The Campus Effect: built environment, physical activity and active transportation behaviors of the Kansas State University Students, Faculty, and Staff in 2008 and 2016

by

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Abstract

Introduction: Transportation-related physical activity can help adults can meet moderate physical activity guidelines. Only 52% of United States adults meet the physical activity guidelines on a regular basis. Active transportation (AT) is a healthier alternative to motorized transport and incorporates more physical activity into one's day. Universities with supportive built environment features, such as pedestrian and bicycling infrastructure and amenities, can support AT choices. This study was conducted to (1) examine differences in the overall physical activity and AT behaviors of university students, faculty and staff in 2008 and 2016; and (2) explore influential factors for transportation choice and perceptions of the campus built environment in 2016. Physical activity and AT behaviors were hypothesized to be greater in 2016 than 2008 due to changes in supportive built environment features on campus. **Methods:** All students, faculty and staff members at Kansas State University's Manhattan campus were eligible to participate in this repeated cross-sectional study by completing a survey in 2008 and 2016. Similar survey questions were asked both years to allow for comparisons. Questions asked about physical activity levels, transportation modes, factors influencing mode choice, and (in 2016) written feedback regarding built environment changes on campus and additional changes needed. After dichotomizing responses by role (students or faculty/staff), independent samples t-tests were used to assess differences in physical activity and transportation modes between survey years. The most influential reasons for transportation mode in 2016 were identified and compared by role. Multiple linear regression models were used to predict variance within each transportation mode. Themes were identified within the written feedback. **Results:** In spring 2016, 1006 participants (815 students, 80 faculty, and 111 staff members) completed the survey. This compared to 800 participants in spring 2008 (368 students, 256 faculty, and 176 staff members). There was a significant difference for greater moderate but not vigorous physical activity for both students and faculty/staff in 2016 than 2008. Days per week of driving, biking, and other transportation were significantly greater for students, while driving, walking, and biking were significantly greater for faculty/staff in 2016 than 2008. For students, linear regression predicted 21.4% of the variance for driving, 14.7% of walking, and 5.4% of biking for transport. Strongest predictors for students were: health benefits ($\beta = -0.27$) and time constraints ($\beta = 0.21$) for driving, traffic congestion ($\beta = 0.19$) and length of time frequenting campus ($\beta = -0.17$) for walking, and safety concerns for crime ($\beta = -0.26$) for biking. For faculty/staff, linear

regression predicted 23.5% of the variance for driving, 70.3% of walking, 29.8% of biking, and 14.0% of other transport. Strongest predictors for faculty/staff were: time constraints (β = 0.34) and health benefits (β = -0.30) for driving, health benefits (β = 0.28) and time constraints (β = -0.55) for walking, environmental concerns (e.g., pollution; β = 0.35) and safety concerns for crime (β = -0.43) for biking, and weather (β = -0.37) for other transportation. From 436 written responses, main themes for AT influences were: construction (n = 174), parking (n = 128), walking (n = 99), and biking (n = 64). From 403 responses for suggestions for improvements on the commute to campus main themes were: bike lanes (n = 85), sidewalks (n = 29), limits of construction (n = 28), and KSU master plan (n = 26). **Conclusions:** Time constraints was a key factor for both students and faculty/staff that positively predicted driving and negatively predicted walking behaviors. Few campus built environment features emerged as key predictive factors. Understanding key influences for transportation-related physical activity and commuting behaviors in a university population are useful for health behavior promotion as well as campus planning. Future research should further study the relationship between mode of transportation and other health behaviors in students, faculty, and staff.

Keywords: Active transportation, built environment, physical activity, college health

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Chapter 1 - Literature Review

Transportation-related physical activity incorporates more activity into one's daily routine and can help reach personal goals, health benefits, and national recommendations. National guidelines for aerobic physical activity recommend 150 minutes of moderate-intensity or 75 minutes of vigorous-intensity physical activity per week or an equivalent combination of both (USDHHS, 2008). Only 52% of adults meet the aerobic physical activity recommendations on a regular basis (CDC, 2017). Approximately 45 percent of adults are not sufficiently active to achieve health benefits (Trust for America's Health and the Robert Wood Johnson Foundation, 2018). To counter the lack of physical activity in adults, the use of non-motorized transportation modes can help meet daily physical activity recommendations.

Various factors influence physical activity behavior, especially in a university setting. Forty to 45% of college students do not meet physical activity recommendations on a regular basis and total physical activity levels decrease the longer they attend a university (Judge, Bellar, et al. 2012). Common measures taken to promote physical activity in a university environment are better recreation facilities, improving the campus built environment, and educating the population on the importance of incorporating activity into daily routines (Institute of Medicine, 2012). Regular participation in moderate and vigorous physical activity is known to be

beneficial for overall health and wellness as well as academic and work performance (AHA, 2015). Those factors are especially important for the university population. For those that do not exercise, transportation-related physical activity allows for more opportunity to meet physical activity recommendations.

Active (non-motorized) transportation refers to human-powered forms of travel such as walking, cycling, skateboarding, etc. (PHAC, 2017). Rates of active transportation vary depending on city infrastructure. Cities not originally designed for citizens to get around locally by walking or biking have higher rates of car dependency to access destinations (Buehler, 2016). To understand what changes can be made to allow for more active transportation, assessments can be taken to see how friendly and supportive an area is toward walking and biking (State of Place, 2017). Community citizens are more likely to be active when the built environment makes it a desirable alternative to motorized transport (King, 2014). In college towns, rates of active transportation are higher for those with closer living proximity to campus (Daisy, N., Hafezi, H., Liu, L., & Millward, H., 2018).

Key factors influencing active commuting for university populations included self-efficacy, environmental concerns, and ecological concerns (Bopp, M., Kaczynski, A, & Wittman, P., 2011). Promoting use of non-motorized transportation can be incorporated into

existing programming for the university population relating to student and employee health, sustainability efforts, and health promotion (Bopp, M., Kaczynski, A, & Wittman, P., 2011). Another method is altering the campus built environment to better facilitate all modes of transit. An effective way to do this is to incorporate the "6 D's" into the planning (density, diversity, design, destination, distance to transit, and demand management). When these factors are considered when improving infrastructure, they are linked to increased transportation physical activity (Ogra, A. N. & Ndbele, R., 2014). Initiatives, such as altering campus planning to account for active transportation modes, positively impact the ability for the university populations to use multimodal transportation.

The built environment refers to "the human made, physical characteristics of our surroundings such as buildings, streets, parks, road systems, and transportation networks" (B.E.A.T, p. 3) When studying transportation behaviors, various street segment-level attributes of the built environment are assessed since they influence people's transport mode choices. Pedestrian-scale infrastructure such as sidewalks, crosswalks, proximity of buildings to the street, lighting, amenities (i.e. benches, bike racks) and aesthetics (i.e. green spaces, landscaping) are factors that influence people's choice to walk in certain areas (Bushell, M.A., Poole, B.W., Zegeer, C.V., & Rodriguez, D.A, 2013). Street-scale infrastructure refers to the features that

influence the motorists (cars, bikes, buses) such as lane features, parking, lighting, street connectivity, intersections, bike lanes, and road density (Bushell, M.A., Poole, B.W., Zegeer, C.V., & Rodriguez, D.A, 2013). The pedestrian and street scale infrastructure features influence the safety and efficiency of transportation networks within cities.

The City of Manhattan, KS is home to Kansas State University (KSU), a population of 28,204 that contributes to half of the city's population of 56,308 (City of Manhattan Kansas, 2018). To accommodate the university population, the city's programs, recreational resources, public transportation and rental housing help to accommodate the needs of the university population (City of Manhattan Kansas, 2018). In addition, planning documents such as the Master Bike Plan, City Plans, and the Complete Streets initiative are in the process of being funded and implemented to transform the community.

Improving the transportation infrastructure of Manhattan, KS can improve the flow of traffic and more efficiently move people from one place to another both on and off campus. Within the past 10 years, the City of Manhattan and Kansas State University (KSU) have both made noticeable changes to the built environment to efficiently facilitate more active forms of transportation. Recent changes include bike boulevards, bike lanes, route connectivity, and safer intersections on and off campus. In addition to environmental changes, road and trail

infrastructure, the local bike sharing program, and public transportation services have been prioritized and improved in the past few years. The allocation of funds to such projects helps promote and support multi-modal transportation, especially for the university population.

For those that bike to and from campus, the city's Master Bike Plan and road and trail infrastructural improvements help increase convenience and safety while decreasing cyclists' commute times. The addition of bike lanes, signage, bike racks, and bike boulevards has made biking a safer and more efficient mode of transportation. As a result of infrastructure changes to support biking, both the city and KSU have received recognition. Manhattan was named a bronze level bicycle-friendly community in 2012 and 2016, one of five communities in the state of Kansas recognized by the League of American Bicyclists (City of Manhattan Kansas, 2018). By receiving this award, Manhattan was recognized for being a community that "encourages people to bike for transportation and recreation through the five Es: engineering, education, encouragement, enforcement, and evaluation" (League of American Bicyclists, 2018). The 5 Es refers to the built environment and how that impacts active transportation. In 2015, KSU was also recognized as a bicycle-friendly university, being the first in the state of Kansas (Bike and Pedestrian Information, 2017). Figure 1.1 highlights the trails and bike boulevards throughout

Manhattan. This is particularly interesting for the University community since it depicts how the city infrastructure supports cycling commutes to and from campus.

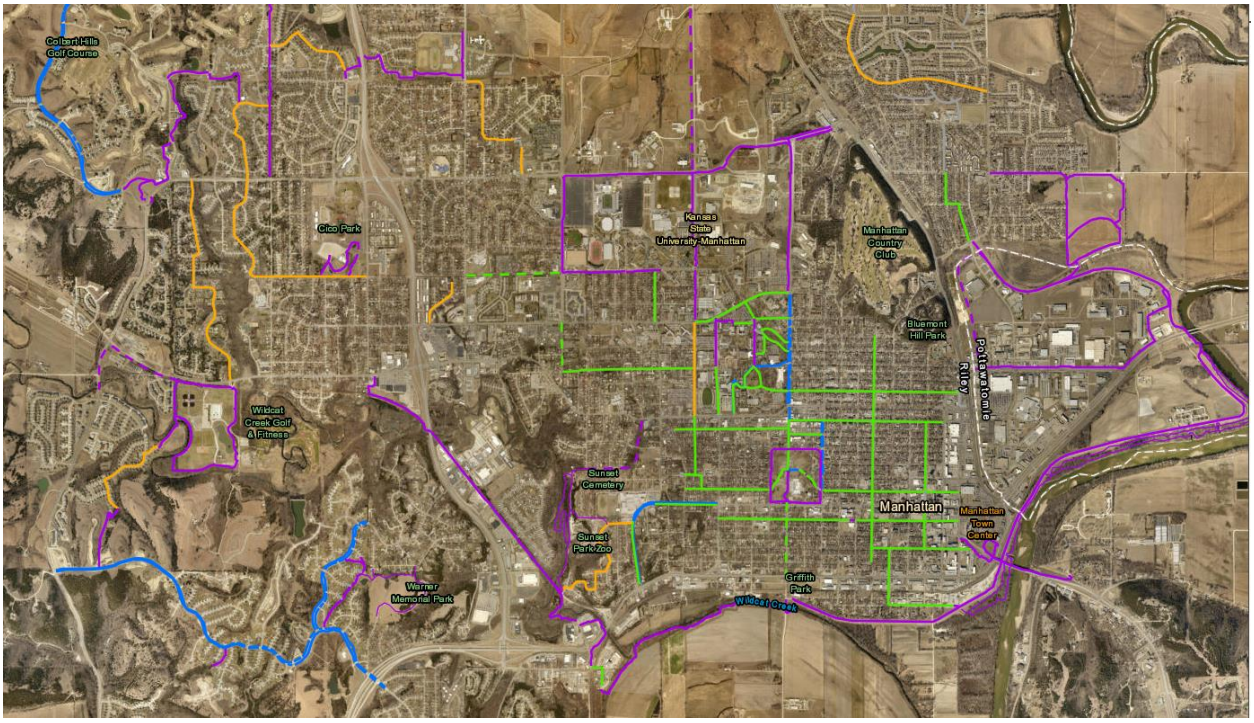

Figure 1.1. Current and future bike boulevard and trail systems in Manhattan, KS

To support all individuals who wish to bike, Green Apple Bikes (GAB) is a local bike share program that is free for anyone to use (GAB, 2018). For maximum availability to all, users are encouraged to use the bike for 4 hours or less and return it to any of the GAB racks. University community members could find a rack close to their residence and ride the bike to

and from campus, if a bike is available for use. This can meet the needs of individuals who do not have access to a car or bike, live too far to walk, or need a faster form of transportation than walking or taking public transportation on some days. In 2016, there were 3 GAB racks on the outskirts of campus (Figure 1.2) and 5 additional racks located in the interior of campus. Numerous GAB bikes and rack locations make biking an appealing and convenient choice for students, staff, and faculty members that live in the area.

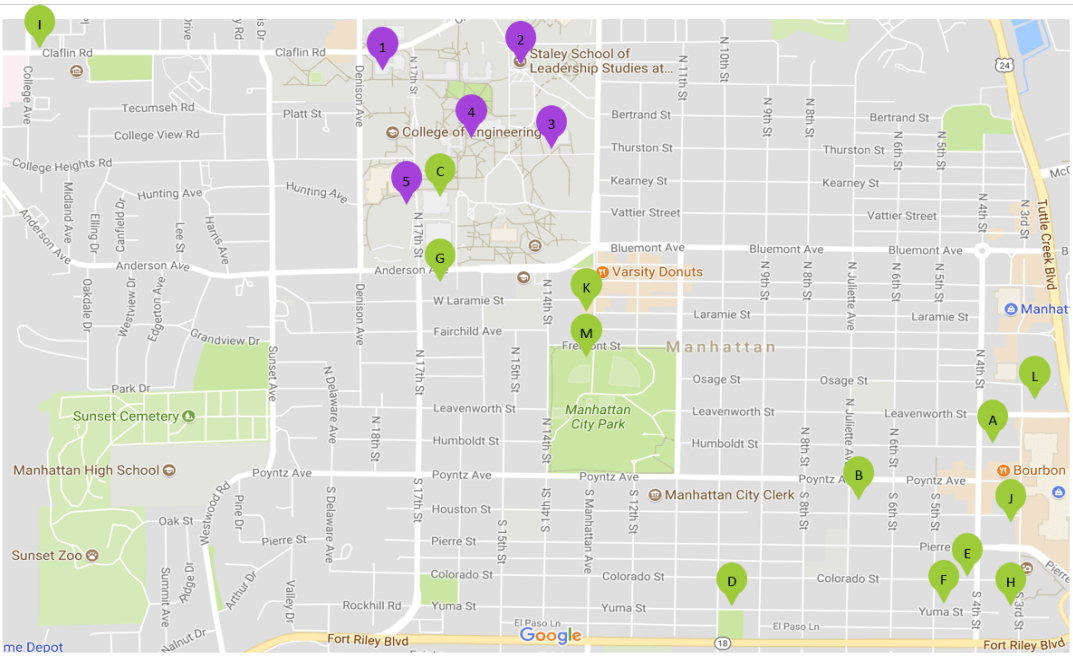

Figure 1.2. Green Apple Bike stations on KSU campus and around Manhattan, KS

The main public transportation system available in the City of Manhattan, KS is the aTa bus service provided by the Flint Hills Area Transportation Agency. KSU students, faculty and staff with current ID ride for free from point to point, with several stops around campus, including the Student Union (Flint Hills Area Transportation, 2018). The route schedule can be found online and rides can be scheduled for those who need rides and cannot conveniently access the fixed routes ((Flint Hills Area Transportation, 2018). Routes are depicted in Figure 1.3. Several routes are dedicated to when KSU is in session so that several stops and routes are more convenient for the university population. Well-developed public transportation services support active transportation and promote mobility within communities (APTA, 2018).

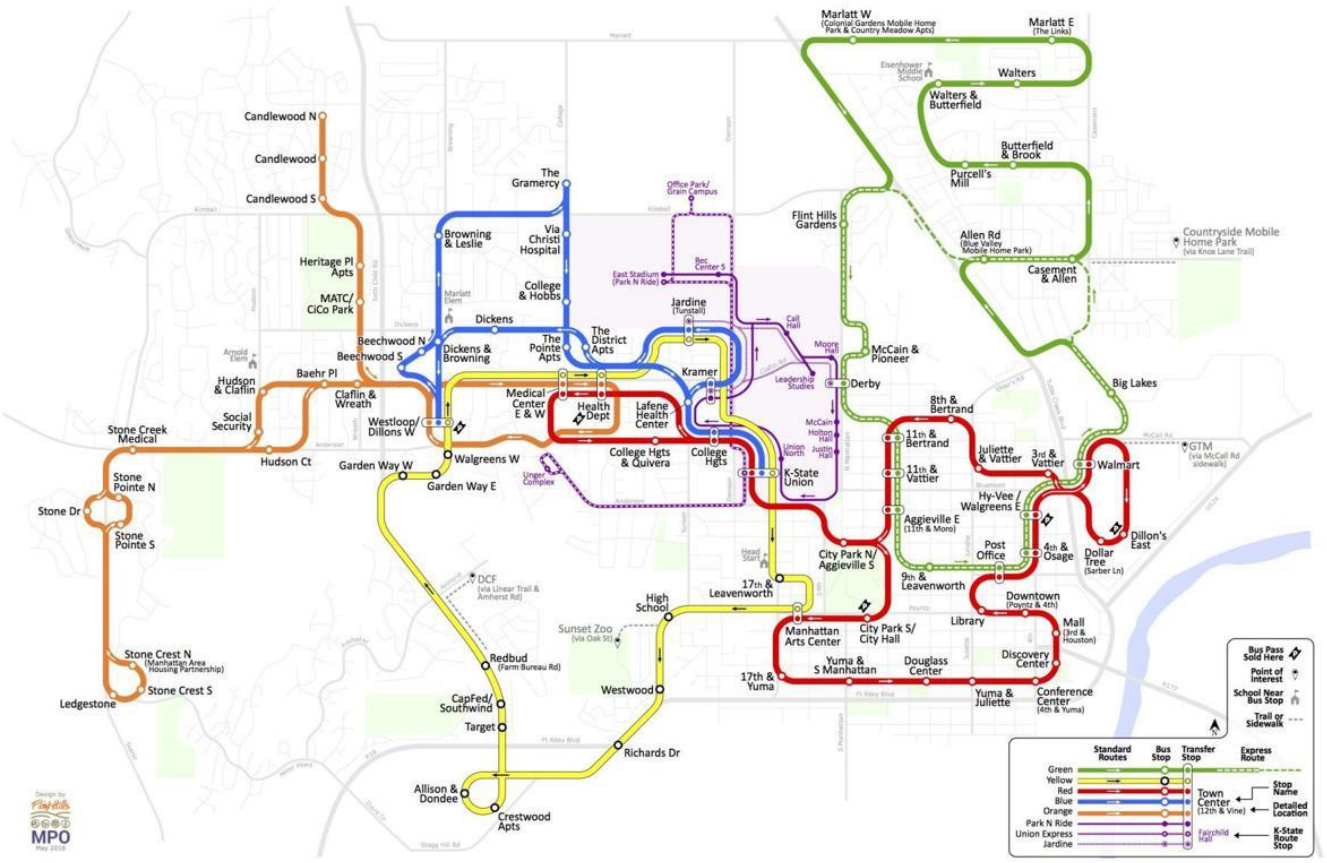

Figure 1.3. aTa Bus routes servicing Manhattan, KS

While alternate/active forms of transportation are gaining popularity, motorized transportation (mainly personal vehicles) is still predominate in the City of Manhattan, KS. Factors influencing motorists include availability of parking in the garage and lots, location of parking lots, parking in neighborhoods and businesses surrounding campus, cost and availability

of parking passes, cost of tickets, and road connectivity (KSU, 2015). These factors influence transportation mode choices students, faculty and staff members who live farther from campus and those coming to the university for programs and events. While the campus transitions to allow for active transportation within and around campus, it will still need to accommodate both motorized and non-motorized transportation modes.

Chapter 2 - Introduction

How supportive the built environment is for multi-modal transportation can influence community behaviors. The K-State 2025 Master Plan is the “university’s strategic plan that describes the aspirations and goals for K-State by 2025” (KSU, 2018). One section of the plan identifies changes to transportation, parking, and perimeter streets as interventions for managing multi-modal transportation on the Manhattan campus, and a section of the Master Plan focuses on improving the built environment of campus to be more supportive of a healthier lifestyle for the students, faculty, and staff. These changes can support healthy choices by promoting active transportation and physical activity. Some supportive changes include: converting inner campus roads to pedestrian malls, improving sidewalk conditions and connectivity, adding and improving crosswalks, and creating additional bike lanes and racks. As a result, the transportation and commuting patterns of the KSU community should change to favor more active lifestyles.

In 2008, a cross-sectional study was conducted among students, faculty, and staff at the Kansas State University (KSU) Manhattan campus to explore factors related to active commuting using a social ecological framework for transportation, commuting, and physical

activity behaviors (Bopp, M., Kaczynski, A, & Wittman, P., 2011). The survey assessed individual-level influences, environmental-level influences, and active commuting patterns (Bopp, M., Kaczynski, A, & Wittman, P., 2011). Main findings included that men and women reported equal active commuting behavior; faculty members actively commuted more often than staff and students actively commuted more than either group; those who lived within 20 minutes walking distance were two times more likely to walk than those who lived further away; those who lived within 20 minutes biking distance were 17 times more likely to bike to campus than those that lived further away; and the 5 most influential reasons for mode of commute were time constraints, weather, other destinations before/ after campus, health benefits, and parking availability (Bopp, M., Kaczynski, A, & Wittman, P., 2011). This thesis project extends the 2008 study with another survey capturing a second "snapshot in time". This allows for the comparison of physical activity and commuting behaviors as well as understanding influential factors for transportation behaviors and perceptions of the campus built environment.

The purpose of this thesis study is two-fold: (1) examine differences in the overall physical activity and active transportation (AT) behaviors of KSU students, faculty and staff in 2008 and 2016; and (2) explore influential factors for transportation choice and perceptions of the campus built environment in 2016. The hypothesis for the first purpose statement is that

overall rates of active transportation and physical activity will be greater for students and faculty/ staff in 2016 than they were in 2008. Awareness of physical inactivity and more resources to promote active lifestyles could lead to an increase in overall physical activity. The hypothesis for the second purpose statement is that changes in the campus built environment, to include more supportive features for AT, will play an influential role in the transportation behaviors of the University population. The idea is that as the built environment becomes friendlier for multi-modal transportation, there will be more individuals choosing active transportation. Accessibility, resources, safety, and desirability of multi-modal transportation can vary from person to person based on how they perceive the built environment. When promoting incorporating more physical activity into one's day, it has to seem like an easy choice. Asking additional, more subjective questions, can provide needed insight for how the KSU population responds to the campus built environment.

Chapter 3 - Methods

Design and Participants

This study used a repeated cross-sectional survey design to study active transportation behaviors of the KSU community. Replicating and extending a 2008 survey by Dr. Bopp and Dr. Kaczynski, the 2016 survey was generated using Qualtrics, an online survey platform that was free for survey creation, participant use, and data analysis. All students, staff, and faculty that frequented the Manhattan campus during the spring semesters of 2008 and 2016 were able to voluntarily complete these surveys. All participants indicated informed consent online before proceeding with the 2016 survey and the study was approved by the KSU Institutional Review Board.

Survey

In total, the 2016 survey had 43 questions and took about 15 minutes to complete (Median = 9 minutes, 90% of participants completed it in 20:34 or less). The 29 survey questions carried over from 2008 covered the following topics: demographics, physical activity participation, modes of transport, distance of commute, frequency of commute, ability to actively commute, and parking choices. Additional topics included in the 2016 survey included use of

various built environment features, changes on campus that influence choice of transportation, and suggestions for further improvements on campus that promote active transportation.

Demographics. Participants first indicated their sex (male or female) and age. They were asked how long they had frequented main campus with options from less than a year to 5 or more years. They indicated their role at KSU as student, faculty, or staff. Students indicated their year from freshman to graduate student.

Physical Activity. A modified international physical activity questionnaire (IPAQ) was used to assess physical activity behaviors (IPAQ, 2016). After being provided definitions and examples for each, participants were asked to indicate "in a usual week" whether or not they had participated in moderate and vigorous physical activities. Those who had, were asked to indicate the number of days per week they had completed those activities for at least 10 minutes at a time as well as how much total time per day they spent doing those activities. These data were used to calculate the total weekly minutes of physical activity, by multiplying the days per week by the time per day for each intensity level. IPAQ data truncation guidelines were used to limit the total amount of each activity to no more than 1260 minutes per week (i.e., 3 hours per day) (IPAQ, 2016).

Transportation Behaviors. Participants were asked to indicate "during a typical week" how many times per week they came to campus in an automobile, by walking, by bicycle, or by other non-motorized transportation (e.g., roller skates, skateboard). Participants were also asked to indicate how long it would take them to walk and bike from their place of residence to campus, with answers ranging from less than 5 minutes to more than 30 minutes.

Factors Influencing Transportation Behaviors. To assess influential factors on choice of transportation, a 5-point Likert scale (from 1 "it is not an important factor" to 5 "it is a very important factor") was used to measure 17 total factors (e.g., time constraints, traffic congestion, weather, terrain, safety, health benefits).

Open-Ended Questions. At the end of the survey, two open-ended questions were asked to receive feedback on changes to the campus built environment, active/alternative transportation, and suggestions on how to improve commuting behaviors.

Procedures

The survey was marketed on-campus for two months prior to opening (i.e., February and March) via flyers, speaking to classes, emails via listservs and within the Kinesiology department, and ads placed in the Collegian and on K-State Today. In April the survey was opened and available campus wide (online and mobile device friendly). To promote more survey

participation, reminder emails were sent out to the listserv along with ads in The Collegian and K-State Today. After being available for month, the survey was terminated in May. Incentives via gift card drawings were distributed to students, faculty, and staff faculty according to random selection of applicable individuals.

Data Analysis

Descriptive analyses were completed using Qualtrics, including sample means, standard deviations, and percentages, cross tabs for comparisons between populations, and themed responses and word clouds for the qualitative data. SPSS 25 was used for further analysis and the 2008 survey responses were imported as well to create a combined dataset. To determine differences between 2008 and 2016 survey responses, independent samples t-tests were conducted for each role (students or faculty/staff) with weekly minutes of moderate and vigorous physical activity and average days for each type of transportation to campus as the dependent variables. Independent sample t-tests were also used to assess the differences in these commuting behaviors in students as well as faculty/staff in both years. To assess if there were significant relationships between physical activity and mode of transportation for each year, bi-variate correlation analyses were conducted for each role (students or faculty/staff) and year (2008 or 2016). Then, the most influential factors for mode of transport were identified for the 2016

participants and compared by year and role using independent samples t-tests. After separating the 2016 data by role (i.e., student or faculty/staff) multiple linear regression models were conducted to predict the variance for each transportation mode with influential factors as the independent variables. To account for length of time frequenting the campus, it was entered into step 1 of the models, and all influential factors were entered in step 2 of the model. After first accounting for multicollinearity, backward elimination was used to individually remove non-significant factors until a significant model remained. In some cases, this resulted in the removal of length of time frequenting the campus, leaving a single step regression model. Lastly, Qualtrics was used for thematic analysis of the open-ended questions in which common themes were created based on quantity of common responses. Word clouds were created as a visual representation of the themes for each question. Tables were then created with quotes from participants to provide context for the type of responses that contributed to each of the main themes.

Chapter 4 - Results

Demographics

Participant demographics for both survey years are presented in Table 4.1. More participants completed a survey in 2016 than 2008, including a significantly greater proportion who were students ($t = 14.3$, $p < 0.001$). The majority of participants each year were female, 56% in 2008 and 65% in 2016. The average age of participants was significantly higher in 2008 ($m = 32.9$, $SD = 14.0$) than in 2016 ($m = 26.7$, $SD = 10.8$; $t = 10.7$, $p < 0.001$). Almost a third of the 2016 participants (31.3%) reported being at the Manhattan campus for 5 or more years. The students' year in school was not significantly different between surveys; seniors were the largest group with 41.7% in 2008 and 30.7% in 2016.

Table 4.1. Participant Demographics from Both Survey Years

		2008		2016	
Characteristic		**N (%)**	**Mean (SD)**	**N (%)**	**Mean (SD)**
Sex					
	Male	397 (44.3)		354 (35.3)	
	Female	501 (55.7)		649 (64.7)	
Age in years		898 Range = 18-70	***32.9 (14.0)	1003 Range = 18-77	26.7 (10.8)

Length of time on Campus		
Less than a year	--	107 (10.7)
1 year	--	97 (9.7)
2 years	--	180 (17.9)
3 years	--	182 (18.1)
4 years	--	124 (12.3)
5 or more years	--	315 (31.3)
Role		***810 (80.8)
Student	457 (50.9)	78 (7.8)
Faculty	266 (29.6)	115 (11.4)
Staff*	175 (19.5)	
Year in School (students only)		
Freshman	37 (8.2)	98 (12.1)
Sophomore	65 (14.4)	132 (16.3)
Junior	109 (23.9)	188 (23.2)
Senior	190 (41.7)	249 (30.7)
Graduate Student	54 (11.8)	144 (17.8)

*Staff were combined with Faculty for all statistical analyses.
***Significantly greater than other year ($p < 0.001$)

Physical Activity Behaviors

Physical activity data were reported by part of the sample each year and are shown below in Table 4.2. For 2008, students reported their average weekly physical activity as follows: moderate (m = 271.0, SD = 248.3) and vigorous (m = 225.8, SD = 224.8). Faculty/ staff reported their average weekly physical activity as follows: moderate (m = 215.3, SD = 195.3) and vigorous (m = 164.7, SD = 151.0). For 2016, students reported their average weekly physical

activity as follows: moderate (m = 480.9, SD = 388.8) and vigorous (m = 241.6, SD = 245.3). Faculty/ staff reported their average weekly physical activity as follows: moderate (m = 332.7, SD = 287.4) and vigorous (m = 183.6, SD = 154.4).

Independent samples t-tests were used to assess differences in students' and faculty/staff members' physical activity participation in 2008 and 2016. For students, it showed that moderate physical activity was significantly greater in 2016 ($t = 11.3$, $p < 0.001$) but there was no significant difference in vigorous physical activity between years ($t = 1.0$, $p = 0.34$). These results were mirrored in faculty/staff where moderate physical activity was significantly greater in 2016 ($t = 4.9$, $p < 0.001$) but no significant difference was found for minutes of vigorous physical activity ($t = 1.1$, $p = 0.28$).

Table 4.2. Self-Reported Physical Activity from Both Survey Years

Characteristic	**2008**		**2016**			
	N	**Mean (SD)**	**N**	**Mean (SD)**	**t**	**Sig.**
Weekly Minutes of Moderate Physical Activity						
Students	422	271.0 (248.3)	761	***480.9 (388.8)	11.3	<0.001
Faculty/Staff	376	215.3 (195.3)	175	***332.7 (287.4)	4.9	<0.001
Weekly Minutes of Vigorous Physical Activity						
Students	335	225.8 (224.8)	547	241.6 (245.3)	1.0	0.34
Faculty/Staff	248	164.7 (151.0)	107	183.6 (154.4)	1.1	0.28

***Significantly greater in 2016 than 2008 ($p < 0.001$)

Transportation Behaviors

To assess the frequency of commuting via various transportation modes, participants were asked to report the average days per week that they drove, walked, biked, and used other non-motorized means of transportation to get to and from campus. As shown in Table 4.3, the most frequently reported mode of transportation to campus in 2016 was driving (85.5%), followed closely by walking (79.7%). Less than half of the sample reported biking (40.7%), and few reported other transportation (8.4%).

Table 4.3. Frequency of Transportation Mode Use in 2016

Transportation Mode	Average Days/ Week Mean (SD)	% Reporting use ≥ 1 day/week n (%)
Driving	3.5 (2.1)	614 (85.5)
Walking	3.7 (2.4)	507 (79.7)
Biking	1.4 (2.1)	122 (40.7)
Other	0.2 (0.8)	17 (8.4)

Independent samples t-tests were used to assess the differences in these commuting behaviors in students as well as faculty/staff in 2008 and 2016. As seen in Table 4.4, students had significantly more days of driving ($t = 7.5$, $p < 0.001$), biking ($t = 4.1$, $p < 0.001$), and other transportation ($t = 3.0$, $p = 0.003$) to campus per week in 2016 than 2008. Faculty/Staff had

significantly more days of driving (t = 2.2, p = 0.029), walking (t =4.0, p <0.001) and biking (t = 3.1, p = 0.003) to campus per week in 2016 than 2008.

Table 4.4. Weekly Frequency of Each Travel Mode from Both Survey Years

Travel Mode to Campus (days/week)	2008		2016			
	N	Mean (SD)	N	Mean (SD)	t	Sig.
Driving						
Students	436	2.2 (2.3)	555	***3.3 (2.1)	7.5	<0.001
Faculty/Staff	393	4.2 (2.0)	162	*4.5 (1.5)	2.2	0.029
Walking						
Students	436	3.7 (2.7)	574	3.8 (2.3)		
Faculty/Staff	392	0.8 (1.7)	62	***2.0 (2.3)	4.0	<0.001
Biking						
Students	436	0.8 (1.8)	253	***1.4 (2.1)	4.1	<0.001
Faculty/Staff	393	0.4 (1.3)	47	**1.4 (1.9)	3.1	0.003
Other						
Students	434	0.0 (0.2)	169	**0.2 (0.9)	3.0	0.003
Faculty/Staff	390	0.0 (0.1)	33	0.1 (0.5)		

Significantly greater than 2008 *(p< 0.05), **(p < 0.01), ***(p < 0.001)

Relationship between Physical Activity & Transportation

For students in 2008, moderate and vigorous physical activity were not significantly correlated with any of the transportation modes. For students in 2016, moderate physical activity was negatively correlated with driving ($r = -0.13$, $p = 0.003$) but positively correlated with other transportation to campus ($r = 0.15$, $p < 0.05$). Vigorous physical activity was not significantly correlated with any of the transportation modes.

For faculty/staff in 2008, moderate physical activity was positively correlated with other transportation to campus ($r = 0.17$, $p = 0.001$), while vigorous physical activity was negatively correlated with driving ($r = -0.14$, $p = 0.033$) but positively correlated with other transportation to campus ($r = 0.29$, $p < 0.001$). For faculty/staff in 2016, moderate physical activity was positively correlated with walking to campus ($r = 0.46$, $p < 0.001$) and other transportation to campus ($r = 0.4$, $p = 0.02$). Vigorous physical activity was not significantly correlated with any of the transportation modes.

Influential Factors for Transportation Mode Choice

The 17 factors rated in importance in 2016, role was used to separate students from faculty/staff, as seen in Table 4.5. The response rate was high for both groups; 92% of students and 89% of faculty/staff completed this question. For the overall population, the top 3 most

influential factors were time constraints ($m = 4.2$, $SD = 1.2$), weather ($m = 3.7$, $SD = 1.3$), and traveling to other points ($m = 3.6$, $SD = 1.4$). There were two factors that were significantly different between students and faculty/staff. Parking availability was rated significantly higher by students ($t = -3.2$, $p < 0.01$) while safety concerns for traffic was rated significantly higher by faculty/staff than students ($t = 5.1$, $p < 0.001$).

Table 4.5. Key Factors Influencing Transportation Mode Choice in 2016 (n = 922)

Factor	Overall mean (SD)	Students (n = 749)	Faculty/Staff (n = 173)	% Rating factor as most influential (5)
Time Constraints	4.16 (1.21)	4.11 (1.23)	4.39 (1.12)	56.6
Weather	3.67 (1.31)	3.67 (1.27)	3.66 (1.46)	34.0
Traveling to other points	3.58 (1.39)	3.55 (1.38)	3.70 (1.45)	33.6
Parking availability	3.49 (1.49)	3.57 (1.46)**	3.15 (1.59)	35.3
Parking cost	3.38 (1.53)	3.42 (1.54)	3.18 (1.49)	34.4
Health benefits	2.99 (1.42)	3.00 (1.41)	2.94 (1.45)	17.2
Traffic Congestion	2.89 (1.45)	2.91 (1.42)	2.82 (1.56)	17.9
Safety concerns (traffic)	2.47 (1.47)	2.34 (1.39)	3.04 (1.65)***	14.3
Availability of sidewalks	2.45 (1.48)	2.43 (1.47)	2.56 (1.52)	13.4
Terrain (e.g. hills)	2.41 (1.36)	2.37 (1.32)	2.61 (1.50)	10.1
Access to a bike	2.38 (1.50)	2.44 (1.51)	2.12 (1.43)	14.4
Economic concerns	2.28 (1.35)	2.28 (1.36)	2.31 (1.35)	8.7
Traveling with others	2.27(1.42)	2.24 (1.39)	2.40 (1.55)	10.7
Environmental concerns	2.26 (1.33)	2.19 (1.31)	2.58 (1.36)	8.8
Access to a vehicle	2.22 (1.52)	2.22 (1.51)	2.25 (1.57)	15.3
Safety concerns (crime)	2.19 (1.47)	2.21 (1.37)	2.08 (1.34)	9.1
Health problems	1.93 (1.28)	1.90 (1.25)	2.04 (1.37)	7.1

Ratings were based on a 5-point scale (from 1 “it is not an important factor” to 5 “it is a very important factor”)
**Significantly higher than faculty/staff ($p < 0.01$)
***Significantly higher than students ($p < 0.001$)

Linear Regression Models Predicting Transportation Mode Choice in 2016

Days driving to campus per week

Students. Multiple linear regression analysis was conducted for students in 2016, with days per week of driving to campus as the dependent variable. Length of time frequenting main campus was entered in step 1 of the model and accounted for 2.6% of the variance, $f(1,530) = 13.89$, $p < 0.001$. Influential factors for mode choice were entered in step 2 of the model and after accounting for multicollinearity using backwards elimination, the remaining factors, along with length of time frequenting main campus, accounted for 21.4% of the variance, $f(7,530) = 20.32$, $p < 0.001$. As seen below in Table 4.6, positive predictors included time constraints ($\beta = 0.21$), terrain ($\beta = 0.19$), safety concerns for traffic ($\beta = 0.14$), and length of time frequenting campus ($\beta = 0.12$), while negative predictors included health benefits ($\beta = -0.27$), traffic congestion ($\beta = -0.10$), and parking cost ($\beta = -0.10$).

Table 4.6. Linear Regression Model for Days Driving to Campus per Week (Students)

Model		Unstandardized Coefficients		Standardized Coefficients		
		B	**Std. Error**	**Beta**	**t**	**Sig.**
1	(Constant)	2.42	0.24		10.20	.000
	How long have you frequented main campus?	0.21	0.06	0.16	3.73	.000

2	(Constant)	1.79	0.45		4.02	.000
	How long have you frequented main campus?	0.16	0.05	0.12	2.99	.003
	Time constraints	0.40	0.08	0.21	5.35	.000
	Traffic congestion	-0.16	0.07	-0.10	-2.41	.016
	Terrain (e.g. hills)	0.31	0.07	0.19	4.34	.000
	Parking cost	-0.14	0.06	-0.10	-2.52	.012
	Health benefits	-0.41	0.06	-0.27	-6.44	.000
	Safety concerns (for traffic)	0.21	0.07	0.14	3.00	.003

R^2 = 0.026, 0.214 ($p < 0.001$), n = 531

Faculty/Staff. The final regression model for faculty/staff accounted for 23.5% of the variance in days per week of driving to campus, $f(4,153) = 11.46$, $p < 0.001$. As seen below in Table 4.7, positive predictors were time constraints ($\beta = 0.34$) and safety concerns for crime ($\beta = 0.23$), while negative predictors were health benefits ($\beta = -0.30$) and traveling to other points before/ after visiting campus ($\beta = -0.16$).

Table 4.7. Linear Regression Model for Days Driving to Campus per Week (Faculty/Staff)

		Unstandardized Coefficients		Standardized Coefficients		
Model		**B**	**Std. Error**	**Beta**	**t**	**Sig.**
1	(Constant)	2.97	0.61		4.85	.000
	Time constraints	0.56	0.12	0.34	4.61	.000

Traveling to other points before/ after visiting campus	-0.17	0.08	-0.16	-2.10	.037
Safety concerns (for crime)	0.26	0.09	0.23	2.98	.003
Health benefits	-0.32	0.08	-0.30	-3.90	.000

$R^2 = 0.235$ ($p < 0.001$), n=154

Walking to campus per week

Students. Length of time frequenting main campus was entered in step 1 of the linear regression model for days per week of driving to campus for students and accounted for 3.9% of the variance, $f(1,543) = 21.89$, $p < 0.001$. Influential factors for mode choice were entered in step 2 of the model and after accounting for multicollinearity using backwards elimination, the remaining factors, along with length of time frequenting main campus, accounted for 14.7% of the variance, $f(9,543) = 10.25$, $p < 0.001$. As seen below in Table 4.8, positive predictors included traffic congestion ($\beta = 0.19$), parking cost ($\beta = 0.14$), and health benefits ($\beta = 0.11$), while negative predictors included length of time frequenting campus ($\beta = -0.17$), time constraints ($\beta = -0.12$), safety concerns for traffic ($\beta = -0.12$), weather ($\beta = -0.11$), and terrain ($\beta = -0.11$).

Table 4.8. Linear Regression Model for Days Walking to Campus per Week (Students)

Model	Unstandardized Coefficients	Standardized Coefficients	t	Sig.

		B	Std. Error	Beta		
1	(Constant)	4.89	0.25		19.94	.000
	How long have you frequented main campus?	-0.28	0.06	-0.20	-4.68	.000
2	(Constant)	4.75	0.49		9.76	.000
	How long have you frequented main campus?	-0.24	0.06	-0.17	-4.04	.000
	Time constraints	-0.22	0.08	-0.12	-2.86	.004
	Traffic congestion	0.31	0.07	0.19	4.20	.000
	Weather	-0.21	0.09	-0.11	-2.36	.019
	Terrain (e.g. hills)	-0.20	0.09	-0.11	-2.29	.022
	Safety concerns (for traffic)	-0.20	0.08	-0.12	-2.41	.016
	Parking cost	0.20	0.06	0.14	3.23	.001
	Health benefits	0.18	0.07	0.11	2.52	.012

$R^2 = 0.039, 0.147 (p < 0.001), n = 544$

Faculty/Staff. The final multiple regression model for faculty/staff in 2016 accounted for 70.3% of the variance in days per week of walking to campus, $f(6,61) = 21.65$, $p < 0.001$. As seen below in Table 4.9, positive predictors were health benefits ($\beta = 0.28$) and traffic congestion ($\beta = 0.20$), while negative predictors were time constraints ($\beta = -0.55$) access to a vehicle ($\beta = -0.27$), safety concerns for traffic ($\beta = -0.22$), and access to a bike ($\beta = -0.16$).

Table 4.9. Linear Regression Model for Days Walking to Campus per Week (Faculty/Staff)

Model		Unstandardized Coefficients		Standardized Coefficients		
		B	Std. Error	Beta	t	Sig.
1	(Constant)	5.69	0.70		8.13	.000
	Time constraints	-0.92	0.13	-0.55	-7.06	.000
	Traffic congestion	0.31	0.13	0.20	2.37	.021
	Safety concerns (for traffic)	-0.31	0.12	-0.22	-2.56	.013
	Access to a vehicle	-0.42	0.13	-0.27	-3.20	.002
	Access to a bike	-0.28	0.14	-0.16	-2.03	.047
	Health benefits	0.45	0.13	0.28	3.32	.002

$R^2 = 0.703$ ($p < 0.001$), $n = 62$

Biking to campus per week

Students. The final multiple regression model for students accounted for 5.4% of the variance in days per week of biking to campus, $f(2,241) = 6.86$, $p = 0.001$. As seen below in Table 4.10, biking more days per week was positively associated with health benefits ($\beta = 0.19$) and negatively associated with safety concerns for crime ($\beta = -0.18$).

Table 4.10. Linear Regression Model for Days Biking to Campus per Week (Students)

Model		Unstandardized Coefficients		Standardized Coefficients		
		B	Std. Error	Beta	t	Sig.
1	(Constant)	1.14	0.37		3.10	.002
	Safety concerns (for crime)	-0.28	0.10	-0.18	-2.80	.006
	Health benefits	0.28	0.10	0.19	2.93	.004

$R^2 = 0.054$ ($p = 0.001$), n=242

Faculty/Staff. The final linear regression model for faculty/staff accounted for 20.8% of the variance in days per week of biking to campus, $f(2,45) = 5.65$, $p = 0.007$. As seen below in Table 4.11, biking more days per week was positively associated with environmental concerns (e.g., pollution; $\beta = 0.35$) and negatively associated with safety concerns for crime ($\beta = -0.43$).

Table 4.11. Linear Regression Model for Days Biking to Campus per Week (Faculty/Staff)

Model		Unstandardized Coefficients		Standardized Coefficients		
		B	Std. Error	Beta	t	Sig.
1	(Constant)	1.29	0.70		1.86	.070
	Safety concerns (for crime)	-0.61	0.20	-0.43	-2.97	.005
	Environmental concerns (e.g. pollution)	0.49	0.20	0.35	2.43	.019

$R^2 = 0.208$ ($p < 0.01$), n=46

Other transportation to campus per week

Students. No statistically significant regression model was found for other transportation for students (data not shown).

Faculty Staff. The final multiple linear regression model for faculty/staff accounted for 14.0% of the variance in days per week of other transportation to campus, $f(2=1,32) = 5.04$, $p = 0.032$. As seen below in Table 4.12, using other transportation (e.g., skateboard) more days per week was negatively associated with weather ($\beta = -0.37$).

Table 4.12. Linear Regression Model for Days of Other Transportation to Campus per Week (Faculty/Staff)

Model		Unstandardized Coefficients		Standardized Coefficients		
		B	**Std. Error**	**Beta**	**t**	**Sig.**
1	(Constant)	0.65	0.26		2.47	.019
	Weather	-0.15	0.07	-.37	-2.25	0.032

$R^2 = 0.14$ ($p = 0.032$), n=33

Thematic analysis of written responses for campus changes and suggestions

Participants were asked two open-ended questions at the end of the survey. The first was to indicate what other changes they had noticed around campus that influenced their choice of transportation (besides what was asked in previous survey questions). There were a total of 436 participant responses. Of those comments, 182 addressed construction, 129 addressed parking, 101 addressed walking, and 65 addressed biking. Other frequent themes were: no changes noticed (none), campus changes, time, and changes in Manhattan. A visual representation of the themes (sorted by size to indicate frequency of response) is shown below in Figure 4.1.

Figure 4.1. Word cloud of changes influencing commuting behaviors

To provide further insight on participant feedback, Table 4.13 has direct quotes pulled as examples of responses within the four main themes for this question.

Table 4.13. Examples of participant responses of changes to campus influencing active commuting behaviors

Q. What other changes have you noticed around campus that influence your choice of transportation?

Themes	Participant Responses
Construction	"Lots of construction that would make it really stressful to drive. Biking is just as fast as driving and less expensive." "All the construction has forced me to change walking routes and patterns." "Construction seems to be the biggest influence, I still mostly ride my bike around campus but the routes change." "The construction has definitely influenced my choice of transportation between classes but not to and from campus." "There is a lot of construction on campus that blocks many of the sidewalks so it is more of a pain to get around, but I still walk because I live so close to campus." "I have to drive to campus because I live so far away, but I bike to get around on campus because I cannot make it on time across campus between classes walking with the current construction."
Parking	"I have a parking permit now, but I'm considering not paying for it next year. I often park at the City Park and walk to work. It is just as far as some of the other lots, so it seems pointless to pay for permit." "Even though I have a parking permit I rarely find a spot. My parking permit is basically a "license to hunt" and to limit my time/stress I often park off campus and walk a block or two." "Reduction of parking availability and high prices means riding a motorcycle to campus." I do not park in the parking garage because I have to arrive even earlier to campus to secure a spot. It's so much easier to just park on a side street like Kearney or Thurston and walk up the hill to Bluemont Hall." "Lack of designated parking spots near where I teach/attend classes"

	“Parking is a nightmare here. This is my 4th university campus (I'm staff) and for a small town, the organization, planning and execution of parking is unnecessarily complicated.”
Walking	“I walk because it's really the only good option. But when weather is bad then I have no choice but to walk in the rain.” “When I was taking more classes and did not work on campus, I used to walk all the time. But now I work in a research lab on campus and am on campus all day; it's usually dark when I leave so I choose to drive so I don't have to walk alone in the dark. I'd love to walk more but time-wise, it's easier to drive.” “I do not have the money for a car or other transportation options” “It's (campus) more accessible for pedestrians.” “Less car traffic on campus makes walking and biking to class more enjoyable.”
Biking	“I've biked to school for years and the loss of parking places/lots due to the campus master plan only reaffirms my desire to continue to bike to campus" “More of a bike friendly campus. There are more spacious sidewalks for both bikes, walking, and other.” “Cyclists are reckless and do not obey traffic laws. Great effort has been made to make Manhattan and KSU campus cyclist friendly, yet cyclists are not held to the same standards as motorists when it comes to obeying traffic laws.” “Parking and parking prices would cause me to bike to campus but weather (cold) and time restraints cause me to drive.” “The Green Apple Bikes that have been made open to use for the public have definitely encouraged me to bike more frequently to places.”

Participants were then asked what additional changes they would suggest for improving walking and biking on or during the trip to/from campus. There were a total of 403 participant responses. Of those, 207 addressed walking, 181 addressed biking, 56 addressed parking, and 27 addressed the K-State Master Plan. Other common themes were: construction, infrastructure of Manhattan, and proximity of residence. A visual representation of the themes (sorted by size to indicate frequency of response) is shown below in Figure 4.2.

Figure 4.2. Word cloud of suggested improvements to promote active commuting behaviors

To provide further insight on participant feedback, Table 4.13 has direct quotes pulled as examples of responses within the four main themes for this question.

Table 14.14. Examples of participant responses regarding suggested improvements to promote active commuting behaviors

Q. What additional changes would you suggested to improve walking and biking on or during the trip to/from campus?	
Themes	**Participant Responses**

Walking	"Increase the size (width) of sidewalks near campus, improved crosswalks and street lighting. "Better sidewalk conditions (even, less cracks, shrubbery around sidewalks maintained) could be conducive to influence students, faculty and staff to walk to campus." "I would like to see more sidewalks throughout the neighborhoods surrounding the campus. It's difficult to walk when they do road work on one side with no sidewalk on the other side." "Marked cross walks with flashing lights. Increase police presence, ticketing drivers not yielding to pedestrians in cross walks, cyclists disobeying traffic rules, and pedestrians jay walking."
Biking	"Make a restricted path for bikers only that goes all the way around and through campus in different directions." "More designated bike areas. Biking is kind of scary for the biker when in the road and for the pedestrian while on the sidewalk." "More education about the rights and responsibilities of cyclists and motorists (to make cycling safer), and more bike lanes" "Teach people to go in the direction of the arrows in the bike lanes that flow oppositely to vehicular traffic on one-way roads, such as that on Mid-Campus Drive around Eisenhower, Anderson, Kedzie and Calvin Halls."
Parking	"Build 2 or 3 more parking garages in the parking lots that are already on campus. If more parking garages were built, more people could have access to parking around campus. The university could charge a modest fee for the service and they would sell out immediately." "We need more parking spaces for vehicles. Manhattan does not have developed roadways for biking or walking within the city."

	"Quit limiting motorcycle parking"
K-State (2025) Master Plan	"The master plan calls for removing numerous main campus lots and using satellite parking for a reduced permit fee. It would be nice for some people if satellite lots included easy access walking/bike paths & bike racks for people who are interested in a little physical activity to get from satellite parking to main campus instead of taking the shuttle." "Getting rid of all the roads makes biking, not just driving, more difficult. Sidewalks congested with people makes biking useless." "I think we are moving in the right direction with more bike racks & less car traffic on campus!" "Quit closing roads and open more parking lots."

Chapter 5 - Discussion

To extend the study of transportation-related physical activity, this study looked to examine changes in active transportation behaviors over time as the built environment of Kansas State University's campus changed. The two-fold purpose of this study was to examine differences in the overall physical activity and active transportation (AT) behaviors of KSU students, faculty and staff in 2008 and 2016; and explore influential factors for transportation choice and perceptions of the campus built environment in 2016. Based on trends in previous research, it was hypothesized that (1) overall rates of physical activity and active transportation were greater for students and faculty/staff in 2016 than they were in 2008 and (2) changes in the campus built environment will play an influential role in the transportation behaviors of the KSU population. Having survey data from two points in time, before and during major renovations to the KSU campus built environment, allowed for comparison of physical activity, transportation, and commuting behaviors as the environment changed.

The first hypothesis was mostly supported in that students and faculty/staff in 2016 reported significantly more moderate physical activity than the students and faculty/staff did in 2008; however, there were no statistically significant differences in vigorous physical activity. Moderate physical activity was particularly of interest since by definition, it could include active

transportation, such as walking and biking for 10 minutes or more (USDHHS, 2008). Almost 50 percent of (college) students met the current federal guidelines for aerobic physical activity in spring 2010 and 43.5% of adults (faculty/ staff) met moderate physical activity guidelines in 2008 (ACHA, 2018). Incorporating transportation-related physical activity into the weekly routine can help students, faculty and staff meet (or exceed) the moderate physical activity guidelines (CDC, 2015).

For active transportation, students reported significantly more biking and other active transportation in 2016 than in 2008. Faculty/staff reported significantly more walking and biking to campus in 2016 than in 2008. However, both students and faculty/staff reported more driving to campus in 2016 than in 2008. Those in the 2016 survey sample seemed to visit campus more frequently overall than those who completed the 2008 survey. Many college campuses are dealing with increased demand for parking, while consequently removing available parking spaces from campus to encourage more active transportation (Prevost, 2017).

Higher rates of active transportation are to be expected in environments that can safely and easily facilitate active transportation (DOT, 2015). The walkability and bikeability of the KSU campus has improved since 2008 (KSU, 2018). Changes to the built environment of Manhattan, specifically trail and bike route connectivity, could explain the significantly higher

rates of walking and biking for faculty/ staff (Manhattan Bike Plan). However, just because the environment supports walking and biking, does not mean all users will participate in active transportation. Regardless of benefits of transportation-related physical activity, the convenience and accessibility of cars is why a large portion of university populations drive when possible, especially when time constraints exist.

The second hypothesis was partially supported. Over 20% of the variance for students driving to campus was accounted for by greater importance ratings for time constraints, terrain, and traffic safety concerns and lower importance ratings for health benefits, traffic congestion, and parking costs. Almost 15% of the variance in students walking to campus was accounted for by greater importance ratings for traffic congestion, parking costs, and health benefits, and lower importance ratings for time they had frequented campus, time constraints, traffic safety concerns, weather, and terrain. Only 5.4% of the variance in students biking to campus was accounted for by greater importance ratings for health benefits, but lower importance ratings for safety concerns for crime. Thus, for students, it appeared that greater concern about campus features (i.e., traffic congestion and parking costs) facilitated driving for transportation, while lower concern for those features facilitated walking. Students who biked were less concerned about crime safety, which could be related to an increased availability of bicycle racks throughout

campus. Other factors not specific to campus built environment changes were also influential for students' transportation mode choice. In particular time constraints were a greater concern for those driving and a lesser concern for those walking to campus, while health benefits were a lesser concern for those driving and a greater concern for those walking and biking to campus.

Over 23% of the variance for faculty/staff driving to campus was accounted for by greater importance ratings for time constraints and safety concerns for crime and lower importance ratings for health benefits and traveling to other destinations. Over 70% of the variance in faculty/staff walking to campus was accounted for by greater importance ratings for health benefits and traffic congestion, and lower importance ratings for time constraints, vehicle access, traffic safety concerns, and bicycle access. Over 20% of the variance in faculty/staff biking to campus was accounted for by greater importance ratings for environmental concerns but lower importance ratings for safety concerns for crime. Fourteen percent of the variance in other transportation use for faculty/staff was accounted for by lower importance ratings for weather. For faculty/staff it appeared that campus features (i.e., traffic congestion and parking costs) were not influential in transportation mode choice, but rather time constraints positively predicted driving and negatively predicted walking, while health benefits for each were opposite predictors. This mirrors other studies of choice of transportation in that one of the main

predictors of transportation-related physical activity in adults is accessibility of destinations (Peachey, 2015). This may explain why the faculty/ staff who chose to drive were more concerned about time constraints and less about health benefits.

When we examined the relationship between physical activity and transportation, we found no significant relationship between moderate or vigorous physical activity and any transportation modes for students in 2008. However, in 2016, students' moderate physical activity was negatively correlated with driving and positively correlated with other transportation. Similar to previous research, students on a campus with a more walkable environment had higher overall minutes of weekday physical activity than students at a campus with inferior walkability (Sisson & Tudor-Locke, 2008). In 2008, faculty/staff moderate physical activity was positively correlated with other transportation and vigorous physical activity was negatively correlated with driving and positively correlated with other transportation. In 2016, faculty/staff moderate physical activity was again positively correlated with other transportation, but also with walking. While these data continue to highlight the positive relationship between moderate physical activity and active transportation behavior, the relationship between choice of transportation and vigorous physical activity levels is not

conclusive. Factors influencing choice of transportation are not commonly the same factors that influence vigorous physical activity due to intrapersonal variables (CDC, 2017).

Based on average days per week, the most frequently reported mode of transport was driving, followed closely by walking and distantly by biking. This is the same breakdown as what was seen in 2008, even though driving has significantly increased for students and faculty/ staff. In addition, rates of biking and other modes of active transportation for students and walking and biking for faculty/ staff significantly increased as well. Seeing significant increases in all modes of transportation could mean that more people are coming to campus during the week or trips made during the day which tend to differ based on role at the university.

Factors that influenced choice of transportation fell into individual, economic, and environmental categories. Factors within the individual category were: time constraints, travelling to other places, access to a vehicle, access to a bike, health problems, health benefits, and travelling preference of others travelling with you. Economic factors were: parking cost and economic concerns (e.g. cost of maintaining a car). Environmental factors were: traffic congestion, weather, terrain, safety concerns for crime, safety concerns for traffic, parking availability, environmental concerns (e.g. pollution), and availability of sidewalks. For the entire population, time constraints, weather and traveling to other points were rated as the most

influential factors (5 out of 5) on choice of transportation mode. Students were assessed individually from faculty/staff since the two groups tend to have different lifestyles based on (SES, age, responsibilities, location of residence, etc.).

For students, the top factors (all averaging above a 3.5 out 5 for importance) were time constraints, weather, parking availability, and traveling to other points. For faculty/ staff the top 3 factors were time constraints, weather, and traveling to other points. There were two factors that were significantly different between students and faculty/ staff; parking availability was ranked significantly higher by students and safety concerns for traffic was rated significantly higher by faculty/staff. These differences were expected as there was a large student population with limited parking access. Faculty/ staff tended to have greater concerns about traffic safety since many drive due to the greater distance many live from campus. In this population there was it took for students significantly less time to walk and bike to campus than faculty/ staff. The data from this study increase the understanding of which factors influence choice of transportation for this population. In this population, individual and environmental factors were rated as more important and knowing that can aid in increasing the active transportation rates as they can be addressed. These intrapersonal factors can hinder transportation-related physical

activity but with education and awareness of ways to overcome those barriers, rates of physical activity could increase (CDC, 2017).

The question that asked participants what campus changes influenced their commuting behaviors resulted in four key themes of construction, parking, walking, and biking. Within the construction theme, participants mentioned altering their choice of transportation due to the inconvenience it caused for commuting and travelling throughout campus; routes through campus changing and living proximity provided additional challenges. Many mentioned switching their mode of transportation to biking instead of driving or parking farther away and walking/biking throughout campus to get to their destinations. Bike friendly campuses (such as KSU) facilitate the use of bikes to avoid traffic, parking and other issues (BPRC Commuting, 2012). Those who chose to walk said they had to change their routes through campus and then it took longer to get to their destinations. While participants understood construction was meant for improvements to campus there was push back due to large sections of campus being under construction at the same time in 2016. More people were affected since the interior of campus was transitioning from car friendly to very limited car access which blocked off the roads and surrounding sidewalks. With the same amount of parking and limited access to paths around campus with a large population, most were forced to alter their route and/ or mode of

transportation. Referring to the “6 D’s”, distance of transit and destination are important factors when people go from one place to another (Ogra, A. N. & Ndbele, R., 2014). This can be used to explain why participants felt inconvenienced when construction inhibited the fastest and most convenient route between destinations for most of the Spring 2016 semester (i.e., during the survey period).

Parking was the second most common theme. Participants mentioned parking permits, parking availability, parking off-campus, lack of faculty/ staff accommodations and parking infrastructure. Parking permits do not guarantee spots so many participants had to either go out of their way to come early/ leave later or not use their permit by parking off-campus and walking. This led to many students not purchasing permits or using them sparingly. Faculty/ staff members faced similar problems, even with designated lots there were not enough spots and the lots were not conveniently located for all campus destinations. Some made comparisons to universities they had worked at prior to coming to KSU and how inconvenient the parking environment was at this campus. Many participants, who primarily commute by vehicle, admitted that they were still willing to drive even if it meant hunting for spots or parking off campus and walking. This is not uncommon at universities, at Iowa State for example, the majority of commuting students park off campus (KSU, 2015).

Participants who chose walking as their mode of transportation felt influenced by living closer, convenience in comparison to other modes, cost of transportation and campus transitioning to be friendlier for pedestrians and cyclists. While walking was not always the first choice for transportation mode, participants liked that it was free, avoided parking issues and used the campus amenities such as the pedestrian mall as intended. While walking posed its own problems for some, it was commonly referred to as the "only good option" by several participants. Kansas State University is among many universities becoming more accommodating for active transportation such as Georgia State University, University of Vermont, and the University of Utah. Active transportation plans for these universities focus on making active transportation options safer and more attractive for the university population (Alta Planning + Design, 2018).

Responses within the biking theme focused on use of this mode of transportation, bike culture and built environment changes. Campus changes made biking safer and more desirable for bike owners and those using the Green Apple Bikes. On the other hand, several mentioned they would bike but other factors such as time, weather, terrain and safety made them choose to drive. Those are common factors that inhibit the use of active transportation (Andrade & Kagaya, 2013). Cyclists on campus were perceived to be reckless by drivers and pedestrians alike, which

could be addressed with education and enforcement of traffic laws. Most participants were open to biking if safety, convenience, built environment and community receptiveness supported that choice of transportation. This is consistent with a study on bicycling for transportation and health that found supportive environments (i.e. one with proper bike infrastructure) encourage biking for everyday travel (Dill, 2009).

Participants also suggested improvements to promote active transportation and commuting behaviors on campus. Responses regarding improving walking during the trip to/ from campus focused on sidewalk conditions, improved crosswalks on and around campus, and safety regarding crosswalk and street lighting and education on pedestrian and motorist laws. All of these suggestions fall within the realm of pedestrian-scale infrastructure. While, as mentioned earlier, influences how pedestrians move from one place to another and proper infrastructure and amenities facilitate walking for transportation (Bushell, M.A., Poole, B.W., Zegeer, C.V., & Rodriguez, D.A, 2013). When transportation networks provide safe and convenient opportunities for active transportation, there will be more appeal for more people to actively commute (Health, N. C., 2011).

Participant responses regarding improving cycling suggested: improved bike paths (number and connectivity), more education for pedestrians, cyclists, and motorists (to make

biking safer) and enforcing the proper use of bike infrastructure on and off campus. These suggestions coincide with other studies on the built environment and behaviors of cyclists. In a study on how the built environment influences healthy transportation choices, specifically biking, the characteristics of routes (e.g. bicycle signage, traffic calming and cyclist-activated lights, educational land use and higher population density) were more influential than origin or destination characteristics (Winters, M., Brauer, M., Setton, E. M., & Teschke, K, 2010). When it comes to transportation-related built environment, "it is important that pedestrian and bicycle facilities be integrated into transportation systems" during the planning process instead of an afterthought (LaHood, R., 2010). This has begun to be addressed on the KSU campus with the additions of bike infrastructure on and around campus, and should continue to increase rates of cycling.

In relation to motorists, responses regarding parking were the most popular. Suggestions included building parking garages in existing parking lots around campus to fix limited parking issues, adding more parking for motorcyclists, and creating more parking off-campus. Parking was quite limited for the KSU population since the current infrastructure was unable to meet the needs of the growing campus. With more than 80% of the participants reporting vehicle dependency, they will find a place to park, even if it meant parking illegally on campus and in

surrounding neighborhoods and at businesses. Drivers of cars, motorcycles, and scooters were all looking for spots which was why the suggestion for 2 to 3 more parking garages was popular. The parking issues on campus are being addressed in the K-State 2025 Master Plan, including plans for a second parking garage, satellite parking structures with shuttle services, and other circulation improvements (KSU, 2018).

The portion of the K-State 2025 Master Plan addressing the campus built environment was the fourth most common theme in terms of what was accomplished by 2016 and what was to come. For those familiar with the plan, they were aware of the push for using satellite parking and shuttle services, removal of unnecessary roads through campus and the addition of pedestrian-scale amenities. Feedback was both positive and negative. Those who supported the plan were excited for the transition of roads to pedestrian malls and the addition of bike lanes and racks. Those who were upset with the proposed changes wanted to keep the roads (for cars and bikes) and focus on more parking. King (2014) explains that the shift to multi-modal streets is a dramatic change from the traditional American auto-oriented personal transportation and is more difficult since many modes requires multiple actors in the planning process, all with different priorities and preferences. While the KSU campus built environment is changing to

accommodate more active transportation there will still be parking and roads around campus available for motorists, an effort to balance multi-modal transportation.

Participant feedback to these two questions provided insight into the way the university population responded to the current built environment, how it dictated their transportation choices and what changes they want to see on the campus. Walking, biking and parking were common themes for what currently influenced transportation mode choices and suggestions for how to improve active transportation. These data help elucidate what campus built environment elements influenced active transportation behaviors in this population.

Study strengths included the large samples size, particularly students, for both survey years, access to data from 2008 to allow for comparison between two populations over time, and diversity of questions allowed for varied analyses. With large sample sizes, the data were more representative of the population. For 2016, there were 23,189 students, 1485 faculty and 3071 staff at KSU's Manhattan campus (KSU Office of Planning and Analysis, 2018). The survey was able to capture over 1000 participants, with students making up the majority (matching the proportions of the population). Access to the survey and dataset from the 2008 study provided for a unique opportunity to compare data from two cross-sectional studies on the KSU population. The repetition of survey questions made it possible to statistically compare the two

populations. While this does not compare to a longitudinal study, it does extend the study of transportation and commuting behaviors by comparing data from two time points.

There were some limitations to this study. First, the demographic questions queried role and years on campus for students, but there were no sub-categories for faculty or staff. Future research could ask additional questions about transportation-related behaviors common to faculty/staff since this population tends to be overlooked in college health studies. Second, the questions on physical activity participation did not specifically include active transportation. While is it common to use standardized questions from the International Physical Activity Questionnaire (IPAQ, 2016), additional questions pertaining to specific activities and minutes of transportation physical activity would have provided more relevant information for this study. It was difficult to determine what influence transportation mode choices had on physical activity and if active transportation changed between years versus simply differences in overall minutes of physical activity. Third, influential factors that were given importance ratings did not include enough items specific to the recent built environment changes (e.g., availability of bicycle parking, pedestrian malls, etc.) that were different since the original survey in 2008. Lastly, the use of survey questions specific to university populations, such as the National College Health Assessment (NCHA) survey, could have allowed for greater comparisons with other university

populations (ACHA-NCHA , 2015). While the NCHA survey is commonly used to study student behaviors, questions considering additional factors that influence university population active transportation and physical activity behaviors could provide more insight.

Recommendations for future studies on campus built environment, active transportation and commuting behaviors are as follows: be narrow in focus, choose smaller segments of the university population or campus or both, collect data from various times in the year, separate students, faculty, and staff to account for differences in these sub-populations, and assess the interaction between the university and the surrounding city since commuting and built environment usage do not stop at campus borders. Studies at Universities, such as KSU, with large populations and large campuses can be difficult. Narrowing in on specific portions of the population and/or segments of campus would allow for a better understanding of population sub-group behaviors. Collecting data at various times over the year could provide a better understanding of seasonal factors that often influence built environment usage and active transportation behaviors. Lastly, dedicating studies to the understanding of faculty and staff behaviors will capture an understudied aspect of university populations, as compared to more research addressing college students. Active transportation and commuting behaviors of a university population are influenced by the built environment and amenities surrounding campus

therefore studies can develop a more comprehensive understanding if they study the surrounding city infrastructure and its role on these behaviors.

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