Active mobility storage on public transportation

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Abstract

From the analysis of existing literature, it becomes evident that in order to make active mobility a practical choice for a wider audience, several obstacles need to be surmounted. Foremost among these is the need for essential infrastructure and the establishment of a comprehensive, interconnected bicycle system to function as a catalyst. While personal motor vehicles continue to dominate as the primary mode of transportation, individuals can be persuaded to opt for public transport or active mobility given the right incentives or motivations.

Research surveys and interviews revealed a generally unfavourable sentiment toward using active mobility instead of cars, yet this sentiment can be effectively addressed through appropriate incentives. Equally crucial is the consideration of how the current transportation framework must adapt to fulfill the demand for a fully integrated active mobility system.

Initial concepts, drawn from both literature and research findings, have a dual focus. Firstly, they aim to enhance the bicycle parking experience at destinations and transit stops, thereby encouraging the shift in transportation preferences. Secondly, they seek to integrate active mobility seamlessly with public transit vehicles, improving the first and last segments of journeys and promoting trip chaining.

The five conceptual solutions developed address these two primary focuses, with variations designed to tackle specific challenges and criteria. While none of these concepts represents a flawless resolution to the issue at hand, they offer a conceptual framework for further refinement and development of active mobility storage solutions within the context of public transportation.

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Section 1 The Topic

Introduction

The subject of this project is active mobility storage on public transportation. Active mobility is a transportation method involving the person being active, including walking and biking. Active mobility promotes a healthier lifestyle and produces no carbon emissions compared to cars. It is also an alternative and viable transportation option for short journeys in outer city suburbs with less public transit coverage.

Public transit provides a lower-cost and more sustainable travel option that provides mass mobility, especially for commuting. Both transportation options provide alternative options to using cars and act as a social safety net for those who cannot own/drive a car. Integrating active mobility and public transport expands the coverage and use of public transit while promoting active mobility options to complete the remaining part of a journey.

This project aims to explore how the storage of personal active mobility vehicles affects peopleôs decision to use them in conjunction with public transportation options as part of the same journey. Mobility vehicles such as bikes are personal property. Thus, a user can be deterred from using if inadequate storage options do not adequately prevent theft or damage.

Special attention is to be placed on the effect of travelling from one outer suburb to another, where the first and last mile is generally necessary to complete the journey from the transit stops/stations to their destination. Additionally, outer suburb transit stops are more sparse and spaced out than inner and city stops. Thus, it can deter usage if the distance is too great between the starting point/destination and the closest transit stop.

The project design begins with reviewing existing literature and conducting research. Conclusions and gaps drawn from the literature review and research will be discussed and used to inform the design direction and proposal of concept designs. The design process and report outline are illustrated in the following.

Section 1: The topic

Introduction

Literature Review

Section 2: The research

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Conclusion

Literature review

The literature review reviews reputable knowledge on public transit, active mobility and general transportation methods. The review is used to gain critical insights into crucial area concepts, the current state of the subjects, and opinions contrary to the mainstream and previously studied areas.

According to the Napper cycling typology, there are six aggregated journey types (Napper, 2023).

- Recreation - trips involving travelling for social and recreation purposes, exercising and dining out.
- Commuting ï trips to and from work/education and utilitarian/other transportation purposes.
- Task and errands ï trips for carrying cargo, shopping and personal business.
- Passenger ï trips specifically for carrying other passengers, such as taking a child to a friendôs home.
- Work ï trips for work-related purposes such as carrying cargo or going between branches but not to/from work.
- Sport ï trips exclusively for competitive sports such as road racing or bike marathons.

This typology aims to differentiate the different journey types people take to understand the purpose/motivation of taking the trip.

Inherently, there are barriers and enablers to people choosing biking as a transportation method. Primary barriers include:

- Poor weather
- Safety perceptions
- Car-centric culture and transportation planning
- Lack of cycling infrastructure
- Too great of a distance or time requirement to reach the destination
- negative perception and attitudes of cyclists

(Walsh et al., 2021)

Primary enablers include:

- exercise, enjoyment and personal improvement
- viable transportation method ï economically and simplicity
- environmentally friendly alternative transport option

(Limb & Collyer, 2023; Walsh et al., 2021)

Bicycles have existed for two centuries, so it is a time-tested and reliable personal mobility option. Whilst cars may cover far greater distances in a shorter time span, it has a relatively high financial cost for both upfront purchase, running and upkeep (Walsh et al., 2021). Conversely, bikes are slower and human-powered (except e-bikes). However, they are far cheaper, which is not only an enable but is a crucial social safety net for those who cannot afford to use cars as their primary mode of transport (Handy et al., 2014; Walsh et al., 2021; Zhang et al., 2014).

For people to actively choose biking as their primary transportation method, it is necessary to ensure the journey is viable, convenient and desirable (before, during and after the trip). Primarily, proper biking infrastructure is necessary. This includes dedicated bicycle lanes (preferably wholly separated from motor traffic) and destination storage/parking facilities (Coxon & Napper, 2021; Heinen & Buehler, 2019; Napper, 2020). In Australian cities, there is a moderate amount of biking infrastructure but no complete biking system and a primary focus on car-centric development (Anwar, 2012); Brisbane City Council, 2021). Comparatively, in European cities, biking is much more widespread and socially accepted (Heinen et al., 2010). There are thoroughly planned and integrated biking infrastructure and a complete bicycle transport system (Heinen et al., 2010). Additionally, European cities have a higher population density with mixed-use spaces/buildings and walkable/cyclable destinations (Heinen et al., 2010). This can be attributed to those cities having been built up centuries ago in a non-automobile age.

The introduction of automobiles also came with urban sprawl and expansion. Urban sprawl can generally be characterised by low-density, single-use (e.g. only residential) and single-family homes (Buehler & Pucher, 2021). Amenities and destinations such as schools, shops and workplaces are too far for active mobility options (Buehler & Pucher, 2021). Thus, people must depend on using cars to make any trip, even quick, simple ones (Debnath et al., 2021). This is the same for public transit, as each personôs home may be too far from a stop for it to be convenient, thus leading to a decrease in service use (Coxon & Napper, 2021; Friman et al., 2019). The number of people covered by a walkable to reach public transit stop is far higher in higher-density neighbourhoods than in lower-density ones (Buehler & Pucher, 2021); (Coxon & Napper, 2021).

Like active mobility options, public transit provides a more economically viable transportation option than a personal motor vehicle (Coxon & Napper, 2021). Again, this can act as a social safety net for people who cannot use/drive a car (Coxon & Napper, 2021). Additionally, it is especially required for people who cannot drive due to impairments, as public transit provides them with independent mobility for their daily lives and needs (Coxon & Napper, 2021).

The benefits of public transport include:

- reduced congestion on roads due to the removal of potential cars on the road
- more economically viable transportation method
- reduction in air pollution

(Translink, 2023; Walsh et al., 2021)

However, there are also drawbacks of public transit and can be:

- Being stuck in the same congestion as cars (applies to buses)
- Crowding and long wait times during peak hours
- Elevated chance of contracting infections and diseases due to proximity to others
- High infrastructure costs (e.g. rail tracks, busways)
- Potentially limited frequency and capacity depending on route and time of day
- Does not go directly to a personôs destination (compared to a car)
- Longer travel times to final destination
- Lack of network funding for expansion in routes and frequency
- Routes may not go to the personôs intended destination

(Gbban et al., 2023; Translink, 2023; Walsh et al., 2021)

Whilst there may be numerous drawbacks to using public transport, it is essential to ask why people choose to use it over the seemingly more convenient automobile option. Reasons may include an inability to drive or find parking at the destination or that parking costs too much (Coxon & Napper, 2021; Handy et al., 2014). This shifts a person's choice from driving to using public transit as their primary transport option and mainly applies to commuting. When using personal mobility (e.g., car) is no longer convenient, viable or cost-effective, people seek alternatives and thus consider public transit (Coxon & Napper, 2021; Friman et al., 2019).

As per Napper (2023), suburb-to-suburb trips represent a majority of trips made aside from commuting as the reason for the journey. However, for suburb-to-suburb, the frequency of public transit service is lower compared to suburb-to-city routes (Napper, 2014). This is attributed to the hub and spoke type of transit, where most high-frequency routes travel to and from the city to the suburbs (Gbban et al., 2023). This makes suburb-to-suburb journeys additionally difficult as there may not be a direct route from one suburb to another. Instead, it would require the user to travel to the hub (city/inner city), change bus/train and then travel out of the hub and towards the spoke suburbs (Gbban et al., 2023; Napper, 2014). This exponentially increases the distance and time of a journey, thus discouraging the use of the service.

In summary, active mobility and public transport are both viable transportation methods. However, for the general population, there has to be a reason/motivator for people to choose either option over the convenience of personal motor vehicles. Infrastructure improvements and creating a system with active mobility as the focus is required to break barriers and enable potential users.

Section 2 The Research

Research

Two types of qualitative research were conducted to inform this projectôs design direction. Interviews were conducted with people with knowledge of the subject matters of active mobility and public transportation. Additionally, a survey was deployed to gather an understanding of a more general populationôs views on public transportation and active mobility.

Interviews

Interviews were one of the chosen research methods, allowing questions to be more tailored to the intervieweeôs expertise. Compared to surveys, the information captured is more accurate and from people of authority in their profession. Additionally, the questions can be more detailed, nuanced and niche, something a more general population may not be knowledgeable about nor can answer correctly.

Three interviews were conducted in total. All interviewees have a working, research and or teaching background in the active mobility and public transit area.

Participant	Role/area of knowledge
1	Associate professor at Monash University
2	Senior transport network planner at Brisbane City Council
3	E-mobility and active mobility strategy services coordinator at Brisbane City Council

All the interviews were conducted through online Zoom meetings for the convenience of both parties and with audio and video recordings, allowing the interview to be replayed and analysed. The interviewees were asked questions in two categories: one standard set of questions that all were asked and one smaller set constructed according to their background and area of expertise. This was done so that more specific information could be captured from their respective areas of expertise while also being able to corroborate more basic/standard information.

Limitations

The primary limiting factor of interviews is the limited sample size/interviews that can be conducted in a given timeframe. Compared to surveys, interviews require 30-60 minutes to conduct in addition to organising a mutually available timeslot and reviewing/replaying the interview to analyse the information. Secondly, interviews with experts in their fields may not result in a range of viewpoints, especially if the sample size is also limited. The base information may be the same. However, a personôs interpretation/opinion of a subject may be different from another personôs.

Surveys

Surveys were the other chosen research method as they allowed information to be captured more broadly from the general population. Compared to interviews, survey participants may not be the most knowledgeable about the subject matter but may still have an opinion/view. The advantage is the ability to capture the sentiment of a broader range of the population as well as a larger sample size compared to interviews.

The survey was created using QUTôs Qualtrics survey tool, with the completed survey being deployed using social media. It was distributed by asking friends and connected people on Instagram and Facebook to share it in their networks. The first level of friends and connections are of the ages 18-24 and were the majority of participants. Second-level friends and connections are more uncertain but may include participants of older age brackets.

The survey questions were constructed to be non-leading to capture an unbiased answer better. The questions consisted of rating type and short answer response questions. The rating-type questions were placed at the front of the survey to engage the participants, who may have been turned off if the short answer questions were first. The rating-type questions captured more straightforward information that gauged the participantôs sentiment. The short answer questions captured more complex information where participants could express their opinions/views on the issue. Rating-type responses were captured and displayed in a graph format that is easy to analyse. In contrast, the short answer responses had to be analysed more closely to extract the necessary information.

Limitations

Surveys are constrained by the demographic captured. This includes that the sample is limited to only an Australian demographic (more car-centric) and a more general public than expert responses. Additionally, the anonymous survey encourages people to answer freely, which attracts firm opinions that may not be useful. Finally, the survey captured responses primarily from the younger and more able-bodied generation as it was distributed from my personal connections on social media. Personal connection participants may also skew their responses to what they believe is a more favourable response for my purposes compared to their unbiased opinion.

Interviews and surveys were the two primary research methods deployed to capture information and responses that informed the direction of this project. The two research methods are complementary as they capture the opposite types of information (expert/knowledgeable vs. general populace) and reinforce the interviewsô small sample size and viewpoints with a more extensive range from surveys.

Analysis and findings

Based on the surveys and interviews, the information captured from the research will be analysed to understand the subject areas. The data needs to be analysed as the relevancy has to be determined and arranged to extract key information. That information can then be used to determine findings and conclusions for the design direction.

Surveys

In total, fifteen participants were surveyed during the deployed timeframe. As seen in Figure 1, a majority of participants own cars, with a minority also owning an active mobility vehicle. This is important as owning and using a transportation method can skew a personôs sentiment of their use. Figure 1 also shows, as predicted, that there is a general neutral or positive sentiment of using cars as the primary transportation method. This can be due to the social and cultural acceptance of using cars. However, the use of active mobility varies with an equal amount of people with positive and negative sentiments, and many participants have a neutral opinion. Of those who owned both cars and active mobility vehicles, their opinion on active mobility is either somewhat negative or neutral. This could be because, while having experienced both, they have a preference for cars over active mobility.

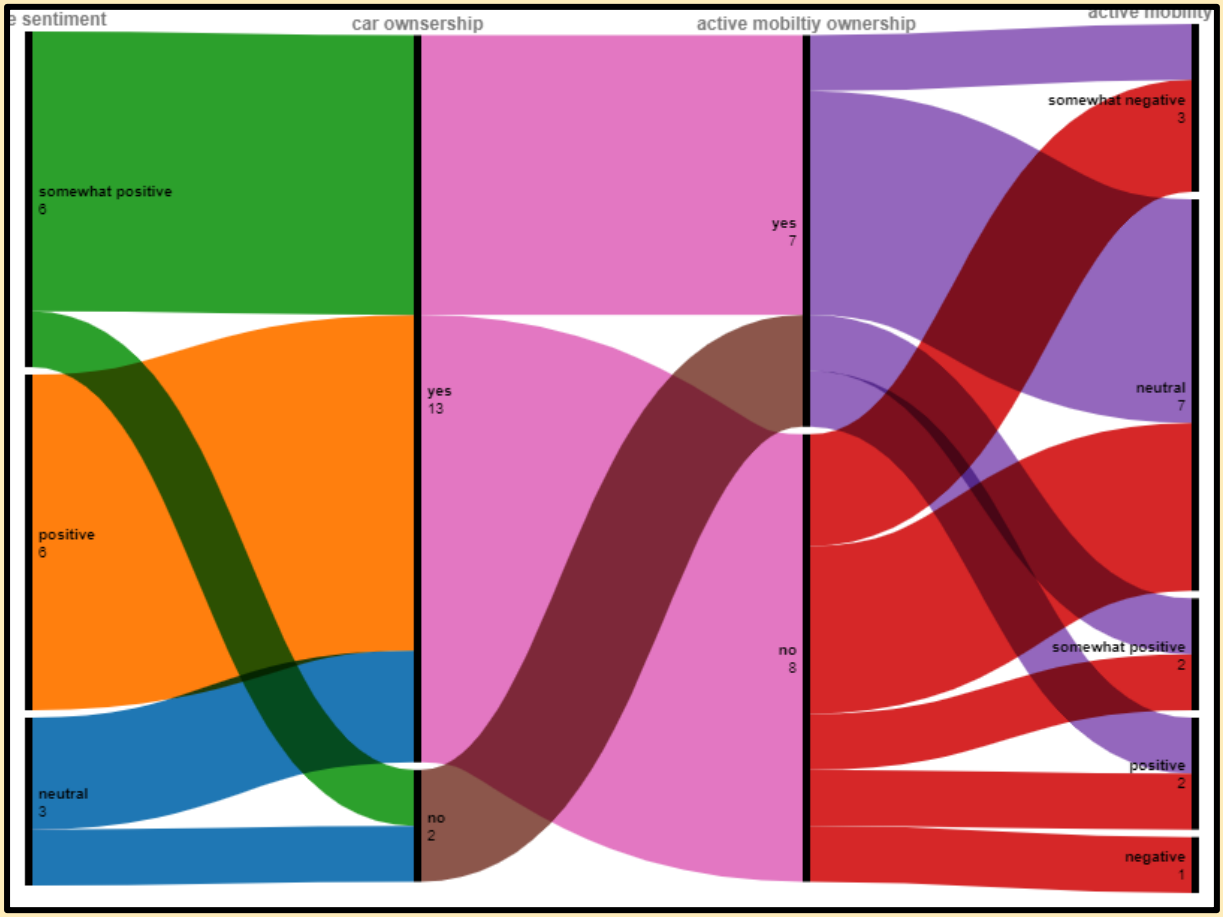


Figure 1 Alluvial diagram depicting the relationship between car use sentiment, car ownership, active mobility ownership and active mobility sentiment.

Figure 2 shows that most people would not use active mobility as a transportation option due to the seen barriers, except for physical activity, which is in the minority. The other barriers are barriers, which are generally not an issue for cars with proper infrastructure, distance is not an issue, it is convenient, perceived to be safe, and weather is a non-issue. It can be concluded that peopleôs reasons for not using active transport is not necessarily due to physical activity but instead being used to driving and the convenience of it.

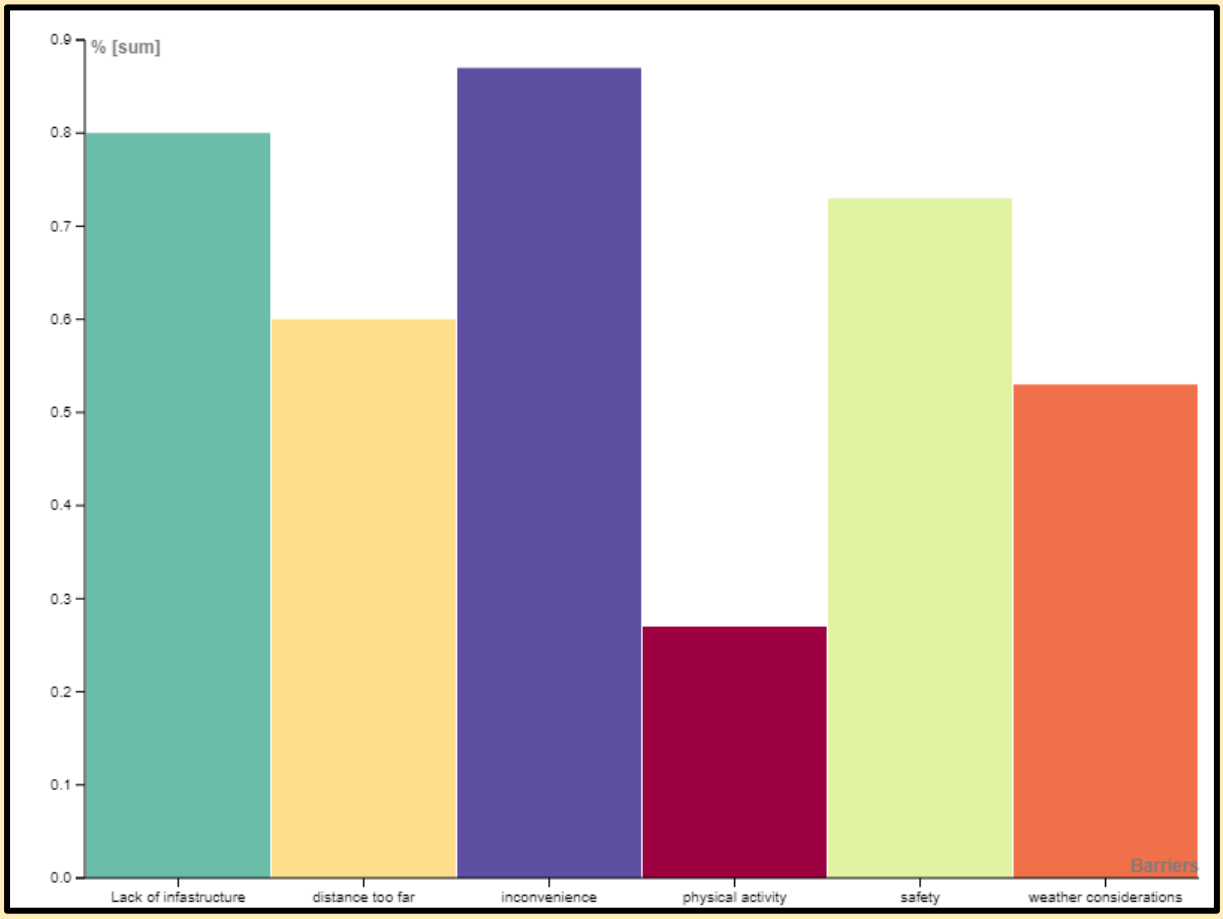


Figure 2 Percentage of respondents who agree that barriers exist for active mobility usage

From Figure 3, it can be seen that 87% of participants use public transit weekly. Compared to active mobility, public transit use is more accepted with participants having fewer objections to using it than active mobility. The two distance objections are the only two physical issues with public transit, while inconvenience and frequency objections are due to the councilôs lack of resourcing for particular routes.

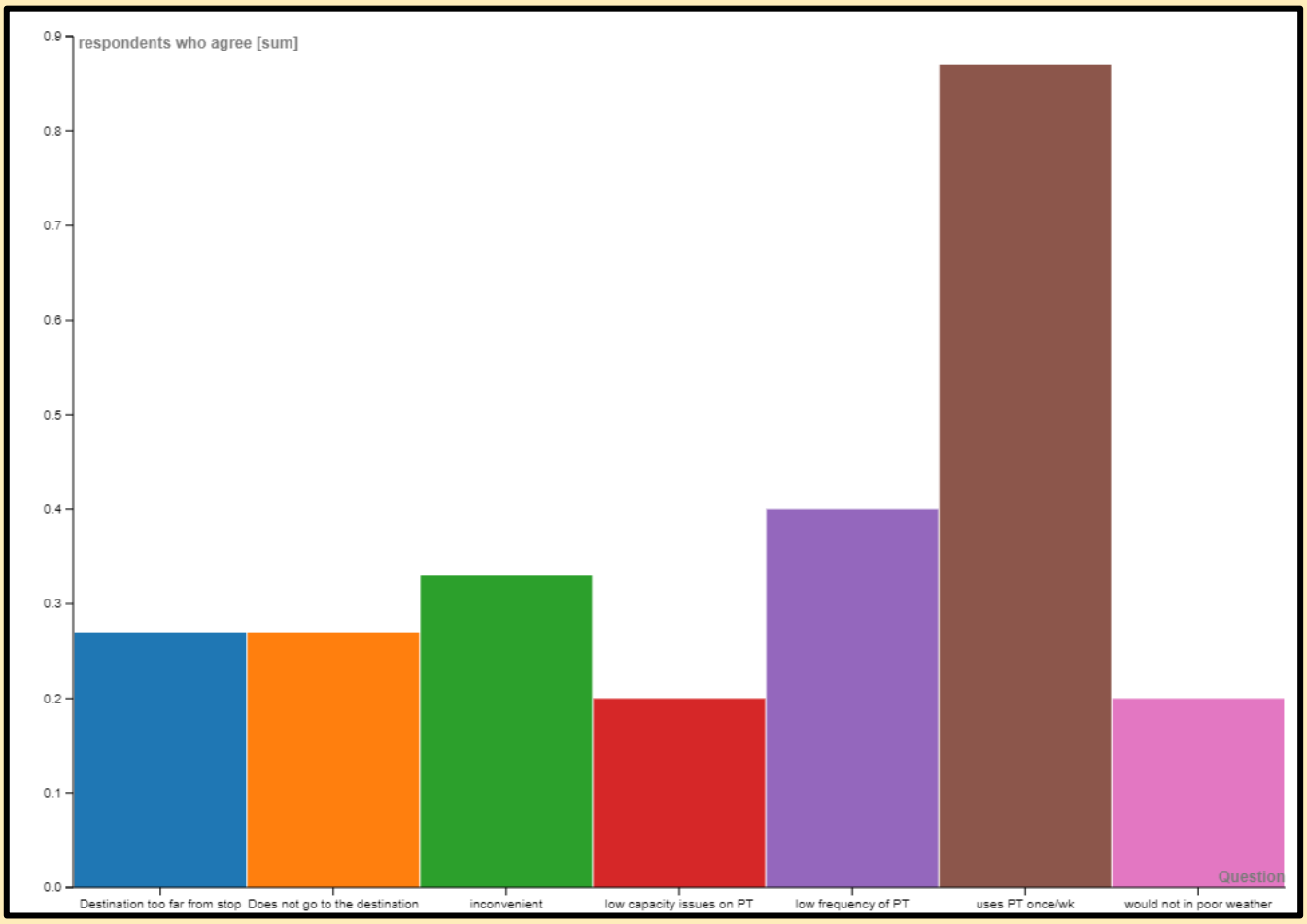


Figure 3 Percentage of respondents who agree with public transit questions

Regarding the short answer, particularly what would make participants want to use active mobility and public transit, car parking at their destination was a recurring talking point. If car parking at their destination became too inconvenient or expensive, they would consider using active mobility or public transit. The first and last-mile issue of public transit was also another focal point. Whilst active mobility vehicles would remedy this issue, most participants do not own one and cannot take it with them on public transport to complete their journey.

Interviews

P1 introduced the theme of cars vs. bikes. To create meaningful change that encourages active mobility, solutions must be benchmarked against cars to gauge whether a person is willing to meaningfully swap transportation methods when given a choice. In addition to the noted barriers previously, cultural, behavioural, technological and physical factors affect the usage and perception of active mobility. These factors also influence and are a contributing factor to the lack of a complete and integrated bike system, which cars have and dominate. In terms of cars vs. bikes, there is an inherent opportunity cost where cars (which are larger) require more resources to accommodate compared to bikes in terms of infrastructure and costs. The question posed is what the opportunity cost of accommodating cars is vs. using that resource to accommodate more (and smaller comparatively) bikes. This is important as more bikes can be served, meaning a larger number of people are served. This is crucial, with active mobility acting as a social safety net and the concept of trip chaining. Bikes are generally thought of as single trips, while journeys made by cars are thought of as making multiple trips in a journey.

P2 introduced the theme of transport planning and its effect on subsystems. The concepts of predict and provide and induced demand are crucial in resourcing public transit. With too much capacity, resources may be wasted; however, without extra capacity, demand may not rise to increase service usage. Additionally, any additional capacity dedicated to active mobility vehicles on public transit has the opportunity cost of capacity for more people on the bus/train. Predicting demand is used to plan future demand but does not necessarily change the demand for certain services.

P3 introduced the theme of the use of active mobility within and outside of a system. Storage of active mobility vehicles whilst using less space and resources than cars still requires capacity. To improve the use of active mobility or establish an active mobility system, individual systems have to be created first. These systems may not be effective individually, but it is necessary for progress to be made to create a complete system.

Section 3 Discussion and Design Implications

Discussion

Based on the literature review research conducted, two key themes emerged. The first theme is the limiting factor of active mobility due to the lack of proper infrastructure and system and inconvenience. The second theme is for users to use active mobility before and after a public transit component of the journey, especially when trip chaining.

Firstly, cars provide the convenience of driving up, parking and securing the vehicle quickly and easily. Biking, however, requires more effort and, more importantly, requires the user to actively bring their locking devices. Ordinarily, bringing a lock may be just an inconvenience; however, if it is forgotten, it becomes the case of being unable to secure your vehicular transport while the user is commuting/accomplishing their task.

Secondly, the suburb-to-city journey may be completed without needing a bike due to numerous public transit stops and routes and the proximity of destinations to the stops. However, especially for suburb-to-suburb journeys (primarily non-commute journeys), bicycles are more necessary due to the distance of public transit stops from the user's intended destination. Trains and ferries only allow a limited number of bicycles to be boarded at one time, and buses have no capacity to board bikes, especially during peak hours. Additionally, when trip chaining is considered, a bike is necessary as the journey is not just home, bus, destination and then the reverse. Instead, it may look like home, bus, destination, destination 2, destination 3, bus and then home. The distance between destinations may be too great to be walkable but is cyclable, requiring the user to bring their bicycles during every stage of the journey.

As such, the following how might we questions have been put forward to challenge the current thinking.

How might we improve bicycle parking/storage so that it is as convenient as parking a car?

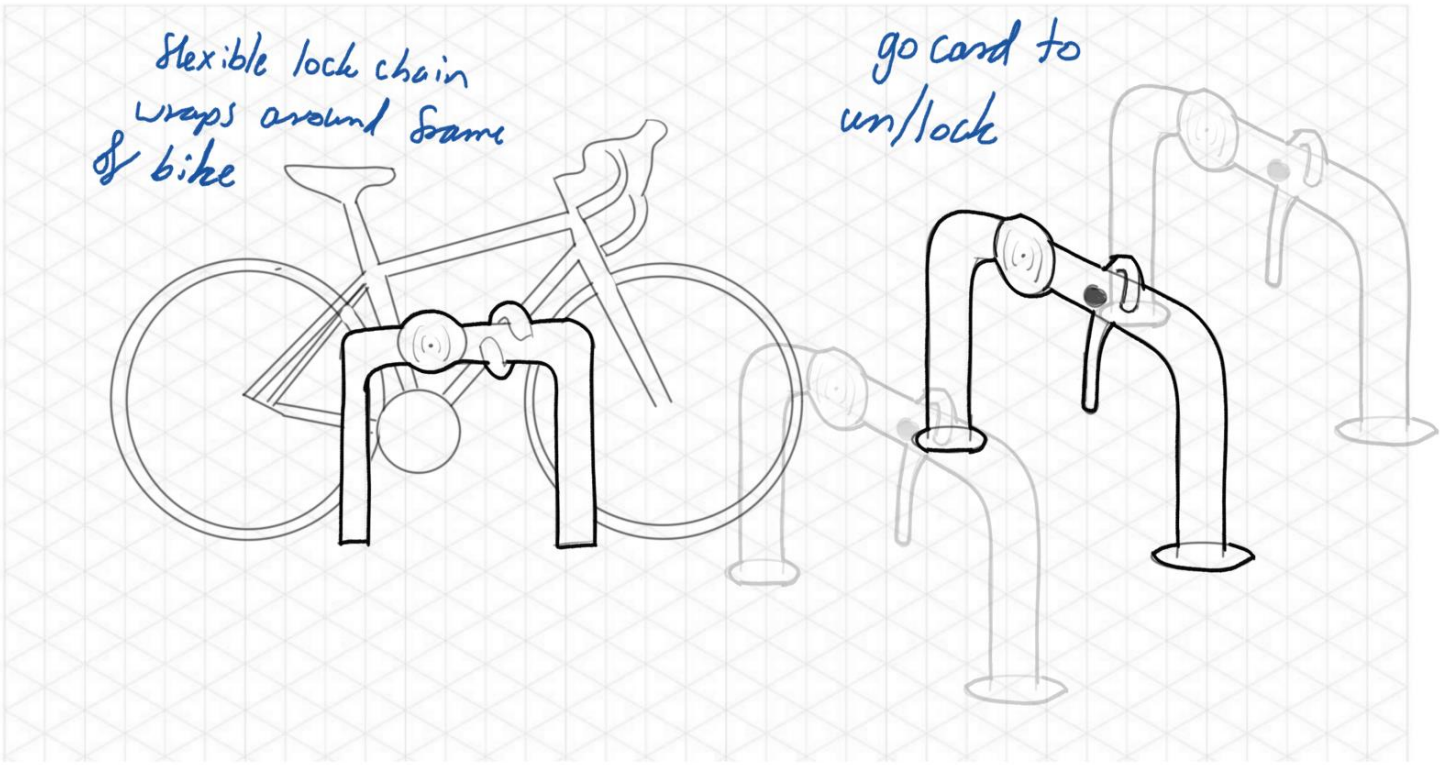
How might we modify public transit vehicles to allow passenger to bring their bicycles with them?

Design Implication and initial concept sketches

The initial concepts are split between the two themes created by the how might we questions posed based on research and analysis. Three focuses on improving the parking method and securing bikes at destinations or transit stops, benchmarking them against cars. The other two concepts focus on changing the approach to how bike journeys are made in conjunction with public transport, especially when trip chaining.

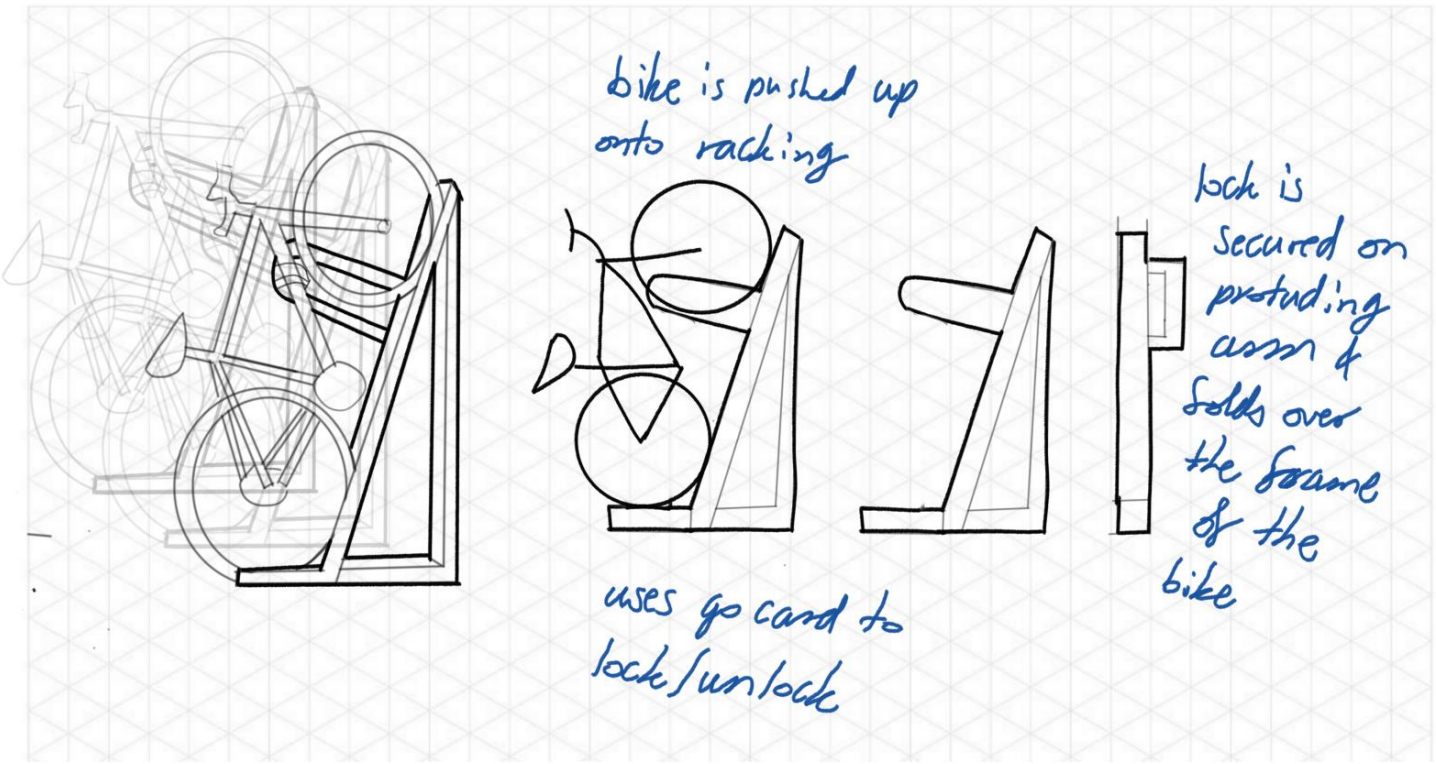
CONCEPT 1: Ride up and park

This concept utilises an integrated, flexible bike lock that is un/locked using a Go card. This allows for the convenience of arriving at the rack and parking seamlessly and securely, much like a person would with a car. The benefit is that the user does not need to remember to bring their lock. A person cannot forget the lock device for a car but without a locking device for a bike, the user cannot expect it to be there still when they return. Otherwise, the concept utilises a simple U-frame for the base rack.



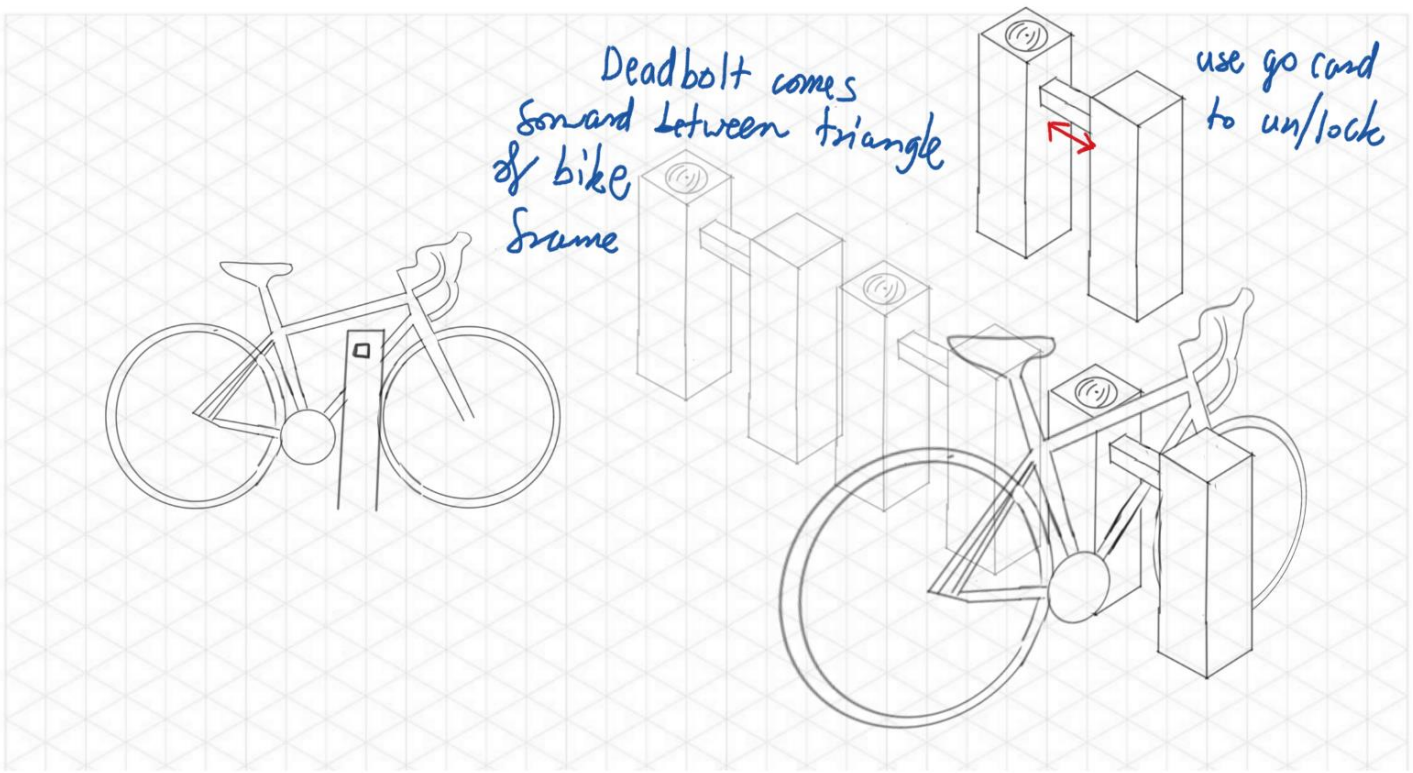
CONCEPT 2: V Ride up and park

This concept is similar to concept 1 in that it uses an integrated bike lock and utilises the go card as the key. The difference is that this concept is designed to be more space efficient with the bikes being parked vertically/at a steep angle. This concept does not use a flexible bike lock but rather a broad U-lock secured to the bikeŝs mid-frame. A go-card is the preferred un/locking mechanism as it removes the need for a key that may be stolen, discarded or removed, thus rendering the public bike rack unusable. Additionally, Go cards have a connection with transportation, can be easily acquired, provide a traceable connection to the user and unlike bank cards or similar, do not need to have enhanced security for processing un/locking requests.



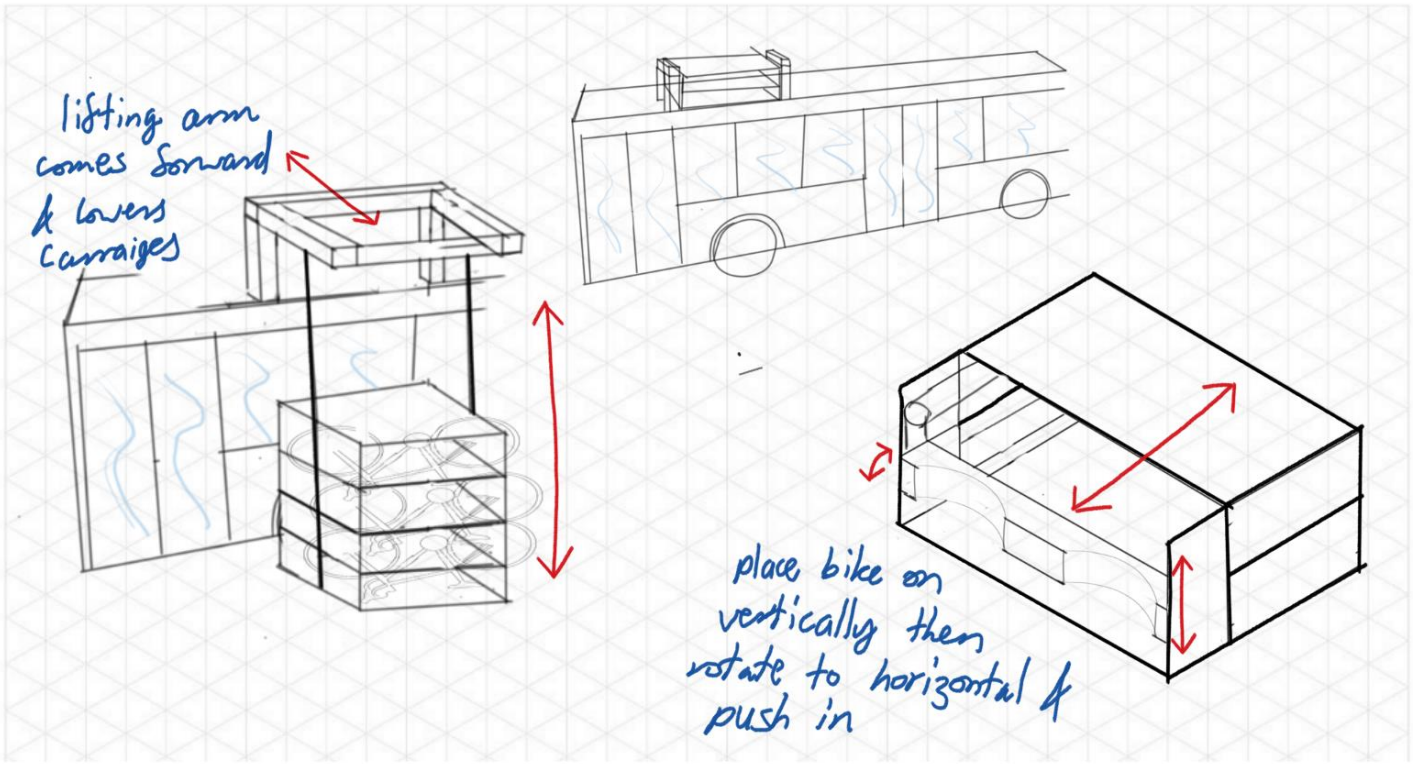
CONCEPT 3: Deadbolt immobiliser rack

This concept is similar to the previous two, using an integrated lock and go card un/locking system. The critical difference is the reinforced deadbolt that connects between the two frame pillars. This bolt is placed in between the mid-frame of the bike. This removes the possibility of removing the bike without unlocking the rack. The design is geometric and imposing to reinforce its secure aesthetic.



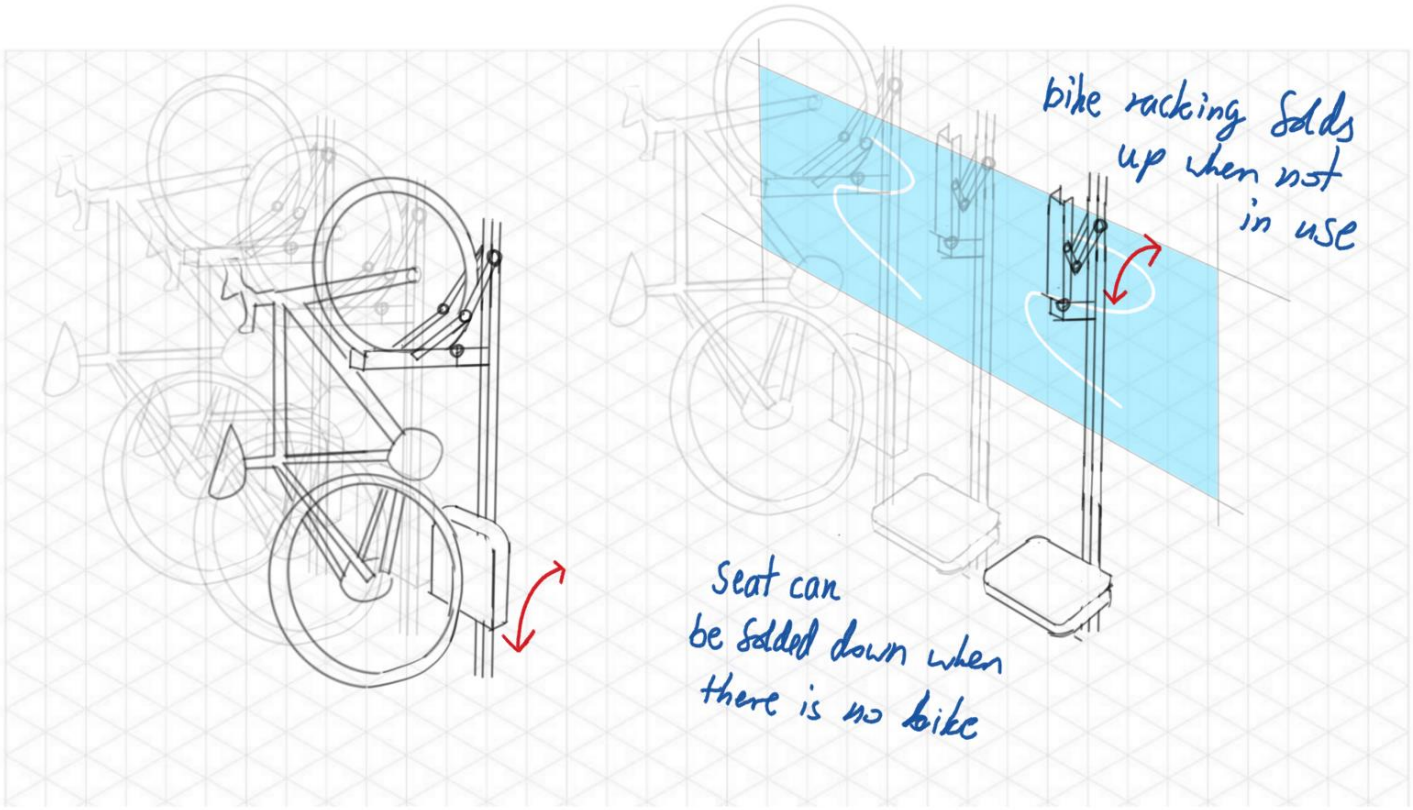
CONCEPT 4: Bicycle carriage

This concept uses a horizontal bike carriage to store the bikes on top of the bus (or train). The carriage is lowered with a crane/lifting arm. Bikes are placed on the rack upright with the wheels immobilised. The user then turns the bike horizontally, with the rack and bike then slid into the carriage. The two carriages (each carriage houses two bikes) are lifted up and stored side by side to decrease the overall height. The advantage of this system is that no capacity is given up inside the bus for passengers. Unlike front/rear mounted bike racks, it does not increase the overall length of the bus, which would affect turning radiuses and have safety considerations when used.



CONCEPT 5: Standing bike racking

This concept is an internally mounted bike rack where the bike is parked vertically with the front wheel placed onto the lowerable immobiliser. The seats mounted lower on the racking can be folded out when the bike component is not used. This also allows wheelchair and mobility scooter users to use that space when required. However, the drawback is that it will be difficult to manoeuvre bikes inside the bus during peak hours. Additionally, there is an inherent opportunity cost of having bikes there, which would not allow a pram or wheelchair to occupy the same space, especially during busier periods.



Conclusion

From the review of the literature, for active mobility to be a viable option for the many to use, barriers must be overcome, with the foremost being the required infrastructure and a complete and integrated bike system to act as an enabler. Personal motor vehicles are still the main preferred mode of transportation, but given a purpose/motivator, people accept the substitution for public transport or active mobility.

From the research surveys and interviews, it was determined that there is a general negative sentiment for using active mobility over cars, but can be overcome with enough incentives/motivation. It is also important to consider how the current transportation system has to change to create and meet demand for an integrated active mobility system.

The focus for initial concepts based on literature and research was improving the use experience of bicycle parking at destinations/transit stops to encourage substituting transportation methods. The second focus is the integration of active mobility with public transit vehicles to allow for better first and last-mile parts of a journey and facilitate trip chaining.

The five concepts were developed to address either of the focuses, with each having variations to address specific pain points and criteria. None of the concepts are perfect solutions to the problem, but they provide a conceptual direction for further development to improve active mobility storage on public transportation.

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Appendix

Appendix 1

Excerpt transcript from interview with participant 1

Interviewer: Why is active mobility important, especially in today's urban environments?

P1: Active mobility has a multitude of benefits, both for individuals and society as a whole. Firstly, it promotes physical activity, which is crucial for our health and well-being. It's also environmentally friendly, reducing pollution and greenhouse gas emissions. In cities, it can alleviate traffic congestion and reduce the need for extensive parking infrastructure. Moreover, it can lead to safer and more vibrant urban spaces, fostering social interactions.

Interviewer: What are some of the challenges that cities face when promoting active mobility?

P1: There are several challenges. First, cities often lack the necessary infrastructure like bike lanes and pedestrian-friendly pathways. Safety concerns, especially for cyclists and pedestrians sharing roads with motor vehicles, can deter people from choosing active mobility. Additionally, there's a cultural shift required to prioritize these modes over cars in many societies.

Appendix 2

Excerpt transcript from interview with participant 2

Interviewer: What are some of the key challenges in public transport planning, especially in growing urban areas?

P2: One of the major challenges is accommodating the increasing demand for public transport in rapidly growing urban areas. This often requires expanding existing systems, building new infrastructure, and ensuring that services are reliable and convenient. Balancing the needs of different user groups, from daily commuters to occasional riders, can be another challenge.

Interviewer: How does sustainability factor into public transport planning?

P2: Sustainability is a crucial consideration. We strive to reduce the environmental impact of public transport by promoting the use of clean energy sources, improving fuel efficiency, and minimizing emissions. Additionally, we work to make public transport accessible to all, which includes designing routes that connect underserved communities.

Appendix 3

Excerpt transcript from interview with participant 3

Interviewer: What are some key strategies that city planners can use to promote active mobility?

P3: City planners can implement various strategies. First and foremost, we need to develop safe and accessible pedestrian and cycling infrastructure, such as dedicated lanes and well-maintained sidewalks. Creating mixed-use neighbourhoods where people can live, work, and access services within walking or cycling distance is also essential. Finally, public awareness campaigns and incentives can encourage residents to choose active modes of transportation.

Interviewer: What challenges do city planners face when trying to incorporate active mobility into urban planning?

P3: There are several challenges. One of the primary obstacles is retrofitting existing cities designed primarily for car travel. This often requires reallocating road space and changing the mindset of residents. Funding can also be a challenge, as investing in active mobility infrastructure can be expensive, but the long-term benefits outweigh the costs.