case of public transport trip for leisure activity shows that those who are not satisfied with neighborhood beautification shows lower odds for selecting public transport. Therefore, to increase more leisure trip by public transportation it is important to think about the aesthetic aspects of neighborhood. Furthermore, non-residential facilities in the neighborhood also motivate people to use public transport, since those who are not satisfied with non-residential facilities in the neighborhood shows higher odds for public transport for shop/grocery purpose (*OR 7.716*). Also, poor perception about

pedestrian and cycling facilities shows higher odds for public transport for leisure activity. It refers that satisfaction about pedestrian and cycling facilities are important not only for commuting trip, leisure trip as well. Availability of such facilities diverts or motivates people to use certain mode for different purposes.

#### **6.4 Chapter conclusion**

Through this chapter, it is statistically shown that there is different socio demographic, travel as well as environmental factors affecting students active travel behavior. Some factors are influential for particular trip, whereas not significant if the purpose is different. Therefore, the assumption to have different factors affecting different trip in a different way is justified. Similarly, depending on the mode choice, factors and their significance also vary. Positive and negative influences of significant factors propose to contemplate about multidimensional impacts of such factors and how to cope with the negativity and adopt the positivity in a more effective way.

## 7. Chapter: Framework to promote active transportation

It is already proved in the previous chapter that various socio-demographic, traffic and land use factors are associated with the active travel behavior of young adult. This is prescribing to have more synergistic approach incorporating different strategies targeting the actual demand of students or in general the demand of people towards active transportation with an aim to develop a long term active travel behavior among adults. The aim of this chapter is to describe the framework developed through incorporating different types of measures already adopted in different countries, to promote active transport as the means to commute among the young adults. Then, the developed framework is evaluated from the opinion of university students aged 18 to 25 and ground observation.

### 7.1 Framework of intervention

As, it is agreed that to promote the active transport use for commuting as well as for leisure purpose, integrated package of strategies comprised of many complementary interventions are imperative. However, in the existing literature, a comprehensive framework comprised of such interventions that can be used to identify potential alternatives is not explored yet. Therefore, as part of the study, here the first attempt is to develop the framework form the literature review, where authors tried to evaluate each of the alternatives in promoting the use of active transportation.

Through different studies, authors have tried to reinforce the importance of infrastructures in facilitating active transportation. For instances, according to some researcher, complete street intervention having provision for both walking and cycling as well as public transportation has significant impacts in promoting active transportation (Brown et al., 2016a). Similarly, it is affirmed that higher level of bicycle infrastructures and facilities are associated with higher level of bicycle commuting (Dill and Carr, 2003). However, in some studies some structural approaches are evaluated and resulted with no significant association with the promotion of active transport (Bhatia et al., 2016). On the other hand, some studies have emphasized more on awareness raising, green travel initiatives and positive attitude development towards active transport as more effective strategies to promote active transport movement (Ho et al., nd). Meanwhile, land use policies, land use mix and densification are also considered as effective and potential interventions to promote active transportation (Aytur et al., 2007). Therefore, the developed comprehensive framework in this study incorporates three strategies-structural approach, management and spatial planning approach. These three approaches are already synergized with each other and adopted in different countries and metropolitan areas (like in UK., Bogota, Berlin , Paris, Barcelona) to promote active transportation.

Table 7-1: Comprehensive framework of interventions to promote active transportation

Type of strategies	Intervention
<b>Structural approach</b>	<p><b>Measures for walking</b></p> <ul style="list-style-type: none"> <li>• Wide side walk</li> <li>• Raised crosswalk</li> <li>• Center island</li> <li>• Continuation of side walk</li> <li>• Curb in the sidewalk</li> <li>• Driveway cut</li> </ul> <p><b>Measures for cycling</b></p> <ul style="list-style-type: none"> <li>• Bicycle track (Recessed track, Truncated track)</li> <li>• Right turning track</li> </ul>

	<ul style="list-style-type: none"> <li>• Segregated on road cycle lane</li> <li>• Completely segregated off road cycle track</li> <li>• Bicycle boulevard</li> <li>• Continuous cycle connection</li> <li>• Bike box</li> <li>• Bike station and bike rack</li> <li>• En-route facilities</li> <li>• Journey end facilities (shower/changing room)</li> </ul> <p><b>Physical elements for both walking/cycling</b></p> <ul style="list-style-type: none"> <li>• Road surface</li> <li>• Street amenities (signage, signal, color, marking, street lighting, street furniture, trash bin)</li> <li>• Road side visualization (road side building design, aesthetics of street area, road side non-residential development, landscaping)</li> <li>• Green elements along the street (road side planation and landscaping)</li> <li>• Pedestrian cycling detection system,</li> </ul> <p><b>Complete street</b></p>
<b>Spatial planning approach</b>	<p><b>At city level</b></p> <ul style="list-style-type: none"> <li>• Land use mix</li> <li>• High density development</li> <li>• Zoning</li> <li>• Control of urban sprawl</li> <li>• Access to public transportation facilities</li> <li>• Access to pedestrian and cycling facilities</li> <li>• Access to public spaces</li> <li>• Pedestrian pocket park</li> </ul> <p><b>At neighborhood level</b></p> <ul style="list-style-type: none"> <li>• Neighborhood walkability</li> <li>• Traditional neighborhood development</li> <li>• Access to front door, sidewalk, adjacent property, common spaces, transit stoppage and parking</li> </ul> <p><b>At street level (road side development)</b></p> <ul style="list-style-type: none"> <li>• Multiple activities along the street side</li> <li>• Presence of buffer land use: restaurant and retail use</li> <li>• Intersection density</li> </ul>
<b>Management approach</b>	<p><b>Land use management</b></p> <ul style="list-style-type: none"> <li>• Non-motorized transport improvement program in the land use plan</li> <li>• Land development</li> <li>• Land use classification</li> <li>• Land-transport policy</li> <li>• Localized land use plan</li> </ul> <p><b>Institutional management</b></p>

	<ul style="list-style-type: none"> <li>• Partnership between health and transport professional</li> <li>• Public private partnership</li> <li>• Community participation/community input</li> <li>• Inclusion of user opinion</li> </ul> <p><b>Traffic management</b></p> <ul style="list-style-type: none"> <li>• Escalation of public transportation use instead of privately owned vehicle</li> <li>• Car pooling</li> <li>• Road pricing</li> <li>• Car free zone</li> <li>• Home zone</li> <li>• Control of car parking</li> <li>• Traffic calming initiatives</li> <li>• Control of vehicle speed and traffic volume</li> <li>• Traffic free pedestrian and cycling bridge/route</li> <li>• Restriction of car on city center and special places</li> <li>• Traffic management at junction: crosswalk, crosswalk scramble, countdown in signal, crossing speed</li> <li>• Proper signage, marking and signal</li> </ul> <p><b>Safety management</b></p> <ul style="list-style-type: none"> <li>• Accident investigation and reconstruction</li> <li>• Accident prevention</li> <li>• Danger reduction</li> <li>• Intersection and crossing safety</li> <li>• Safety education</li> <li>• Law enforcement</li> </ul> <p><b>Time and cost management</b></p> <ul style="list-style-type: none"> <li>• Payment for active transport to work</li> <li>• Pedestrian/cyclist prioritization at intersection</li> <li>• Cut through techniques to shorten active transport route</li> </ul> <p>Program management</p> <ul style="list-style-type: none"> <li>• Promotional campaign like green travel club to educate residents</li> <li>• Traffic education</li> <li>• Training</li> <li>• Promotion of active transport culture</li> <li>• Green travel initiative (walking group in local areas)</li> <li>• Promotional program like local bike events, bike library</li> </ul> <p><b>Evaluation and monitoring</b></p> <ul style="list-style-type: none"> <li>• Performance assessment of active transport facilities</li> </ul>
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Literatures reviewed to develop the framework: (Bhatia et al., 2016, Boettge et al., 2017, Brown et al., 2016a, Dill and Carr, 2003, Ha et al., 2011, Heath et al., 2006, Ho et al., nd, Jung et al., 2017, Kim et al., 2014, Krizek et al., 2009, Madsen and Lahrmann, 2016, Moura et al., 2017, Nelson and Allen, 1997,

Panter et al., 2016, Park et al., 2013, Pucher et al., 1999, Pucher and Buehler, 2008, Reynolds et al., 2009, Silla et al., 2016, Song et al., 2017, Teschke et al., 2012, Aytur et al., 2007, Green and Klein, 2011, Hajna et al., 2015, Hoehner et al., 2003, Khisty, 1994, De Nazelle et al., 2011, Pucher et al., 2010b, Tight et al., 1998, Wardman et al., 2007)

## 7.2. Strategies adopted in Grenoble

### 7.2.1. Structural approach

In the city of Grenoble, the metropolitan transport authority (SMTC) has adopted multiple strategies to improve the walking and cycling in Grenoble. From the ground observation, the city center and other important places in Grenoble has: wide-continuous pedestrian walkway, segregated on street and off street bike way, bike parking, bike racks, road side nonresidential activities and street amenities etc. (cf. Image 7-1 to Image 7-6). However, it is important to note that all places are not equally furnished with all amenities in the same way. Therefore, from the students' opinion/comments found in online questionnaire as well as in the face to face interview, clearer pictures are revealed (cf. Image 7-7, Image 7-8, Image 7-9).

#### Available Structural approach



Image 7-1: Separated sidewalk with greenery, Cours Jean Jaurès



Image 7-2: Complete street, Boulevard Gambetta



Image 7-3: Street amenities, Rue de l'Arlequin



Image 7-4: Completely segregated off road cycle track, Cours Jean Jaurès



Image 7-5: Proper signage, marking and signal, Quai Créqui



Image 7-6: Road side restaurant and bike rack, Quai Créqui

Source: Author's ground observation, 2017

About structural interventions, from the online questionnaire, it is found that higher percentage of respondents asked for more cycling facilities compared to pedestrian facilities necessary to promote active transportation in Grenoble. In the face to face interview, students explicated that at the city center there are appreciable amount of cycling (bike rack and parking) as well as walking facilities (wide side and continuous side walk), however, at the peripheral area one could find continuous side walk but not the bike rack or parking. In the questionnaire, 55% students vote for wider street, whereas 76% vote for separated bike track and 63% for right turning route for cycling. Moreover, in front of major commercial



places in the center one can easily find the bike rack facilities which are not common in the other part of the city (cf. Image 7-7). More often, the bike lane is shared with other vehicles and putting the biker in a danger of traffic collision (Image 7-8 and Image 7-9). Apart from facilities en-route, students mention about facilities necessary at the destination, for instances a locker at the university to put bike accessories.

Figure 7-1: Response from the students about walking and cycling facilities

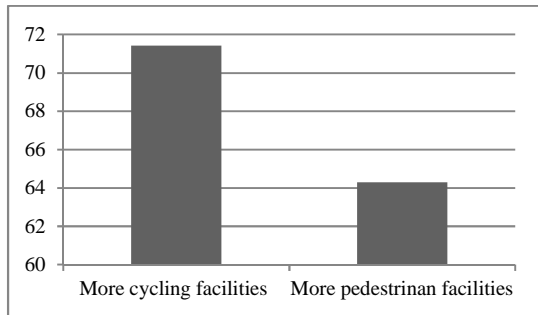
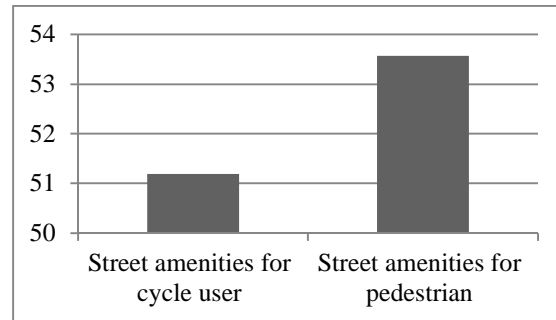


Figure 7-2: Response from the students about street amenities



Source: Online and face to face questionnaire survey, 2017



Image 7-7: In front of bank, no bike rack, Rue de village



Image 7-8: Narrow bike lane & side walk, Avenue Jean Perrot

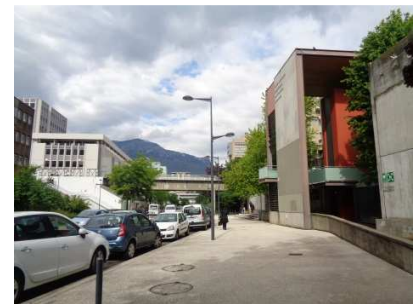


Image 7-9: No bike lane or marking for cycling in front of ENSAG

Source: Author's ground observation, 2017

Compared to cycling or walking facilities, from the questionnaire it is found that students responded to have more street amenities for the pedestrian compared to cycle user (Figure 7-1 and Figure 7-2). The reason behind such response was explicated by the students about their security and safety concerns as pedestrian are less mobile than cycle users. They asked for adequate street light and security particularly in the southern part of the city. Furthermore, they said compared to cycle users, pedestrian has higher probability to explore the nature and interact with the surrounding environments. Therefore, students referred that it is more important to have more street amenities for pedestrian. In addition to street amenities, almost 80% students vote for green element along the street side to create environmentally pleasing environment for both pedestrians and cycle users as they are explicitly exposed to pollution.

### 7.2.2 Spatial planning approach

It is unambiguously approved by the researcher that spatial planning approach has positive and significant correlation in promoting and supporting more active transportation. In the city of Grenoble, the reinforcement of such approach is apparent. As Grenoble is the center of Grenoble Metropolitan area, mix use and high density development is found almost in the extensive part of the city. Even, from the walkability map of Grenoble (cf. Map 5-2), it is apparent how this concept of mix use and dense

development pattern is applied in this city. But it is undeniable that, compared to city center other peripheral parts are lagged behind in terms of mix use development.



Image 7-10: Mix use development in the southern part of the city, Avenue Jean Perrot



Image 7-11: Mix use development in the northern part of the city, Rue Saint-Laurent



Image 7-12: Very little mix use development, Avenue Marcelin Berthelot

Source: Author's ground observation, 2017

Also at the neighborhood level, some neighborhoods are developed through the concept of mix use and high density development (e.g. Championnet cf. Image 7-15). Meanwhile, some city quarters are following homogenous sprawling (e.g. Melherbe Teisseire cf. Image 7-13). In comparison to these two neighborhoods, the following one is less dense and domination of more privatized open space/garden is also visible. Even though, density is compromised in different places of the city, however, minimum commercialization with primary schools, connection with sidewalk and access to public transport are well maintained throughout the city. Also, from the literature it is found that higher walkability at the neighborhood level is the evidence of higher walking for daily activity among the adults (Hajna et al., 2015). Hence, from the ground observation as well as from the literature, it can be suggested that to implement spatial planning approach in promoting active transportation, it is necessary to focus on different scale of implementation (both city scale as well as neighborhood scale). Since, from the holistic view deficits at micro scale would not be prominent to notice, therefore, local scale observation as well as modification particularly at the neighborhood scale is necessary.



Image 7-13: Low density and small scale mix use development in the quartier, Melherbe Teissier



Image 7-14: High density and medium scale mix use development in the quartier, Villeneuve



Image 7-15: High density and mix use development in the quartier, Championnet

Source: Author's ground observation, 2017

Also at the street level, attempts to make the street life livelier (e.g. street side beautification, commercialization as well as access to public spaces) are easily noticeable in different parts of the city (cf. Image 7-16 to Image 7-18). According to the student's point of view, this street level development is

necessary as this kind of development placed an invisible eye on the street and gives them feeling of security.



Image 7-16: Street side commercialization, Rue Joseph Rey



Image 7-17: Street side beautification, Cours Jean Jaurès

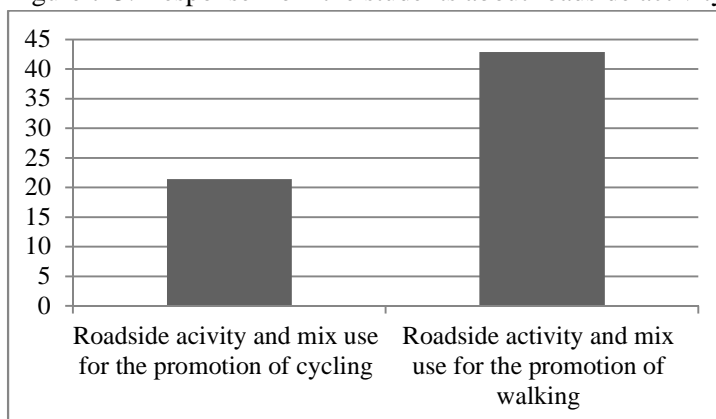


Image 7-18: Street side weekly market, Avenue de Vizille

Source: Author's ground observation, 2017

At the street level, from the student's opinion, roadside activity and mix use development is more important to promote walking compared to cycling. According to their point of view, pedestrian's interaction with the surroundings and access to multiple destinations within walking distance help to promote more walk trip for leisure as well as commuting purpose.

Figure 7-3: Response from the students about roadside activity and mixed used development



Source: Questionnaire survey and face to face interview, 2017

### 7.2.3 Management approach

In the city of Grenoble, different types and multi-level managerial approaches to promote active transportation are visible. However, significant changes have been happening after the formation of Grenoble métropole.

#### 7.2.3.1 Land use management

In terms of land use management, so far two separate governing bodies are responsible for preparing land use plan and transportation plan for the Grenoble metropolitan area. Before the formation of métropole (metropolitan administrative status), each municipality was responsible for their own land use management and development plan i.e. Plan Local d'Urbanisme (PLU). After 1<sup>st</sup> January 2015, because of the formation of the métropole, the responsibilities to prepare local interurban plan, i.e. Plan Local d'Urbanisme Intercommunal (PLUI) were transferred to Grenoble-Alpes Métropole (called "La Métro"). PLUI is the upcoming comprehensive and coherent spatial planning policy for 49 municipalities of the métropole. It is expected that PLUI will be in action from 2019 and will incorporate the major planning,

mobility, economic development and housing policies for the 49 municipalities as well as major zones and particular rules for the construction in each zone (Grenoble-Alpes-Métropole, 2009e). Even though, Grenoble métropole is considering the mobility plan as part of the land use plan, however, this mobility plan entitled as Plan de Déplacements Urbains (PDU) is the responsibility of Syndicat Mixte des Transports en Commun (SMTC), rather the Grenoble-Alpes Métropole. SMTC is the responsible authority for the mobility plan of Grenoble métropole that incorporate all modes of transport (public transport: tramway and bus, cycling, walking, car: parking and roads). Therefore, the plan for non-motorized mode is part of the holistic mobility plan of métropole, also, this mobility plan is included in the overall comprehensive spatial planning policy (Grenoble-Alpes-Métropole, 2009d). It can be construed that the city of Grenoble is a distinct paradigm of integration between land use and transportation plan that exhibits the importance of such integration for successful implementation of active transportation. This finding is also justified in literature where the importance of land use and transportation planning is reinforced for promoting active community environments (Aytur et al., 2007).

### **7.2.3.2 Institutional management**

In terms of institutional management, different types of institutions from formal to volunteer, public-semiprivate-private organizations are involved and working together for the promotion of active transportation in Grenoble. As mentioned above, SMTC is working as a public-formal organization in promoting non-motorized transport through plan preparation and implementation. In order to ensure more proficiency, SMTC has been welcoming participatory consultation with all the actors and inhabitants of the Grenoble agglomeration since 2012. On the other hand, L'Association pour le Développement des Transports en Commun (ADTC) is a user's association working for inter-modality and better sharing of public space. The objectives of this institution are to moderate car traffic, promote alternative mode of transport through supplementing tram and cycling network and required facilities. This organization is communicating with the users and negotiating with the decision makers to convince them to response based on the users opinion (ADTC, nd). Therefore, from the institutional point of view, the city of Grenoble is holding a good example that is a combination of both top-down and bottom up approach. Indeed, it is noteworthy to mention that the essence of such institutional successful arrangement for promoting the active transportation is the prioritization of participation and user's opinion which is also suggested in the literature.

As, the importance of active transportation is not only limited to transport sector, apart from the attempt of integration and participation among professional institutions, similar prioritization and collaboration is yet to notice in the field of research in the city of Grenoble. A significant progress to enhance collaboration among health and transport researchers with an aim to promote researches related to active transportation from different discipline is still under progress. However, Such interventions to promote active transportation and increase awareness and evidence in support of active transportation is widely recognized and justified through several studies (Green and Klein, 2011, De Nazelle et al., 2011, Hoehner et al., 2003).

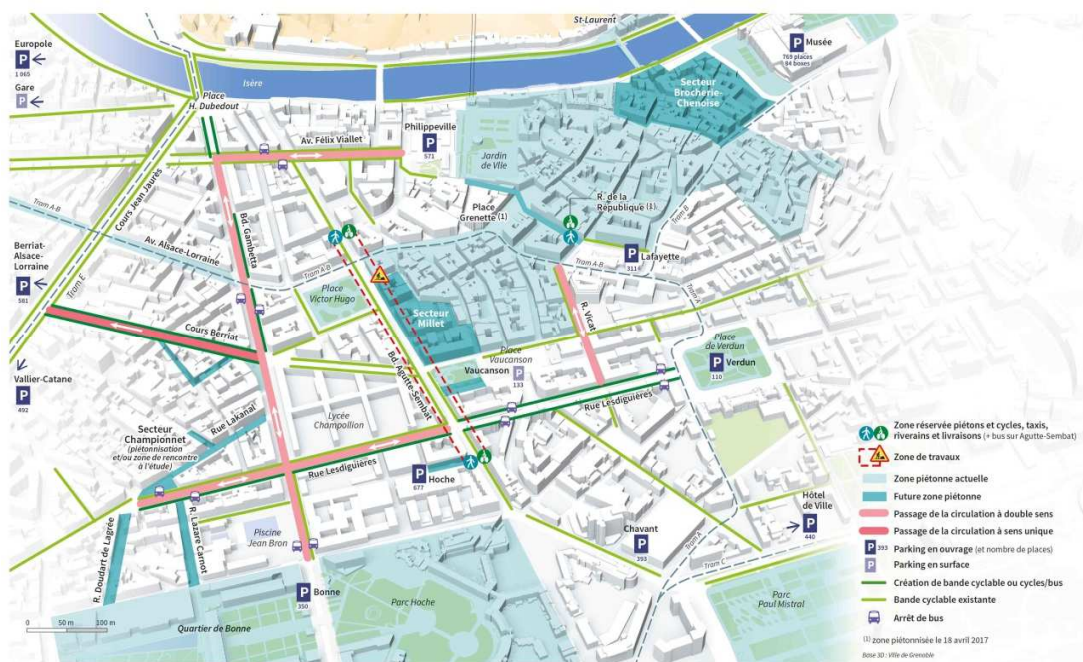
Furthermore, after having all of this institutional preponderance, still there are some difficulties mentioned by the students that more often exhibits limiting attitude towards motivation for active transportation. According to the students' point of view, even though there are attempts to incorporate users and community opinions in practical and research fields, however, very little is known about its implications in actual decision making process. Here, the focus of the students' opinion is to think about the level of participation, either it's confined only at the level of hearing or it really has control in changing the decision maker's opinion (Arnstein's ladder of participation).

### 7.2.3.3 Traffic management

Different plans and policies to reduce car traffic and consecutively, to promote active transportation are already implemented. Day by day, new innovative approaches are still under consideration in the city of Grenoble. Even though, there are no road pricing policies adopted within the city, however, other traffic calming speed reduction policies along with escalation of public transport use interventions are already adopted and adjustments with the contemporary needs are still under consideration.

In this regard, “Cœur de Ville Cœur de Métropole” (City Heart, Metropolitan Heart) is one of such recent projects accepted with a prime devotion to increase the pedestrian walkable area at the city center. Apart from the extension of pedestrian area, project contains several interventions pertinent to reorganization of traffic, redevelopment of some areas, enhancing the architectural heritage and boost up the local commerce to make the city center more accessible and enjoyable. The major points of interest for the extension of pedestrian area are shown in the Map 7-1. These places are Place Grenette to the Saint-Laurent and Championnet / Bonne districts. However, such initiative is limited at the central part of the city, sector wise such interventions are not yet under consideration. Beside this project, there are already some places and plaza at the center of Grenoble where car is completely forbidden (car free zone) or restricted only for the residence (cf. Map 7-1) (Grenoble, 2017).

Map 7-1: Plan of new car free area at the center of Grenoble



Source: Grenoble (2017)

Moreover, for the very first time in France from the beginning of 1<sup>st</sup> January, 2016, Grenoble city and metropolitan area has adopted a mandatory regulation of 30km/h speed for all streets and exceptionally 50 km/h for some major axis as a global approach for the métropole to move towards a traffic calm city (cf. Map 7-2) (Grenoble.fr, 2015). Additionally, students in the questionnaire survey and interview acknowledged the importance of traffic calming initiatives with greater importance for the cycle users

compared to pedestrian as there are some roads (Figure 7-4) where cycle and motorized vehicles are sharing the same road and have greater chance of traffic collision (Image 7-20).



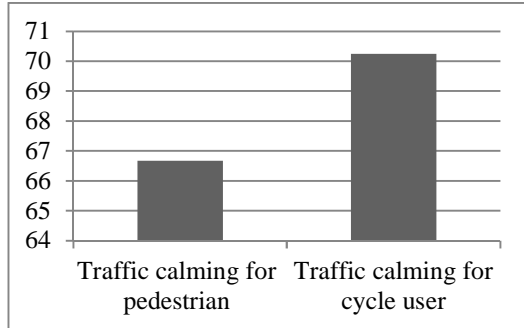
Image 7-19: Observation phase of project Cœur de Ville Cœur de Métropole  
Source: Author's ground observation, 2017

Map 7-2: Speed limit map of the city of Grenoble



Source: (Grenoble.fr, 2015)

Figure 7-4: Response from the students about traffic calming measures for pedestrian and cycle user



Source: Online and face to face questionnaire survey, 2017

Image 7-20: Sharrowed lane, Rue de Stalingrad



Source: Author's ground observation, 2017

Also, SMTC is providing the parking relais opportunities in the metropolitan area. There are 19 parking-relays offering car, motorcycle and bicycle parking spaces near the tram and bus lines (Tag, nd). This is free for travelers with a valid TAG pass or a Métrovélo "consigne". The use of this free parking relais encourage people to leave their car in the parking places and allow to park at a lower cost, and encourage motorists to prefer the alternative modes. However, though there are many off-street car parking facilities available in the city, on street car parking is apparently available everywhere. Meanwhile, almost 54% students in the online questionnaire and interview emphasized the necessities to reduce on street car parking in order to reduce collision with bike. Also, some students emphasized the car parking on the bike lane which is often very annoying and risky for the cycle users.

Apart from this, provision of crosswalk and signalized crossing, proper signage, marking and signals are available everywhere in the city, but no crosswalk scramble and countdown signal were observed during the ground observation. Moreover, the carpooling nationally famous system in France is the use of Bla Bla car ([www.blablacar.fr](http://www.blablacar.fr)). But, this Bla Bla car is often used for long distance (city to city) travelling purpose rather than for within city movement.

#### 7.2.3.4 Safety management

SMTC, the responsible public authority of all types of roadway transportation in Grenoble metropolitan area, is accountable for accident prevention and reconstruction. Through their regular monitoring, they identify the flaws (both structural and non-structural) associated with accident in the existing transportation system and take initiatives to reduce the risk from the road. Also, at major hot spots of accident (intersection and crossing), proper signage, marking and signals are available and worthily (cf. Image 7-21 and Image 7-22), followed by the inhabitants. Moreover, apart from this regular observation, a state law related to the safety of bicycle and other soft mode use entitled LAURE (Loi sur l'Air et l'Utilisation Rationnelle de l'Energie, 1996), is also strongly functional in all the cities in France. This law is enforced with a vision that it will allow France, to gradually have a cycling network and to achieve a better environmental balance compared to other European countries. The aim of this law is to strengthen the claim of bicycle users more effectively (FUB, 2015). Similar law for pedestrians is not available, which is also necessary to ensure pedestrians' safety and promote walk trip. Then, the SRU Law (Loi relative à la Solidarité et au Renouvellement Urbains, 2000) imposed the monitoring of pedestrian and bike users accidents for every agglomeration in preparing its own PDU (mobility plan). Also, to ensure safety and to fight against road accident in general, a national priority within the territory of France makes

a mandatory safety education in school and college level (éduscol, 2016). From the student's opinion, this government level initiative of road safety education is important for both walkers and cyclists and emphasized its importance for the promotion of walking compared to cycling. At the same way, in case of law enforcement, greater emphasis found to ensure pedestrian safety. However, it is worth to mention, students were quite satisfied related to the existing law enforcement situation in Grenoble (cf. Figure 7-6). Most of the cyclist in the face to face interview complained against abrupt parking on bike lane or footpath.

Figure 7-5: Response from the students about education and training for walking and cycling

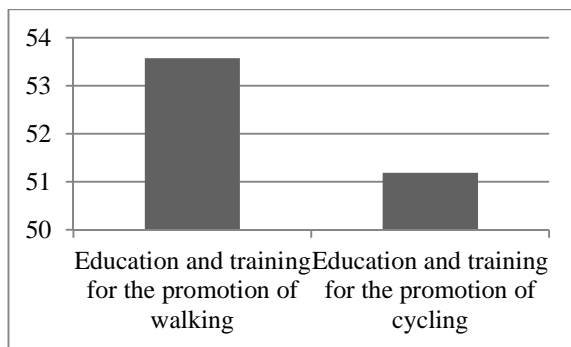
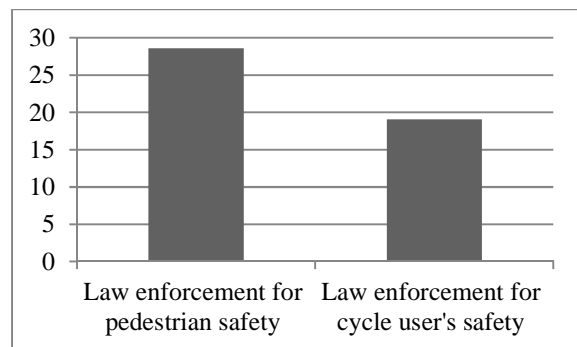


Figure 7-6: Response from the students about law enforcement for walking and cycling



Source: Online and face to face questionnaire survey, 2017

Image 7-21: Ordinary walking and cycling crossing



Image 7-22: Marking on the road



Source: Author's ground observation, 2017

### 7.2.3.5 Time and cost management

To manage the time during the trip, for the Grenoble metropolitan area, there is an official website of Métromobilité ([www.metromobilite.fr](http://www.metromobilite.fr)), where one can arrange their own trip plan depending on their time and available transport facilities. On the other hand, very little amount of pedestrian crossing button (push-to-walk) to prioritize pedestrian is found at major junction and busy road, which is quite necessary to reduce the time required for walk trip. This observation is also evident in the results from students' online and face to face questionnaire where priority of pedestrian at intersection was highly demanded (cf. Figure 7-7). Moreover, to reduce time for walking, there are different infrastructures like ped-way, shortcut route etc. available, however no additional signage for such facilities is found. But, a time distance signs showing the direction and walking distance in minute (considering standard walking speed 4km/h) to some special destinations are found in the city of Grenoble, especially around the city center and some other parts of the city with an aim to inspire walk trip among urban dwellers through time management (cf. Image 7-23 and Map 7-3 ). Such approach is a flagship action of municipality health



plan (project entitled as l'INPES) to reinforce pedestrianisation in the city of Grenoble and to develop a health friendly environment (Direction-Santé-Publique-et-Environnementale, nd).

Figure 7-7: Response from students about priority of pedestrian and cyclist at intersection

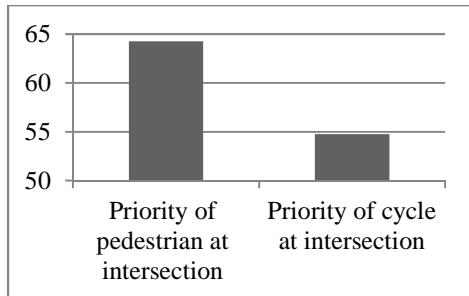
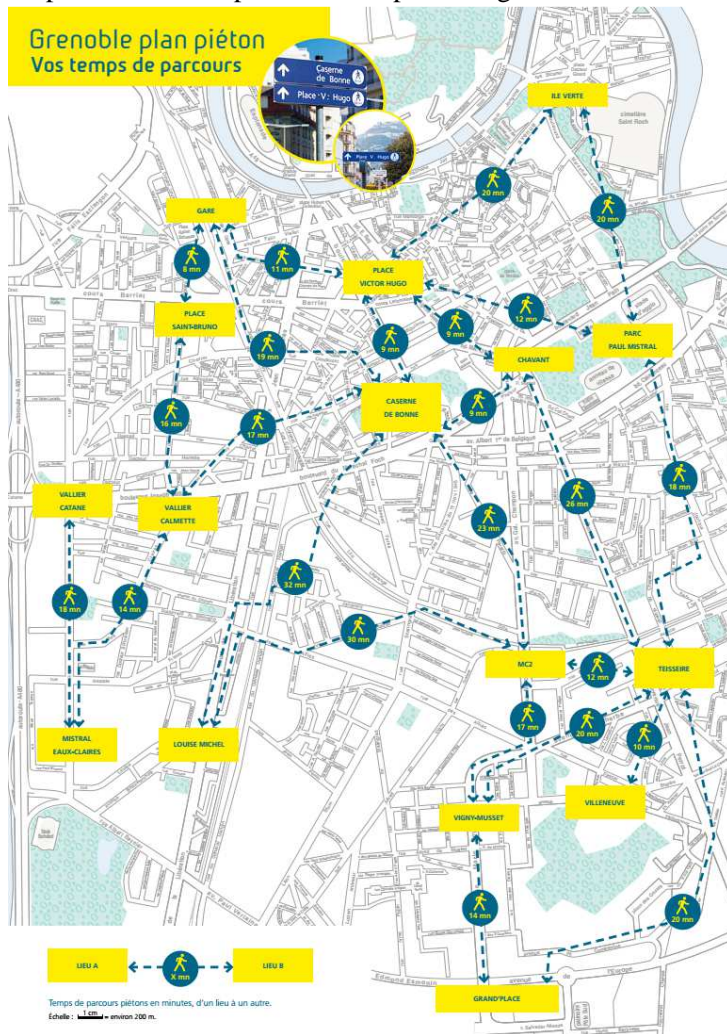


Image 7-24: Use of yellow colored bike "Métrovélo"

Source: Online and face to face questionnaire survey, 2017

Image source: Author's ground observation, 2017

Map 7-3: Grenoble pedestrian map showing travel time



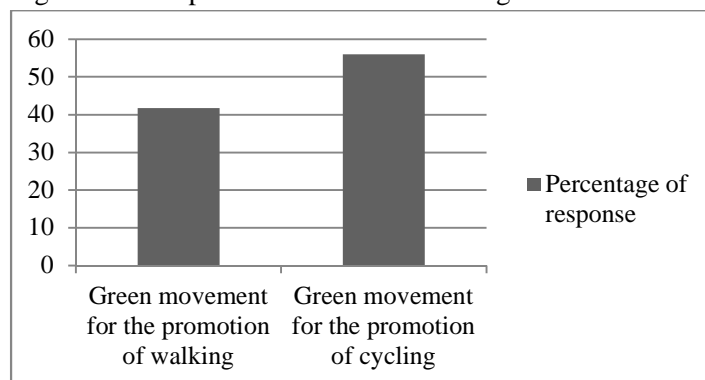
Source: Direction-Santé-Publique-et-Environnementale (nd)

Also, to promote the use of public transportation, from each workplace depending on the employer's contract, there is official provision to offer at least 50% cost of public transport for employees' trip to workplace. This provision of payment for active transport is not yet adopted entirely, but some enterprises have already started such setting. If, it is adopted entirely, it could be more effective for the promotion of active transportation. Moreover, at the city scale in order to augment bicycle use, there is a provision to rent a yellow colored bike called "Métrovélo" in a cheap rate on a day (3€ per day), month (25€ per month and 60€ per 3 months) or year basis (132€ per year) where the maintenance of bike is ensured by the agencies (cf. Image 7-24) (Métrovélo, nd). Also, in case of bike renting special price for students who are aged below 25 years old and people who are eligible to get social security, have reduced price level to rent this métrovélo. There are almost 6000 bicycles to hire from 2 agencies (Métrovélo Gare and Métrovélo Campus) (Grenoble-Alpes-Métropole, 2009a). However, from students' point of view this bike renting is a unique idea adopted in Grenoble, but the rent price is quite high, as one of the students commented that the monthly rental price of métrovélo for students below 25 years old is similar to their reduced public transport price (15€ per month), where the later one provide more option to use (both tramway and bus). Therefore, to promote more cycle use, it is necessary to think about the rent price and services available in this price accessible for the students.

### 7.2.3.6 Program management

The program management for active transportation in Grenoble has reached in another dimension. There is an official website of ADTC ([www.adtc-grenoble.org](http://www.adtc-grenoble.org)) and SMTC ([www.smtc-grenoble.org](http://www.smtc-grenoble.org) & [www.tag.fr](http://www.tag.fr)), where information about promotional events of bike racing, bike festival, movie festivals, and walk day are broadcasted and advertised throughout the city for the promotion of active transportation. Also, there is an association named Le p'tit Vélo dans Ma Tête, a volunteer association in Grenoble to provide free bike repair tools and services as well as training to bike users to repair their bike by their own. However, community level green travel movement for the promotion of walking and cycling is not observed, whereas students highly prioritized such intervention alleging that such intervention has potentiality in promoting walking and cycling from the community level (Figure 7-8). Their opinion was that the way students are motivated seeing their peers are using cycle or walking, such movement at the community level could be an effective intervention in promoting active transport behavior among the inhabitants.

Figure 7-8: Response from students about green movement for walking and cycling



Source: Questionnaire survey, 2017

### 7.2.3.7 Evaluation and monitoring

SMTC, being the responsible authority for the mobility plan of Grenoble métropole, is monitoring and evaluation the public transport services and their performance of associated infrastructures and facilities.

User opinion is collected in order to assess the performance from the user's point of view by this authority through online questionnaire survey of Tag user. However, this performance assessment survey is limited only for the user of public transportation, whereas performance assessment of walking and cycle facilities and services are not yet adopted.

### **7.3 Chapter conclusion**

This chapter explains the framework consisted of different types of measurements (structural and non-structural) already adopted and implemented in different countries in order to promote active transportation. In the meantime, the scenario of Grenoble city with respect to the developed framework is also assessed based on existing and ongoing projects and adopted interventions taken by the responsible authorities. It is also elaborated from the ground observation and information from the official web site of responsible organizations. This explicates how Grenoble has adopted multi-level measures for the promotion of active transport like the other European countries. Also, explains the newer forms of innovation in order to increase active transportation. Moreover, from this chapter, the necessities of existing interventions and other non-existed interventions are substantiated from the perspective of university going young adults.

## **8. Chapter: Findings and discussion**

In this chapter, findings from spatial analysis and statistical analysis are accumulated to verify the consistency of the findings and its relevance with the ongoing literature. Furthermore, findings from the analysis of Grenoble with respect to the proposed active transport improvement intervention framework are also summarized. Based on the findings, a concluding remark is also demonstrated to justify again the necessities and potentiality of this study through the major observations and their significance.

### **8.1 Discussion and findings from spatial analysis**

The spatial analysis, through the application of spatial mapping with respect to three selected criteria (land use, land use mix and public transport service area), reveals that depending on trip purpose different spatial attributes have significant impacts on students' active mode choice behavior. For those trips, which are mandatory and time bound like trip to university, students' prime impedance is the distance and time. Here, students' trip choice or mode is not dependent on the land use mix or density or the availability of diversified destinations. Therefore, university dormitory near the university is a possible intervention to promote walk trips to university and it is supported by Chaney et al. (2014) that proximal constructs support active transportation. However, student's daily movement is consisted of multiple trips and their trip to university is also linked to the other activities (like shopping, grocery, office etc.), which is evident in the spatial map prepared from students geocode point. Furthermore, from the spatial analysis of other trips, it is found that students' movement pattern and mode choice is also dependent on the type of land use, land use mix and destination options available, in the places where they are going or living. Therefore, just to provide student dormitory near the university is not enough to promote more active movement. To facilitate student's trip chain and promote walk trip for the other purpose (shop, office, leisure activities) it is also necessary to increase land use mix, diversification of destinations and densification. In this regard diversification limited at the city center would not be sufficient. More decentralized diversification and mix is necessary. Therefore, if a particular trip is considered, like trip to university, it would not reveal the holistic picture of students' movement and potential factors affecting their active transport behavior. Spatial mapping for different types of trips helps to understand these complexities and associated impetus affecting students' mode choice behavior in their young adult time stage.

Apart from this, the importance of public transport facilities and diversified alternative options (Bus, tram etc.) available for students' choice is justified for all types of trip. Predominantly, places (origin and destinations) which are not within walking distance call for better public transport or cycling facilities, instead of mere driving facilities to promote more active movement. Hence, better provision of transport facilities and service area are principle components to promote active transportation, as, public transportation also involves a certain amount of active movement and reduces car dependency. This finding also supports the research by Brown et al. (2001), where it is empirically evident that unlimited access to public transport increases students' ridership and reduces their parking demand from the campus. Also, as it is agreed that cycling is faster than walking and another means of active transportation, so, it is also necessary to provide better cycling facilities to increase more cycle trip. Therefore, better walking, cycling and pedestrian facilities along with land use mix and diversification is supportive to active travel behavior among the young adult studying in university. These findings also support the findings of various relevant researches (Handy and Xing, 2011, De Geus et al., 2008, Van Cauwenberg et al., 2012, Craig et al., 2002, Frank et al., 2004).

## 8.2 Discussion and findings from statistical analysis

The statistical analysis assumes that students' active travel behavior is dependent on different socio-demographic and environmental and trip factors. Keeping in mind this assumption, through several logistic regression models, this study reveals that depending on different trip purposes there are multiple factors affecting student active mode choice behavior (cf. Table 8-1). In this regard, factors classified based on different active transport mode is given in Table 8-2. Among these factors some of them are same for all trip purposes, however, with different types of impacts. On the other hand some of them are only significant for particular trip purpose. For example, housing type (Students dormitory) is positively affecting the walk trip to the university, but, negatively the cycle trip to shop. Furthermore, ethnicity negatively affects the walk trip, which is also linked to the housing type, where the students are residing, evident in the spatial analysis. Similarly, higher age positively affects walk trips but negatively affects public transport trips. Here, the reason could be the age limit of Tag card discount. Moreover, gender and bicycle ownership are significant factors for all trip purpose, where bicycle ownership apparently positively affect cycle trip and negatively affect the walk trip as well as public transport trip. Also, significant differences are found from the gender influences on different trip purposes. It is observed that male students are more motivated towards walk trip and public transport use, whereas female students show higher inclination for cycle trip. More interestingly, students study level exhibits that higher education negatively affect the propensity to walk trip, which supports gradual sedentary behavior of students. Moreover, car ownership is negatively associated with cycle trips and the effect is similar for trips to shop, office, and university. Also, higher body mass index is positively associated with students' active transport behavior, particularly walking.

Among the travel factors considered in this study, students preferred mode choice is positively associated with trips by public transport, but negatively associated with walking. It gives a hint about young adults less inclination for walking and cycling, which reveals students more sedentary behavior. Similarly, distance is negatively affecting walk trip, that is supporting the finding from spatial analysis, and positively affecting public transport use. It reinforces the recommendation from spatial analysis about necessities of public transport service area coverage for the promotion of active movement. Also, availability of alternative modes of transportation (walking, cycling, and car) negatively affect the use of public transportation. But, it does not explain that whether the alternative option is car or any other active means of transportation, which call for further investigation.

Like the socio-demographic and travel factors, different environmental factors are also substantially related with active travel behavior of young adults. Poor perception about driving facilities in the neighborhood is positively influencing walking behavior for trip to shops or offices. Similarly, higher satisfaction with pedestrian facilities has positive influence (as lower satisfaction is negatively associated with cycle use) on active transport uses, particularly cycle use, since pedestrian and cycle users share a common interest. Besides, poor perception about traffic safety and neighborhood non-residential facilities are negatively associated with walking behavior and positively with public transport uses. Therefore, traffic safety and pedestrian facilities in the neighborhood are demanding further attention in this regard. Meanwhile, poor perception about crime safety in the neighborhood does not preclude students from walking or from public transport use; however, negative effect is found for cycle uses and walking only for leisure trips. Therefore, the crime could be more associated with cycling or time of performing each trip, as most of the trips to university, shops and offices incurred within working hours of weekdays, whereas leisure trips often takes place at night or weekend. Moreover, importance of social interaction with neighbor is justified, as, poor perception of social interaction increases public transport trips than

walking and cycling. Also, it is worth to mention that satisfaction with facilities often does not reflect people’s actual mode choice behavior. As, in terms of cycling facilities in the neighborhood, compared to those who are highly satisfied with available cycling facilities, show lower propensity to choose cycle as a means of transport for commuting purposes. Instead, students who are less satisfied and moderately satisfied show higher probability of cycling. Similarly, poor perception about neighborhoods aesthetic quality is positively affecting the walking and cycling behavior for different trip purposes. Therefore, satisfaction level is more subjective that often does not coincide and reflect the actual behavior.

Table 8-1: Significant factors affecting active travel behavior of different trip purpose

	Trip to university	Trip to shop	Trip to administrative office	Trip to leisure activity
Potential factors motivating or restricting active transport mode choice of young adult studying in university	<ul style="list-style-type: none"> <li>•Ethnicity</li> <li>•Gender</li> <li>•Housing type</li> <li>•Bicycle ownership</li> <li>•Car ownership</li> <li>•Affiliation with the university</li> <li>•Preferred mode choice</li> <li>•Time required to make each trip to university</li> <li>•Perception about neighborhood pedestrian facilities</li> <li>•Perception about neighborhood cycling facilities</li> <li>•Perception about neighborhood Crime safety</li> <li>•Perception about neighborhood traffic safety</li> <li>•Aesthetic quality in neighborhood</li> </ul>	<ul style="list-style-type: none"> <li>•Present study level</li> <li>•Age</li> <li>•Gender</li> <li>•Housing type</li> <li>•Bicycle ownership</li> <li>•Car ownership</li> <li>•Preferred mode</li> <li>•Alternative available mode</li> <li>•Perception about neighborhood cycling facility</li> <li>•Perception about neighborhood driving facilities</li> <li>•Perception about neighborhood crime safety</li> <li>• Perception about neighborhood traffic safety</li> <li>•Aesthetic quality in neighborhood</li> <li>•Perception about neighborhood non-residential facilities</li> </ul>	<ul style="list-style-type: none"> <li>•Present study level</li> <li>•Age</li> <li>•Gender</li> <li>•Bicycle ownership</li> <li>•Car ownership</li> <li>•BMI</li> <li>•Time required to make each trip to office</li> <li>•Perception about neighborhood pedestrian facilities</li> <li>•Perception about neighborhood cycling facilities</li> <li>•Perception about neighborhood driving facilities</li> <li>•Perception about neighborhood crime safety</li> <li>•Perception about neighborhood traffic safety</li> <li>•Perception about neighborhood cycling safety</li> <li>•Aesthetic quality in neighborhood</li> </ul>	<ul style="list-style-type: none"> <li>•Age</li> <li>•Gender</li> <li>•Housing type</li> <li>•Bicycle ownership</li> <li>•BMI</li> <li>•Preferred mode</li> <li>•Perception about neighborhood pedestrian facilities</li> <li>•Perception about neighborhood cycling facilities</li> <li>•Perception about neighborhood driving facilities</li> <li>•Perception about neighborhood Crime safety</li> <li>•Perception about neighborhood traffic safety</li> <li>•Aesthetic quality in neighborhood</li> <li>•Perception about neighborhood nonresidential facility</li> <li>•Neighborhood social interaction</li> </ul>

Source: Chapter 6 (cf. Table 6-1, Table 6-2, Table 6-3, Table 6-4, Table 6-5, Table 6-6, Table 6-7, Table 6-8, Table 6-9)

Table 8-2: Significant factors affecting mode choice behavior

Trip by walk		Trip by cycle		Trip by public transport	
Present study level (Master's)	-	Gender (Male)	-	Affiliation with university (IGA and IUG)	-
Age	+	Housing type (Students dormitory)	-	Present study level (Master's)	+
Gender (Male)	+	Bicycle ownership	+	Age	-
Ethnicity (Native students)	-	Car ownership	-	Gender	+
Housing type (Students dormitory)	+	Poor perception about pedestrian facility	-	Housing type (Students dormitory)	+
BMI	+	Poor perception about cycling facility	+	Bicycle ownership	-
Bicycle ownership	-	Poor perception about crime safety	-	Preferred mode choice	+
Preferred mode	-	Poor perception about traffic safety	+	Total time required to make each trip	+
Total time required to make each trip	-	Poor perception about neighborhood beautification	+	Poor perception about pedestrian facility	+
Poor perception about driving facility	+			Poor perception about cycling facility	-
Poor perception about crime safety	+			Poor perception about crime safety	+
Poor perception about traffic safety	-			Poor perception about non-residential facilities	+
Poor perception about non-residential facilities	-			Poor perception about neighborhood aesthetic quality	-
Poor perception about neighborhood aesthetic quality	+			Poor perception about neighborhood social interaction	+

Source: Chapter 6 (cf. Table 6-1, Table 6-2, Table 6-3, Table 6-4, Table 6-5, Table 6-6, Table 6-7, Table 6-8, Table 6-9)

### 8.3 Analysis of alternative intervention

The developed framework for active transportation, using of multidimensional interventions explained in different studies, is used for the analysis of the city of Grenoble to understand city's motivation regarding active transportation. The framework contains three different strategies, i.e., structural, management and spatial planning approach. In case of Grenoble, three types of strategies are already adopted though different types of interventions. The findings show that along with different structural improvements and spatial planning policies, management related interventions are also prioritized in this city. Therefore, at the city scale, the framework supports the recommendation of ongoing investigations related to the promotion of active transportation. Despite having so many potentialities of such implementation of multiple interventions, from the ground observation and students' opinion some weaknesses and gaps are also revealed. Even though, there are different types of structural interventions adopted in the city, however, higher concentrations of such facilities are concentrated at the city center. The peripheral area,

does not exhibit the similar attraction and brilliance. Also, some places are identified where facilities, as for instances, bike parking or provision for bike stands, to support cycling are not in an adequate amount. From students' opinion, the similar result is found, as, they demanded for more cycling facilities to promote active transportation in Grenoble. In the face to face interview one of the students made a comment-

*“des pistes cyclable plus larges”*

Furthermore, there is a need for more street amenities and facilities for pedestrian, as, they are less mobile and have higher interaction with the environment than cycle users.

Similarly, land use mix is dominant at the city center compared to other places. Even though, the city maintains a minimum mix use development all around the city as well as along the street side, yet in terms of leisure activity, facilities are still concentrated at the city center or outside of Grenoble. One of the students alleged that-

*“...Eh bien, C'est difficile de trouver les loisirs dans mon quartier, je doit aller au centre Ville pour voir mes amis. De plus, les équipements sportifs sont tous au centre ou à la campus”*

Therefore, further investigation about student's necessities and land use mix is necessary to promote more activities and active movements among the students.

Apart from these structural and spatial interventions, in terms of managerial approach, lots of transitions are observed after the development of métropole. Comprehensive land use plan is under process for the métropole which is important for better integration at the métropole scale. It is noteworthy to mention, the plan for non-motorized vehicle is part of the holistic mobility plan and which is a part of overall holistic land use plan. Such integration is an exemplary attempt and requires further evaluation to affirm as a recommended way for other cities. Besides, the land use management, institutional integration and collaborations are found. However, collaborative research by health researcher and urban planner is yet to come.

Also, for traffic and safety management different plan and policies and laws are adopted (like Cœur de Ville Cœur de Métropole, speed limit, Laure, éducol etc.). However, as traffic calming and pedestrian oriented projects are concentrated at the center, attention is necessary for the other places in or around the city. At the same time, special rules for car parking are not observed, as, many students complained against the car parking here and there. One of the students comments in the face to face interview that-

*“Ce me dérange de voir les voitures qui s'arrêtent dans la piste cyclable, mais on peut le voir tout le temps et partout”*

Therefore, for safety and traffic management, additional attention is necessary to restrict the abrupt car parking and ensure better safety for pedestrians and cyclists.

For the time and cost management online trip plan apps are available which only incorporate existing public transport facilities. However, from students' perception and observation, it is suggested for pedestrian short-cut map, or signage for shortest route (pedway) or particular apps for pedestrian showing shortest route could be useful in promoting more walk trip. Also, several programs are arranged for the promotion of active transportation, however, to internationalize these program non-native students demand for such program at-least a subtitle in English and advertisement both in English and French. Furthermore, a suggestion for community level green movement arose during the face to face interview to accelerate the attempt to increase more active movement. This suggestion is also found in the study of Ho et al. (nd).



#### **8.4 Conclusion**

Due to changes in life style and contemporary way of living, young adults are far behind from a healthy way of living. This pattern of lifestyle is reflected in their adulthood too and becomes more prone to health related chronic diseases. Therefore, it is important to think about active lifestyle of young adults. In this regard, active transport behavior is undeniably an important adaptation to attain an active lifestyle. Through this study, it is identified that land use mix and diversity of destinations are important spatial attributes to promote active travel behavior among young adults. Also, it is statistically elicited that different socio-demographic, travel and environmental factors are either positively or negatively affecting students active travel behavior. Among these factors, housing type, age, BMI, availability of different neighborhood facility (pedestrian, cycling facility, on residential facility) positively affect the active mode choice. On the other hand, car ownership, total time required to make each trip as well as some neighborhood factors (Traffic safety, social interaction in the neighborhood, driving facility etc.) negatively influence the active travel behavior. Furthermore, in case of Grenoble, multi-level strategies are adopted to promote active transport movements. Some of the interventions are vivid and exemplary, whereas some interventions still need further study and evaluation. However, through the incorporation of students views in this regard, some gaps and weaknesses are identified that need to be addressed. Moreover, the aim of first objective, to explore the association between active transport behavior of young adults and different socio-demographic, travel, and environmental factors, is accomplished through spatial and statistical analysis. At the same time, the second objective, to analyze the alternative improvement measures adopted in the city of Grenoble, is fulfilled through the evaluation of the alternative interventions with respect to the developed framework and from the opinion of young adults studying in university. Therefore, this research justifies the importance of young adults' life stage for the promotion of active transportation and potentiality of their participation in research work

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## Appendix A

Table: Coordination Schema

Objective	Variables	Collection method	Outcome
To analyze the travel behavior of active transport user going to university as well as in the stage of emerging adulthood through spatial mapping and statistical analysis	Socio-demographic, travel and environmental factors based on the conceptual framework developed by the concept of Theory of Triadic influence established by Flay & Petraitis (1994)	Online questionnaire survey and face to face interview. (Primary data)	Major factors and their significance in affecting the active travel behavior of young adult
To analyze the potentiality of alternative improvement measures through the development of a comprehensive framework to augment future active transport use in case of Grenoble including the perspective of young adult	Potential interventions adopted in different countries and students perception and opinion about those strategies	Literature review, online and face to face questionnaire survey, ground observation (Primary and Secondary data)	Potentiality of active transport interventions adopted in Grenoble and gaps in those intervention from the perspective of future geographer, planner and architect

Source: Prepared by author, 2017

## Appendix B

Online and face to face questionnaire format

Title: Questionnaire pour le travail de mémoire Master2/Questionnaire for master's thesis

1. Affiliation pour vos études/Affiliation with the university
  - IUG
  - IGA
  - ENSAG
2. Votre niveau d' études actuel/Present study level
  - Licence/Bachelor
  - Maîtrise/Master's
  - PhD
  - Post Doc
3. Quels sont les types de déplacements que vous faites dans une semaine ordinaire?/What are the types of journey that you make in an ordinary week?
  - Déplacements a l'université (1)/Trips to University (1)
  - Déplacements d'achats (au magasin) (2)/Trips to shopping or Grocery(2)
  - Déplacements administratifs (ex. banque, poste, assurances, administration)(3)/ Trip to office like bank, insurance or other administrative space(3)
  - Déplacements pour des activités de loisirs (sport, culture, amis) (4)/Trip to leisure activity(4)
  - Déplacements au travail Autre/Other
4. Pour le déplacement à l'université : Indiquez le(s) mode(s) que vous utilisez et celui/ceux qui vous sont disponible(s) / Point the mode(s) that you use and those which is/are available to be used for trip to university

	Bus	Tram	Voiture/ Car	Marche a pied/Walk	Veto/Cycle	Autre/Other
Mode utilisé pour le déplacement à l'université/Mode for trips to university						
Si vous devez utiliser plus d'un mode/If you have to use more than one mode						
Autre mode disponible pour un déplacement à l'université/other mode available						
Si plus d'une option est disponible/If there is more than one option available						
Votre mode préféré à cette fin/Your preferred mode for this purpose						
5. Pourquoi avez-vous choisi ces modes pour le déplacement à l'université? (Max 3 réponses)/Why did you choose those mode for trip to university?(Choose the most suitable three options)
  - Moins coûteux parmi les modes disponibles/Less costly than other mode

- C'est le mode le plus rapide/It is the quickest mode
- Il est le plus commode à partir du lieu d'origine/It is the most convenient from the place of origin
- Il est le plus sûr parmi les options disponibles/It is the safest one among the other option
- C'est le plus confortable/It is most comfortable
- Ce mode correspond à mon statut/This mode match with my status
- Pour ma propre indépendance et mon plaisir/For own personal independence and enjoyment
- Il est bon pour la santé aussi bien que pour l'environnement/It is good for health as well as environment
- Autre/Other

6. Fréquence de déplacement à l'université par semaine/Frequency of trip to university per week:  
 .....

7. Durée de déplacement à l'université en minute/Requires time for each trip to university in minute:  
 .....

8. Pour les déplacements d'achats (au magasin): Indiquez le(s) mode(s) que vous utilisez et celui/ceux qui vous sont disponible(s) / Point the mode(s) that you use and those which is/are available to be used for trip to shop or grocery

Bus	Tram	Voiture/ Car	Marche à pied/Walk	Vélo/Cycle	Autre/Other
-----	------	-----------------	-----------------------	------------	-------------

---

Mode utilisé pour le déplacement à d'achats au magasinage ou à l'épicerie/Mode for trips to shopping or grocery

---

Si vous devez utiliser plus d'un mode/If you have to use more than one mode

---

Autre mode disponible pour un déplacement au magasinage ou à l'épicerie /other mode available

---

Si plus d'une option est disponible/If there is more than one option available

---

Votre mode préféré à cette fin/Your preferred mode for this purpose

---

9. Pourquoi avez-vous choisi ces modes pour le déplacement d'achats (au magasinage ou à l'épicerie)? (Max 3 réponses)/Why did you choose those mode for trip to shop or grocery?(Choose the most suitable three options)

- Moins coûteux parmi les modes disponibles/Less costly than other mode
- C'est le mode le plus rapide/It is the quickest mode

- Il est le plus commode à partir du lieu d'origine/It is the most convenient from the place of origin
- Il est le plus sûr parmi les options disponibles/It is the safest one among the other option
- C'est le plus confortable/It is most comfortable
- Ce mode correspond à mon statut/This mode match with my status
- Pour ma propre indépendance et mon plaisir/For own personal independence and enjoyment
- Il est bon pour la santé aussi bien que pour l'environnement/It is good for health as well as environment
- Autre/Other

10. Fréquence de déplacement d'achats par semaine/Frequency of trip to shop or grocery per week:

.....

11. Durée de déplacement d'achats en minute/Requires time for each trip to university in minute:

.....

12. Pour les déplacements administratifs (ex. banque, poste, assurances, administration): Indiquez le(s) mode(s) que vous utilisez et celui/ceux qui vous sont disponible(s) / Point the mode(s) that you use and those which is/are available to be used for trip to administrative purpose (ex. bank, post, insurance etc.)

Bus	Tram	Voiture/ Car	Marche à pied/Walk	Vélo/Cycle	Autre/Other
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---

Mode utilisé pour le déplacement dans des bureaux/Mode for trips to office

---

Si vous devez utiliser plus d'un mode/If you have to use more than one mode

---

Autre mode disponible pour un déplacement dans des bureaux /other mode available for trips to office

---

Si plus d'une option est disponible/If there is more than one option available

---

Votre mode préféré à cette fin/Your preferred mode for this purpose

13. Pourquoi avez-vous choisi ces modes pour le déplacement administratifs (ex. banque, poste, assurance, administration)? (Max 3 réponses)/Why did you choose those mode for trip to office (bank, post, insurance and other administrative spaces)?(Choose the most suitable three options)

- Moins coûteux parmi les modes disponibles/Less costly than other mode
- C'est le mode le plus rapide/It is the quickest mode

- Il est le plus commode à partir du lieu d'origine/It is the most convenient from the place of origin
- Il est le plus sûr parmi les options disponibles/It is the safest one among the other option
- C'est le plus confortable/It is most comfortable
- Ce mode correspond à mon statut/This mode match with my status
- Pour ma propre indépendance et mon plaisir/For own personal independence and enjoyment
- Il est bon pour la santé aussi bien que pour l'environnement/It is good for health as well as environment
- Autre/Other

14. Fréquence de déplacements administratifs par semaine/Frequency of trip to office per week:

.....

15. Durée de déplacements administratifs en minute/Requires time for each trip to office in minute:

.....

16. Pour les déplacements pour des activités de loisirs (sport, culture, amis): Indiquez le(s) mode(s) que vous utilisez et celui/ceux qui vous sont disponibles / Point the mode(s) that you use and those which is/are available to be used for trip to administrative purpose leisure activity

Bus	Tram	Voiture/ Car	Marche à pied/Walk	Vélo/Cycle	Autre/Other
-----	------	-----------------	-----------------------	------------	-------------

---

Mode utilisé pour le déplacement pour des activités de loisirs /Mode for trips to leisure activity

---

Si vous devez utiliser plus d'un mode/If you have to use more than one mode

---

Autre mode disponible pour un déplacement dans des bureaux /other mode available for trips to office

---

Si plus d'une option est disponible/If there is more than one option available

---

Votre mode préféré à cette fin/Your preferred mode for this purpose

17. Pourquoi avez-vous choisi ces modes pour votre déplacement de loisirs (sport, culture, amis)? (Max 3 réponses)/Why did you choose those mode for trip to office (bank, post, insurance and other administrative spaces)?(Choose the most suitable three options)

- Moins coûteux parmi les modes disponibles/Less costly than other mode
- C'est le mode le plus rapide/It is the quickest mode
- Il est le plus commode à partir du lieu d'origine/It is the most convenient from the place of origin

- Il est le plus sûr parmi les options disponibles/It is the safest one among the other option
  - C'est le plus confortable/It is most comfortable
  - Ce mode correspond à mon statut/This mode match with my status
  - Pour ma propre indépendance et mon plaisir/For own personal independence and enjoyment
  - Il est bon pour la santé aussi bien que pour l'environnement/It is good for health as well as environment
  - Autre/Other
18. Fréquence de déplacement pour des activités de loisirs (sport, culture, amis) par semaine/Frequency of trip to leisure activities per week:  
.....
19. Durée de déplacement pour des activités de loisirs (sport, culture, amis) en minute/Requires time for each trip to leisure activity:  
.....
20. (Personnes qui utilisent la marche à pied / Only applicable for those who are making trip with walking) Quels sont les facteurs qui vous rendent difficile la marche? /What are the factors make you feel uncomfortable while walking? max 3 points
- Les emplacements sont loin/locations are quite far
  - Accidents de la route/Traffic collision
  - Manque de sécurité la nuit/Lack of security at night
  - Peur de harcèlement et d'abus/ Chance of harassment and abuse
  - Manque d'aménagements pour la marche à pied et de mobilier urbain (ex. banc, zone piétonne)/lack of walking facilities and street furniture
  - Les trottoirs comportent de nombreux obstacles et les passages piétons sont mal sécurisés /Sidewalks have many obstacles and crosswalks are dangerous
  - Stationnement fréquent sur les trottoirs /Frequent car parking on road
  - Etat de trafic (ex. charge)/Road side condition (Covered and calm)
  - Pollution de l'air et le bruit/ air and noise pollution
  - Regard des autres, normes et représentations sociales/Social status and norms like work environment, stereotype attitude, discouraging options of others
  - Météo défavorable (neige, froid, pluie, vent, soleil)/Do not like to walk in winter and rainy day
21. Si vous ressentez d'autres problèmes, indiquez-les/If your case is different from the given option, you can explain  
.....
22. (Question à toutes les personnes qui se déplacent / Question concerning all mode users) Selon vous, quelles seraient les améliorations utiles pour les déplacements à marche à Grenoble? /What type of improvement do you think would be worthwhile to increase more walking trip in Grenoble?

	Yes	No
Trottoir piétonnier plus large et continu/Wider and continuous pedestrian sidewalk		
Fourniture d'installations piétonnes		



	Yes	No
adéquates ex: aménagement assis, centre-ville, traversée/Provision of adequate pedestrian facilities ex: sitting arrangement, center island, raised crosswalk		
Espaces verts le long de la rue/Green element along the street		
Des activités côté rue comme magasin de détail, restaurant, environnement récréatif/Promotion of street side activity like retail shop, restaurant, Recreational environment		
Équipements de la rue (signal, lampe, poubelle, signalisation, façade)/street amenities (Signal, lamp, trashcan, Signage, façade design)		
Initiative d'apaisement du trafic/Traffic calming initiative		
Priorité du piéton à l'intersection ex Lumière pédiatrique/Priority of Pedestrian at intersection ex. pelican light		
Initiative Green Travel ex. Green Club pour enseigner aux étudiants marcher/Green travel initiative ex. green club to teach student to walk		
Éducation et formation pour promouvoir la marche/Education and training to promote walking		
Sécurisation par forces de l'ordre/law enforcement		

23. Si vous pensez à d'autres améliorations, indiquez-les/If your case is different from the given option, you can explain

.....

24. (Personnes qui utilisent le vélo / Only applicable for those who are cycling)Quels sont les facteurs qui vous rendent difficile le déplacement à vélo? /What are the factors make you feel uncomfortable while cycling? max 3 points

- Accidents de la route/Traffic collision
- Manque de sécurité la nuit/Lack of personal security at night
- Vol de vélo/Bicycle stealing rate

- Peur de harcèlement et d'abus/ Chance of harassment and abuse
  - Manque d'aménagements de velo (ex piste cyclable, place de stationnement pour velos)/ lack of facilities for bicycle user
  - Pollution de l'air et le bruit/ air and noise pollution
  - Etat de trafic (ex. chargé)/ Road side condition (Covered and calm)
  - Regard des autres, normes et représentations sociales/Social status and norms like work environment, stereotype attitude, discouraging options of others
  - Météo défavorable (froid, pluie, vent)/ Do not like to use bicycle in winter and rainy day
25. Si vous ressentez d'autres problèmes, indiquez-les/If your case is different from the given option, you can explain
- .....

26. (Question à toutes les personnes qui se déplacent / Question concerning all mode users) Selon vous, quelles seraient les améliorations utiles pour les déplacements à vélo Grenoble? /What type of improvement do you think would be worthwhile to increase more bicycle trip in Grenoble?

	Yes	No
Aménagement en pistes cyclables/Provision of bicycle track		
Piste cyclable avec des "tourner à droite" facilités /Bike lane with provision for right turning cycle		
Priorité du cycliste à l'intersection/Priority of bicycle rider at intersection		
Diversité des pistes cyclables: Itinéraires à vélo sur route, pistes cyclables marquées sur route et pistes cyclables tout terrain, piste protégées de la route/Mixity of diversified bike route ex. on-road bike routes, on-road marked bike lanes, and off-road bike paths, recessed track)		
Réduction du stationnement sur chaussée/Reduction of on street parking		
Réduction de la densité d'intersection/Reduction of intersection density		
Aménagement adéquat des équipements de rue (Signal, lampe, poubelle, signalisation, façade)/Provision of street amenities (Signal, lamp, trashcan, Signage, façade design)		
Activités de la rue comme magasin de détail, restaurant, environnement récréatif/Street side activity like retail shop, restaurant, Recreational environment		
Initiative d'apaisement de la circulation ex. Piste cyclable sans circulation/Traffic calming initiative ex. Traffic free bicycle path		
Événements promotionnels comme course à vélo ou journée de vélo/Promotional event like bike racing or bike day		
Les installations de vélo comme le parc de vélo, le magasin de réparation et d'entretien de vélo, la disponibilité de magasin de location de vélo à bas prix/Biking facilities like bike park, bike repair and maintenance shop, availability of low cost bike renting shop		
Éducation et formation pour promouvoir cyclisme /Education and training to promote cycling		
Sécurité assurée par des forces de l'ordre/law enforcement		

27. Si vous pensez à d'autres améliorations, indiquez-les/If your case is different from the given option, you can explain

.....

28. Perception du quartier ou de l'espace urbain alentours/Perception about Neighborhood or local area

Not satisfied      Moderately satisfied      Very satisfied

- 
- Disponibilité des aménagements pour piétons/Availability of pedestrian facilities
- 
- Disponibilité des aménagements cyclables/Availability of cycling facilities
- 
- Disponibilité des aménagements de transport en commun/Availability of public transit facilities
- 
- Disponibilité des aménagements pour voiture/Availability of driving facilities
- 
- Disponibilité des espaces ouverts et pares/Availability of green spaces and park
- 
- Sécurité personnelle /Crime safety
- 
- Sécurité routière/Traffic safety
- 
- Proximité des espaces non résidentiels/Proximity of non-residential land uses
- 
- Esthétique/Aesthetic Interaction
- 
- Sociale avec le voisinage/Social interaction with the neighbor
29. Date de naissance/Date of Birth (Example: December 15, 2012)  
 .....
30. Sexe/Gender
- Homme/Male
  - Femme/Female
31. Hauteur en mètre/Height in meter.....
32. Poids en kg/Weight in kg .....
33. Quel est votre type de revenu actuel?/What is your current income status?
- une bourse/I have scholarship
  - Je dépends de mes parents/I am dependent on my parents
  - J'ai un emploi à temps partiel/I have part-time job
  - J'ai un emploi à plein temps/ I have full-time job
  - Autre/Other
34. Nationalité/Nationality .....
35. Type de logement/Housing Type
- Propriétaire/Owner occupied
  - Location privée/private rental
  - Résidence universitaire/University dormitory
36. Avez-vous des bicyclettes?
- Yes
  - No
37. Propriétaire de la voiture/Car Ownership
- Yes
  - No
38. Permis de conduire/Driving license
- Yes
  - No

## Appendix C

Additional questions asked in face to face interview

1. Pouvez-vous marquer sur la carte, l'emplacement approximatif où habitez-vous? /Can you mark on the map, the approximate location where do you live?
2. Pouvez-vous marquer sur la carte, les endroits approximatifs où allez-vous pour faire du shopping ou de l'épicerie? /Can you mark on the map, the approximate locations where do you go for shopping or grocery?
3. Pouvez-vous marquer sur la carte, les endroits approximatifs où vous allez pour le travail administratif (comme banque, poste, assurance, CAF)? /Can you mark on the map, the approximate locations where do you go for administrative work (like bank, post, insurance, CAF)?
4. Pouvez-vous marquer sur la carte, les endroits approximatifs où vous partez pour les loisirs? /Can you mark on the map, the approximate locations where do you go for leisure activities?
5. Pour ceux qui utilisent la voiture pour un de ces objectifs, pourquoi choisissez-vous la voiture parmi les solutions de rechange disponibles? /For those who are using car for any of this purpose, why you are choosing car among the alternatives available to you?

## Appendix D

Table: Key explanatory variables and corresponding coding from questionnaire (cf. Appendix B)

<b>Socio-demographic factor</b>	
Affiliation with the university	1. IUG 2. IGA 3. ENSAG
Present study level	1. Master's 0. Bachelor
Age	Exact age in year
Gender	1. Male 0. Female
Ethnicity	1. Native 0. Non-native
Housing type	1. Private rental Student dormitory 0.
Bicycle ownership	1. Yes 0. No
Car ownership	1. Yes 0. No
Driving license	1. Yes 0. No
Current income status	1. Dependent on parents 0. Not entirely dependent on parent
BMI	Calculated from height and weight of the students
<b>Travel factors</b>	
Other alternative mode available	1. Other alternative mode available 0. There is no other alternative mode available
Preferred mode for particular purpose	1. If the chosen mode is different to the preferred mode 0. If the chosen mode is same to the preferred mode
Trip frequency (in a week)	Number of trip per purpose accomplished by the students in an ordinary week
Trip duration (per trip)	Total duration (in minute) of each trip for particular trip purpose
<b>Environmental factor</b>	
Perception about existing pedestrian facilities (in neighborhood)	1. Not satisfied 2. Moderately satisfied 3. Very satisfied
Perception about existing cycling facilities (in neighborhood)	1. Not satisfied 2. Moderately satisfied 3. Very satisfied
Perception about existing public transport facilities (In neighborhood)	1. Not satisfied 2. Moderately satisfied 3. Very satisfied
Perception about existing driving facilities (in neighborhood)	1. Not satisfied 2. Moderately satisfied 3. Very satisfied
Perception about existing green spaces and park(in neighborhood)	1. Not satisfied 2. Moderately satisfied 3. Very satisfied
Perception about existing crime safety (in neighborhood)	1. Not satisfied 2. Moderately satisfied 3. Very satisfied
Traffic safety (in neighborhood)	1. Not satisfied 2. Moderately satisfied 3. Very satisfied
Perception about existing available non-residential facilities (in neighborhood)	1. Not satisfied 2. Moderately satisfied 3. Very satisfied
Perception about existing available beautification (in neighborhood)	1. Not satisfied 2. Moderately satisfied 3. Very satisfied
Perception about existing social interaction with the neighbor(in neighborhood)	1. Not satisfied 2. Moderately satisfied 3. Very satisfied

Source: Prepared by author, 2017