THE PENNSYLVANIA STATE UNIVERSITY
SCHREYER HONORS COLLEGE

JOHN AND WILLIE LEONE FAMILY
DEPARTMENT OF ENERGY AND MINERAL ENGINEERING

# Shared E-Bike: Understanding the Economic Benefits and Costs on University Campuses

SIHAN LIU
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A thesis
submitted in partial fulfillment
of the requirements
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in Energy Business and Finance
with honors in Energy Business and Finance

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# ABSTRACT

My thesis explores the economic benefits and costs of shared e-bikes on university campuses. Shared e-bikes provide access to consumers who do not own their own e-bikes. They are electric bikes that can be shared by multiple riders through an e-bike share program. There has been dramatic growth in the number of e-bike users in Europe, America, and China (Schleinitz et al., 2017). Many universities in the United States (U.S.) have adopted a shared e-bike or e-scooter system on campus. Shared e-bikes on university campuses help with decreasing traffic congestion and parking needs, lowering greenhouse gas (GHG) emissions, and potential cost savings for riders compared to traditional transportation options such as driving and ride-hailing. It provides improved accessibility and convenience for students, faculty, staff, and visitors.

However, there are fixed and marginal costs associated with adopting and sustaining a shared e-bike program. This article is a case study on The Pennsylvania State University (Penn State)'s current Spin e-bike share program on Penn State University Park campus. Riders and Penn State can benefit from enhanced accessibility to sustainable transportation and cost savings.

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## ACKNOWLEDGEMENTS

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# Chapter 1

## Introduction

Climate change has become a major pressing challenge in the 21st century. The transportation industry produces the second largest amount of GHG emissions in the European Union (Eurostat, 2017). It generates around one-fifth of the total emissions (Eurostat, 2017).

Currently, there are various approaches to reducing GHG emissions. E-bikes are electricity-powered bikes. There are electric motors on e-bikes that enable riders to have an enhanced riding experience. Shared e-bikes are created to be a convenient, cost-effective, and sustainable transportation approach for temporary trips in cities. E-bikes are considered a feasible option to reduce the GHG emissions impact of a region's passenger transportation system (McQueen et al., 2020). The sharing economy is the "acquisition or distribution of a source coordinated by people for a compensation or a certain fee" (Belk, 2014). Shared e-bikes provide access to consumers who do not own their own bikes. There has been dramatic growth in the number of e-bike users in Europe, America, and China (Schleinitz et al., 2017). In Germany, e-bikes account for 11% of all bicycles sold (Schleinitz et al., 2017). China contributes more than 90% of all e-bike sales in the world (Fishman & Cherry, 2016). Not only can e-bikes offer users sufficient physical activity to improve health (Castro et al., 2019), but they are also able to decrease GHG emissions, urban traffic, and city noise (Weiss et al., 2015).

There has been a growing popularity of electronic vehicles on university campuses. The electric bike-sharing and electric scooter-sharing company, Spin, runs electric scooter programs in partnership with more than 28 universities in the U.S. (Spin, n.d.). In August 2021,

Penn State adopted a Spin shared e-bike program (Penn State News, 2021). Although there has been abundant research conducted on e-bikes, there has not been much light shed on shared e-bikes on university campuses. My research is intended to fill a small gap in this area. This article focuses on shared e-bikes on university campuses. In the past few years, dozens of universities including Penn State have adopted the shared electronic vehicles, Spin, on campuses. Some of you might have used it yourself in the past. I would like to understand what benefits these shared e-bikes have brought to students and the community, as well as the constraints and drawbacks they present.

I hope to learn about the economic benefits and costs of riding shared e-bikes on university campuses. I expect shared e-bikes' total net benefit to be positive and they will be more widely adopted on university campuses in the upcoming years.

# Chapter 2

## Campus Environment

Penn State is the largest public university in Pennsylvania, contributing over $11.6 billion to the Pennsylvanian economy. There are 759,000 living alumni worldwide and over 47,560 students currently at Penn State University Park main campus (Penn State, 2021). First-year students at University Park are required to live on campus. After the first year, many students still tend to choose to live near campus. Populations near universities oftentimes have higher possibilities of bicycle use (Balsas, 2003).

State College, the city where Penn State University Park campus is located, offers many flat, dry areas for riders to utilize, and these areas are what is considered cycling-friendly (Balsas, 2003). In 2016, Penn State University Park was awarded by the League of American Bicyclists as a silver "Bicycle Friendly University" (Penn State Transportation Services, n.d.). Furthermore, biking is often seen as one of the healthy and sustainable options for short trips or last-mile travel. It does not present the same problem as driving which is often expensive and comes with parking problems (Cleland, 2004). Resident student parking permits at University Park cost $672 per year, and faculty/staff parking permits can cost up to $1104 per year (Penn State Transportation Services, n.d.). Overall, biking seems to be a cost-effective, convenient, and sustainable solution for short trips at Penn State University Park.

# Chapter 3

## Introduction to Micro-Mobility Programs at Penn State University Park

Biking has always been an important transportation approach for Penn State University Park to reach its sustainability goals. In August 2017, Penn State initiated its first bike share program at University Park with 85 bikes over 17 stations for short trips (Penn State Transportation Services Request for Proposal for Micro-Mobility Transportation System, 2021). Later, the number of bikes and stations grew to 110 bikes across 21 stations. Annual membership and single-use opportunities were both available (Penn State Transportation Services Request for Proposal for Micro-Mobility Transportation System, 2021). However, during the third and final contracted year with its bike provider, Zagster, the company went out of business (Penn State Transportation Services Request for Proposal for Micro-Mobility Transportation System, 2021). Penn State started looking for a new contractor to fulfill its sustainable transportation goals while collaborating with the Borough of State College.


**Figure 1. Spin shared e-bikes on Penn State University Park campus**

In January 2021, Penn State released its Request for Proposal for its Micro-Mobility Transportation System. The Federal Highway Administration defines micro-mobility as “any small, low-speed, human- or electric-powered transportation device, including bicycles, scooters, electric-assist bicycles, electric scooters (e-scooters), and other small, lightweight, wheeled conveyances” (The Federal Highway Administration, 2021). In August 2021, Penn State University Park launched its first shared e-bike program with Spin. Spin is a key player in the micro-mobility industry. It was founded in 2017 as a start-up and is currently based in San Francisco (Spin, n.d.). Spin offers both e-bikes and e-scooters. It partners with over 28 universities in the U.S. including Carnegie Mellon University, Michigan State University, Vanderbilt University, and University of California, Berkeley (Spin, n.d.).

**THE PENNSYLVANIA STATE UNIVERSITY**

**REQUEST FOR PROPOSAL**
**SCOPE & SPECIFICATIONS DOCUMENT**

**RFP External of SIMBA**

**Micro-Mobility Transportation System**

| CRITICAL MILESTONES | DATE |
|---|---|
| Release of RFP | January 28, 2021 |
| Deadline for Questions | February 12, 2021 @ 2:00PM EST |
| Proposal Due Date | February 26, 2021 @ 2:00PM EST |
| Supplier Presentations (if invited) | TBD |

**For questions pertaining to this RFP, please contact:**

**Curtis Bechtel**
**Senior Purchasing Agent**
cdb111@psu.edu

**Figure 2. Penn State's Request for Proposal for Micro-Mobility Transportation System**

There is no cost to university administration for Spin scooters (Spin, n.d.). However, due to the Pennsylvania State law restrictions on scooters, Penn State has decided to adopt Spin' shared e-bike program instead with the option to expand to scooters in the future (Penn State Transportation Services Request for Proposal for Micro-Mobility Transportation System, 2021). Penn State is contracted with Spin for three years. The shared e-bikes are available 24 hours a day and have a maximum electric-assist speed of 15 miles per hour (Penn State News, 2021). Since the cost of production and maintenance of shared e-bikes are substantially more expensive

than the cost of shared e-scooters, Penn State Transportation Services pays Spin $24,000/month to recover their labor, warehouse, battery costs, etc. (Penn State Transportation Services, 2023). Furthermore, Penn State Transportation Services is not spending student fees or tuition on the Spin shared e-bike program. The funding is from its revenue including parking permit fees, employee and visitor tickets, etc. (Penn State Transportation Services, 2023). University Park campus first started with 300 shared e-bikes. Later, Spin added 200 shared e-bikes to campus at no incremental cost. Penn State is not receiving revenue from the shared e-bike program in its contract with Spin (Penn State Transportation Services, 2023).

# Chapter 4

## Economic Costs and Benefits of Shared E-Bikes at Penn State

There are many economic benefits and costs of shared e-bikes. In a research study on Factors Influencing Consumers' Purchase Intention towards Electric Two-Wheelers in 2021, researchers found that consumers perceive electric two-wheelers including e-bikes to have high economic benefits. Therefore, consumers will also have a favorable attitude toward electric two-wheelers (Jayasingh et al., 2021). Due to technological advancements in the production and operation of shared e-bikes, the number of e-bikes and bike share have both increased dramatically in the past two decades (Meddin, 2015; Jamerson and Benjamin, 2013, Jamerson and Benjamin, 2015).

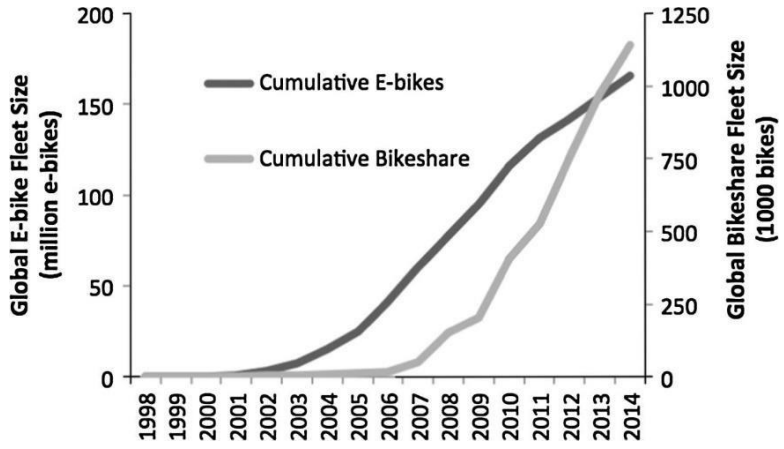



**Figure 3. "Growth in personal e-bike and public bikeshare systems" (Meddin, 2015; Jamerson and Benjamin, 2013, Jamerson and Benjamin, 2015)**

The diagram below is an overview of components of benefits and costs regarding economic benefits from Penn State's shared e-bike program.

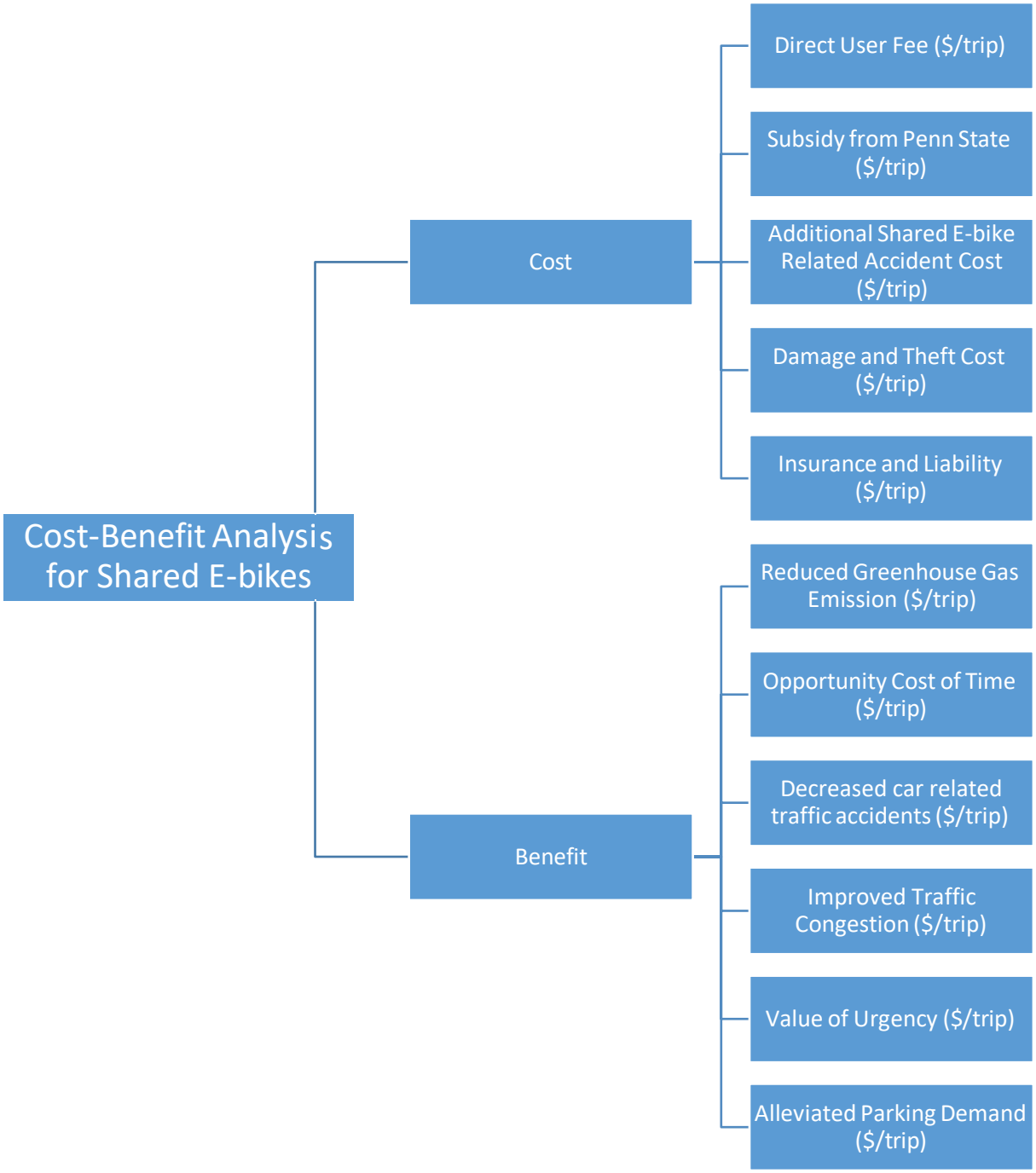



**Figure 4. Overview of Cost-Benefit Analysis for Shared E-bikes**

Due to the scope of this paper, it is not possible to discuss every area of costs and benefits of shared e-bikes. Based on the information gathered from the Penn State Transportation Services, this paper will focus on the direct user fee ($/trip), the subsidy from Penn State Transportation Services ($/trip), the reduced GHG emissions ($/trip), external benefit ($/trip), the opportunity cost of time ($/trip), and value of urgency in transportation congestion in State College ($/trip).

I calculate the total net benefit of Spin e-bike share program using the function below:

$$Total\ Net\ Benefit = \left(Benefit\ \left({}^{\$}/_{trip}\right) - Cost\ \left({}^{\$}/_{trip}\right)\right) \times Total\ Trips\ Taken$$

Below is the direct user fee of Spin e-bike share program at Penn State University Park:

- $1 to unlock per ride
- $0.30 per minute, per ride

Costs of Spin shared e-bikes at Penn State University Park include the direct user fee ($/trip) and the subsidy from Penn State ($/trip).

$$Cost\ of\ Spin\ Shared\ E-bike\ \left({}^{\$}/_{trip}\right)$$
$$= Direct\ User\ Fee\ \left({}^{\$}/_{trip}\right) + Subsidy\ from\ Penn\ State\ \left({}^{\$}/_{trip}\right)$$

Here is how I calculate the direct user fee ($/trip). The median assisted speed for an e-bike is 23.1 km/h (Berntsen et al., 2017) which is around 14.35 mph. Therefore, it will take

around 4 minutes to ride a mile on an e-bike. Therefore, $0.30 per minute multiplied by 4 equals $1.2. It costs users $1.2/mile to ride a Spin shared e-bike at Penn State University Park. There has been a total of 308,602 miles taken by Spin shared e-bikes at Penn State University Park (Penn State Transportation Services, 2023). Thus, the total direct user fee would be $370,322.4. Furthermore, there has been a total of 365,218 trips taken by Spin users at Penn State University Park (Penn State Transportation Services, 2023). With the $1 unlocking fee, consequently, the direct user fee ($/trip) would be around $2.01/trip.

In addition, to calculate the subsidy from Penn State ($/trip), it was mentioned that Penn State Transportation Services pays Spin $24,000/month to recover their maintenance costs. There are currently 500 Spin shared e-bikes at Penn State University Park (Penn State Transportation Services, 2023). It has been 20 months since the start of the Spin shared e-bike program from August 2021. $24,000 multiplied by 20 months and divided by the total number of trips would be $1.31/trip. Therefore, the subsidy from Penn State ($/trip) would be $1.31/trip. With the direct user fee ($/trip) being $2.01/trip and the subsidy from Penn State ($/trip) would be $1.31/trip, the cost of using a Spin shared e-bike at Penn State University Park is $3.32/trip.

$$Benefit\ of\ Spin\ E-bike\ Share\ program\ \left(^{\$}/_{trip}\right)$$
$$= Reduced\ GHG\ Emissions\ \left(^{\$}/_{trip}\right) + External\ Benefit\ \left(^{\$}/_{trip}\right)$$
$$+ Opportunity\ Cost\ of\ Time\ \left(^{\$}/_{trip}\right) + Value\ of\ Urgency\ \left(^{\$}/_{trip}\right)$$

Regarding the reduced GHG emissions ($/trip), the total estimated CO2 emissions saved is 91,552 lbs (Penn State Transportation Services, 2023). If I assume the price of CO2 emission

is $77/metric ton (Poelhekke, 2019) which is around $0.035/lb. Therefore, the total dollar saved from CO2 emissions would be $3,204.32. Since there has been a total of 365,218 trips, the reduced GHG emissions ($/trip) would be $0.009/trip. This suggests that the Spin e-bike share program has had a positive impact on the reduction of GHG emissions in the past 20 months.

Now that we have calculated the direct user fee ($/trip), the subsidy from Penn State Transportation Services ($/trip), and the reduced GHG emissions ($/trip), to ensure the effectiveness of the Spin e-bike share program, private marginal willingness to pay (PMWTP) ($/trip) of Penn State University Park Spin users must be greater than or equal to the total cost of the Spin shared e-bikes ($/trip).

$$PMWTP\ \left(^{\$}/_{trip}\right) \geq Direct\ User\ Fee\ \left(^{\$}/_{trip}\right) + External\ Benefit\ \left(^{\$}/_{trip}\right) + reduced\ GHG\ emissions\ \left(^{\$}/_{trip}\right) + Additional\ Amount\ of\ PMWTP$$

The external benefit includes traffic accident, congestion, and local air pollution components. Based on data from a study conducted by Ian W. H. Parry And Kenneth A. Small, I get $0.084/trip for these three external benefits (Parry et al., 2005). However, this number is not current. Thus, it is necessary to account for the current consumer price index (CPI) and the fraction of vehicle miles displaced by an e-bike mile.

1.53 is the CPI from the Bureau of Labor Statistics to convert the year 2000 prices to the year 2020 prices. In addition, to obtain the fraction of vehicle miles displaced by an e-bike mile, I divide the total miles taken by Spin shared e-bikes, 308,602 miles, by 18 miles/gallon (U.S.

Department of Transportation Federal Highway Administration, 2021) and multiplied by 0.00889 metric tons (United States Environmental Protection Agency, 2022). 18 miles/gallon is the average miles traveled per gallon of fuel consumed and 0.889 metric tons is the amount of CO2 emitted per gallon of motor gasoline burned. The total lbs of GHG emissions saved by Spin shared e-bikes are 91,552 which is 41.53 metric tons. I divide 41.53 metric tons by the number obtained from the previous calculation and get 0.272. 0.272 is the fraction of vehicle miles displaced by an e-bike mile. Therefore, the external benefit will equal \$0.084/trip multiplied by 1.53 CPI and multiplied by 0.272, the fraction of vehicle miles displaced by an e-bike mile. I get \$0.035/trip for the external benefit.

$$PMWTP\ ({}^{\$}/_{trip}) \geq \$2.01/trip + \$0.035/trip + \$0.009/trip + Additional\ Amount\ of\ PMWTP$$

The direct user fee (\$/trip), the external benefit (\$/trip), and the reduced GHG emissions (\$/trip) are \$2.01/trip, \$0.035/trip, and \$0.009/trip, respectively. The total cost of the Spin shared e-bike program per trip is \$3.32. Therefore, the additional amount of PMWTP would be:

$$Additional\ Amount\ of\ PMWTP\ ({}^{\$}/_{trip}) \geq\ 3.32 - (\$2.01/trip + \$0.035/trip + \$0.009/trip)$$

Hence, the additional amount of PMWTP must be greater than or equal to \$1.266/trip. This suggests that if the additional benefit in the following calculation is less than \$1.266/trip, the Spin e-bike share program might not be a good mico-mobility initiative for Penn State University Park to continue with.

Furthermore, to calculate the opportunity cost of time ($/trip), the majority of Spin trips on campus are used to fulfill the “last mile” which is essentially displacing walking. The average salary in State College is $22,873/year which is $11.44/hour (United States Census Bureau, 2021). The average walking speed of people younger than 30 years old is 3 mph (Alves et al., 2020) and the demographic of Penn State University Park Spin users is also less than 30 years old. The median assisted speed for an e-bike is 14.35 mph. Therefore, it saves Spin users 11.35 mph which saves users $1.008/mile. The total number of miles 308,602 divided by the total number of trips 365,218 would be 0.845 miles/trip. $1.008/mile multiplied by 0.845 mile/trip would be around $0.852/trip. Therefore, the opportunity cost of time would be around $0.852/trip.

The value of urgency reflects “ the fact that individuals often face discrete penalties for being late” (Bento et al., 2020). In reality, people are more willing to pay a premium when they are at risk of being late for an important event. The value of urgency in transportation congestion is $3.24/trip in Los Angeles (Bento, 2020). The per capita income in Los Angeles County is $37,924, and it is $22,873 in State College (United States Census Bureau, 2021). $37,924 divided by $22,873 is around 1.658. The value of urgency in Los Angeles, $3.24/trip, divided by 1.658 would be $1.954.

With the reduced GHG emissions of $0.009/trip, the opportunity cost of time of $0.852/trip, the external benefit of $0.035/trip, and the value of urgency in transportation congestion in State College of $1.954/trip, the benefit of using a Spin shared e-bike at Penn State University Park would be 2.85/trip. This number suggests that the additional amount of PMWTP is greater than $1.266/trip. This means that the Spin e-bike share program has been an overall benefit from the perspective of its direct users.

$$Total\ Net\ Benefit = \left(\frac{Benefit\ (\$)}{Trip} - \frac{Cost\ (\$)}{Trip}\right) \times Total\ Trips\ Taken$$

$$Total\ Net\ Benefit = \left(\frac{\$2.85}{Trip} - \frac{\$3.32}{Trip}\right) \times 365{,}218 = \$ - 171{,}652.46$$

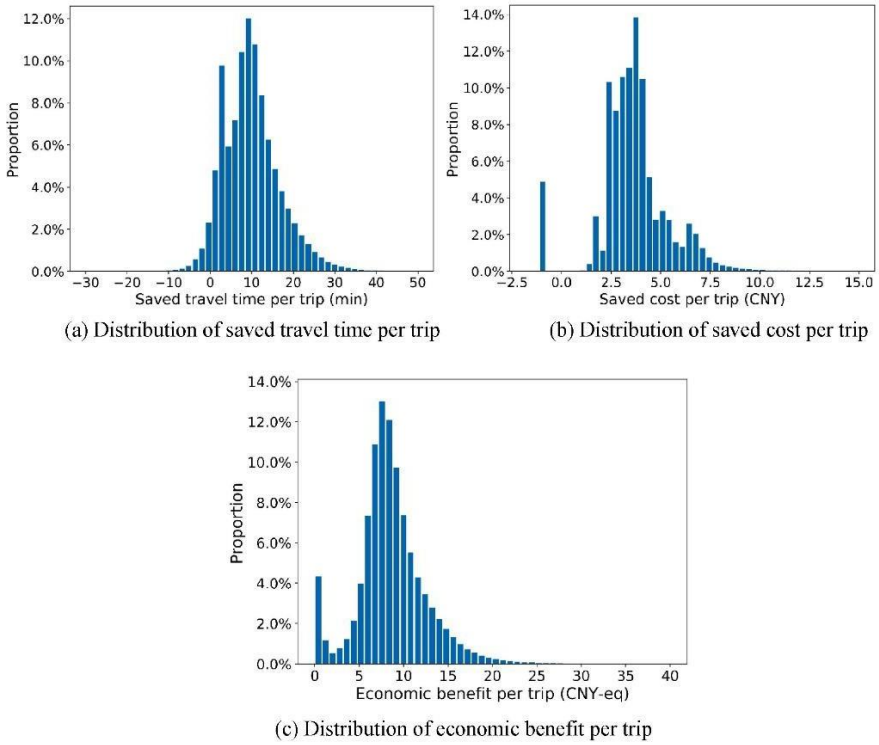
This result suggests that the total net benefit of this program is negative. However, there are limitations to this number that would be further discussed in the conclusion.

# Chapter 5

## E-bikes Programs Around the World

When comparing different e-bike programs around the world, some similarities are shared by different e-bike programs. One shared attribute is the diverse bike-sharing programs.

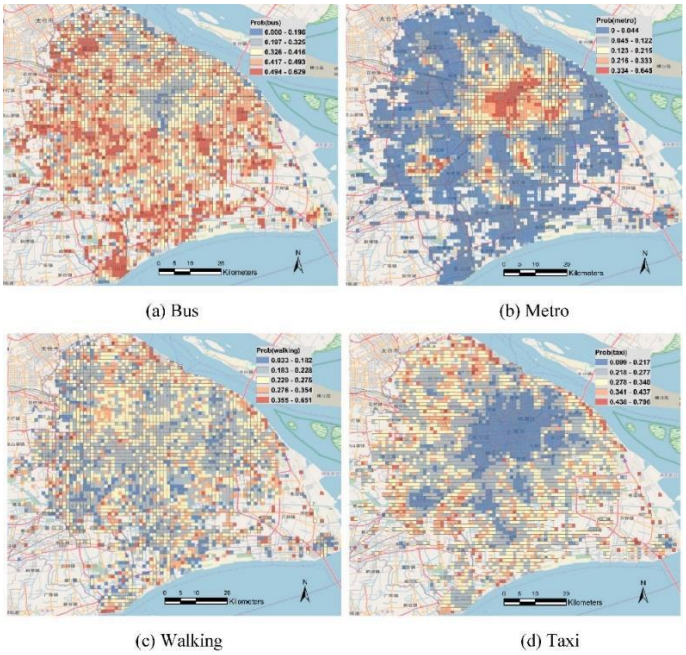
For example, the free-floating bike-sharing system (FFBS) is a type of bike-sharing program. It allows riders to lock bikes in place at their destination without having to lock their bikes at designated stations. In a 2021 study focusing on quantifying the economic benefits of FFBS in Shanghai, China, the approximate saved travel time, cost, and economic benefit of using FFBS per trip accordingly are 9.95 min, 3.64 CNY (= $0.53), and 8.68 CNY-eq (= $1.26) compared to situations that no FFBS was in place (Gao et al., 2021). Based on all FFBS data gathered in Shanghai, the annual saved travel time, cost, and economic benefits for riders accordingly are estimated to be 17.665 billion min, 6.463 billion CNY (= $938.477 million), and 15.410 billion CNY-eq (=$2.237 billion) (Gao et al., 2021). In addition, e-bikes possess advantages against carbon- intensive vehicles (personal vehicles, buses) at distances from 1-2.5 miles with the benefit of reducing transportation emissions (Kontar et al., 2022).




(a) Distribution of saved travel time per trip (b) Distribution of saved cost per trip

(c) Distribution of economic benefit per trip

**Figure 5. Distribution of saved travel time, saved cost, and economic benefit per trip (Gao et al., 2021)**



(a) Bus (b) Metro

(c) Walking (d) Taxi

**Figure 6. "The substitution rates of FFBS to different transport modes in different urban contexts" (Gao et al., 2021)**

Furthermore, regarding bike-sharing programs in other countries in addition to China, in a 2018 study focusing on European cities, researchers have also found bike sharing systems (BSS) can provide economic benefits. Car drivers can especially benefit from the promotion of BSS (Otero et al., 2018).

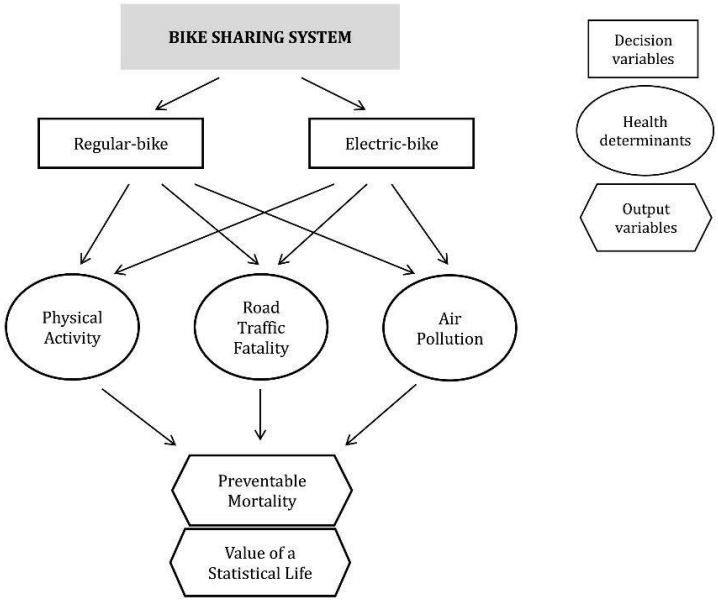



**Figure 7. "Conceptual framework of bike sharing systems and health" (Otero et al., 2018).**

# Chapter 6

## Conclusion

Based on calculations in Chapter 4, I learned that the total net benefit of the Spin shared e-bike program at Penn State University Park is negative since its adoption in August 2021. This does not align with my expectation for the total net benefit to be positive in Chapter 1. However, this total net benefit only accounts for direct user fee ($/trip), subsidy from Penn State ($/trip), reduced GHG emissions ($/trip), external benefit ($/trip), the opportunity cost of time ($/trip), and value of urgency in transportation congestion in State College ($/trip). Therefore, there are limitations to the number I calculated for the total net benefit of the Spin shared e-bike program at Penn State University Park. Other meaningful factors I would recommend including in future total net benefit calculations for shared e-bikes are:

**The Cost of Shared E-bike Per Trip**

- Additional shared e-bike related accident ($/trip)
- Damage and theft cost ($/trip)
- Insurance and liability ($/trip)

**The Benefit of Shared E-bike Per Trip**

- Decreased car-related accidents ($/trip)
- Improved traffic congestion ($/trip)
- Alleviated parking demand ($/trip)

Based on the estimations in Chapter 4, the total net benefit of the Spin shared e-bike program at Penn State University Park is negative. Therefore, there are areas for improvement in the Spin shared e-bike program. However, due to the scope of this paper, some relevant cost and

benefit factors are not accounted for in the total net benefit calculation. The benefits and costs of the Spin shared e-bike program will change in the following years due to fluctuations in costs, technological advancements, and user interests, and will require further research and studies at that time.

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**ACADEMIC VITA**

# Sihan Liu

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## EDUCATION

**The Pennsylvania State University, College of Earth and Mineral Sciences** — **University Park, PA**
*Schreyer Honors College* — *May 2023*
**Bachelor of Science in Energy Business and Finance, Minor in Korean Language**
Recognized with 11 scholarship and achievement awards for academic excellence and leadership

- Dean's List (8/8 semesters) — December 2022
- David M. Demshur Global Business Strategies Endowment — September 2022
- John D. Ridge, Biello Family Endowment for Global Business Strategies — August 2022
- 2021/2022 Energy Business and Finance Undergraduate Merit Award Winner — April 2022
- Energy Crisis Leadership Challenge (1st Place Team Lead) — April 2022
- EMS Centennial Education Endowment — August 2021
- Energy Business and Finance Scholarship in Honor of Dr. Richard L. Gordon — May 2021
- The Joseph W. and Margaret Nesbit Hunt Scholarship — August 2020
- The Matthew J Wilson Honors Scholarship — August 2020
- The Richard J. Entler Scholarship for the Advancement of Women in Energy and Sustainability — August 2020
- Outstanding Achievement in Korean Studies Award — March 2020

## WORK EXPERIENCE

**Deloitte** — **Philadelphia, PA**
*Incoming Junior Staff, Business Project Management* — *May 2023 – Present*

**Avient Corporation** (Plastics Material and Resin Manufacturing Company) — **Avon Lake, OH**
*Sourcing Intern* — *May 2022 – August 2022*

- Advised process owner on new conflict mineral platform by conducting due diligence on current suppliers, evaluating platform capabilities, and gathering stakeholder input; recommendation resulted in a 3-hour review process reduction
- Developed a dashboard in Tableau to visualize 1,433 vendor' industry classifications (manufacturer, distributor, etc.)
- Collaborated with 13 sourcing managers to reallocate 46 unassigned raw materials and regroup 90 unassigned vendors
- Improved sourcing support and resource optimization following company acquisition by reassigning 76 vendors to their appropriate stakeholders (category managers, supply chain, development opportunities, etc.) using data analyses

**Cenovus Energy** (Integrated Oil and Natural Gas Company) — **Dublin, OH**
*Marketing Support Co-op* — *May 2021 – December 2021*

- Utilized Spotfire to create a terminal dashboard with $5 million in annual revenue that automatically generates monthly margin comparison data analyses on refined products and future terminal lift schedules
- Identified 36 incremental customers for 2 refineries after developing a regional asphalt market diversification strategy
- Contributed ad-hoc analytical support for Supply Balance Coordinators by tailoring refined oil products sales insights

**EasyTransfer** (International Education Payments Company) — **Beijing, China**
*Regional Marketing Coordinator Intern* — *May 2020 – August 2020*

- Acquired 400 new clients through phone calls and online chats for the international payment service
- Nominated for team leader by the supervisor, coached and mentored 3 interns, and led weekly performance reviews
- Delivered recommendations to the supervisor on program improvements after collecting intern feedback

## RELEVANT EXPERIENCE

**Dr. Andrew Kleit's Prosumer Research Project** **University Park, PA**
*Research Assistant* *April 2022 – January 2023*

- Researched Community Solar Program financials to identify practical technological solutions for disadvantaged communities that would benefit from and participate in a clean energy transition to solar
- Examined 13 distributed energy resources (DER) initiatives in low-income neighborhoods in California and New York
- Conducted interviews with internal stakeholders of existing DER programs and collected key information regarding the sustainability and practicality of current and future programs

**Energy Crisis Leadership Challenge** **University Park, PA**
*1st Place Team Lead* *April 2022 – April 2022*

- Elected as 5-person team lead for a 21-hour capstone crisis challenge, presenting crisis responses in a board meeting and a press conference while managing competing objectives in a fast-paced, dynamic environment

**Nittany Lion Consulting Group (NLCG)** **University Park, PA**
*Associate Consultant* *January 2021 – May 2021*

- Collaborated with 2 peers on a 5-month engagement to address student organization diversity and inclusion challenges
- Facilitated primary research by developing 28 questions in Qualtrics, surveying 344 students, and delivering 2 recommendations for improvement to Smeal College of Business students organizations based on data analyses

## CAMPUS ENGAGEMENT

**Raw Aesthetic Movements** (Freestyle Hip-hop Dance Organization) **University Park, PA**
*Secretary* *August 2019 – May 2021*

- Planned 3 fundraising events, raising an incremental $4,000 for THON 2021 pediatric cancer care and research
- Coordinated 4 new outreach events and successfully recruited members to fill 7 executive board positions
- Created weekly workshop and event emails to promote engagement in hip hop dance for 200+ members

**Penn State Energy Marketing Association** **University Park, PA**
*Director of Renewables* *April 2020 – May 2021*

- Led 3 students in the renewable energy group to develop reports; published 4 market update newsletters on LinkedIn informed by self-conducted renewable energy market data analysis
- Collaborated with the club president to develop and facilitate 2 educational career workshops and a company information session with Direct Energy to prepare members for employment in the energy sector

**Korean International Club** **University Park, PA**
*Event Chair* *August 2018 – May 2020*

- Gained a strong understanding of the Korean culture by building an intercultural community
- Planned and coordinated up to 9 events per semester to help educate students on Korean traditions & culture
- Promoted the organization by tag teaming with social media chairperson to conjure new ideas

**Penn State Alternative Breaks** **University Park, PA**
*Environmental Service Volunteer* *March 2020 – March 2020*

- Engaged in daily service projects ranging from urban tree planting to environmental cleanups in Asheville, North Caroline and participated in educational workshops regarding littering and waste reduction
- Gained a deep understanding of the causes of environmental degradation and its effect on urban communities

## ADDITIONAL SKILLS & INTERESTS

**Technical Skills:** Adobe Premiere Pro, Microsoft Excel, Microsoft PowerPoint, Python, Qualtrics, Spotfire, Tableau
**Language Skills:** Fluent in verbal and written Chinese, conversational in verbal and written Korean
**Interests:** Cooking, hip-hop dance, intercultural communication, martial arts, reading