EXPLORING OPTIONS FOR CARGO BICYCLES FOR PARK OPERATIONS

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Prepared for:
Vancouver Board of Parks and Recreation

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Executive Summary

This Greenest City Scholars report was prepared to support the City of Vancouver's (the City) goal to become the Greenest City in the world by 2020. As part of the Greenest City Action Plan goals, the City is aiming to 'green' its operations by reducing GHG emissions from operations by 50% of 2007 levels and eventually eliminating fossil fuel dependency. In keeping with that goal, the Vancouver Board of Parks and Recreation (Park Board) is aiming to reduce carbon dependency and enhance energy conservation, one element of which is to explore the feasibility of using electric cargo bicycles for park operations.

Light utility vehicles (i.e., gators, golf carts, and pickup trucks) are used by most horticulture and other operations staff to perform a broad range of park management activities. Staff have observed that there are tasks for which trucks and other gas-powered vehicles are not required, but are used because they are the only available option. These vehicles have relatively high operating and maintenance costs, some of them operate on fossil fuels, and occasionally are considered disruptive to users in parks and golf courses. Through this study, the Park Board is exploring the feasibility of replacing or augmenting the existing vehicle fleet with cargo bicycles.

The objectives of this research are to:

1. Identify parks and golf courses where cargo bicycles can be used.
2. Review the available types, technology, and manufacturers of cargo bicycles.
3. Review worldwide case studies demonstrating cargo bicycle use for similar operational activities to those in Vancouver's parks and golf courses.
4. Conduct a survey of relevant staff in selected parks and golf courses.
5. Provide recommendations and considerations for the Park Board regarding the feasibility of using cargo bicycles for park operations.

To provide context for the research, criteria for selecting applicable parks and golf courses where cargo bicycles could be used in were set. Based on these criteria, site tours, and discussions with senior staff the following locations were included in the study:

Golf Courses	Parks and Gardens
Langara Golf Course	Queen Elizabeth Park
Fraserview Golf Course	VanDusen Botanical Garden
McCleery Golf Course	Stanley Park and Downtown Parks
	Jericho Park

Staff were surveyed on their experience using light utility vehicles; their perception of the number of vehicles available to them; their familiarity with cargo bicycles; the type of cargo bicycle they would prefer for the activities they undertake; concerns that they might have about using cargo bicycles; benefits that cargo bicycles could bring to park operations; and if they believed that cargo bicycles can be used for their work.

Some important findings were:

- 91% of the respondents had limited to no knowledge about cargo bicycles
- 77% of the staff expressed the belief that cargo bicycles can be used at their location
- 46% reported that they would use cargo bicycles daily for their work
- 81% are interested in trying an electric cargo bicycle

Staff expressed that inclement weather, the ability of the bicycles to carry heavy loads and a variety of tools, and the limitations and safety of the bicycle were their primary concerns; however, staff also communicated that the bicycles would benefit them and others by lessening environmental impact, providing additional vehicles in the fleet and active and quiet transportation, and accessing some sites more easily.

Based on supporting external evidence, feedback from superintendents and staff survey results, this study demonstrates that electric cargo bicycles can be used to supplement the existing fleet of light utility vehicles and offer opportunities to reduce trips made with those vehicles.

Survey results and complementary research indicate that cargo bicycles offer some comparative advantages over light utility vehicles, including:

- Cost effective (lower capital and operating costs)
- Fast and reliable
- Environmentally friendly
- Quiet and nimble
- Positive image – public perception
- Fitness (light exercise while transporting)
- No congestion and parking problems
- No legal license requirements for drivers
- Creating a domino effect for use of cargo bicycles for other applications in the city operations; and
- Staff embraces cargo bicycles

The report presents a set of recommendations for implementing a pilot cargo bicycle program for operation at the Park Board. This includes launching a 1 to 3 month trial with two electric cargo bicycles and a follow up survey to understand how bicycles should be deployed across operational areas. The cost to acquire two cargo bicycles in the seven selected parks and golf courses would range from $99,190 to $147,000. Indicatively, the cost for one customized cargo bicycle is approximately $7,085 to $10,500 based on the two bicycle types identified by staff as the most adequate.

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1. INTRODUCTION

1. INTRODUCTION

The Vancouver Board of Parks and Recreation (Park Board) plays an important role in achieving the City of Vancouver's (the City) goal to become the Greenest City in the world by 2020. As part of the comprehensive set of actions laid out in the Greenest City Action Plan, the City and Park Board are working to reach the Green Operations goal, including reducing water use, diverting waste in city facilities and reducing carbon emissions from city operations; the latter is being addressed through this project, which explores the feasibility of replacing or supplementing the existing fleet of light utility vehicles, namely gators, golf carts, and trucks, with cargo bicycles. Vancouver is often recognized for being one of the greenest cities in the world (Smith, 2015; Worldatlas, 2017). By reducing vehicle use where bicycles are a possible form of transportation, the Park Board is demonstrating commitment to this important designation and to visitors and residents of Vancouver who visit the City's parks, golf courses, open spaces, and other facilities to feel closer to nature.

1.1 Relevant Background

- *Greenest City 2020 Action Plan, Zero Carbon Goal*: The City and Park Board are aiming to reduce GHGs from City operations by 50% from 2007 levels, a target under the Walking the Talk: Greening Our Operations goal (City of Vancouver, 2015); to meet this goal, the Park Board is seeking to reduce fossil fuel use for transportation.
- *Vancouver Board of Parks and Recreation Strategic Plan*: One of the nine goals that have been set by the Park Board is to Green Operations. The Park Board strives to minimize emissions through green policies and practices that reduce carbon dependency, enhance energy conservation and reduce waste. In the current Park Board Action Plan 2015-2018, one relevant action is to reduce GHG emissions, by reducing the number of units in fleet by 20% (Vancouver Board of Parks and Recreation, 2012).

1.2 Methodology

To capture accurate information from across relevant operational areas of the Park Board, this study was guided by the following actions:

- Collaboration with senior staff to identify parks and golf courses where cargo bicycles for operations would be feasible;
- Site tours on the selected locations to identify opportunities and limitations;
- Research on applicable cargo bicycles options and local retailers-manufacturers;
- Research on worldwide case studies demonstrating cargo bicycles for similar uses;
- Development and administration of survey for staff working in identified sites; and
- Analysis of survey results and research, and development of recommendations on how best to apply cargo bicycles as part of the Park Board's fleet.

2. OPPORTUNITIES & CHALLENGES USING CARGO BICYCLES IN PARKS & GOLF COURSES

2. OPPORTUNITIES & CHALLENGES USING CARGO BICYCLES IN PARKS AND GOLF COURSES

Vancouver Park Board operates and maintains a wide variety of parks, destination gardens, community centres, and golf courses; over 240 in total. Of these, several locations were deemed appropriate for cargo bicycles for field operations using the following criteria:

- **Size:** *Parks of at least 20 hectares were the focus of this project*
- **Topography:** *Parks that feature flat or moderately hilly terrain were considered for ease of use of the cargo bicycles.*
- **Type of paths:** *Path surfacing can affect the usability of a cargo bicycle for various tasks; asphalt is an optimal type of path for a bicycle. Parks with primarily loose surface or dirt paths were avoided.*
- **Proximity to park service yards or other maintenance facilities:** *Space for bicycle storage and maintenance is required.*
- **Type of park operations:** *Parks where horticulture using light utility vehicles is the primary activity.*

Based on these criteria, site tours and discussions with senior staff the following locations were included in the study:

<u>Golf Courses</u>

1. Langara Golf Course
2. Fraserview Golf Course
3. McCleery Golf Course

<u>Parks and Gardens</u>

4. Queen Elizabeth Park
5. VanDusen Botanical Garden
6. Stanley Park and Downtown Parks
7. Jericho Park

2.1 Opportunities and Limitations

Golf Courses

Golf course operations are unique compared to parks and gardens in that maintenance tasks must not interrupt play and most tasks must be completed before golfers arrive, between 5:00 and 9:00 a.m. These tasks include lawn mowing and course set up; light-duty tasks that can happen around golfers, like trail maintenance, gardening, filling the tee divots, hand-watering the greens, perimeter trail maintenance take place in the afternoon.

Opportunities

- Due to a limited number of light utility vehicles relative to the number of staff, moving people to work areas has become challenging and cargo bicycles can fill that gap.
- The existing fleet of light utility vehicles is being over-utilized as seen in the relevant ratios[1]; cargo bicycles can offer a larger fleet enabling staff to be deployed to more points across the golf course to complete tasks more efficiently.
- Cargo bicycles require less maintenance and have lower capital costs than gators, golf carts or trucks.
- When light utility vehicles break down their maintenance is time-consuming, compared to cargo bicycles that require relatively little maintenance.
- In many cases, light utility vehicles are used for tasks that require only a few tools that a cargo bicycle would be well-suited for.
- Cargo bicycles can be used for tasks that require transportation of staff and equipment within golf courses (e.g., line trimming, pruning, hand-watering the greens, course setup, filling the tee divots, gardening, maintenance of the perimeter trail, course inspection).
- When the gardeners are not required to carry heavy loads, such as soil or mulch, a cargo bicycle is a practical replacement for a light utility vehicle.
- Golf courses hire a large number of auxiliary staff working mostly 6-month contracts during the spring and summer season; larger staff numbers mean more requirement for vehicles.
- Preliminary discussions with staff indicate that there is support for using cargo bicycles to supplement the light utility vehicle fleet.
- Cargo bicycles are mostly ridden on hard surfaces; all the golf courses have mostly asphalt paths.
- Golf courses have a maintenance facility with enough room to store the cargo bicycles.
- Golfers need a quiet environment to play and electric bicycles are nearly silent.

[1] See Appendix A for ratio of staff to gators and golf carts.

Limitations

- Elevation: At the Langara Golf Course there is a variation in elevation of approximately 30m. from the clubhouse to the maintenance facility; winding pathways minimize the impact of this change. At Fraserview Golf Course there can be up to a 60m. elevation change in some areas, with parts of the paths posing a potential challenge for loaded cargo bicycles.
- Based on the site tours, the applications for cargo bicycles are limited for the early morning tasks (5:00 – 9:00 a.m.) that require moving heavy loads and operating specialized utility vehicles.

Parks and Gardens

The city is divided into six maintenance areas – Bloedel, Queen Elizabeth, VanDusen and Sunset Nursery; Beaches, Downtown Parks and Stanley Park; North; South; West; and Golf Courses. Stanley Park and Downtown Parks maintenance area include Stanley Park, Andy Livingstone Park, False Creek Downtown area, Sunset Beach Park and English Bay Beach Park, as well as other smaller parks located in the downtown area. Jericho Park is within the West maintenance area and includes all the parks along the seaside from Spanish Banks to Vanier Park.

Opportunities

- Cargo bicycles can be used for transportation on-site or off-site to travel to nearby locations and for operational tasks (e.g., horticulture activities, clearing paths of leaves and branches, sweeping and cleaning paths, collecting garbage, debris, etc.).
- Asphalt and gravel paths are predominant in the parks being considered and are ideal for cargo bicycles.
- Most paths are narrow and can be easily obstructed by light utility vehicles; a cargo bicycle would require less space and minimize disruption to park users.
- All subject parks have room to store cargo bicycles in their service yards.
- Preliminary discussions with staff indicate that there is support for using cargo bicycles to supplement the light utility vehicle fleet.

Figure 1: Clearing the paths from branches, leaves and typical equipment staff would use.

- Cargo bicycles can move around removable or stationary pathway bollards avoiding removing the bollard, which sometimes results in non-staff driving into parks (e.g., Bloedel Conservatory in Queen Elizabeth Park).
- The Seawall is flat and designed for bicycle access, offering existing infrastructure for using cargo bicycles.
- When using trucks on the Seawall, staff are limited to working outside of high-traffic times. Cargo bicycles can facilitate access throughout the day.
- Bicycles offer a potentially faster alternative to driving through downtown; they can circumvent vehicle traffic and need for parking.
- Cargo bicycles can access locations that the trucks cannot. For example, when picking paper, staff drive to the site and park on pedestrian pathways; cargo bicycles offer a smaller, more efficient mode of transport and make trucks available for other uses.

Figure 2: Truck driving through the pedestrian path on the Seawall.

Limitations

- Some parks have considerable hills (e.g., Queen Elizabeth Park, central part of Stanley Park, northeast part of VanDusen), which can make transporting heavy loads with a cargo bicycle difficult.
- Bicycles may not be recognized as park vehicles.
- Loaded cargo bicycles may be more difficult to maneuver around park users.

2.2 Analysis

All three golf courses and the selected parks meet all of the identified criteria and are considered suitable sites for cargo bicycles. The variety of operational activities, the lack of vehicles to efficiently distribute staff across the golf courses and parks for maintenance, and the temporary employment of staff during the dry season when the weather is favourable for cycling, indicate that cargo bicycles could be a practical addition to the Park Board's operational fleet in these locations.[2] The typical distance a staff member would travel in a day is 7 km, which is considered feasible on an electric-assist cargo bicycle.[3] Electric assist also addresses concerns about the physical exertion required of staff to cycle rather than drive. No staff member will be required to use a cargo bicycle, they would do so voluntarily.

From field observations and discussions with the superintendents it became clear that it is not possible to replace fleet vehicles with cargo bicycles, rather the bicycles would supplement the existing fleet of gators and trucks to allow specific tasks and transportation of heavy loads that cannot be done by cargo bicycles (e.g., carrying soil, mulch, specialized equipment, etc.).

Generally, the equipment carried by staff on a daily basis weighs up to 50 lbs (23 kg) for light duty operations, meaning that the tools would not exceed the payload of the cargo bicycle (Table 1). For loads of up to 200 lbs (91kg), cargo bicycles have a comparative advantage over gators and trucks (Cyclelogistics, 2014); there are a number of operational activities that fall under this category.

[2] See Appendix A for ratio of staff to gators and golf carts that indicates the scarcity of light utility vehicles.

[3] Typically electric bicycle batteries provide 30 – 100 km per charge (Mordkovich, 2015).

Table 1: Typical equipment staff uses for horticulture in parks and golf courses.

Equipment	Weight
Backpack blower	22 lbs (10 kg)
Line trimmer	13 lbs (6 kg)
Spreader (Golf Courses only)	20 lbs (9 kg)
Hose (for hand-watering)	50 lbs (23 kg)
Other long tools and hand tools (e.g., broom, rake, shovel, etc.)	1 lbs – 11 lbs (0.5 kg – 5 kg)

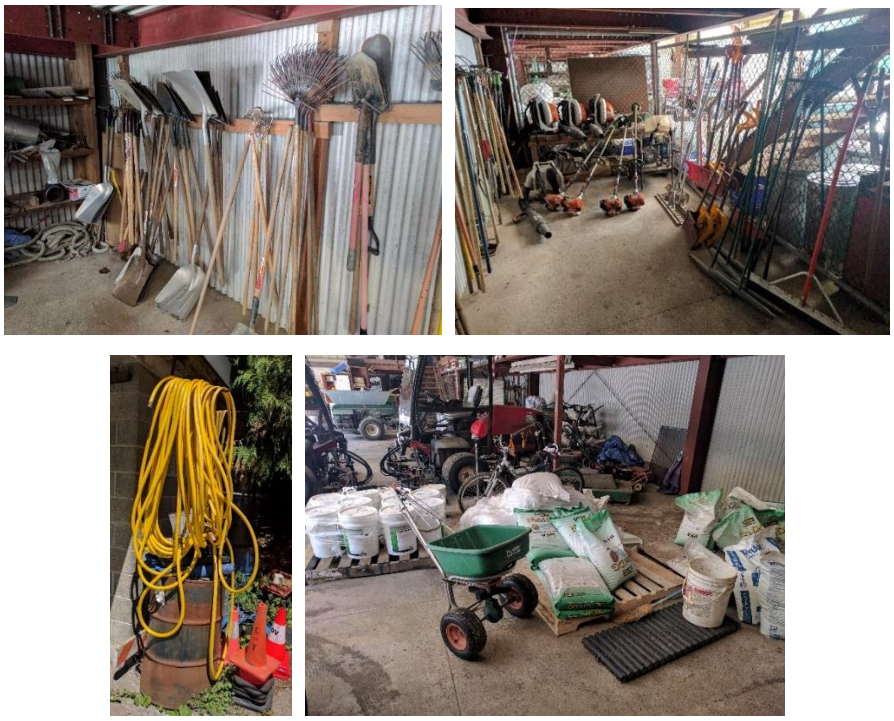


Figure 3: Various equipment used on a daily basis by the staff. The tools can be carried or attached on a cargo bicycle.

3. CARGO BICYCLE TYPES & AVAILABLE TECHNOLOGY

In recent decades, rapid development of bicycle design and technology has allowed for a wide variety of efficient transportation options for people and cargo (Armitage, 2015; Bruntlett, 2015; Walker, 2017).

Figure 4: A four-wheel cargo bicycle and a cargo tricycle designed for freight transport.

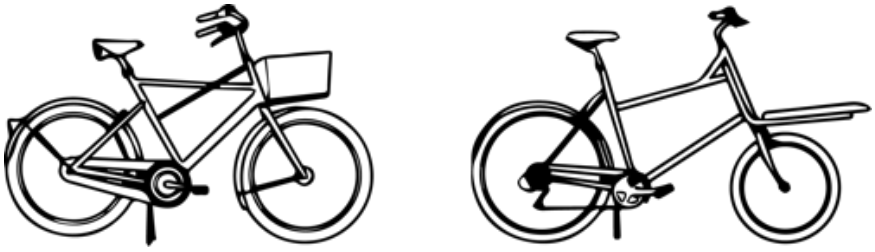
The driver of the technological advancement is primarily global enterprises who are investing in more efficient and productive technology (Figure 5) and developing new cargo bicycle models and modifications (e.g., electric assist, brakes, steering systems, etc.) (Armitage, 2015; DHL, 2015; Eriksen, 2015; Pro-E-Bike, 2016; Pickering, 2017). This has led to a surge in the potential for cargo bicycles in a wider range of applications.

Figure 5: Global courier service companies are investing in cargo bicycle technology.

3.1 Cargo bicycle types

All cargo bicycle types are based on typical bicycle designs that were modified to carry heavier loads than a regular bicycle. While there are various names for similar cargo bicycles and many different types, for the purposes of this study, four types of cargo bicycles suited to operational activities and the selected locations were selected for staff to consider. Cargo bicycles, much like gators, can be modified according to need.

1. Utility bicycle



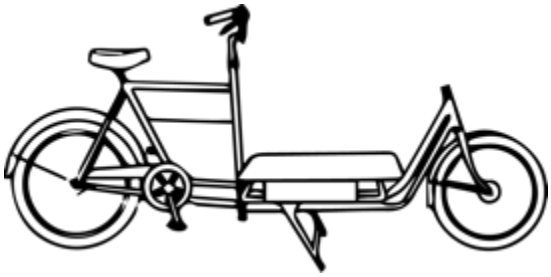
Source: Momentum Mag

Utility bicycles tend to be the same size as a regular bicycle, but are equipped with reinforced frames that enable them to carry larger loads. They may be fitted with baskets or racks on the front and/or back fixed to the handlebars or frame and can pull a detachable trailer. Compared to other types of cargo bicycles, utility bicycles and trailers have a limited payload. Adding a trailer can add maintenance requirements and present challenges for locking in public places.

Figure 6: Example of a utility bicycle and a trailer designed to carry gardening equipment.

Figure 7: Various uses of utility cargo bicycles.

2. Long john

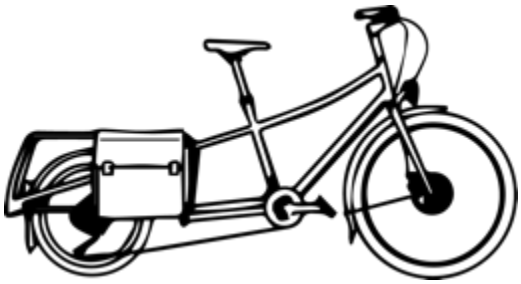


Source: Momentum Mag

A long john is an extended version of a regular bicycle that carries its payload in front of the rider between the handlebars and the smaller front wheel. It has a similar ride experience to a regular bicycle and is being used widely for various purposes, including for park maintenance tasks (Appendix D). A long john is designed to carry heavier loads than a regular bicycle and the electric assist makes it more stable when loaded, because of the initial assistance the rider receives when they start pedalling.

Figure 8: Long johns are widely used for park maintenance tasks.

3. Longtail

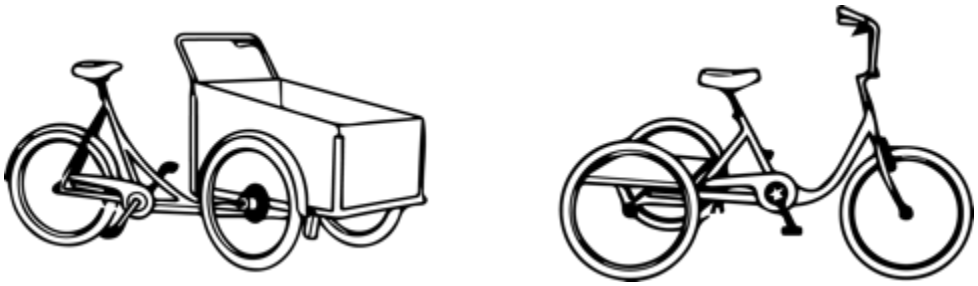


Source: Momentum Mag

A longtail is similar to a long john in that it is an extended version of a regular bicycle, only this type loads the cargo between the rear wheel and the rider's seat. The ride experience feels almost identical to riding a regular bicycle when unloaded. Usually the rear wheel is smaller for a lower center of gravity and better handling. Various professionals, including plumbers, electricians, and compost collection companies have reported using longtails (Appendix D). A longtail can be equipped with a customized utility trailer.

Figure 9: Examples of applications of longtail cargo bicycles.

4. Cargo tricycle



Source: Momentum Mag

Box bicycles and rickshaws are examples of tricycles that have cargo applications. Tricycles have a different riding experience than the other bicycles, as turns are initiated by moving the handlebars rather than shifting the weight of the rider. Most tricycle designs can carry considerably heavier loads than two-wheeled bicycles and, in some cases can be compared with a small cargo van. Cargo tricycles are typically heavier than other types of cargo bicycles. Some documented applications of this type are waste collection, street maintenance, litter pick up, last mile delivery[4], and municipal services like watering flowers (Appendix D).

Figure 10: Examples of cargo tricycles being used for street maintenance.

[4] Trucks bring goods to the edge of the city and bicycles are used to distribute to end points.

Table 2: Summary of the four different cargo bicycle types.

	Utility bicycle w/ trailer	**Long john**	**Longtail**	**Cargo tricycle**
Bicycle Types				
Average payload & width of the cargo box	175 lbs. (130 lbs. on the trailer + 45 lbs. on the front) Trailer: 24 inches	400 lbs. (incl. rider) 18 inches	400 lbs. (incl. rider) 15 inches	500 lbs. 40 inches
Attributes of each bicycle type	Regular bicycle Easily detachable trailer Adequate storage space Less payload Maintenance of two pieces of equipment Less stability when riding with trailer Need to lock both bicycle and trailer	Similar ride experience as a regular bicycle Designed to carry heavier loads than a bicycle Can be modified to carry various tools/equipment Overloading can make bicycle unstable Heavier than a regular bicycle	Almost identical ride experience as a regular bicycle Designed to carry heavier loads than a bicycle Can be modified to carry various tools/equipment Overloading can make bicycle unstable Heavier than a regular bicycle	More stable than a regular bicycle Cargo secured and weather protected Comparable with a small van Different ride experience (i.e., steering) Heavier than the other types Requires more maintenance Requires experienced mechanic to maintain
Price Range	$	$$	$$	$$$

Source of photos: Pashley, Bicycling, Splendid Cycles, Shift delivery

For a list of retailers of cargo bicycles in Vancouver and cargo bicycles manufacturers in North America, see Appendix C.

3.2 Electric assist

Electric assist technology for bicycles has evolved, making it more reliable and cost-effective. Some advantages and disadvantages of using electric cargo bicycles are:

Table 3: Advantages and disadvantages of electric assist on bicycles (Adapted from Mordkovich, 2015).

Advantages	Disadvantages
Making cycling accessible to everyone	Heavier than conventional bicycles
Travel farther	More specialized, complex parts
Light exercise - Improved fitness	Greater initial investment
Cheap transportation	

Electric assist is divided in two categories (Prebus, 2013; Mordkovich, 2015):

- Pedal Electric assist, also known as "pedelec", enhances the efforts of the rider only when they are pedaling and disables the motor when braking. Two sub-categories exist in pedal-assist. The first provides assistance upon detecting pedal strokes and the second provides assistance when a chosen level of torque is reached (e.g., when the rider begins climbing a hill).
- Power-on-demand, describes throttle-activated assistance that is usually handlebar-mounted much like motorcycles or scooters. The rider can use the electric assist without pedaling and brakes like a standard bicycle.

Figure 11: Pedal electric assist (left) and Power-on-demand (right).

Some electric bicycles combine pedal-assist and throttle technologies such that they include both a manual throttle and pedal assist system, and riders can choose varied levels of assistance.

The comparative advantage of pedal electric assist is when the rider requires frequent use of the motor assist. If the bicycle is being used in varied conditions like hills, power-on-demand would be more efficient.

For more information regarding the different motor technology types for electric assist and for regulations governing electric bicycles in British Columbia, see Appendix B.

3.3 Accessories, cost, and maintenance

Accessories

Some accessories can make cargo bicycles more suitable for operational activities including:

- Double kickstand to ensure that the bicycle will not fall over, especially when loaded.
- Metal pedals with steel pins usable with a variety of heavy-duty footwear to provide traction and avoid breaking.
- Comfortable saddle.
- Bell or horn to notify any traffic (pedestrian, bicycle, vehicles) that a bicycle is present.
- Frame locks for cargo bicycles left unattended at public spaces to prevent theft. Locks can be connected to additional accessories such as chains or cables to protect the bicycle even more effectively against theft.
- Rain covers and fenders.
- Custom brackets for carrying operations-specific tools.

Figure 12: Example of a frame lock on a bicycle.

Cost

Prices range from $2,000 - $11,000 depending on the bicycle type; modifications may cost $150 - $2,000. The average price for a modified cargo bicycle would be around $5,500 (personal contact, Shift Delivery & Reckless Bicycles Stores[5], 2017; Angus, 2015).

[5] Shift Delivery & Reckless Bicycles Stores operate in Vancouver, British Columbia, Canada

Maintenance

Cargo bicycles can be more complicated to maintain than regular bicycles due to unique steering linkages, long chains, internal hubs and other unique features and require some mechanical knowledge that could make a trail-side repair difficult (Angus, 2015). Issues like flat tires or minor chain problems can be fixed on the spot, provided that staff using them have received appropriate training. Staff can be trained or contract bicycle mechanics can be hired to perform regular maintenance on the bicycles to avoid major issues.

4. CASE STUDIES & LESSONS LEARNED

Since the 1990's, there has been a steady growth in cargo bicycle usage worldwide (Jorna & Mallens, 2013). Cities across the world use cargo bicycles to deliver goods and services including home care, gardening and waste collection, and cargo bicycles are showing up as part of municipal fleets (Cyclelogistics, 2013; Hagen, Lobo & Mendonca, 2013).

The popularity of electric-assist bicycles is growing as the technology becomes cheaper and more reliable. Travelling longer distances, less charging time, longer battery life, and lighter batteries are just some of the technological advancements that have come about allowing riders to move larger and heavier loads with less physical exertion (Jorna & Mallens, 2013; Mordkovich, 2015).

Today, Europe is leading the way in cycling and cargo bicycle use. Cyclelogistics, an initiative funded by the European Union aims to reduce energy and fuel emissions in urban freight transport by using more cargo bicycles for goods transport in city centres throughout Europe. They enable start-up businesses and municipalities that use cargo bicycles and aid in promoting the use of cargo bicycles more broadly. Cyclelogistics estimates that 51% of all motorised trips in European cities that involve transport of goods could be shifted to bicycles or cargo bicycles, which would result in a 30% reduction in the current energy consumption associated with urban transport (Eriksen, 2015).

Cities like Copenhagen and Amsterdam are known as cargo bicycle capitals of the world; however, Rio de Janeiro and Sao Paulo in Brazil have embraced the cargo bicycle culture and use them extensively for goods delivery, demonstrating that cargo bicycles can be and have been successful across the world (Hagen et al., 2013).

Cargo bicycles are being used by corporations like FedEx, DHL, and UPS that provide mail, parcel, and courier service for 'last mile delivery' as well light-duty street maintenance in Copenhagen where they use over 20 bicycles. Cargo bicycles are being used across a much wider range of applications beyond delivery services thanks to electric assist technology making cargo bicycles more reliable source of transport (Figure 13) (Cyclelogistics, 2014; Pro-E-Bike, 2016).

Figure 13: Some applications of cargo bicycles in Copenhagen.

Global cargo bicycle use can be broken into three categories.

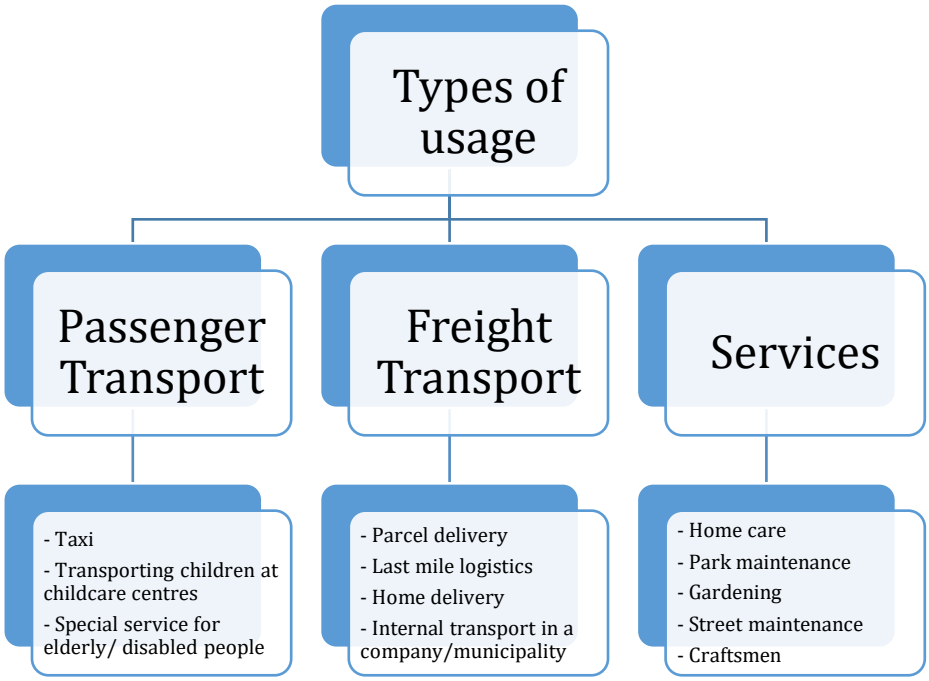


Chart 1: Types of professional cargo bicycle usage (Adopted from Jorna & Mallens, 2013).

The focus of this research is on services, where the main purpose of the cargo bicycle is to transport the rider and, optionally, equipment or other cargo. This category is especially relevant to gardening, park and street maintenance as evidenced by small gardening and landscaping companies who do not have to carry large amounts of equipment finding the electric cargo bicycle a cost-effective and environmentally-conscious mode of transport (Appendix D).

Figure 14: Use of cargo bicycles for street maintenance in three different European cities (Copenhagen, Frederiksberg, and Zagreb). Over the past decade many cities in Europe incorporate cargo bicycles in their fleet for maintenance activities, especially in the urban setting.

4.1 Case studies

Park maintenance in Stockholm

A great example of using cargo bicycles for park maintenance is the Royal Djurgården, located in the heart of Stockholm, Sweden. Djurgården consists of historical buildings, museums, yacht harbours, the open-air museum Skansen, and extensive stretches of forest and meadows. It is one of Stockholm residents' favorite recreational areas and tourist destinations, attracting over 10 million visitors per year, akin to Stanley Park's 8 million per year ("Visit Djurgården", n.d.).

At Djurgården, operations staff explored alternatives to complement their existing fleet of small pickup trucks and golf carts and found that cargo bicycles allowed them greater mobility and accessibility within the park without disturbing visitors (personal contact, Gunnar Björkman, 2017).

Staff were initially reluctant to use the bicycles due to lack of confidence and familiarity with a long bicycle but, with use, staff saw the multiple benefits and now regularly use a fleet of 5 cargo bicycles. The long john bicycle is used at Djurgården to carry equipment weighing up to 220 lbs (100 kg) of equipment, including lawn mowers, line trimmers, and hand tools, in the spring and summer months; bicycles are maintained and stored over the winter. Djurgården's manager noted that no driver's license is required for the bicycles, which expands the potential hiring pool (personal contact, Gunnar Björkman, 2017). See their promotional video.

Figure 15: Djurgården uses electric long-john cargo bicycles for park maintenance.

Table 4: Other examples where bicycles are used for park maintenance.

Location	Cargo bicycle type
Naples, USA	Cargo tricycle
Plovdiv, Bulgaria	Long john
Norfolk, United Kingdom	Longtail
Melbourne, Australia	Longtail
Berlin, Germany	Long john
Stockholm, Sweden	Utility bicycle & Cargo tricycle
Lund, Sweden	Cargo tricycle
Portland, USA	Regular bicycle with trailer

Street Maintenance

In July, 2017, the City of Edmonton introduced a fleet of electric cargo tricycles equipped with solar power water pumps to water plants along the Downtown Bicycle Network. The City of Edmonton found that cargo bicycles were a cost-effective solution, that will help to promote cycling and Edmonton's vision for a sustainable future. As Peter Mueller (park operation co-ordinator) stated: "In total, each cost about $8,500. Compared with the cost of renting and fueling trucks, the trikes will pay for themselves in about a season and a half" (Leitch, 2017). The bicycles were also introduced in response to public concern about trucks blocking bicycle lanes and damaging bicycle lane barriers and were immediately welcomed by Edmonton residents (Ramsay, 2017).

Figure 16: Before and after watering the planters in Edmonton.

The City of Graz, Austria commissioned a custom-made tricycle to be used for street cleaning. With some hesitation, a staff member volunteered to use the bicycle, which has since been used regularly and greeted with excitement by residents. Graz has since purchased two more cargo tricycles (Martens, 2014).

Figure 17: Alois was the first employee to use the electric cargo tricycle, due to his enthusiasm cargo bicycles have been used by the other staff as well.

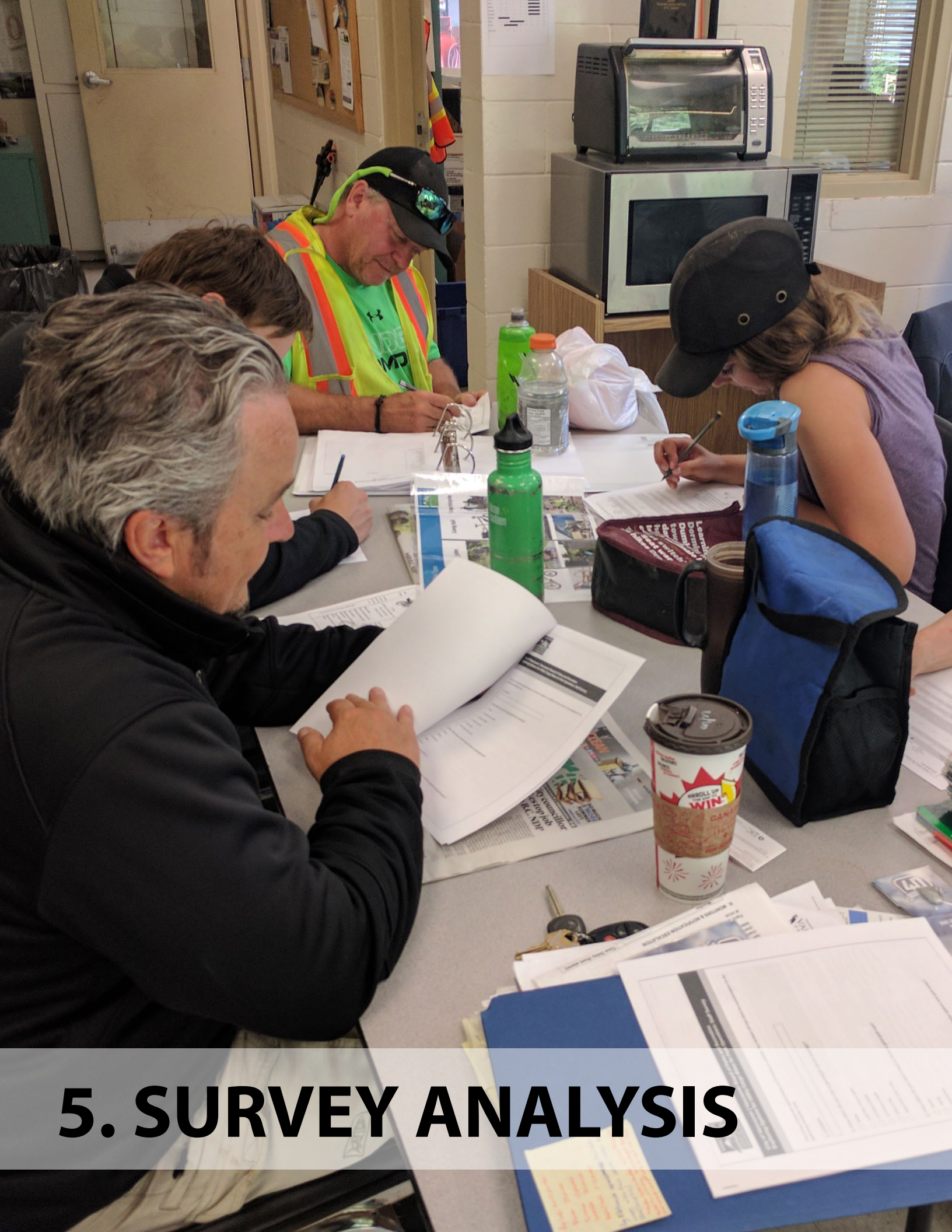
Table 5: Other examples where bicycles are used for street maintenance.

Location	Cargo bicycle type
Philadelphia, USA	Cargo tricycle
Zadar, Croatia	Cargo tricycle
Copenhagen, Denmark	Cargo tricycle
Frederiksberg, Denmark	Cargo tricycle
Zagreb, Croatia	Cargo tricycle

For more case studies see Appendix D.

4.2 Key messages from case studies

- The case studies presented demonstrate that cargo bicycles are being used for park maintenance tasks.
- City employees were initially skeptical of the potential benefits and ease of use of the cargo bicycles; however, after trying them out and becoming familiar with the bicycles, they felt the bicycles were a good addition to the fleet. In some cases, other staff requested cargo bicycles based on colleagues' experiences.
- Park maintenance staff have reported that cargo bicycles made their work easier, more enjoyable, and healthier.
- Providing cargo bicycles to staff for trials and gradually augmenting the city's fleet with bicycles has been a successful way to introduce cargo bicycle programs.
- Cities across the world can and have made the successful transition to cargo bicycles.
- Cargo bicycles can be used for a variety of different tasks, including, but not limited to, delivery of post and parcels, park and street maintenance, and waste collection.
- Pro-active maintenance on cargo bicycles can save time and money.
- The battery of a cargo bicycle must always be secured.
- The cost savings from fuel, maintenance and capital are significant.
- Significant reductions in air and noise pollution were recorded, benefitting the city and its citizens.
- Flat topography encourages cycling, but hills and other challenges like long distances can become negligible with electric assist.
- Using cargo bicycles is especially practical in dense cities and over short distances.
- Local climate (e.g., rain and snow) can dissuade people from riding bicycles, but a positive bicycle culture can go a long way to encourage it.
- Municipalities have the power to promote the use of cargo bicycles more broadly by including them in their fleets and minimizing the use of motor vehicles.



5. SURVEY ANALYSIS

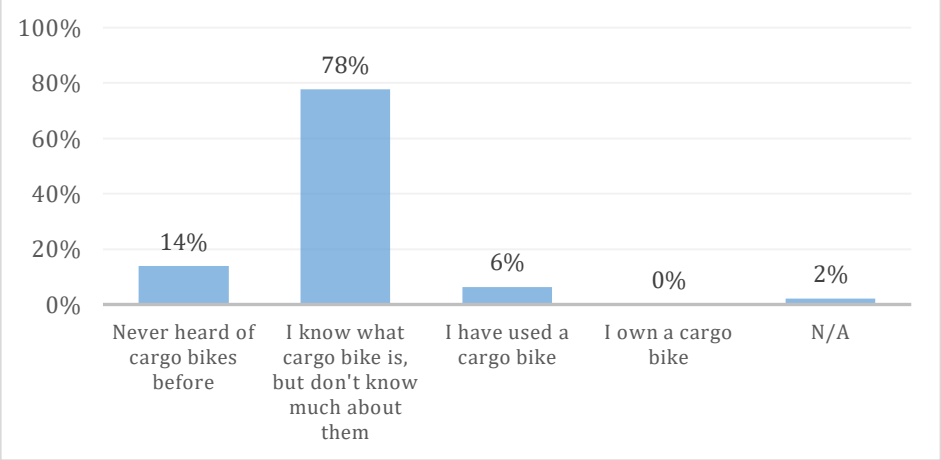
An integral part of this study was the feedback the Park Board received from staff through a survey designed to better understand staff interest, ability and experience with cargo bicycles. Staff were provided an opportunity to try an electric cargo bicycle and ask questions about the applicability of the bicycle to their work and the motivations for the study.

The survey included questions related to, the use of light utility vehicles; the perception of staff regarding the number of vehicles available to them; their familiarity with cargo bicycles; the type of cargo bicycle they would prefer for the activities they undertake; concerns that they might have regarding the use of cargo bicycles; benefits that cargo bicycles could bring to park operations; and if they believed that cargo bicycles can be used for their work. For survey results for each location and the survey, see Appendix E.

This survey aimed to receive feedback from all horticulture staff member working in the selected parks and golf courses. The survey was intended for approximately 100 staff, 94 of which responded.

Most staff had only limited knowledge of cargo bicycles before the presentation and survey (Figure 18). No one owned a cargo bicycle and only a few had used one before, which meant they had limited understanding of cargo bicycle capabilities. Ninety-one percent of the staff had the chance to ride only one cargo bicycle type for the first time in our presentation and look at pictures and descriptions of the other three.

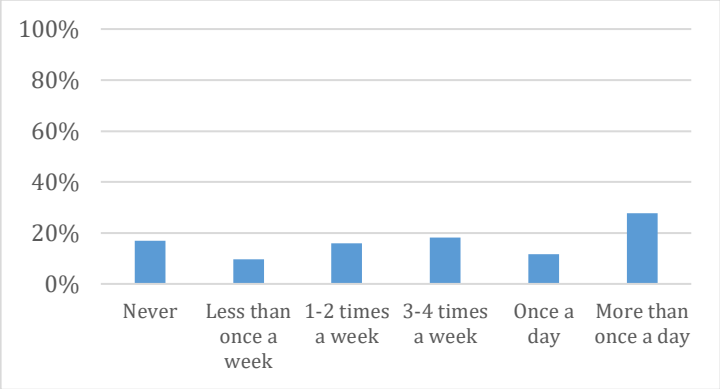
Figure 18: Familiarity with cargo bicycles.



Note: N/A represents no answer.

The majority of staff (83%) use light utility vehicles to some extent; almost 40% of the staff use a light utility vehicle at least once a day; 17% don't use one at all.

Figure 19: How often staff uses a gator/golf cart.



Staff members (38%) find it difficult sometimes to book a light utility vehicle, while 20% of staff often cannot book a light utility vehicle when they need one. The majority of staff (80%) stated that there is a lack of light utility vehicles, demonstrating a need for additional transportation options. When we asked if cargo bicycles can be used at the location that they work, 77% said that they agree somewhat or strongly (Figure 22).

Figure 20: How frequently staff find it difficult to book a gator/golf cart.

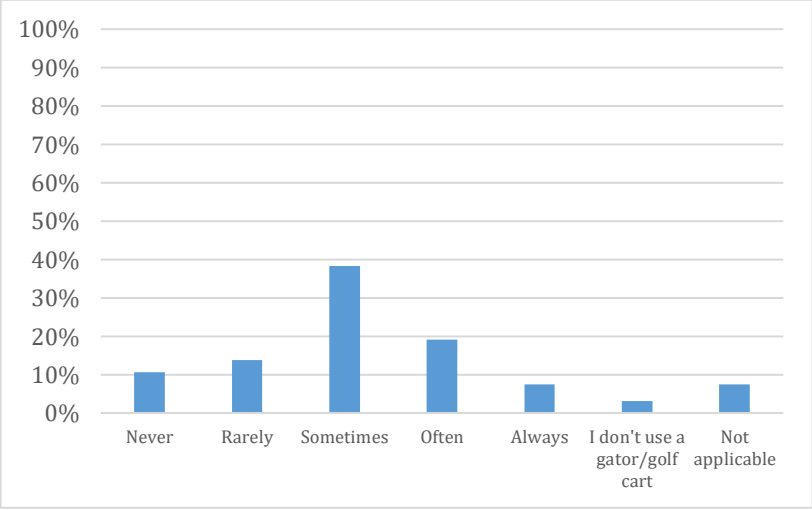
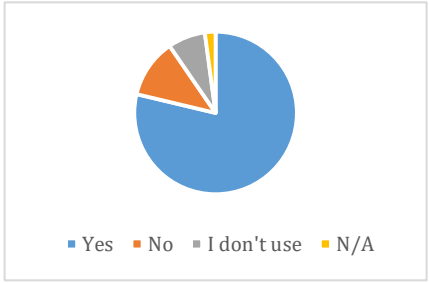
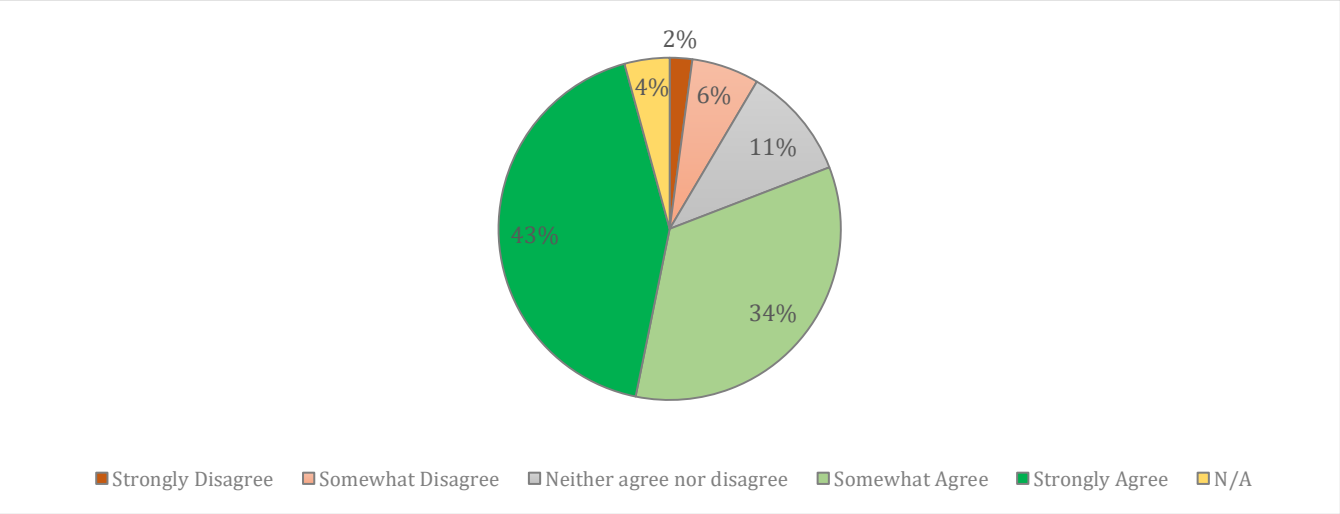


Figure 21: Do you feel there is a lack of light utility vehicles?



Note: N/A represents no answer.

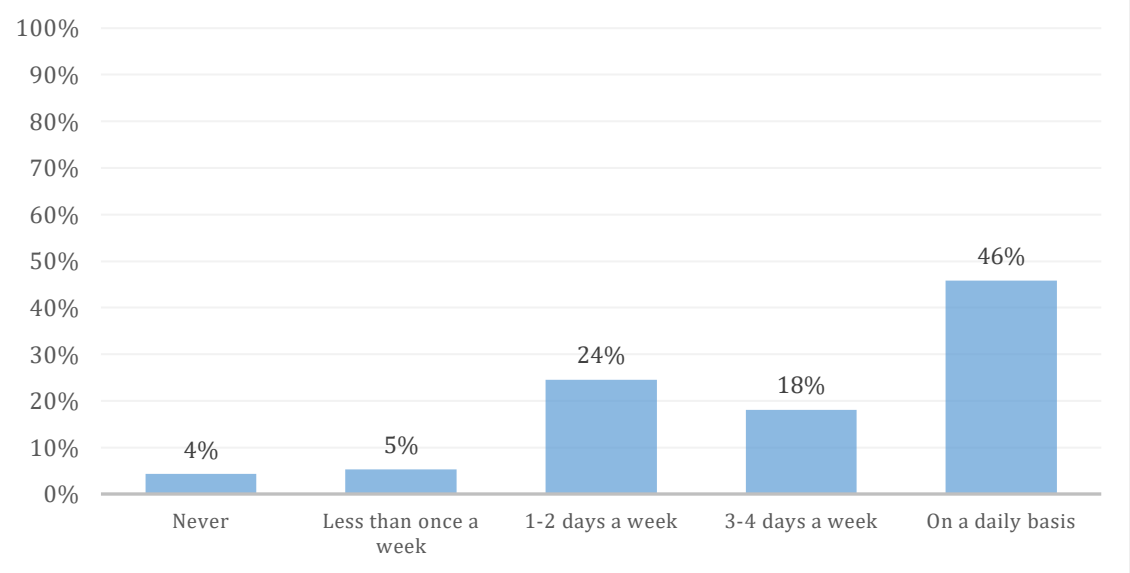
Figure 22: Can cargo bicycles be used where you work?



Note: N/A represents no answer.

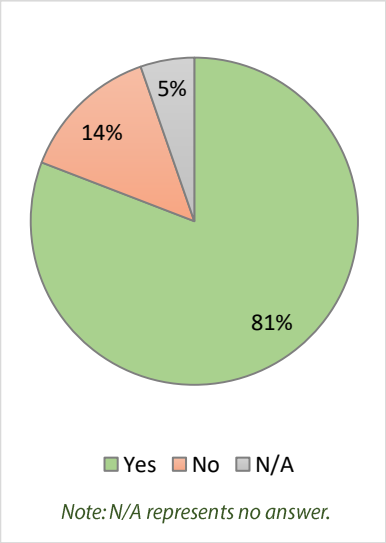
Following this positive feedback, when staff members were asked how often cargo bicycles could be used for the work they do, almost half replied every day (Figure 23). However, some staff members pointed out that they would not use cargo bicycles in inclement weather.

Figure 23: How often do you think cargo bicycles could be used for your work?



The majority of staff want to try cargo bicycles with 81% replying positively to trying an electric cargo bicycle (Figure 24). Langara Golf Course staff had a 100% positive response to trying electric cargo bicycles. In every location more than 50% of the staff were interested in testing a cargo bicycle for their work (Table 6).

Figure 24: Are you interested in trying an electric cargo bicycle?



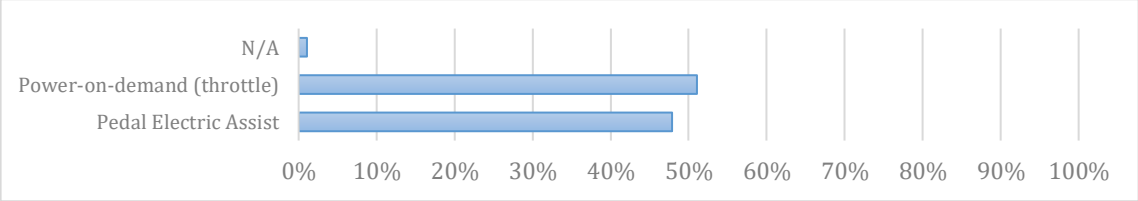
Note: N/A represents no answer.

Table 6: Responses regarding interest in trying electric cargo bicycles.

Location	Yes	No	N/A
Langara Golf Course	100%	0%	0%
Fraserview Golf Course	64%	27%	9%
McCleery Golf Course	85%	8%	8%
Queen Elizabeth Park	58%	25%	17%
VanDusen Botanical Garden	87%	13%	0%
Stanley Park and Downtown Parks	86%	11%	4%
Jericho Park	75%	25%	0%

When asked which electric-assist technology staff would prefer to use, responses were almost evenly split with 51% leaning towards power-on-demand (throttle) (Figure 25). Note that staff were only able to try the pedal electric assist as part of the survey.

Figure 25: Which electric assist would you prefer?



Note: N/A represents no answer.

Staff expressed their top 5 concerns from greatest to least:

Table 7: Most important concerns for the use of cargo bicycles by staff.

	Concerns	
Greatest Concern	**1. Weather restrictions (rain, snow, etc.)**	22%
	2. Weight handling capacity	21%
	3. Tools capacity	15%
	4. Can perform limited tasks	14%
Least Concern	**5. Safety**	14%

Weather restrictions: Staff expressed concern about using cargo bicycles year round considering the consistent rain through the winter season.

Weight handling capacity: Staff were concerned whether or not the bicycles would be able to carry tools and soil, mulch or debris in addition to the rider.

Tools capacity: Staff felt the number and type of tools the bicycles could carry relative to light utility vehicles that provide more flexible carrying capacity might be limiting.

Can perform limited tasks: Staff thought that cargo bicycles might be unable to perform a similar variety of tasks to a light utility vehicle (e.g., when one uses the gator for an activity, there is always the option to carry additional equipment to perform another activity or pick-up waste on the way back).

Safety: With uneven terrain and/or a loaded cargo bicycle, some staff felt that cargo bicycles would be unsafe for them to use.

Other concerns that were addressed by staff and should be mentioned: ease of maintenance of the cargo bicycles, and theft of bicycles left unattended in public spaces, particularly in downtown parks.

In an open-ended question asking what staff thought the greatest benefit of the cargo bicycles would be, responses included:

Table 8: Benefits that staff considered cargo bicycles could provide for park operations.

	Benefits	
Greatest Benefit	**1. Environmentally friendly**	22%
	2. More vehicles	21%
	3. Quiet	12%
	4. Healthy	12%
Least Benefit	**5. Easy to get around & access to places**	11%

Environmentally friendly: Staff felt that the number one benefit is that introducing cargo bicycles is a green initiative; they reported that it is important to them that no fuel is required and no emissions are created, leading to cleaner air and less pollution.

More vehicles: An alternative to light utility vehicles was considered the second most important benefit. As vehicles are currently limited, more vehicles could speed up their work, also described by some staff members as a "huge efficiency boost."

Quiet: Staff from golf courses and destination parks (e.g., VanDusen Botanical Garden) described this mode of transportation as quiet and not disruptive to the visitors.

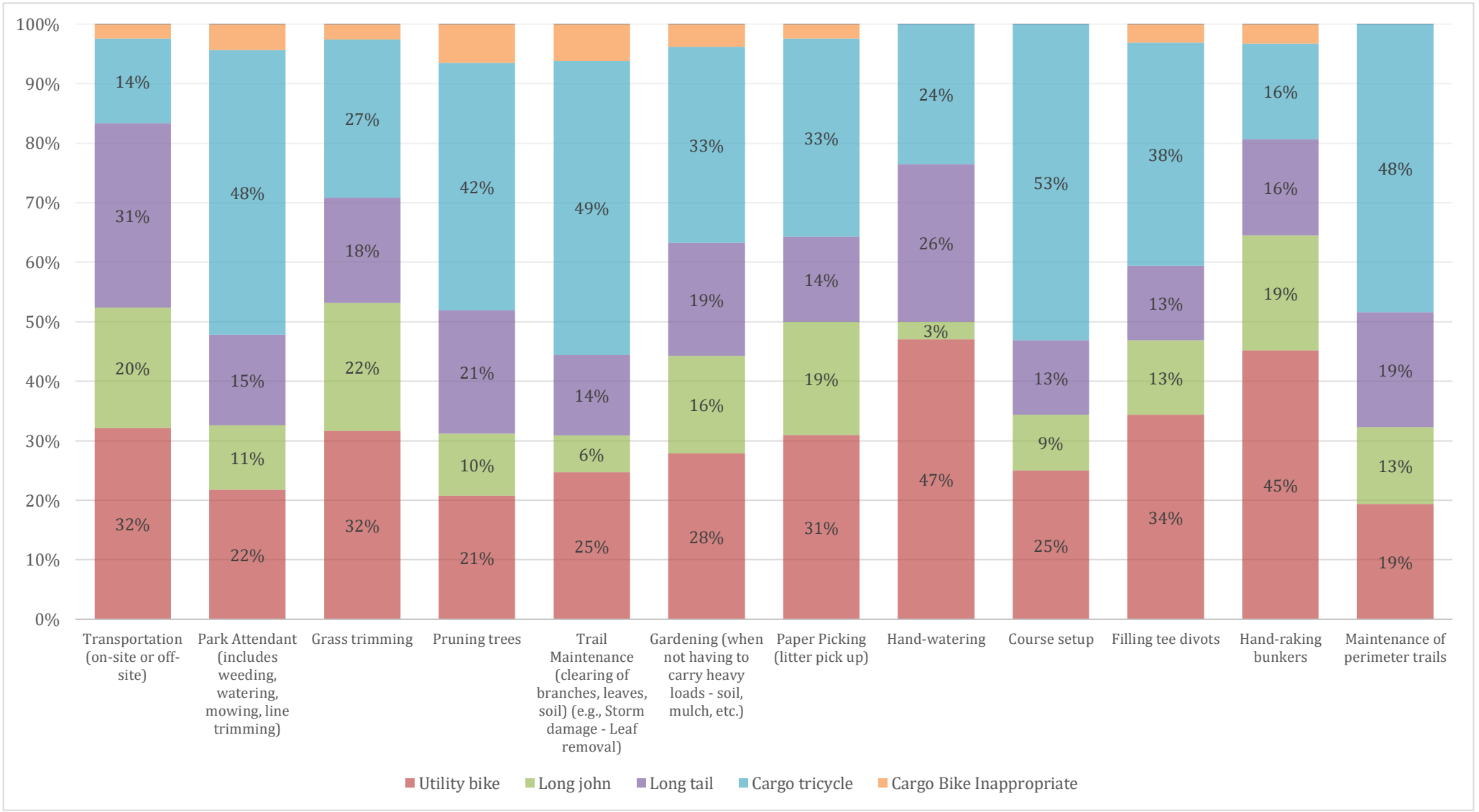
Healthy: Providing light exercise for staff in their everyday work and keeping them healthy was also registered as a benefit.

Easy to get around & access to places: Staff mentioned that cargo bicycles are nimble and less bulky compared to light utility vehicles. Additionally, downtown parks staff indicated that they could bypass traffic by using the bicycle paths and would not have to worry about parking.

Other notable benefits that were mentioned include: perception of the public, faster transportation, cost effective, and inspiration for more green operations and adoption of active transportation by the public.

Finally, staff were asked to select what they would consider the most appropriate cargo bicycle based on each activity they undertake. Results are presented on a proportional basis based on the total number of participants that undertake those tasks as some are only done in parks (park attendant, paper picking) and other only in golf courses (hand-watering, course setup, filling tee divots, hand-raking bunkers, and maintenance of perimeter trails).

Figure 26: Most appropriate cargo bicycle for each activity.



The results demonstrate (Figure 27) that staff are inclined towards the cargo tricycle and the utility bicycle for most tasks. Transportation was one task that managed to have almost the same responses for both utility bicycle and the longtail cargo bicycle. The cargo tricycle was considered the most suitable for tasks like park attendant, pruning trees, trail maintenance, course setup, and maintenance of perimeter trails. The utility bicycle was the prominent choice for a separate group of tasks including hand-watering, and hand-raking bunkers. For tasks like grass trimming, gardening, paper picking, and filling tee divots, staff were split between the cargo tricycle and the utility bicycle. Importantly, no more than 6% (with a 3% overall average) of the responses said a cargo bicycle would not work for those tasks, a positive indicator for the feasibility of this initiative. Based on the responses provided, an overall preference of the cargo bicycles presented would be:

Most preferable	Cargo tricycle	35%	
	Utility bicycle	30%	
	Longtail	18%	
Least preferable	Long john	13%	

Source: Poscher E.

To summarize, the majority of staff had limited knowledge of cargo bicycles and their capabilities; however, most of them were interested in using bicycles to supplement the Park Board fleet of light utility vehicles. For some applications, staff expressed the belief that cargo bicycles can make their transportation faster and replace the use of wheelbarrows for many tasks. Although they see an opportunity for using cargo bicycles for tasks that require one person, bicycles could also be used for crew projects (projects requiring 3 or more people) for various golf course tasks. In such a case, the specific crew could use a number of bicycles and, if needed, one light utility vehicle. Finally, through this survey many staff identified specific tasks and locations that could benefit from using cargo bicycles including: paper picking on beaches, site to site transport, moving equipment on site, debris removal, gardening, and watering. Locations like English Bay, the Seawall and Stanley Park (sport side) identified that cargo bicycles would be suitable for their tasks.

6. FINANCIAL & ENVIRONMENTAL IMPACTS OF USING CARGO BICYCLES

In order to make a case for supplementing the existing Park Board fleet with cargo bicycles a rough comparison of capital and operating costs should be made to understand if this is a cost-effective option.

Regarding purchase costs of light utility vehicles, this study compared gators with cargo bicycles, as those vehicles are used more than golf carts and trucks in all seven locations. The cost of a gator ranges from $12,500 to $14,000, depending on whether the gator is gas or electric (gas gators are more expensive). Additionally the accessories/attachments for the gator cost approximately $2,000.

Gator	
Purchase cost	$12,500 - $14,000
Accessories/attachments	Approx. $2,000

The purchase costs for the selected cargo bicycles are lower and have a wider range than gators. (Note that the following prices are for "budgetary" pricing. Actual prices require a Request for Proposal).

Electric Cargo Bicycle	
Utility bicycle (w/ front & rear baskets)	$5,900 - $6,900
Cargo tricycle (rickshaw style)	$6,500 - $10,500

Figure 27: *Examples of utility bicycle (left) and cargo tricycle (right).*

Some accessories that have been identified to enhance the cargo bicycles:

Accessories for Electric Cargo Bicycle	
Rear trailer (open box w/one or two wheels)	Approx. $500
Double heavy duty kick stands	$50 - $150
Extra wide, steel pedals (w/ pins)	$45 - $99

"Tractor" style saddles	$75 - $150
Fenders	$50 - $150
Warning bells	$15 - $50
Rain covers	$100 - $500
Locks	$50 - $200

Figure 28: Examples of rear trailers with two wheels (left) and one wheel (right).

Table 9: Comparison of capital costs

	Gator	Electric Cargo Bicycle	Difference
Vehicle	$12,500 - $14,000	$6,200 - $8,700[6]	$5,300 - $6,300
Accessories	Approx. $2,000	Approx. $885 - $1,800	Approx. $200 - $1,115
Total	$14,500 - $16,000	$7,085 - $10,500	$5,500 - $7,415

Based on those estimates, it becomes clear that there could be a significant cost reduction in capital costs from adding cargo bicycles in the fleet instead of gators ranging from $5,500 to $7,415 (Table 9).

Understanding the amount by which fuel use can be decreased by augmenting Park Board operational fleets with bicycles will be difficult as accurate data is not available. Cars, trucks and other heavy-duty fleet vehicles are equipped with an automatic data recorder to capture fuel use and efficiency information; drivers of light utility vehicles are required to record mileage and fuel use and the recorded information is not always accurate or complete.

In an effort to calculate the impacts of using an electric cargo bicycle in park operations, available data were entered into a simulation tool offered by the Pro-E-Bike project (Occam, 2015). While the results may be slightly inaccurate since some data points were assumed and this tool is designed

[6] Average range of the two cargo bicycle types.

for European countries, the exercise was considered useful to have a base case for comparing potential changes in operating costs and emission reduction should cargo bicycles be introduced to the fleet. Changes to fleet efficiency and fuel use should be tracked as best as possible if bicycles are introduced.

Regarding the input data, the maximum value for gators was used as gas gators are more expensive. The average price of the two cargo bicycle types was used, as both bicycle types are suggested to be deployed to all selected parks and golf courses. Prices related to fuel and electricity were adjusted to reflect average Vancouver prices.

Table 10: Input data

Gas Gator	
Average consumption (Miles per gallon) [l/100km]	20 [12]
Average distance (km/day)	10
Average load (lbs) [kg]	50 [23]
Acquisition ($)	16,000
Maintenance ($/year)	1,000

Electric Cargo Bicycle	
Acquisition ($)	8,800
Maintenance ($/year)	175

Table 11: Results

	Gas Gator	Electric Cargo Bicycle
Fuel costs ($/100km)	16.6	-
Costs ($/100km)	-	0.04
Average annual costs ($/veh)	1,400	177
Emissions (kg CO_2/100km)	28.3	0.31

Table 12: Savings

	Gas Gator	Electric Cargo Bicycle	Savings
Economic ($/year)	1,400	177	1,223
Environmental (kg CO_2/year)	700	8	692

This analysis demonstrates that cargo bicycles are both cost efficient and more environmentally friendly than gators. Although the results could vary as those are estimates and based on assumptions, the general trend would be the same in the sense that cost saving from capital and operating costs, as well as reductions in GHGs is significant. The results demonstrate the savings of replacing one gas gator with one electric cargo bicycle, if one gas gator was to be replaced in each of the seven parks and golf courses, it would amount to a total reduction of 4.8 tones CO_2 per year.

In an effort to provide an estimate for the implementation of such an initiative in all seven locations by introducing two cargo bicycles (one utility bicycle and one cargo tricycle), the overall cost would be approximately in the range of $99,190 - $147,000.

Table 13: Overall cost for implementation

Utility bicycle (w/accessories)	$6,785 - $8,700
Cargo tricycle (w/accessories)	$7,385 - $12,300
Total (for seven locations)	$99,190 - $147,000

Regarding the cost for a trial of those cargo bicycles, more information are needed.

7. RECOMMENDATIONS

7.1 Program Implementation

1. Acquire accurate and consistent fuel use data on light utility vehicles so there can be a basis for comparison of savings on operating costs, fuel emission savings, and energy consumption should a cargo bicycle offset vehicle use.
2. Organize staff focus groups to understand what modifications the bicycles would require to make them suitable for operational tasks.
3. Trial one cargo tricycle and one utility bicycle at each park and golf course, as staff requested in the survey.
4. Hold a cargo bicycle training workshop including operation, safety and basic maintenance at each location.
5. Launch a 1-3 month trial with two electric cargo bicycles at each location.
6. After the trial period, distribute a follow-up survey or conduct a focus group to understand what worked and what did not including staff perceptions and expectations, the efficiency of cargo bicycles, and what alterations to bicycles, scheduling or other program aspects need to be made to improve the success of the program.
7. Based on survey or focus group feedback, purchase, modify and deploy cargo bicycles on a permanent basis.
8. Engage a local bicycle mechanic or train a Park Board employee to visit each location monthly to perform regular maintenance on the bicycles, ensuring they are always ready for use.

7.2 Recommendations for cargo bicycles specific to Park Board operations

- Introduce cargo bicycles on a voluntary basis.
- Many Park Board operations staff work part time in spring and summer, with up to one year contracts. There is an opportunity to include cargo bicycle use in the relevant job postings.
- Considering the limitations of cargo bicycles; some coordination with other staff and vehicles will be required to maximize their use and the efficiency of the entire fleet.
- Consider the challenges before providing incentives to staff for using cargo bicycles (Appendix F).
- Park Board staff preferred the cargo tricycle (rickshaw style) and the utility bicycle, therefore they should be included in the trial. Based on the trial and the anticipated cost and maintenance requirements the Park Board may choose to employ different bicycles or a combination of bicycles and tricycles.
- Explore the feasibility of equipping a cargo tricycle (box in front) with a wheelbarrow instead of a cargo box as various staff considered it an ideal scenario.

- Ability to carry necessary tools, supplies and other equipment was found to be one of the primary concerns for staff. Cargo bicycles should be modified in such a way that they are easy to use and can carry all the necessary equipment required by staff.
- Based on the results of the survey, a preferred type of electric assist could not be decided; following best practices cargo bicycles should be equipped with pedal electric assist.
- Equip bicycles with bells, or horns and lights. Electric bicycles are quiet and riders may need to notify park users, golfers or other staff of their presence.
- Equip each cargo bicycle with a reflective cone or triangle to enhance visibility when riding or parked.
- Equip each bicycle with an easy-to-use frame or other lock to prevent theft from work sites.

Based on the set criteria and survey responses, cargo bicycles are most likely to be successful at the following parks and golf courses, in order:

1. Jericho Park
2. Langara Golf Course
3. McCleery Golf Course
4. Stanley Park and Downtown Parks
5. VanDusen Botanical Garden
6. Fraserview Golf Course
7. Queen Elizabeth Park

7.3 Conclusion

Overall, introducing cargo bicycles into the Park Board fleet has a low risk of failure as there is a need for more vehicles for transportation. It was found that cargo bicycles would be applicable and accepted by staff at all seven golf courses and parks mentioned in this report. Even if staff do not use it for operational tasks, results indicate that they will likely use the cargo bicycles for transportation without a load.

Survey results indicate that staff welcomed the idea of cargo bicycles and a cargo bicycle trial would be received well from an operational perspective. However, significant modifications will need to be made to the bicycles to make them easy-to-use and practical for park operations.

Further, the greatest benefit staff identified was that by introducing cargo bicycles to the fleet it would help green the operations; a significant finding which indicates that Park Board staff culture is aligned with the values of the Park Board.

Cargo bicycles can reduce both the number of trips being made by light utility vehicles, and the travel time of staff that currently don't have access to light utility vehicles, but would use a cargo

bicycle. The use of light utility vehicles could be minimized for tasks that do not include transportation of heavy loads.

Cargo bicycles support the Park Board in its operations, in addition to helping the Park Board reach the Greenest City Action Plan – Green Operations goal. This project may also encourage other City service and operational teams to use cargo bicycles instead of vehicles, further reducing environmental impacts and expenses institution-wide. Based on the needs and applicability detailed in this report, the Park Board could implement a pilot cargo bicycle program for operations by adding 14 bicycles to the vehicle fleet at a cost ranging from $99,190 to $147,000.

Cargo bicycles are cost effective and environmentally friendly making their use by public institutions attractive to the public. Subsequently, this could motivate more people to use active transportation modes, thus indirectly help make cycling a preferred transportation option.

To summarise, the comparative advantages of cargo bicycles are:
Cost effective (lower capital and operating costs)
Fast and reliable
Environmentally friendly
Quiet and nimble
Positive image – public perception
Fitness advantage (light exercise while transporting)
No congestion and parking problems
No legal license requirements for drivers
Creating a domino effect for use of cargo bicycles for other applications in the city operations; and
No legal license requirements for drivers

APPENDIX

Appendix A: Existing Fleet

The tables below show vehicles and staff at each of the focus sites in May 2017 and represent approximate fleet and staff numbers.

1. **Langara Golf Course**

Existing Fleet
1x Golf Cart (Clubcar – DSElectric)
2x Gator (John Deere HPX 4x4 Gas & John Deere Egator)
2x Truck (Ford F450 & Ford F250)

Number of staff	
Full-time/Permanent	4
Auxiliary – Temporary	12
Staff:Gators & Golf carts ratio	16:3

2. **Fraserview Golf Course**

Existing Fleet
1x Golf Cart (Yamaha - Ydre (electric))
4x Gator (Clubcar – Turf/Truckster & John Deere XUV & John Deere Egator (x2))
2x Truck (Ford F150 & Toyota Tacoma)

Number of staff	
Full-time/Permanent	5
Auxiliary – Temporary	10
Staff:Gators & Golf carts ratio	15:5

3. **McCleery Golf Course**

Existing Fleet
1x Golf Cart (Clubcar - DSelectric)
3x Gator (Clubcar – Turf/Truckster & John Deere HPX 4x4 & John Deere TE gator)
1x Truck (Ford F150)

Number of staff	
Full-time/Permanent	4
Auxiliary – Temporary	9
Staff:Gators & Golf carts ratio	13:4

4. Queen Elizabeth Park

Existing Fleet
2x Gator (John Deere HPX 4x4 Gas & John Deere HPX Gas)
2x Truck (Ford F450 & Ford Ranger)

Number of staff	
Full-time/Permanent	6
Auxiliary – Temporary	6
Staff:Gators & Golf carts ratio	12:2

5. VanDusen Botanical Garden

Existing Fleet
1x Golf Cart (Yamaha YDRE)
4x Gator (John Deere HPX Gas & Toro Workman MDE (x3))
1x Truck (Ford F350)

Number of staff	
Full-time/Permanent	10
Auxiliary – Temporary	7
Staff:Gators & Golf carts ratio	17:5

6. Stanley Park and Downtown Parks*

Existing Fleet
6x Gator (Clubcar Turf-Truckster & John Deere HPX & John Deere HPX 4x4 Gas & John Deere Egator (x3))
21x Truck (Ford F150 (x9) & Ford F450 (x2) & Ford F250 (x5) & Ford F350 (x2) & Ford Ranger & GMC Sierra 1500 & GMC 3500)

Number of staff	
No. of respondents	28
Staff:Gators & Golf carts ratio	28:6

7. Jericho Park*

Existing Fleet
1x Gator (John Deere Egator)
11x Truck (Ford F150 & Ford F250 (x6) & Ford F350 (x2) & Ford Ranger & Dodge 2500)

Number of staff	
No. of respondents	4
Staff:Gators & Golf carts ratio	4:1

* For these two parks the ratio is based on the number of respondents. Only a proportion of staff at these sites participated in the survey as a large number of staff whose tasks for which cargo bicycles are not suited are based at these service yards.

Appendix B: Electric Assist Motors & Regulation in British Columbia

The motor is the source of the electric assist; there are two types of motors that are used in electric bicycles. Initially, hub motors dominated the market, but there has been a shift toward mid-drive motors. The main difference between the two is the price, with the latter being more expensive; however there are advantages and disadvantages to each type depending on user needs (Hicks, 2012; Prebus, 2015).

Hub motors are located in the hub of one of the bicycle's wheels, and provide power by spinning that wheel. They can be installed on the front or back wheel.

Front hub motors, give to the rider the feeling that the bicycle is being "pulled" forward. Since the front wheel is free from chains, derailleurs, and cassettes, hub motors are easy to install, remove, and maintain. The front wheel can have a tendency to "slip" when heavy loads are being carried behind the front wheel. Although, it enables an all-wheel drive bicycle which can ride more efficiently on snow and sand (Hicks, 2012; Prebus, 2015; Toll, 2015; personal contact, Shift delivery staff, 2017)

Figure 29: Front hub motor.

Rear hub motors, on the other hand, "push" the bicycle forward. The ride experience feels more natural, like riding a conventional bicycle. As the bulk of the bicycle's and rider's weight is closer to the rear wheel, the rear wheel tends to spin out less often that front hub motors. However, rear hub motors are harder to install, remove and maintain because of the chain, derailleur, and cassette and the overall handling of the bicycle can be affected by all the weight on the rear end (Hicks, 2012; Toll, 2015; Prebus, 2015).

Figure 30: Rear hub motor.

Table 14: Advantages and disadvantages of hub motors.

Advantages	Disadvantages
Most affordable option on the market today; popular with cheaper components	Rear wheel hubs can be difficult to put on and take off; more difficult to repair or replace parts
Front hub motors are easy to put on and take off; easier to repair or replace parts	Can result in an unbalanced riding experience
Work with both assist technologies (pedal-assist & throttle)	Hub motors do not work in coordination with bicycle's gears; inefficient use of power
Rear hub motors can provide regenerative braking	May spin out on hills or in slippery conditions when loaded.

Mid-drive motors are located in the bicycle's drivetrain, commonly as part of the crankset. The motor works in coordination with the bicycle's already existing gears and delivers additional torque. As the motor is located at the mid-point of the bicycle it doesn't interfere with the ride experience and leaves the majority of components unaltered, making maintenance simple (Mordkovich, 2015; Prebus, 2015).

Figure 31: Mid-drive motor.

Table 15: Advantages and disadvantages of mid-drive motor.

Advantages	Disadvantages
Provides power directly to bicycle's drivetrain	More expensive than hub motors
Works in coordination with bicycle's gears to maximize efficiency and power	May add wear and tear to bottom bracket, cranks, chains, derailleurs, or cassettes
Located near the bicycle's centre of gravity, for a balanced ride and smooth handling	Limits the gear range to the rear cogset
Doesn't interfere with other components	

Electric bicycle and regulations in British Columbia

"An electric bicycle, or motor-assisted cycle, is a two- or three-wheeled cycle with a seat, pedals and an electric motor (up to 500 watts). A motor assisted cycle (MAC) cannot be gas-powered." (ICBC, 2014)

To be considered an electric bicycle it must have:

- Electric motor up to 500 W;
- Functional pedals;
- Maximum speed of 32 km/h when power assisted; and
- The motor must disengage in any of the following: rider stops pedaling, throttle is released, brake is applied.

If the above mentioned characteristics are met then there is no requirement for driver's license, vehicle registration, or insurance. However a bicycle helmet must be worn and the rider must be at least 16 years old.

Electric bicycles in British Columbia must comply with all standards outlined in Motor Assisted Cycle Regulation, BC Reg. 151/2002.

Appendix C: Retailers & Manufacturers of Cargo Bicycles

Some retailers in Vancouver

Business	Types
Reckless Bicycles	Longtail, Long john, Cargo tricycle
Bicycle Doctor	Long john, Longtail
Dandy Lion Cargo	Long john
Tandem Bicycle Cafe	Long john
Grin Technologies	Longtail

A small independent manufacturer in Vancouver: Curious Cargo bicycles (mainly Long john, Longtail)

North American Cargo Bicycle Companies

Business	Types
Yuba Bicycles	Longtail, Long john
Xtracycle	Longtail
Bilenky Cargo Bicycles	Utility bicycle, Long john
Cetma Cargo Bicycles	Long john
Worksman Cycles	Utility bicycle, Cargo tricycles
Metrofiets	Long john
Republic Bicycle	Utility bicycle
Surly	Longtail, trailers
Radwagon	Longtail
Wike	Long john, Cargo tricycle (front box), trailers
Virtue Cycles	Utility bicycle, Long john, Cargo tricycle (front box)
Kona Bicycles	Longtail
Ahearne Cycles	Utility bicycle
Felt	Utility bicycle, Longtail
Pedego Electric Bicycles	Utility bicycle
Fiets of Strength	Long john

Notable mention: Cycles Maximus for cargo tricycles (rickshaw style) as it has been preferred by various companies/organisations to move heavy loads.

Appendix D: Case Studies

Park Maintenance

In the US, the Naples Botanical Garden in Florida, has been using cargo tricycles for activities including horticulture work and janitorial duties. The staff have reported that they find it much easier to get around the garden on bicycles than in golf carts and it has a positive impact to the visitors (Haley Tricycles, n.d.).

Figure 32: Staff riding cargo tricycles in Naples Botanical Garden.

Transport learning was an EU-project that ran from 2011 to 2013. The main objective of the project was to develop knowledge and capacity on sustainable transportation policies and measures in municipalities of Europe's convergence regions. One of those projects took place in the municipality of Plovdiv, Bulgaria where they trialed two cargo bicycles for park maintenance at the city's largest sports and recreational area, a gathering place of people who bicycle, exercise, and walk. The two cargo bicycles were used for park maintenance works and collecting waste along the rowing channel. The users of the cargo bicycles were highly satisfied with the bicycles because they made it easier for them to transport tools and actively move throughout their work day. From spring until the end of summer, the cargo bicycles were used daily for trips of at least 5km. Due to public interest and positive feedback, the cargo bicycles were made permanent at the park and replaced the old trucks. Another benefit of their use there is that they are visible to many park visitors and could inspire other applications such as individuals and businesses (Transport Learning, 2013).

There has also been similar movement in the private sector: the company, the Jobbing Gardener, has been using a longtail cargo bicycle for more than five years. The usual routes include trips between the villages of rural Norfolk, United Kingdom, sometimes towing a lawnmower on a trailer behind the bicycle. The bicycle is always carrying tools and buckets of soil, and the gardener feels his chosen mode of transport has been a great advert for his business (8Freight, n.d.).

Figure 33: Gardener riding his longtail cargo bicycle to rural villages in East England.

Similarly, a gardener in Melbourne, Australia has given up his van for a longtail e-cargo bicycle.

Figure 34: Gardener in Melbourne, Australia using a longtail cargo bicycle.

Cargo bicycles are well-suited for simple tasks where using a pickup truck or light utility vehicle may not be needed. Various professionals have been reported using a cargo bicycle instead of a car, truck, van, etc. A German company Velogut has been providing cargo bicycles to more than 150 companies for a free 1-3 month trial period and the feedback has been very positive. One of those is the Tierpark in Berlin, where they have been using cargo bicycles for various tasks and carry loads of up to 400 lbs (180 kg) (Velogut, n.d.).

Figure 35: One of the tasks long-john cargo bicycles are being used for in Tierpark is for feeding the elephants.

Figure 36: Cargo bicycles in the Bergius Botanic Garden in Stockholm, Sweden.

Figure 37: Cargo tricycles for park maintenance in Norra kyrkogården in Lund, Sweden.

Figure 38: Bicycle with a trailer used by an arborist in Portland, USA.

In Portland, USA, in 2010 a young certified arborist started his own company using a bicycle with a trailer. In 2013 he said: "For my first years in business I used a Bicycles-At-Work 8 ft. flatbed cargo trailer to carry my 12 ft. orchard ladder, debris, and other tools. This January I upgraded to a custom railed trailer designed by Haulin' Colin in Seattle. The extra dimension of height allows me to mount the ladder on the side and reserve the cargo area for branches." He continues to mention that: "Gardening with goggles, earplugs, gloves, and power tools is like being a chef who isn't allowed to taste the food… So when I describe my business as bicycle-transported, I say 'respecting your trees begins with the trip there,' But it can't end with it." (Maus, 2013).

Street Maintenance

In 2011, a neighborhood improvement corporation in Philadelphia, USA (NKCDC) started cleaning commercial corridors with one cargo tricycle. Three years later they acquired a second one, as it made the task easier and faster (Haley Tricycles, 2014).

Figure 39: Street cleaning in New Kensington, Philadelphia is being done with this cargo tricycle.

In the city of Zadar, Croatia electric cargo tricycles are used by municipal services for street cleaning, by local authority inspectors within the historic core of the city where traffic restrictions apply, and for delivery of supplies and food to clients of a residential home for adults. The e-bicycles have proven very useful for short distances within the city centre and staff support their use (Pro-E-Bike, 2016).

Figure 40: Electric cargo tricycles in Zadar enable staff to access places where a vehicle cannot.

Mail Service

In Cambridge, UK, the Cambridge City Council uses cargo bicycles for their internal mail service. Before 2012, the City Council used a van run by two staff, but was forced to explore more cost-effective options after the 2008 financial downturn. A three month cargo bicycle trial was a huge success and the Council commissioned the cargo bicycle delivery company to provide the daily postal.

Figure 41: The longtail cargo bicycle that is being used in Cambridge, UK.

Delivery Service

Shift Delivery Courier service operates in Vancouver, BC and is using electric cargo tricycles for delivery services and advertising on their tricycles. Shift Delivery co-founder, Robyn Ashwell, after 5 years of using tricycles for her business, shared the opportunities, strengths, limitations, and weaknesses of using cargo tricycles in Vancouver. Some insights from Shift include:

- Maintenance of the tricycles is a challenge because they have unique structure and components compared to a typical bicycle and, therefore, require a specially trained mechanic.
- Pro-active maintenance is essential to save time and money.
- Cargo tricycles offer more stability even when heavily loaded, however the ride and steering experience is different.
- The battery is expensive and must be secured if the bicycle is left unattended.

Figure 42: Shift Delivery cargo tricycle.

Similar to Shift Delivery, B-line in Portland, Oregon has been operating for more than seven years doing sustainable urban delivery and recycling services with their electric cargo tricycles. Recently they added long john electric cargo bicycles to their fleet.

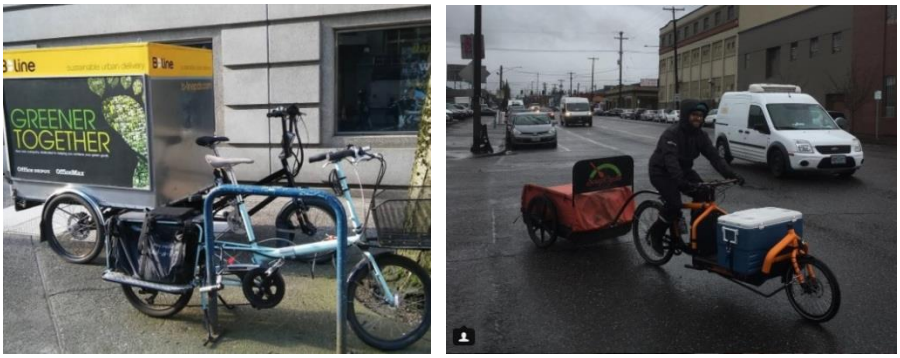


Figure 43: B-line cargo tricycle (left) and long john cargo bicycle (right).

Figure 44: Revolution rickshaws is providing delivery services and pedicab services in New York.

Hereford Pedicabs and Cargo offers a variety of services using cargo bicycles such as, passenger transport, parcel delivery, and recycling. Using cargo tricycles with bespoke cages they collect paper, cardboard and plastics from over 370 businesses. These four companies share the same bicycle manufacturer, which is Cycles Maximus. Based on the feedback received from Shift Delivery, Cycles Maximus cargo tricycles are preferred as they are considered more convenient and sturdier.

Figure 45: Cargo tricycles used for parcel delivery, and recycling.

Compost collection service

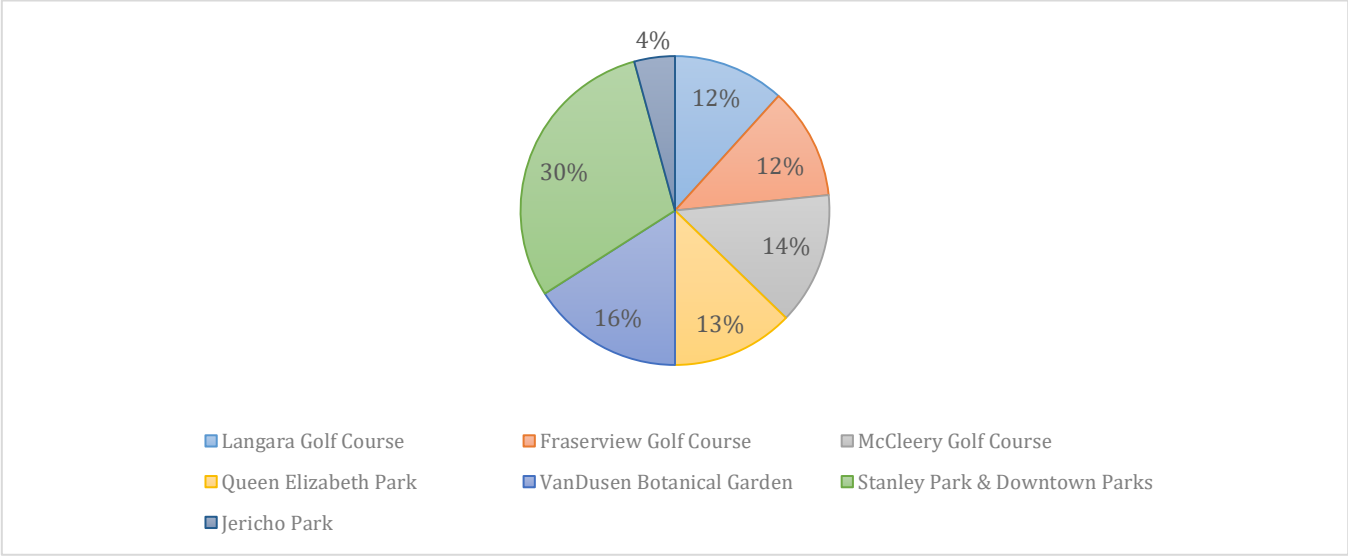
Compost pedallers is a bicycle business that uses longtail cargo bicycles to collect compost around Austin, Texas, USA. They support "community composting" meaning the organic material they collect don't leave the neighborhood or community, rather they are composted and used nearby (Hodges, 2016).

Figure 46: A longtail cargo bicycle with a trailer is being used for compost collection in Austin, USA.

Appendix E: Survey & Additional Results

As presented in Figure 47, the total responses represent the seven locations almost evenly. Because Stanley Park and Downtown Parks require more staff to maintain them, they are over-represented in the total responses. Conversely, Jericho Park employs limited horticulture staff thus they are being under-represented in the total population.

Figure 47: Staff representation.



Langara Golf Course

Table 16: Do you think cargo bicycles can be used at Langara Golf Course?

Response	Percentage
Strongly disagree	0%
Somewhat disagree	0%
Neither agree nor disagree	9%
Somewhat agree	36%
Strongly agree	55%
N/A	0%

Table 17: Most appropriate cargo bicycle for each activity.

	Trans-portation	Grass trimming	Pruning trees	Trail main-tenance	Gardening	Hand-watering	Course setup	Filling tee divots	Hand-raking bunkers	Maintenance of perimeter trails
Utility	40%	27%	9%	9%	22%	45%	0%	18%	45%	18%
LongJohn	0%	0%	0%	0%	0%	0%	9%	9%	9%	0%
LongTail	30%	9%	9%	9%	0%	9%	18%	9%	9%	9%
Cargo tricycle	30%	55%	82%	82%	78%	45%	73%	64%	36%	73%
Bicycle Inappropriate	0%	9%	0%	0%	0%	0%	0%	0%	0%	0%

Fraserview Golf Course

Table 18: Do you think cargo bicycles can be used at Fraserview Golf Course?

Response	Percentage
Strongly disagree	9%
Somewhat disagree	9%
Neither agree nor disagree	9%
Somewhat agree	64%
Strongly agree	9%
N/A	0%

Table 19: Most appropriate cargo bicycle for each activity.

	Trans-portation	Grass trimming	Pruning trees	Trail main-tenance	Gardening	Hand-watering	Course setup	Filling tee divots	Hand-raking bunkers	Maintenance of perimeter trails
Utility	36%	50%	30%	20%	30%	30%	40%	40%	30%	10%
LongJohn	18%	40%	20%	0%	30%	10%	20%	10%	30%	20%
LongTail	36%	10%	10%	20%	10%	60%	10%	30%	30%	30%
Cargo tricycle	9%	0%	30%	60%	30%	0%	30%	20%	0%	40%
Bicycle Inappropriate	0%	0%	10%	0%	0%	0%	0%	0%	10%	0%

McCleery Golf Course

Table 20: Do you think cargo bicycles can be used at McCleery Golf Course?

Response	Percentage
Strongly disagree	0%
Somewhat disagree	8%
Neither agree nor disagree	0%
Somewhat agree	31%
Strongly agree	54%
N/A	8%

Table 21: Most appropriate cargo bicycle for each activity.

	Trans-portation	Grass trimming	Pruning trees	Trail main-tenance	Gardening	Hand-watering	Course setup	Filling tee divots	Hand-raking bunkers	Maintenance of perimeter trails
Utility	46%	27%	10%	17%	33%	62%	36%	45%	60%	30%
LongJohn	31%	9%	0%	8%	17%	0%	0%	18%	20%	20%
LongTail	15%	45%	40%	8%	17%	15%	9%	0%	10%	20%
Cargo tricycle	8%	18%	30%	58%	33%	23%	55%	27%	10%	30%
Bicycle Inappropriate	0%	0%	20%	8%	0%	0%	0%	9%	0%	0%

Queen Elizabeth Park

Table 22: Do you think cargo bicycles can be used at Queen Elizabeth Park?

Response	Percentage
Strongly disagree	0%
Somewhat disagree	25%
Neither agree nor disagree	0%
Somewhat agree	17%
Strongly agree	50%
N/A	8%

Table 23: Most appropriate cargo bicycle for each activity.

	Transportation	Park attendant	Grass trimming	Pruning trees	Trail maintenance	Gardening	Paper picking
Utility	18%	36%	45%	36%	45%	42%	22%
LongJohn	27%	0%	18%	0%	9%	17%	11%
LongTail	55%	18%	18%	36%	9%	17%	44%
Cargo tricycle	0%	36%	18%	27%	27%	17%	22%
Bicycle Inappropriate	0%	9%	0%	9%	9%	8%	0%

VanDusen Botanical Garden

Table 24: Do you think cargo bicycles can be used at VanDusen Botanical Garden?

Response	Percentage
Strongly disagree	7%
Somewhat disagree	0%
Neither agree nor disagree	20%
Somewhat agree	27%
Strongly agree	40%
N/A	7%

Table 25: Most appropriate cargo bicycle for each activity.

	Transportation	Park attendant	Grass trimming	Pruning trees	Trail maintenance	Gardening	Paper picking
Utility	21%	15%	38%	29%	29%	29%	27%
LongJohn	14%	8%	31%	7%	7%	14%	27%
LongTail	57%	15%	23%	21%	21%	29%	9%
Cargo tricycle	0%	54%	8%	36%	29%	14%	27%
Bicycle Inappropriate	7%	8%	0%	7%	14%	14%	9%

Stanley Park and Downtown Parks

Table 26: Do you think cargo bicycles can be used at Stanley Park and Downtown Parks?

Response	Percentage
Strongly disagree	0%
Somewhat disagree	4%
Neither agree nor disagree	18%
Somewhat agree	32%
Strongly agree	43%
N/A	4%

Table 27: Most appropriate cargo bicycle for each activity.

	Transportation	Park attendant	Grass trimming	Pruning trees	Trail maintenance	Gardening	Paper picking
Utility	33%	20%	19%	16%	30%	20%	44%
LongJohn	29%	20%	29%	26%	10%	20%	22%
LongTail	14%	15%	10%	16%	15%	30%	6%
Cargo tricycle	19%	45%	38%	37%	40%	30%	28%
Bicycle Inappropriate	5%	0%	5%	5%	5%	0%	0%

Jericho Park

Table 28: Do you think cargo bicycles can be used at Jericho Park?

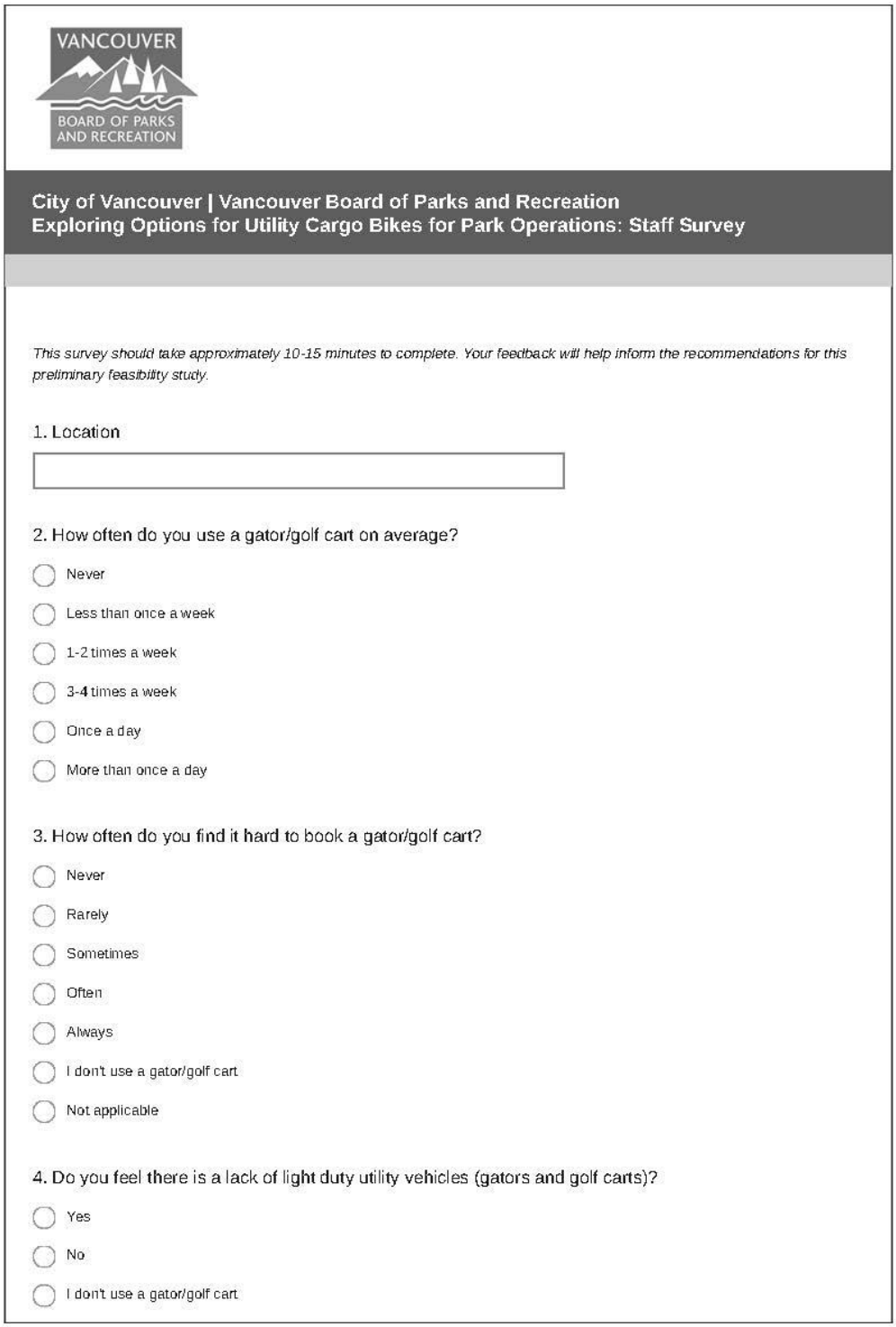
Response	Percentage
Strongly disagree	0%
Somewhat disagree	0%
Neither agree nor disagree	0%
Somewhat agree	50%
Strongly agree	50%
N/A	0%

Table 29: Most appropriate cargo bicycle for each activity.

	Transportation	Park attendant	Grass trimming	Pruning trees	Trail maintenance	Gardening	Paper picking
Utility	25%	0%	0%	0%	0%	0%	0%
LongJohn	0%	0%	0%	0%	0%	0%	0%
LongTail	0%	0%	0%	0%	0%	0%	0%
Cargo tricycle	75%	100%	100%	100%	100%	100%	100%
Bicycle Inappropriate	0%	0%	0%	0%	0%	0%	0%

Survey

This is the survey distributed to staff working on golf courses. The only difference with the survey that was distributed to staff working on parks was the type of activities (Park attendant and paper picking instead of hand-watering, course setup, filling tee divots, hand-raking bunkers, and maintenance of perimeter trails).



VANCOUVER BOARD OF PARKS AND RECREATION

City of Vancouver | Vancouver Board of Parks and Recreation
Exploring Options for Utility Cargo Bikes for Park Operations: Staff Survey

This survey should take approximately 10-15 minutes to complete. Your feedback will help inform the recommendations for this preliminary feasibility study.

1. Location

2. How often do you use a gator/golf cart on average?

- ◯ Never
- ◯ Less than once a week
- ◯ 1-2 times a week
- ◯ 3-4 times a week
- ◯ Once a day
- ◯ More than once a day

3. How often do you find it hard to book a gator/golf cart?

- ◯ Never
- ◯ Rarely
- ◯ Sometimes
- ◯ Often
- ◯ Always
- ◯ I don't use a gator/golf cart
- ◯ Not applicable

4. Do you feel there is a lack of light duty utility vehicles (gators and golf carts)?

- ◯ Yes
- ◯ No
- ◯ I don't use a gator/golf cart

5. Please select the most important consideration for each activity you undertake when you use a gator/golf cart.

	I do not undertake this activity	Time-sensitive	Loading capacity - Weight	Loading capacity - Item size/Number of items	Access to places	Other...
Transportation *(on-site or off-site)*	○	○	○	○	○	○
Grass trimming	○	○	○	○	○	○
Pruning trees	○	○	○	○	○	○
Trail maintenance *(clearing of branches, leaves, soil) (e.g. Storm damage – Leaf removal)*	○	○	○	○	○	○
Gardening *(when not having to carry heavy loads - soil, mulch, etc.)*	○	○	○	○	○	○
Hand-watering	○	○	○	○	○	○
Course setup	○	○	○	○	○	○
Filling tee divots	○	○	○	○	○	○
Hand-raking bunkers	○	○	○	○	○	○
Maintenance of perimeter trails	○	○	○	○	○	○
Other...	○	○	○	○	○	○

Electric assist is divided mainly into two categories:

1) Pedal Electric Assist	2) Power-on-demand
The pedal-assist enhances the efforts of the rider when they are pedaling. Motor is disabled when braking.	The motor is activated by a throttle, usually handlebar-mounted just like on most motorcycles or scooters. Brakes like a regular bike.
The rider must pedal to receive electric assistance.	The rider can use the electric assist without pedaling (e.g. use the e-assist to help push the bike uphill)
	

6. Which electric assist would you prefer?

- ◯ Pedal Electric Assist
- ◯ Power-on-demand (throttle)

7. Are you familiar with cargo bikes?

- ◯ I have never heard of cargo bikes before
- ◯ I know what cargo bike is, but don't know much about them
- ◯ I have used a cargo bike
- ◯ I own a cargo bike

There are 4 bike types that have been identified as potentially suitable for park operations. *(*The pictures show examples of the available types; bikes can be modified based on your needs)*

	Utility bike w/ trailer	Long john	Long tail	Cargo tricycle
Bike Types				
Average payload & width of the cargo box	175 lbs. (130 lbs. on the trailer + 45 lbs. on the front) Trailer: 24 inches	400 lbs. (incl. rider) 18 inches	400 lbs. (incl. rider) 17 inches	500 lbs. 40 inches
Characteristics of each bike type	Regular bike Easily detachable trailer Adequate storage space Less payload Maintenance of two pieces of equipment Less stability when riding with trailer Need to lock both bike and trailer	Similar ride experience as a regular bike Designed to carry heavier loads than a bike Can be modified to carry various tools/equipment Overloading can make bike unstable Heavier than a regular bike	Almost identical ride experience as a regular bike Designed to carry heavier loads than a bike Can be modified to carry various tools/equipment Overloading can make bike unstable Heavier than a regular bike	More stable than a regular bike Cargo secured and weather protected Comparable with a small van Different ride experience Heavier than the other types Requires more maintenance Requires experienced mechanic to maintain

8. Based on your experience, please choose the most appropriate bike for each activity.

	I do not undertake this activity	Utility bike w/trailer	Long john	Long tail	Cargo tricycle	None of the bikes would work for this task
Transportation *(on-site or off-site)*	◯	◯	◯	◯	◯	◯
Grass trimming	◯	◯	◯	◯	◯	◯
Pruning trees	◯	◯	◯	◯	◯	◯
Trail maintenance *(clearing of branches, leaves, soil) (e.g. Storm damage – Leaf removal)*	◯	◯	◯	◯	◯	◯
Gardening *(when not having to carry heavy loads - soil, mulch, etc.)*	◯	◯	◯	◯	◯	◯
Hand-watering	◯	◯	◯	◯	◯	◯
Course setup *(support role for course service)*	◯	◯	◯	◯	◯	◯
Filling tee divots	◯	◯	◯	◯	◯	◯
Hand-raking bunkers	◯	◯	◯	◯	◯	◯
Maintenance of perimeter trails	◯	◯	◯	◯	◯	◯
Other...	◯	◯	◯	◯	◯	◯
Other...	◯	◯	◯	◯	◯	◯
Other...	◯	◯	◯	◯	◯	◯

9. How often do you think cargo bikes could be used for your work?

- ◯ Never
- ◯ Less than once a week
- ◯ 1-2 days a week
- ◯ 3-4 days a week
- ◯ On a daily basis

10. What concerns do you have regarding using cargo bikes for operations? (Please select up to 5 and rate them with 1 being your greatest concern to 5 being your least concern)

- Safety
- Lack of cycle confidence/training
- Physical exertion
- Weather restrictions (rain, snow)
- Can perform limited tasks
- Weight handling capacity
- Tools capacity
- Long distances
- Health issue
- Other...

11. Name 1-3 benefits that you think cargo bikes could provide for park operations

I.

II.

III.

12. Do you think cargo bikes can be used at the Park that you work?

- Strongly disagree
- Somewhat disagree
- Neither agree nor disagree
- Somewhat agree
- Strongly agree

13. Are you interested in trying an electric cargo bike?

- Yes
- No

14. Do you have any additional comments?

Appendix F: Incentives

Providing incentives could be a good tool to encourage staff to use cargo bicycles and support the demonstration, introduction, and transition to cleaner vehicles and potentially a more efficient alternative to light utility vehicles, however it could be considered unfair by staff who are uncomfortable or unable to ride a bicycle for various reasons.

Introducing cargo bicycle use in the FitCity program could be one incentive option, or even upgrading the interface of the FitCity to something similar to From5To4 (F5T4) (http://www.f5t4.co.uk/), which was part of the European project MOBI 'Promoting Smart Mobility to Employees'. Essentially, F5T4 is a game that promotes positive change in travel behaviour by awarding points to employees that travel smart (e.g., walking, cycling, public transit, and car sharing) to work and provides accurate data on the emissions that they save. The Park Board could create an application that would inform staff of their cost and emissions savings by using a cargo bicycle over a light utility vehicle (for more information visit: http://www.mobi-project.eu/site/assets/files/1071/d1_3_mobi_final_report_-_results_and_lessons.pdf).

GLOSSARY

Glossary

Last mile delivery

The term is being used to define the movement of goods from a transportation hub to the final delivery destination.

Light Utility Vehicles

Light utility vehicles are gators, golf carts and half ton pickup trucks.

The Park Board mainly uses John Deere Gators and Toro Workman GTX (Gas and Electric models) for park and golf course maintenance. The price ranges from $12,500 to $14,000 depending on the model and the accessories/attachments are an additional ~$2,000. The average lifetime of utility vehicles is 5 years.

Figure 48: John Deere Gator.

Electric Gators

John Deere Gator TE 4x2 Electric: 48 Volt Electrical System, Max Speed 24km/h, Payload 900 lbs (408 kg), Cargo Box: Length: 1.14m, Width inside: 1.32m, Depth: 0.3m, Capacity: 500 lbs (227 kg)

Figure 49: Toro Workman MDE.

Toro Workman MDE: 48 Volt Electrical System, Max Speed 26km/h, Payload 1,200 lbs (544 kg), 500amp drivetrain (controller), complemented with regenerative braking, Cargo Box: Length: 1.02m, Width: 0.98m, Depth: 0.28m, Capacity: 800 lbs (363 kg)

Gas Gators

John Deere HPX 4x4 Gas: 21 horsepower, Max Speed 40km/h, Payload 1,400 lbs (635 kg), Cargo Box: Length 1.12m, Width 1.24m, Depth 0.23m, Capacity 1000 lbs (454 kg)

Figure 50: John Deere Gator stored in Queen Elizabeth Park.

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