Engaging with My Health: Information Required to Support the Mixed-Use of Passive and Active Assistive Technology Devices for Mobility

Tulio Maximo[1][0000-0001-5703-885X]

[1] The Hong Kong Polytechnic University, Hong Kong, China
tperei@polyu.edu.hk

Abstract. The use of physically passive assistive technology devices like powered wheelchairs and scooters by people with some preserved walking ability may impose the risk of physical de-conditioning on the user's physical capacity and their mobility function at a faster rate than those who had used a more physically active assistive technology such as manual wheelchair and walking aids. This project explores the information required to support the combined use of passive and active assistive technology for mobility, aiming to enhance the well-being of people with disability who are users of mobility devices. The study utilized an online survey to gather insights from individuals in Hong Kong using multiple mobility devices. The survey focused on demographic data, user behavior, mobility device usage, IoT elements, and information requirements. Results from 263 respondents revealed the prevalence of mixed active and passive mobility device usage, shedding light on the use of IoT devices and the essential information needed for commuting, device selection, and overall well-being. The findings provide valuable insights for healthcare professionals, policymakers, and technology developers aiming to improve assistive technology systems and promote well-being.

Keywords: Mobility, Active Aging, Assistive Technology Devices, Internet of Things.

1 Introduction

Assistive technology devices (ATDs) such as canes, walkers and wheelchairs are often prescribed to increase people's mobility and help them maintain balance while performing activities of daily living [1,2]. Nonetheless, expanding the capabilities of people with disabilities and the senior population requires various solutions. The Association for the Advancement of Assistive Technology in Europe (AAATE) coined the term assistive solution, in which mainstream commercial products, ATDs, and services are summed to personal assistance and individual environmental adaptations to equal an assistive solution [3]. It is well-established that an AT system is essential to offer expertise to support the assistive solution selection and provide user training and follow-up [3,4,5]. In contrast, people often purchase ATD without going through an AT system or receiving expert advice [3]. Regardless of the AT service provision in place,

end users should be supported in their choices, and information and professional support services play a fundamental role in empowering the user to be capable of responsible decisions [3,4].

ATDs for mobility are often purchased in Hong Kong through a consumer model of AT service delivery in which the user decides on the devices and purchases them directly [6]. Given the dense population and high vehicular traffic flow in Hong Kong, electric mobility devices (EMDs) such as electric scooters and power-assisted pedal cycles are not allowed on footpaths or carriageways [7]. The government currently adopts the definition of "motor vehicle" in the Road Traffic Ordinance (Cap. 374) for regulating all EMDs [7]. Among various types of EMDs, the Hong Kong government classifies powered wheelchairs as Motorized Personal Mobility Aids (PMAs) manufactured for medical purposes. It regards them as medical devices instead of motor vehicles [8]. Nonetheless, confusion among allowed EMDs often arises, and the government is still working on a framework to regulate and expand the use of EMDs in Hong Kong [7,8].

There is a growing trend of using the Internet and Internet of Things (IoT) devices such as smartphones and smartwatches to make healthcare-related decisions that come with associated risks and benefits [9,10]. This project aimed to understand the information required to support the effective mixed-use of passive and active assistive technology for mobility and active aging among the Hong Kong population.

1.1 The Mixed-Use of Assistive Technologies for Mobility

Commonly, a person uses more than one assistive and other readily available commercial technologies to cater to different needs. For example, a person may use a powered wheelchair or mobility scooter to cover longer distances and a walking frame or cane for community mobility and shopping. Among people with physical disabilities in Hong Kong, 42% of them require either a wheelchair or specialized aids for mobility, and 36% of them use either a wheelchair or specialized mobility aids [11]. A seminal longitudinal study about health differences between mobility scooter users and the unaided pedestrian in the UK showed that of the 77 respondents in the sample who used mobility scooters, 60 also used a cane, 13 used a walker, 30 used a manual wheelchair, and 3 used a powered wheelchair [12]. The study has concluded that mobility scooter users perform worse at physical functioning tasks than other older people. The study also points out that unregulated access to assistive mobility devices, including mobility scooters, leads to a lack of good advice to assess the suitability of a device for a person and vice versa [12].

In the past two decades, there has been a surge in the number of new types of EMDs, like self-balancing scooters [13]. The last can present similar functions to a powered wheelchair. The use of powered wheelchairs and mobility scooters is increasing significantly despite no significant increase in people with mobility difficulties [14]. Like other cities worldwide, EMDs have gained popularity in Hong Kong, with their retained imports reaching 1.16 million units in 2018 [13].

While there is a wealth of data on the relationships between physical activity, health, and aging, there is a lack of evidence on the role of EMDs in promoting physical functioning and physical capabilities [14].

1.2 Information Requirement Versus Information Overload

In ATD service provision, various service stages often require the collection of various service user information to define and follow up with AT solutions and rehabilitation programs. The AAATE suggests seven service steps, all requiring the collection of different information that will affect the effectiveness of the rehabilitation programs [3].

Considering user information is collected in various stages of AT service, there is still the need to analyze the collected data to make complex decisions, such as deciding on the ATD that will compose the AT solution and evaluating required changes for the rehabilitation program and assistive solution after a period of use. However, the complexity of end-user medical data analysis is challenging yet often impossible [10,15,16]. As a result, the long-debated information overload is a constant challenge to healthcare research and service provision. Hence, there is a need to explore more efficient ways to interact with health information from different stakeholders' perspectives and consider the models of service provision, such as the medical, social, or consumer models of AT service provision.

There has been a surge of new ways to collect data to support informed healthcare decisions and well-being, supported by advances in Artificial Intelligence (AI), Big Data, and the Internet of Things (IoT). The last expanded to the Internet of Mobile Things (IoMT). From a user perspective, technology such as wearable devices can make the process of habit formation - essential to avoid AT use discontinuance - more effective and efficient [9]. Users can also learn more about themselves and control lifestyle changes. Another example is mobile Health (mHealth), which delivers healthcare or healthcare-related services through portable devices [16]. However, although commercial app stores hold thousands of healthcare-related apps, most focus on wellness and well-being, neglecting condition-specific solutions such as for people with disabilities and assistive technology [17]. According to a 2022 survey by Rakuten Insight [18] on wearable technology with 3787 respondents in Hong Kong, approximately 42 percent of male respondents and 41 percent of females stated that they owned a smartwatch, while 37 percent of females and 34 percent of male respondents did not own a smartwatch or wearable fitness or activity tracker. Regarding motivation, both male and female respondents claimed they were concerned about their health and would like to monitor and improve it using wearable technologies [18].

2 Methods

We conducted an online survey of people using multiple mobility devices to support commuting in Hong Kong. The survey collected information on people using active and passive assistive technologies for mobility in Hong Kong and their caregivers. We divided the survey into three parts. The first part collected participants' demographic information, such as age, educational attainment, living and employment status. The second part collected information related to user behavior and mobility device usage. We enquired about the mobility device users' health function, types of active and passive devices used for mobility, frequency of device use, required parameters to track mobility function, information about their commute, and factors affecting device

choice. The third part of the survey enquired about IoT elements and information requirements. We enquired about the use of IoT devices, the frequency of IoT device use, the information used to decide the assistive solution for commuting, sharing information with healthcare professionals, and the privacy of information collected by IoT devices.

3 Results and Discussion

3.1 Mixed Use of Active and Passive Assistive Devices in Hong Kong

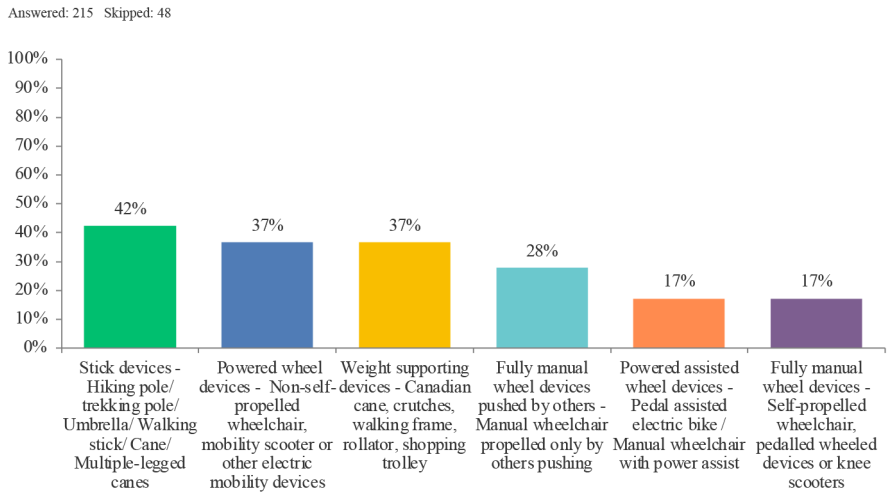

Fig. 1. Mobility device(s) used to support daily commute.

The survey obtained 263 responses from May 2022 to May 2023. Figure 1 shows all the current mobility device(s) respondents reported using to support daily commutes. Among all respondents who declare currently using a powered wheel device (n=79), 13% (n=10) also use a powered assisted wheel device, 15% also operate a fully manual wheel device pushed by others, 19% (n=15) also use a self-propelled fully manual wheelchair, 25% (n=20) also use weight supporting devices such as cane with forearm support, crutches, walking frame, rollator, shopping trolley, 28% (n=22) also uses a walking stick device. Among all respondents who declare currently using a manual wheelchair pushed by others (n=60), 20% (n=12) also use a powered wheel device, 22% (n=13) also use a powered assisted wheel device, 17% (n=10) also use a self-propelled fully manual wheelchair, 50% (n=30) also use weight supporting devices such as cane with forearm support, crutches, walking frame, rollator, shopping trolley, 40% (n=24) also uses a walking stick device.

When asked how often they use a stick or frame device in combination with a wheeled device to commute, 32% responded they use it once or twice a week, 31% use

it every day or most days of the week, 25% never use those devices in combination, and 12% use it once or twice a month.

Despite in lesser proportion than studies conducted in the UK [12], results reveal a common mixed use of powered mobility devices in combination with ATDs for walking in Hong Kong. The differences could be explained by the fact that access and use of powered mobility devices in Hong Kong are strictly regulated [7,8].

From a design perspective, mobility devices are hardly designed considering their use combined with other mobility devices or personal objects such as phones, umbrellas, bags, and drinks. Developers of mobility devices should consider such integrated use of devices to provide a better user experience that reflects the reality of use.

3.2 Information Used to Decide on Assistive Technology Devices

The most frequent type of information used when choosing the mobility device(s) to commute on a typical day was, in order of most frequent response based on weighted average, the weather report, accessibility in the built environment, schedule of the day, availability of others, distance they commute, health information from wearable health trackers devices. Despite the less frequent type of information reported when choosing the mobility device, 13% (n=29) reported always using health information from wearable health tracker devices, 17% reported using it frequently, 24% (n=51) using it sometimes, 15% (n=33) seldom using it, and 30% (n=65) never using it. We asked participants to rank determinant factors in terms of importance when choosing the mobility device(s) for commuting on a regular day, as represented in Figure 2.

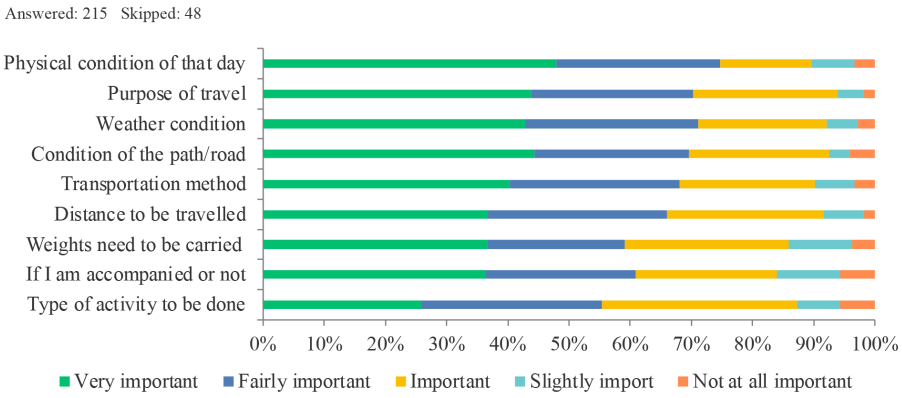

Fig 2. Ranking of important factors when choosing the mobility device(s) for commuting on a regular day, ordered by weighted average.

The results reveal that users of mixed ATDs for mobility in Hong Kong frequently use various information to decide on their devices to commute on a typical day. Similarly, most respondents rated all suggested determinant factors as very important or fairly important when choosing mobility. Notably, physical condition on the day of commute is rated the highest factor, and health information from wearable health

trackers is the least frequent type of information used when choosing the mobility device. This contrast reinforces the gap between the information used and information required to select ATDs, that information from IoT devices needs to reflect better users' physical condition status to be helpful to support mobility device selection, as well as showing the complexity of information required to make daily decisions on which ATDs for mobility to use.

3.3 Information Requirements to Keep Mobility Function and Use of IoT Devices

When asked to rate the IoT elements statements in terms of the agreement, most participants strongly agreed (25%) or agreed (53%) with the statement: "I think proper notifications would prevent me from developing an overreliance on my mobility device." Most participants strongly agreed (25%) or agreed (51%) with the statement: "I think that using the digital device that helps to make an informed decision can help to increase my independence." Most participants strongly agreed (25%) or agreed (48%) with the statement: "I think the tracking ability of the device can help motivate me to do more physical exercise. It aids me with my goal."

When asked which standards are most important for tracking mobility functions, participants answered in order of importance: strength, distance walked, pain level, psychological state, and body posture.

When enquired which IoT device they use the most regularly, 84% of participants responded smartphones, 8% smartwatches, 4% tablets, 2% pedometers, and 2% don't use any of the listed devices. When asked how regularly they use their IoT device to help them decide how they would commute, 39% responded always, 30% frequently, 22% sometimes, 5% seldom, and 4% never.

The results indicate that the smartphone is the IoT device used most frequently by most respondents among users of mixed ATDs in Hong Kong. Most respondents will often use their IoT devices to make judgments on how to commute and agree that using the digital device that helps to make an informed decision can help to increase their independence. Despite the smartwatch's frequent use in Hong Kong [18], developers of IoT devices should consider the popularity of smartphones among the variety of emerging IoT devices when developing apps or IoT solutions for mobility for ATD users. The results also align with the Hong Kong population's reported concern about their health and willingness to monitor and improve it using wearable technologies [18]. Despite our study not enquiring if participants would like to monitor and improve it by using wearable technologies like enquired in the Rakuten Insight survey [18], there is a strong indication of the potential of wearable technology to help track mobility function, informing users about overreliance on mobility devices and make an informed decision to increase independence.

4 Conclusion

The survey results reveal a common mixed use of powered mobility devices in combination with ATDs for walking in Hong Kong. They highlight the current use of IoT devices and the information required for commute planning, mobility device selection, and promoting well-being. Interestingly, the findings indicate that users of mixed ATDs for mobility in Hong Kong frequently use various information to decide on their commuting devices, such as weather reports, accessibility in the built environment, and schedules of the day.

There is a contrast between the information used and the information required to select ATDs. While physical condition on the day was reported as the most important factor, using health information from wearable health tracker devices was the less frequent type of information reported when choosing the mobility device. Information from IoT devices needs to reflect users' physical condition status to be useful in supporting mobility device selection. Furthermore, our results show that most respondents use smartphones as the predominant IoT device. This suggests that developers of IoT devices should consider the popularity of smartphones among the variety of emerging IoT devices when developing apps or IoT solutions for mobility for ATD users.

Our research highlights the significant potential of IoT devices and wearable technology in monitoring mobility functions. These technologies can inform users about excessive reliance on mobility aids and facilitate informed decision-making to enhance independence. This finding aligns with the health-related concerns expressed by the Hong Kong population in another study, who demonstrate a willingness to utilize wearable technologies for self-monitoring and improvement. Consequently, this area presents a promising avenue for future research and development.

Acknowledgments. This research project was supported by the Hong Kong Polytechnic University School of Design Departmental Supporting Fund from the University Grants Committee.

Disclosure of Interests. The author has no competing interests to declare relevant to this article's content.

5 References

1. Murray, M. P., Seireg, A. H., Scholz, R. C.: A survey of the time, magnitude and orientation of forces applied to walking sticks by disabled men. American Journal of Physical Medicine & Rehabilitation, **48**(1), 1-13 (1969)
2. Joyce, B. M., Kirby, R. L.: Canes, crutches and walkers. American Family Physician, **43**(2), 535-542 (1991)
3. Andrich, R., Mathiassen, N. E., Hoogerwerf, E. J., Gelderblom, G. J.: Service delivery systems for assistive technology in Europe: An AAATE/EASTIN position paper. Technology and Disability, **25**(3), 127-146 (2013)
4. Association for the Advancement of Assistive Technology in Europe.: AAATE position paper: A 2003 view on Technology and Disability. [Position paper], (2003)

5. World Health Organization.: Global report on assistive technology: summary, (2022)
6. Maximo, T. P., & Lau, N.: The use of umbrellas, hiking poles and walking sticks to aid walking in Hong Kong. In: RESNA ANNUAL CONFERENCE, RESNA (2021)
7. Legislative Council: Legislative Council Panel on Transport Use of Electric Mobility Devices in Hong Kong. LC Paper No. CB(4)571/2023(05) https://www.legco.gov.hk/yr2023/english/panels/tp/papers/tp20230616cb4-571-5-e.pdf, last accessed 2024/03/29 ,(2023)
8. Legislative Council.: Panel on Transport Review of the Use of Electric Mobility Devices in Hong Kong. LC Paper No. CB(4)698/19-20(02), https://www.legco.gov.hk/yr19-20/english/panels/tp/papers/tp20200619cb4-698-2-e.pdf, last accessed 2024/03/29 ,(2020)
9. Aroganam, G., Manivannan, N., Harrison, D.: Review on wearable technology sensors used in consumer sports applications. Sensors, **19**(9), 1983 (2019)
10. Holzinger.: Semantic information in medical information systems-from data and information to knowledge: Facing information overload. In: MEDIA : A TRANSDISCIPLINARY INQUIRY, Intellect, vol. 7, (2007)
11. Census and Statistics Department.: Persons with Disabilities and Chronic Diseases in Hong Kong. In: Hong Kong Monthly Digest of Statistics, (2015).
12. Thoreau, R.J.: Personal Mobility Scooters: Health differences between mobility scooter users and the unaided pedestrian. (Accessibility Research Group Working Paper). Accessibility Research Group, Department of Civil, Environmental and Geomatic Engineering, University College London: London, UK. Green open access, (2011)
13. Census and Statistics Department.: Interactive Data Dissemination Service for Trade Statistics, (2019)
14. Thoreau, R.J.: The impact of mobility scooters on their users. Does their usage help or hinder? A state-of-the-art review. Journal of transport & health, **2**(2), 269-275, (2015)
15. Holzinger, A., Jurisica, I.: Interactive Knowledge Discovery and Data Mining in Biomedical Informatics: State-of-the-Art and Future Challenges, 2014th ed., Vol. 8401, Springer Nature, (2014)
16. Whittaker, R., Merry, S., Dorey, E., Maddison, R.: A development and evaluation process formHealth interventions: examples from New Zealand. J Health Commun 2012;**17**(Suppl 1), 11– 21, (2012)
17. Jahns, R.G., Houck, P.: Mobile Health Market Report 2013-2017, https://research2guidance.com/product/mobile-health-market-report-2013-2017/, last accessed 2024/03/29
18. Rakuten Insight.: Share of respondents who own wearable electronics in Hong Kong in 2022, by gender [Graph]. In Statista. https://www.statista.com/statistics/1058311/hong-kong-ownership-wearable-tech-by-gender/, last accessed 2024/03/29, (2022).