The Evaluation of a Drug Checking Software Platform that Enables Remote Point-of-Care Drug Checking

by

Derek Robinson
B.Sc., University of Victoria, 2021

A Thesis Submitted in Partial Fulfillment of the
Requirements for the Degree of

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ABSTRACT

In April 2016, drug-related overdoses were declared a public health emergency in British Columbia, Canada. At the heart of this public health emergency is fentanyl, a synthetic opioid and the most commonly detected drug in illicit drug toxicity deaths. However, the illicit drug supply as a whole has become increasingly unpredictable, especially since the COVID-19 pandemic disrupted British Columbia's drug supply, leading to complex drug samples containing benzodiazepines and nitazenes, overdose on which is not reversed by naloxone, the opioid overdose reversal drug as they are not opioids. One harm reduction response to the overdose crisis is drug checking, a process in which a sample of an illicit drug is analyzed to determine its chemical composition. However, access to drug checking is not universal, and the implementation of drug checking services is hindered by several barriers, such as the need for skilled technicians to analyze drug checking data. In this thesis, I describe research I conducted to evaluate a drug checking software platform that facilitates the distributed drug checking model, a model by which drug checking is performed without skilled technicians being geographically present. The research conducted in this thesis comprises two studies: a heuristic evaluation of the software and semi-structured interviews with harm reduction service providers and service users. These two studies lead to three main contributions, which are: (1) a set of usability problems with the software platform and various fixes for them, (2) a set of barriers and facilitators that are associated with the distributed model of drug checking and the software platform, and (3) a set of design considerations for a self-service drug checking kiosk, which is a potential future iteration of the software platform.

Table of Contents

Supervisory Committee ii

Abstract iii

Table of Contents iv

List of Tables vii

List of Figures viii

Acknowledgements ix

Dedication x

1 Introduction 1

1.1 Research Goals, Questions, and Contributions 3

1.1.1 Research Goals and Questions 3

1.1.2 Contributions 4

1.2 Thesis Organization 4

2 Background 6

2.1 Harm Reduction 6

2.2 Drug Checking 7

2.2.1 A History of Drug Checking 7

2.2.2 Drug Checking Service Models 8

2.2.3 Barriers to Accessing Drug Checking 9

2.2.4 Barriers to Implementing Drug Checking 9

2.2.5 A Distributed Model of Drug Checking 11

The Distributed Drug Checking Software Platform 12

2.2.6 Broadening the Reach of Drug Checking 13

2.3 Self-service Kiosks . . . 13
2.3.1 Application of Self-service Kiosks . . . 14
2.3.2 General Guidelines for the Design of Self-service Kiosks . . . 15

3 Methodology **16**
3.1 Understanding the Usability Problems within the Distributed Drug Checking Software . . . 17
3.1.1 Heuristic Evaluation Participants . . . 17
3.1.2 Heuristic Evaluation Data Collection and Analysis . . . 18
3.2 Understanding the Barriers and Facilitators faced by Service Providers and Service Users . . . 18
3.2.1 Service Provider Interviews . . . 18
Service Provider Interview Participants . . . 18
Service Provider Interview Data Collection and Analysis . . . 20
3.2.2 Service User Interviews . . . 21
Service User Interview Participants . . . 21
Service User Interview Data Collection and Analysis . . . 21
Kiosk Design and Build Process . . . 22

4 Results **25**
4.1 Usability Issues Identified by Heuristic Evaluation . . . 25
4.1.1 Non-applicable Issues . . . 26
4.1.2 Pending Fixes . . . 29
4.1.3 Finding a Misleading Usability Problem . . . 29
4.2 Barriers and Facilitators Described by Service Providers . . . 31
4.2.1 Barriers Described by Service Providers . . . 31
4.2.2 Facilitators Described by Service Providers . . . 34
4.3 Barriers and Facilitators Described by Service Users . . . 35
4.3.1 Barriers Described by Service Users . . . 36
4.3.2 Facilitators Described by Service Users . . . 37

5 Discussion **38**
5.1 An Analysis of Trustworthiness . . . 38
5.1.1 Credibility . . . 39
5.1.2 Transferability . . . 40
5.1.3 Dependability and Confirmability . . . 40

5.1.4 Reflexivity 40
5.2 Reflecting on the Heuristic Evaluation Method 41
5.3 Barriers and Facilitators Identified by Both Cohorts 42
5.3.1 Barriers Identified by Both Cohorts 42
5.3.2 Facilitators Identified by Both Cohorts 43
5.4 Improvements to the Distributed Drug Checking Software Platform 44
5.4.1 Distributed Site History Tracking 44
Prototyping and Implementing a History Tracking Feature 45
5.4.2 Visualization Dashboard 46
Prototyping and Implementing a Visualization Dashboard 47
5.5 Providing Value to Service Users Through Additional Features 48
5.5.1 Harm Reduction, Drug-Drug Interaction Information, and Quantitative Results 48
5.5.2 Information Regarding Access to Local Harm Reduction Services . 50
5.5.3 Summary of Local Drug Market Statistics 51
5.6 Future Work: Security and Timeliness of Obtaining Results 51
5.7 Limitations 52

6 Conclusion **54**

Bibliography **56**

A Interview Consent Form **63**

B Certificate of Ethical Approval **65**

C Interview Recruitment Email **67**

D Service Provider Interview Guide **68**

E Service Provider Codebook Exported from ATLAS.ti 8 **70**

F Example Service Provider Quotes **71**

G Service User Interview Guide **72**

H Service User Codebook Exported from ATLAS.ti 8 **74**

I Example Service User Quotes **75**

List of Tables

Table 2.1 Different sample collection and analysis models of drug checking services. 8

Table 3.1 Heuristic Evaluation Participants Roles Within Substance. 17
Table 3.2 The usability heuristics used in the heuristic evaluation and their definitions. Heuristics 1-10 were devised by Nielsen and heuristic 11 (shown in bold) is a domain-specific heuristic I added to the set of heuristics. 19
Table 3.3 Semi-structured Interview Participants. Participants with "SP" codes are service providers and "SU" codes are service users. 20

Table 4.1 Major usability problems found within the distributed drug checking software. 27
Table 4.2 Minor usability problems found within the distributed drug checking software. 28
Table 4.3 Usability problems unrelated to the distributed drug checking software. 28
Table 4.4 Barriers and facilitators identified by service providers, sorted by the number of mentioning participants. Entries which are bolded were were also identified by service users. 32
Table 4.5 Barriers and facilitators identified by service users, sorted by the number of mentioning participants. Entries which are bolded were also identified by service providers. 35

List of Figures

Figure 2.1 Locations of the Substance storefront and the distributed drug checking sites. The Substance storefront is depicted as a star, and the distributed drug checking sites are depicted as diamonds. 11
Figure 2.2 A depiction of the distributed drug checking workflow. 12

Figure 3.1 Overview of the methods used to answer each research question. . . . 16
Figure 3.2 The kiosk design process. 22
Figure 3.3 The kiosk build process. 23
Figure 3.4 The final prototype drug checking kiosk. 24

Figure 4.1 Number of violations per heuristic. 26
Figure 4.2 The first iteration of the IR instructions, found to be problematic due to the cluttered feeling of the page. 29
Figure 4.3 The second iteration of the IR instructions, with the images hidden behind a button: this version is less cluttered but was found to be less usable due to the images being hidden. 30
Figure 4.4 The final iteration of the IR instructions, with more whitespace and annotated images. 30

Figure 5.1 History feature mockups, showing the desktop view on the left and the mobile view on the right. 45
Figure 5.2 The final version of the history feature. 46
Figure 5.3 Mockups of the visualization dashboard. 47
Figure 5.4 The final version of the visualization dashboard. 49

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My cats Maple and Duncan. Thank you for the cuddles, laughs, and always bringing a smile to my face.

DEDICATION

To those affected during the overdose crisis, their families, friends, and loved ones.

Chapter 1

Introduction

More than seven years ago, in April of 2016, drug-related overdoses were declared a public health emergency in British Columbia, Canada [1]. In most illicit drug toxicity deaths during 2022, fentanyl, a potent synthetic opioid with approximately 50–100 times the potency of morphine [2], or fentanyl analogues such as carfentanil, were identified either alone or in combination with other drugs [1]. While fentanyl is the most commonly detected drug in illicit drug toxicity deaths, the illicit drug supply as a whole has become increasingly unpredictable, especially since the COVID-19 pandemic disrupted British Columbia's drug supply [3]. This unpredictability has led to the detection of other drugs such as benzodiazepines [4] and nitazenes [5] in the illicit opioid supply. The inclusion of benzodiazepines and nitazenes in the opioid supply presents complications as naloxone, the opioid overdose reversal drug, is ineffective as benzodiazepines and nitazenes are not opioid-class drugs. Thus, due to the complexity of the illicit drug supply, a varied public health and harm reduction response is required to combat the harms associated with an unpredictable supply of drugs.

Since declaring the overdose public health emergency, British Columbia has seen several harm reduction services scale up their reach to combat drug-related overdoses. As defined by Marlatt, *"harm reduction is a humane approach . . . [which] allows people to provide their peers with the resources and tools they need to cope with the risks of drugs, sex, and violence"* [6]. Many harm reduction services act as a method of combating the harm associated with drugs, such as supervised consumption and overdose prevention sites (SCS and OPS, respectively) [7, 8] which provide a safe place for one to consume their drug of choice, naloxone distribution [9, 10], which allows lay-people to respond to overdoses they may witness, and of greatest importance to this thesis, drug checking [11, 12], which provides people who use drugs with pertinent information about their drug.

Drug checking benefits those who use it [13] by providing service users with information about the composition and potency of their drug, but those living outside urban centers may struggle to access such services [14]. This is because drug checking services often operate out of a single urban location, with limited hours of operation. As a result, users must be available during operating hours and have the means to travel to the service location, which can be difficult for those in rural or suburban communities. These limitations can alienate potential service users.

Implementation barriers also exist for prospective providers who wish to start a drug checking service. One such implementation barrier is the need for skilled technicians who possess the technological ability to operate chemical analysis instruments [11, 15] such as Fourier transform infrared spectrometers (FTIR) [16]. Further barriers regarding implementation also exist, such as the acquisition and operating costs of the chemical analysis instruments; for example, a single FTIR can cost upwards of $40,000 [15]. Finally, the need for harm reduction workers to operate sample intake and provide harm reduction education to service users is another barrier to implementing a drug checking service [11].

However, these barriers are not impossible to overcome. The drug checking service I joined as part of my research has overcome the barriers relating to the need for skilled technicians. This service is named *Substance*[1] and operates five drug checking services throughout Vancouver Island, British Columbia, within a "distributed model of drug checking" [17] (see Section 2.2.5). The main hub site, located in downtown Victoria, British Columbia, hosts the technicians who analyze data for the hub site and the sites throughout Vancouver Island. Using a provided laptop and FTIR spectrometer, the four other sites, referred to as "distributed sites" in this thesis, perform sample intake and data collection through a custom-developed application. Within this thesis, this custom-developed application is referred to as the "distributed drug checking software". The data collected is automatically uploaded to a central database, and from there, the technicians can analyze it and provide results back to the distributed sites. Overall, this method of delivering drug checking allows for the resources of one service to be spread over a larger geographical area, thus increasing the number of people able to access drug checking.

[1] https://substance.uvic.ca/

1.1 Research Goals, Questions, and Contributions

Although the distributed model of drug checking has allowed for drug checking to become available in municipalities which previously did not have access to drug checking, it is the belief of myself, my colleagues at Substance, and the drug checking community as a whole, that the reach of drug checking can still be improved. In previous research, Wallace *et al*. identified that *"non-contact"* options for drug checking could greatly improve the equity of access to drug checking services [14]. As described by a participant in Wallace *et al*.'s study, a non-contact drug checking service would be *"like an ATM machine, no people, you just take a little bit put in the machine and it spits out the results"*; in other words, a self-service drug checking kiosk [14].

Such a kiosk would allow any willing organization to bypass the barriers of skilled technicians and harm reduction workers by empowering service users or service providers to collect their spectra and receive results through the kiosk or by an online reporting platform accessible on their own devices. With self-service kiosks becoming an increasingly common and preferable way to grant the public access to information and services [18] due to their convenience, simplicity, and low-cost compared to other alternatives [18, 19], as a member of the Substance research team, I decided to investigate and evaluate the requirements for a self-service drug checking kiosk.

1.1.1 Research Goals and Questions

My thesis focuses on three main research goals. In my research, I first investigated the usability of the distributed drug checking software, which acted as the basis for developing a self-service drug checking kiosk. This investigation helped determine the software's effectiveness, ease of use, and other relevant factors. Second, I explored the barriers and facilitators experienced by the distributed drug checking sites, providing insights into the contexts in which a self-service drug checking kiosk might operate. Finally, I built a prototype self-service drug checking kiosk using the distributed drug checking software as a starting point. The first two research goals led me to formulate the following two research questions (RQ1 and RQ2):

RQ1: What usability problems are present within the distributed drug checking software?

RQ2: What barriers and facilitators do the distributed drug checking sites face in their operation?

The first two research questions aimed to understand the current state of the distributed drug checking software and sites. However, I also wanted to understand how the distributed drug checking software can be packaged into a self-service kiosk and how it can be used by service users, leading me to my last research question (RQ3).

RQ 3: What barriers and facilitators would prospective service users face in interacting with a self-service drug checking kiosk?

1.1.2 Contributions

Overall, the following are the main contributions from my thesis:

Contribution 1: A description of the usability problems with the distributed drug checking software.

Contribution 2: A description of barriers and facilitators described by service providers of distributed drug checking sites.

Contribution 3: A set of recommendations for improving the distributed drug checking software platform.

Contribution 4: A description of barriers and facilitators described by prospective service users of a self-service drug checking kiosk.

Contribution 5: Design knowledge regarding a self-service drug checking kiosk including:

- What features should be added to the kiosk to improve the value provided to service users.
- Where the kiosk should be located.

1.2 Thesis Organization

The remainder of this thesis is structured in the following manner:

Chapter 2 Background presents background information on drug checking and self-service kiosks, including a history of drug checking, the various service models used, accessibility and implementation barriers faced by drug checking services, the distributed

model of drug checking, and how drug checking may be broadened in the future through self-service kiosks. This chapter also describes self-service kiosks and their applications.

Chapter 3 Methodology presents the methodology I used to conduct the research within this thesis and the specific methods I used for each research question.

Chapter 4 Results describes and lists the qualitative results obtained from each of the three studies I conducted.

Chapter 5 Discussion discusses the results from each of the three studies conducted, how these results align with previously published related work, and my recommendations that stem from the results.

Chapter 6 Conclusion presents the conclusion of this thesis, including a summary of the contributions.

Chapter 2

Background

This chapter presents the background information required to understand the remainder of this thesis. Firstly, I introduce harm reduction and its importance to this thesis. Following this is a brief history of drug checking, the current models used to deliver drug checking, and the barriers faced by those implementing and accessing drug checking are presented. I then describe how a distributed model of drug checking alleviates some of the aforementioned barriers and how the reach of drug checking can be broadened. I conclude the chapter with a brief discussion of self-service kiosks, which includes relevant applications and some general design considerations.

2.1 Harm Reduction

> "Harm reduction is a humane approach . . . [that] allows people to provide their peers with the resources and tools they need to cope with the risks of drugs, sex, and violence" [6].

Harm reduction is a method of combating the harm associated with drug use via initiatives such as supervised consumption and overdose prevention services (SCS and OPS, respectively) [7, 8], naloxone distribution [20, 10], and drug checking [11, 12]. SCS and OPS help manage the harms associated with drug use by monitoring people who use drugs (PWUD) while they consume their drug of choice. If an overdose occurs within an SCS or OPS, a trained professional is able to intervene [7]. SCS and OPS have shown the ability to reduce the number of overdose deaths, reduce transmission of blood-borne diseases, and connect people to other services [21, 22, 23]. The naloxone distribution program within British Columbia initially provided naloxone to those at risk of opioid overdose but was later

expanded to include those likely to witness an opioid overdose [10]. In addition to providing naloxone, British Columbia's naloxone distribution program also provides training on administering naloxone, either in person at any distribution location or online [10]. Finally, of utmost importance to this thesis is drug checking, which is defined by the Nightlife Empowerment and Well-being Implementation Project as *"an integrated service that enables PWUD to have their drugs analyzed and receive advice and, if necessary, counselling"* [24]. Overall, harm reduction services, including drug checking, are important in combating the overdose crisis. However, other responses are also required, including an improved public health response, campaigns to reduce drug use stigma, and criminal justice reform [25]. As drug checking is the focus of this thesis, more details are provided in the following section.

2.2 Drug Checking

> "An integrated Drug Checking service creates awareness about a drug's effects and side effects, educates users about the methods of risk reduction, and thereby reduces the risks for drug users" [24]

2.2.1 A History of Drug Checking

Drug checking, sometimes called pill testing or drug safety testing, has been practiced as a harm reduction method for roughly six decades [26, 27]. Several drug checking services (DCS) have been operating continually for over 25 years [28], namely the Drug Information and Monitoring System[1] in the Netherlands, and International Energy Control[2] in Spain [13]. Many more DCS were founded in the mid to late 1990s, predominately in Europe. However, some arose in North America, namely DanceSafe,[3] which at the time was the only publicly accessible drug checking laboratory in North America. Nevertheless, many drug checking services founded during the 1990s were associated with the rave and nightlife scenes. Due to this, these early DCS were seen to promote drug use rather than reduce harm.

However, within the last decade, drug checking has garnered support as a harm reduction method in Europe and North America [28]. The increased support drug checking has gathered is likely due to three factors [28]: firstly, novel psychoactive substances being

[1] https://www.drugs-test.nl/over-dims/
[2] https://energycontrol-international.org/drug-testing-service/
[3] https://dancesafe.org/

misrepresented as other, more well-known substances [29, 30]; secondly, the increased potency of tablets and powders, especially European MDMA [31]; and finally, again of utmost importance to this thesis, the rise of fentanyl, fentanyl analogues, and the overdose crisis [32, 33, 34]. Furthermore, the COVID-19 pandemic caused global disruption to the illicit drug supply, which in North America only worsened the overdose crisis [35, 36] due to several factors, one of which was the disruption of the production and transportation of illicit substances. Overall, the increased support for drug checking has led to the founding of new DCS, the expansion of existing DCS, and within New Zealand, a legal framework to license drug checking services [37].

2.2.2 Drug Checking Service Models

Drug checking has a long and varied history, and currently serves several target populations, that in turn require different service models. In their 2021 systematic review of drug checking services, Maghsoudi *et al*. stratified the dimensions in which service models differ. These dimensions are as follows: collection models describe how drug samples are collected and analysis models describe the location of chemical analysis instruments relative to where sample collection occurs [13]. Sample collection models include *fixed*, *mobile*, and *postal* models, while analysis models include *on-site* and *off-site*. Descriptions of each model are included in Table 2.1.

Model category	Model type	Description
Collection	Fixed	Occurs within a permanent, fixed location, allowing for samples to be dropped off and/or mailed in
	Mobile	Occurs at events such as music festivals or within the nightlife scene
	Postal	Samples are mailed to the drug checking service
Analysis	On-site	Sample analysis occurs at the same site as sample collection
	Off-site	Sample analysis occurs at a different site as sample collection

Table 2.1: Different sample collection and analysis models of drug checking services.

2.2.3 Barriers to Accessing Drug Checking

Despite the variety of drug checking service models, each tailored to different population groups, and the benefit of accessing drug checking services [13], many people still face difficulty accessing drug checking services because they live outside of urban centers [11, 17]. Accessibility issues are compounded if potential service users have mobility issues [14]. In general, geography and service hours play a role in limiting accessibility to drug checking services [14].

While geography and service hours play a part in how accessible a drug checking service is, they are not the only limiting factors. Other barriers that threaten access to drug checking services are the criminalization of substances, substance use, and stigma towards PWUD [14]. However, in British Columbia, possession of a combined 2.5 grams of *"opioids (such as heroin, morphine, and fentanyl), crack and powder cocaine, methamphetamine, and MDMA"* [38] has been decriminalized as of January 31, 2022. While this is a step in the right direction, many people may still hesitate to access drug checking services due to the stigma associated with substance use [14]. Furthermore, the recent decriminalization does not cover all substances, nor has the change in law been enacted elsewhere in Canada.

Cultural factors also pose a barrier to accessing drug checking services. These barriers include a lack of knowledge about drug checking services and individuals' substance use patterns, such as the desire to use immediately after purchase [14]. Within some Indigenous communities, drug checking may not be welcome [14]. This is because within certain Indigenous communities, the use or sale of illicit substances is highly unacceptable [14]. Overall, there are many barriers that prospective service users may face when trying to access drug checking services. To expand the reach of drug checking, there must be a concerted effort to minimize the accessibility barriers by further tailoring service models to the widespread population groups who wish to access drug checking.

2.2.4 Barriers to Implementing Drug Checking

Those who wish to access drug checking face many barriers, but so do those who wish to implement drug checking services. Barriers faced by drug checking service providers are often placed into five categories: *intervention characteristics*, *outer setting*, *inner setting*, *individual characteristics*, and *process* [11, 15]. These categories and their definitions are based on the Consolidated Framework for Implementation Research (CFIR) [39] and are provided by Wallace *et al.* [11]. *Intervention characteristics* are the key attributes of drug checking as a harm reduction intervention, *outer setting* are the contextual factors outside

of drug checking, *inner setting* are the key attributes of drug checking services and sites, *individual characteristics* are the key attributes of drug checking staff, and finally, *processes* are the key attributes related to the process of implementing drug checking services. Each of these categories influence a successful implementation of drug checking services.

Drug checking as a harm reduction intervention requires the use of chemical analysis instruments to analyze samples, as such, this characteristic of drug checking is a barrier to implementation [15]. Specifically, the use of certain chemical analysis instruments for drug checking is a relatively new and complex use case [15]. This complexity requires skilled technicians [11] who often possess a background in chemistry and the technical ability to operate instruments such as spectrometers [15]. Other skilled staff are also required to operate drug checking services, specifically those with training in harm reduction and substance use [11]. Therefore, an ideal drug checking team is comprised of staff with a variety of backgrounds, including chemistry and harm reduction.

Furthermore, the instruments required to perform drug checking are expensive, both in terms of acquisition cost and operating cost [15]. When coupled with the fact that many drug checking services face funding issues [11, 15], the upfront and operating costs of instruments pose an inner setting barrier to implementation. As an example, a commonly used instrument for drug checking is the Fourier Transform Infrared Spectrometer (FTIR) [16], which costs an estimated US$40,000 [15], while more sophisticated confirmatory instruments such as mass spectrometers cost much more. Operating a drug checking service also requires several disposable items, such as nitrile gloves, alcohol swabs, aluminum foil, test strips, and other items, further increasing operating costs [15].

When considering the outer setting, the criminalization of substances and substance use is a barrier to implementation [15], much like how criminalization acts as a barrier to those who wish to access drug checking services. Within British Columbia, drug checking services must apply for an Urgent Public Health Need Site (UPHNS) exemption in order to operate [40]. However, within other places, such as the United States, drug checking programs often come into existence and operate in a legal grey area [15]. This quasi-legal status of drug checking within the United States means that service providers often worry about police intervention as described by Carroll *et al*. [15]. These worries are further exacerbated by the stigma and structural violence faced by PWUD [11, 17, 15].

Overall, implementing a drug checking service is a complicated task, both because drug checking itself is a complex intervention, and because there are many barriers to implementation. Yet, there continues to be innovation within the drug checking space with the creation of new drug checking service models to lessen implementation barriers, for

example, the distributed model of drug checking [17], as discussed next.

2.2.5 A Distributed Model of Drug Checking

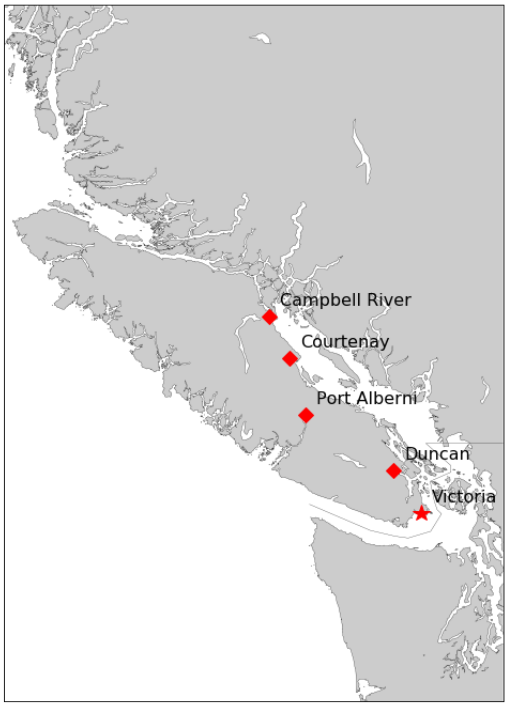


Figure 2.1: Locations of the Substance storefront and the distributed drug checking sites. The Substance storefront is depicted as a star, and the distributed drug checking sites are depicted as diamonds.

A distributed model of drug checking is designed to alleviate certain access and implementation barriers to drug checking services; most notably, the distributed model of drug checking eliminates the need to have a trained technician physically present at the point-of-care. Instead, technicians are located at the Substance storefront (depicted in Figure 2.1 as a star), that acts as the hub location. Making use of a custom software platform, distributed sites perform sample intake and collect FTIR data that is sent to the hub location via central data storage, and from there, Substance technicians analyze the data. The technicians then provide results to the distributed drug checking sites via an online reporting platform.[4] Service users can then access their results by speaking with the service providers within the local distributed drug checking sites or by accessing the results platform on their own

[4]https://substance.uvic.ca/results

devices. Following FTIR data collection, the distributed drug checking sites are encouraged to mail the sample to the hub site for confirmatory analysis via PS-MS. This process is depicted in Figure 2.2, which was adapted from the paper describing the distributed model of drug checking [17].

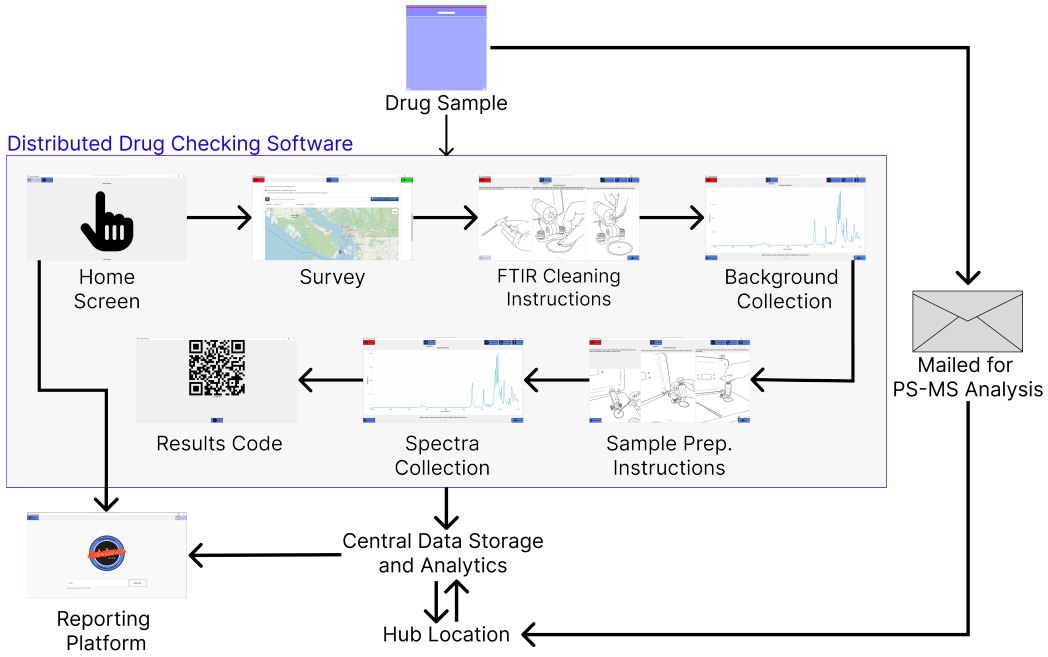


Figure 2.2: A depiction of the distributed drug checking workflow.

The Distributed Drug Checking Software Platform

The distributed drug checking software platform is an application used by the distributed drug checking sites to perform sample intake and data collection. In Figure 2.2, each screen in the distributed drug checking software is shown in relation to how it fits within the distributed drug checking workflow. This software runs on a Lenovo ThinkPad 11e Yoga Gen 6 laptop provided to the distributed drug checking sites by Substance. The software connects to an Agilent 4500a FTIR spectrometer, which is also provided to the distributed drug checking sites by Substance.

The software was designed to be easily operated, as the intended users are front-line harm reduction workers who may not have a background in analyzing spectra. Before offering drug checking within their sites, they complete a virtual and in-person training session on operating the software and acquiring FTIR spectra. In addition to performing sample collection, the distributed drug checking software allows the service provider to

access results on behalf of their clients. Figure 2.2 shows the user interface of version 1.1 of the distributed drug checking software.

2.2.6 Broadening the Reach of Drug Checking

Despite the increased reach of Substance through the distributed model of drug checking, there is still a need for more accessible drug checking services [14]. A majority of drug checking services operate out of a single location within urban centers and have limited hours of operation. Thus, any potential service user must be available during the operating hours of the service and have a means to travel to the service location. Such limitations can alienate potential service users, especially those in rural areas and suburban communities.

In previous research, Wallace *et al*. identified several implementation strategies for drug checking services that could increase equity of access to drug checking services [14]. Highly motivating to the research outlined in this thesis is the strategy of *"locating in every community to increase accessibility."* Essentially, this strategy involves tailoring approaches for different groups of people. They highlight how centralized drug checking services in urban centers are not the best option for people residing outside those urban centers. Instead, they suggest that drug checking services should be located in every community inside locations such as *"walk-in or STI clinics, medical laboratory test sites, or pharmacies"* [14].

Wallace *et al*. also found that *"non-contact"* options for drug checking services [14] were suggested as one way to increase the accessibility of drug checking services. A non-contact option was described as *"like an ATM machine, no people, you just take a little bit put in the machine and it spits out the results"* [14]. This quote highlights the need for research into what a non-contact option for drug checking may look like. In order to address the need for non-contact drug checking options, the research presented in this thesis explores the potential for a self-service drug checking kiosk.

2.3 Self-service Kiosks

Self-service kiosks have become an increasingly common way to grant public access to information and services [18]. Generally, self-service kiosks are preferable to other alternatives due to their convenience, simplicity, and low cost [18, 19] Within this section, several applications of a self-service kiosk are discussed, followed by a brief discussion of the design guidelines for general self-service kiosks.

2.3.1 Application of Self-service Kiosks

Self-service kiosks of the 21st century have shifted away from *"uninteresting boxes"* and *"static displays"*, and moved to *"eye-catching housings with a consistent corporate [look]"* and *"moving images"* [41]. This shift has allowed self-service kiosks to transition from the traditional use cases of ATMs, vending, and ticket machines [42] and into the realm of more complex tasks such as healthcare kiosks [43] and medication information kiosks [44]. In general, modern kiosks support more than a single task, and most often support several tasks such as information provision, transaction processing, relationship building via loyalty schemes, and communication opportunities [41]. Slack and Rowley describe this shift as moving away from *"task focus to customer focus,"* and state how modern kiosks offer a wide suite of information and services designed specifically for the customer [41]. While the applications of self-service kiosks are vast and range from the classical ATM to modern information retrieval kiosks, a small group of applications are of particular relevance to my research.

The first application for self-service kiosks that is relevant is delivering medication information within a pharmacy setting. Lasky *et al*. developed a kiosk that made use of the National Library of Medicine's MedlinePlus database to provide medication information [44]. This kiosk was designed to be used by patients with the help of a kiosk attendant to both facilitate the research survey and offer assistance to the patients. It was found that the introduction of this kiosk was both feasible and acceptable to both patients and pharmacy staff. This was largely attributed to the presence of the kiosk attendant, who alleviated the concern of pharmacy staff having to take time away from their duties to assist patients with the kiosk, and is in line with recommendations by Gaffney to designate "kiosk ambassadors" [44, 45].

Similar in the broad scope of relating to health and medicine, Courtney *et al*. designed a community multi-user health kiosk to enable people to monitor their health and communicate with a healthcare provider [43]. Much like the kiosks described by Slack and Rowley [41], this kiosk performs more than a single function and supports *"a variety of psycho-social assessments and peripheral monitoring tools."* It also features a customizable interface, allowing patients to tailor their experience as needed by allowing three different views of their results: the current assessment, a summary of all assessments, and a history view covering the previous assessments from the past 3, 6, 9, and 12 months.

While the self-service kiosk examples of Lasky *et al*. [44] and Courtney *et al*. [43] are more applicable to medicine and public health, examples of self-service kiosks as

harm reduction initiatives also exist. *MySafe* is an ATM-style kiosk that dispenses opioid agonist therapy medications using a non-touch biometric scanner [46]. Over traditional methods of dispensing such medications, MySafe shows a number of advantages. Most notably, MySafe provides a non-judgmental way for people to pick up their medications and gives them autonomy in doing so. Medications can be picked up at any point during a 24-hour cycle, allowing for flexibility over pharmacy-based alternatives that often require adhering to a pickup schedule. MySafe can also be customized for each person, allowing multiple pickups during the day, which may benefit some people. Each of these pickups is tracked, which minimizes medication recording errors, provides inventory tracking, and allows for follow-ups if someone does not pick up their medication. Furthermore, much like other kiosks, MySafe requires minimal staffing other than registering participants and refilling stock, thus increasing the cost-effectiveness when compared to traditional dispensing methods.

In conclusion, a variety of self-service kiosk applications exist outside of the commonly known ATM and self-service checkouts. These include medication information, health monitoring, and medication dispensing kiosks. While these kiosks are not directly related to drug checking, they help demonstrate the potential for self-service kiosks to be used in a variety of settings and for a variety of purposes. However, it is important to consider the design guidelines for self-service kiosks in order to ensure that they are usable and accessible to the people who need them.

2.3.2 General Guidelines for the Design of Self-service Kiosks

As pointed out by Ekşioğlu, there are many papers that outline the user-interface design guidelines for public information kiosk systems [47]. Namely, Maguire provides general guidelines for user requirements, physical location, encouragement of use, physical access, introduction, instructions, language selection, privacy, help, input, output, structure, navigation, and customization of self-service and public information kiosks [18]. Sandnes *et al*. provide a list of 16 design heuristics better equipped to handle issues faced by modern kiosk interfaces [48], some of which are derived from Nielsen's usability heuristics [49]. The design heuristics proposed by Sandnes *et al*. that stand out include *"avoid unnecessary visual elements," "reveal all the needed steps from the start,"* and *"solicit the advice of experts on language and culture"* [48]. In closing, the design guidelines for the general application of self-service kiosks are well defined, however, the specific requirements for a self-service drug checking kiosk still require determination.

Chapter 3

Methodology

To answer my three research questions, I conducted a two-phase qualitative study between June 2022 and January 2023. In total, I recruited 17 participants across both phases of my research. Phase one of my research, aimed at answering RQ1, was a heuristic evaluation (Section 3.1) of the distributed drug checking software platform with five members of the Substance team. The second phase consisted of semi-structured interviews (Section 3.2) with 12 participants (seven service providers and five members of a local drug user organization), aimed at answering RQ2 and RQ3. Figure 3.1 outlines each phase including the version of the DDC Software evaluated, the physical form presented to participants, methods used, research question addressed, and the date of completion.

User Interface Example			
Software Version	1.0	1.1	1.2
Physical Form	Laptop & FTIR	Laptop & FTIR	Self-service Kiosk
Evaluation Method	Heuristic Evaluation	Semi-structured Interviews	
Research Question Addressed	RQ1: What usability problems are present within the distributed drug checking software?	RQ2: What barriers and facilitators do the distributed drug checking sites face in their operation	RQ3: What barriers and facilitators do prospective service users face in iteracting with a prototype self-service drug checking kiosk?
Date Completed	June 2022	November 2022	January 2023
	Phase One	Phase Two	

Figure 3.1: Overview of the methods used to answer each research question.

3.1 Understanding the Usability Problems within the Distributed Drug Checking Software

To understand the usability problems that exist within the distributed drug checking software (RQ1), I conducted a heuristic evaluation [50], using Nielsen's ten usability heuristics [49] in addition to one domain-specific heuristic. I followed Nielsen's guide to conducting a heuristic evaluation with five evaluators [51, Figure 2]. The usability heuristics and their definitions can be found in Table 3.2; heuristics one through ten are Nielsen's ten usability heuristics [49], and heuristic eleven is the domain-specific heuristic I added to address using the DDC Software as a platform for a self-service drug checking kiosk.

3.1.1 Heuristic Evaluation Participants

Participants were eligible for the heuristic evaluation if they satisfied the following two criteria: (1) they were eighteen years of age or older and (2) they were a staff member of Substance in a non-research capacity. Following a convenience sampling approach, Substance members were chosen to participate as a proxy for distributed drug checking service providers because they possess similar domain knowledge. The role each participant holds within Substance is outlined in Table 3.1.

Participants were recruited to participate in this study through Substance's private Slack channel: an invitation to participate in the heuristic evaluation was posted in the #general channel. Once the invitation was posted, those interested based on their engagement with the invitation were individually messaged to schedule the heuristic evaluation.

Participant Code	Role within Substance
HE 1	Technician
HE 2	Software Developer
HE 3	Software Developer
HE 4	Harm Reduction Worker
HE 5	Training Coordinator

Table 3.1: Heuristic Evaluation Participants Roles Within Substance.

3.1.2 Heuristic Evaluation Data Collection and Analysis

I collected usability problem data according to the associated usability heuristics. During each evaluation, participants made several passes of the DDC software. With each pass, they pointed out any usability problems they found along with the heuristics (a max of two heuristics) they felt suited the problem best. I recorded usability problems in a spreadsheet for later prioritization. Once all evaluations had been completed, the lead software developer for Substance at the time (Abdelhakim Qbaich) and I prioritized the usability issues into major and minor problems. Major problems were defined as those that hindered the use of the software or were obvious bugs within the software, and minor problems were defined as those that are related to the aesthetics of the software. I then created issues within the Substances software version control system: issues were created for each major usability problem, including a description of the problem and applicable screenshots, and one issue was created with a list of all minor usability problems.

3.2 Understanding the Barriers and Facilitators faced by Service Providers and Service Users

To answer research questions 2 and 3, I conducted two sets of interviews, one with service providers at three distributed drug checking sites and one with prospective service users. The interview consent form for both sets of interviews can be found in Appendix A and the certificate of ethical approval can be found in Appendix B. I conducted interviews with the service providers to identify the barriers and facilitators related to the distributed drug checking software and operating the distributed drug checking sites (RQ2). In addition, I also interviewed prospective service users to identify what barriers and facilitators are related to the deployment of a self-service drug checking kiosk (RQ3). Overall, I recruited twelve participants for semi-structured interviews.

3.2.1 Service Provider Interviews

Service Provider Interview Participants

Participants were eligible to participate in the semi-structured interviews if they satisfied the following three criteria: (1) they were eighteen years of age or older, (2) had been trained in operating the distributed drug checking software, and (3) had previously performed drug checking via the distributed drug checking software. The interview co-facilitator (Dr. Bruce

Num.	Usability Heuristic	Definition
1	Visibility of system status	The system should always keep users informed within a reasonable time
2	Match between system & the real world	The system should use language familiar to the user and follow real-world conventions
3	User control & freedom	Users should have a clearly marked "emergency exit" to leave any unwanted state
4	Consistency & standards	Users should not have to wonder whether different words, situations, or actions mean the same thing.
5	Error prevention	Eliminate error-prone conditions or check for them and present users with a confirmation option before they commit to the action
6	Recognition rather than recall	Minimize the user's memory load by making objects, actions, and options visible
7	Flexibility & efficiency of use	Include accelerators (i.e. shortcuts) for advanced users
8	Aesthetic & minimalist design	Dialogues should not contain information which is irrelevant or rarely needed
9	Help users recognize, diagnose, & recover from errors	Error messages should be expressed in plain language, indicate the problem, and suggest a solution
10	Help & documentation	Provide easily searchable documentation
11	**Language does not stigmatize drug use**	**The language used in the user interface does not stigmatize the use of drugs**

Table 3.2: The usability heuristics used in the heuristic evaluation and their definitions. Heuristics 1-10 were devised by Nielsen and heuristic 11 (shown in bold) is a domain-specific heuristic I added to the set of heuristics.

Participant Code	Gender	Ethnic Background	Distributed Drug Checking Site
SP1	Female	White	Site 1 (OPS)
SP2	Female	White	
SP3	Female	White	Site 2 (OPS)
SP4	Female	White	
SP5	Male	White	
SP6	Female	White	Site 3 (Harm Reduction Service)
SP7	Female	White	
Participant Code	**Gender**	**Ethnic Background**	**Made use of a DCS**
SU1	Male	White	Yes
SU2	Male	White	Yes
SU3	Female	White	No
SU4	Female	White	No
SU5	Male	White	Yes

Table 3.3: Semi-structured Interview Participants. Participants with "SP" codes are service providers and "SU" codes are service users.

Wallace) invited the participants to participate in the interviews via email (see Appendix C). Upon accepting the invitation, interviews were scheduled within the working hours of the service providers such that the interviews could be held within their respective harm reduction sites. I recruited seven participants (Table 3.3) within the three distributed drug checking sites that were operating at the time of recruitment (November 2022).

Service Provider Interview Data Collection and Analysis

Data collection occurred within the participants' respective harm reduction sites. Bruce Wallace and conducted the interviews: I facilitated the interview while Bruce co-facilitated and asked follow-up questions. The full interview guide can be found in Appendix D In order to better accommodate some participants' limited time, group interviews were conducted at two of the three sites. The data I collected was in the form of audio recordings of the interviews, which I initially transcribed using Whisper [52] and then manually edited to ensure correctness, remove personally identifying information, and label what was said by each speaker.

The final transcriptions were then imported into ATLAS.ti 8[1] where I performed qualitative analysis. The full codebook can be found in Appendix E, while example quotations

[1]https://atlasti.com/

and their respective codes can be found in Appendix F. I created initial codes based on the interview questions and the interview transcripts, then I grouped the codes into BARRIERS and FACILITATORS. I defined a barrier as an aspect of providing distributed drug checking which presents difficulties, and a facilitator as an aspect of providing distributed drug checking that makes it easier.

3.2.2 Service User Interviews

Service User Interview Participants

Participants were considered eligible to participate in the semi-structured interviews if they satisfied the following two criteria: (1) they were eighteen years of age or older, and (2) they were a potential service user of Substance. Potential service users are defined as those who know what Substance is and might make use of Substance or another drug checking service. A third-party recruiter, who is a member of the local drug user organization, recruited the participants. Before starting the recruitment process, I gave a briefing to the recruiter and potential participants outlining what the study was about and what would be expected of them. Participants were provided with a CAD$25 honorarium for participating. Participant demographics are shown in Table 3.3.

Service User Interview Data Collection and Analysis

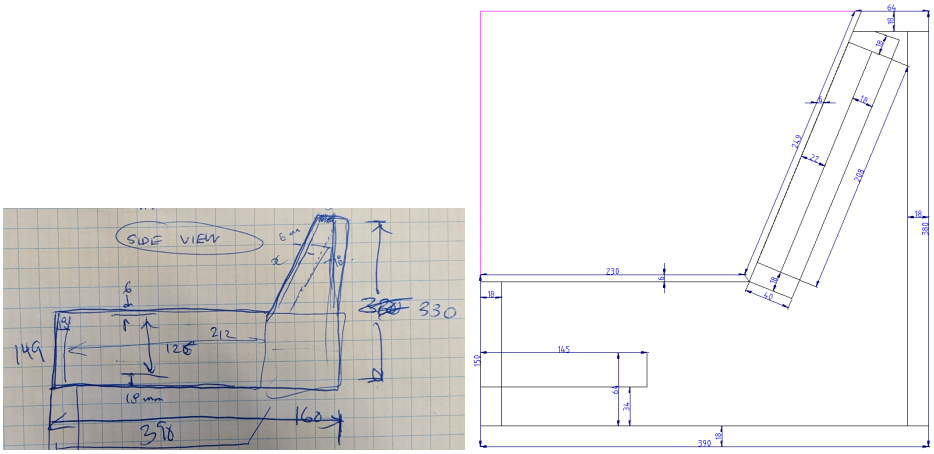
Participants began the interview by using the distributed drug checking software encased in a self-service kiosk enclosure, as depicted in Figure 3.4. This ensured the participants had an idea of how performing drug checking via a self-service kiosk might work. While participants used the prototype kiosk, I observed their interactions and made notes of points where they struggled. Following their use of the kiosk, I conducted a semi-structured interview with them; the full interview guide can be found in Appendix G. In the same manner as the service provider interviews, data was collected in the form of audio recordings of the interviews, which I initially transcribed using Whisper [52] and then manually edited to ensure correctness, remove personally identifying information, and label what was said by each speaker.

In the same manner as with the service provider interviews, the final transcriptions were then imported into ATLAS.ti 8 where I performed qualitative analysis. An example of the full codebook can be found in Appendix H, while example quotations and their respective codes can be found in Appendix I. Initial codes were created based on the

interview questions and the interview transcripts, then I grouped the codes into BARRIERS and FACILITATORS, as done during the analysis of the service provider interviews. Other code groups included INTERFACE CHANGES and LOCATION & SECURITY, which were then later grouped into the BARRIERS code group.

Kiosk Design and Build Process

In order to conduct interviews with service users, a prototype kiosk was required. I began the design of the prototype by first sketching the side profile of the kiosk enclosure based on measurements of the FTIR and laptop (Figure 3.2a). Using the sketch as a reference, a CAD drawing was created of the side profile (Figure 3.2b). The CAD drawing was then used to create the prototype kiosk enclosure using woodworking tools such as a table saw and jigsaw. The kiosk enclosure was then assembled and tested for fit with the FTIR and laptop (Figure 3.3a). Once the fit was confirmed, facades were added to the kiosk to ensure the internals fit well and to provide a more aesthetically pleasing appearance (Figure 3.3b). Finally, the kiosk enclosure was painted and the FTIR and laptop were installed to yield the final prototype (Figure 3.4).



(a) The initial sketch of the kiosk enclosure.

(b) The final CAD drawing of the kiosk.

Figure 3.2: The kiosk design process.

(a) Test fitting the kiosk internals.

(b) Adding facades to the kiosk.

Figure 3.3: The kiosk build process.

Figure 3.4: The final prototype drug checking kiosk.

Chapter 4

Results

In this chapter, I present the results of the three studies I conducted. I begin by presenting the usability problems I found with the distributed drug checking software using a heuristic evaluation. I then present the barriers and facilitators described by service providers within distributed drug checking sites, which emerged from the semi-structured interviews. Finally, I present the barriers and facilitators described by prospective service users when interacting with a self-service drug checking kiosk, which also emerged from the semi-structured interviews.

4.1 Usability Issues Identified by Heuristic Evaluation

Overall, the heuristic evaluation found 40 unique usability problems with the distributed drug checking software. Within those 40 problems, 24 were categorized as major problems, 12 were considered minor problems, and four were unrelated to the distributed drug checking software itself but connected to the reporting and survey platform it displays.

A majority of the usability problems found violated the **Visibility of system status** heuristic, followed by **Consistency & standards**, **Error prevention**, and **Aesthetic and minimalist design**. The least commonly violated heuristic was **User control and freedom**. No usability problems violated the domain-specific heuristic of **Language does not stigmatize drug use**, which is highly important as the distributed drug checking software acts as the software platform for our prototype self-service drug checking kiosk. Figure 4.1 shows the number of violations per heuristic. Tables 4.1 and 4.2 show the major and minor usability problems found within the distributed drug checking software and whether or not they were addressed. Table 4.3 shows the usability issues related to the reporting and

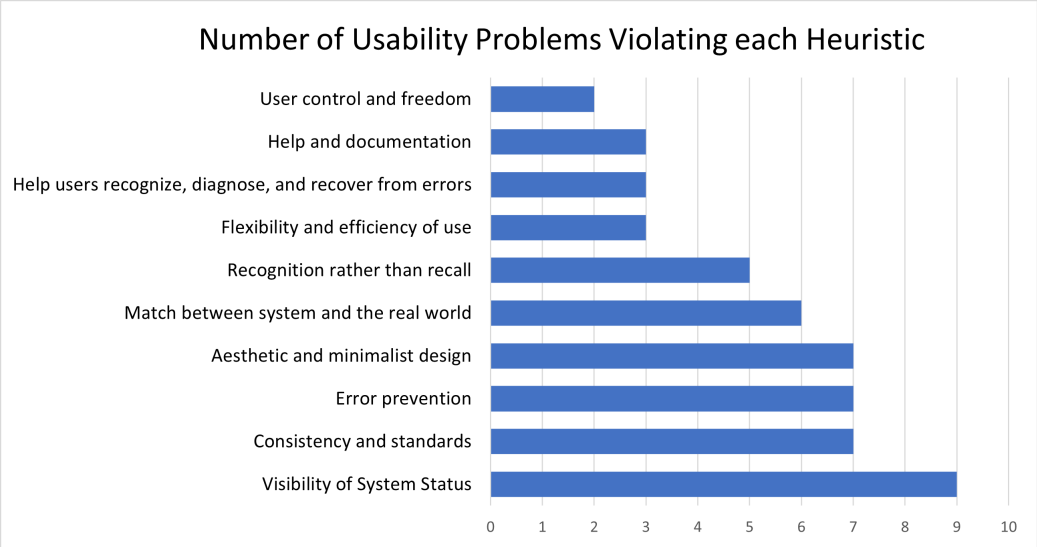


Figure 4.1: Number of violations per heuristic.

survey platform displayed by the distributed drug checking software. Issues within these three tables that are marked as "N/A" were not addressed; this is discussed in Section 4.1.1. Issues within these three tables that are marked as "PENDING" were not addressed at the time of writing this thesis but are planned to be addressed in the future; this is discussed in Section 4.1.2. In instances where a usability problem was fixed, this was done by Abdelhakim Qbaich, Oscar Sandford, or myself. No rigorous process was followed when fixing usability issues: if the issue was simply a bug, it was fixed, and if it was a user interface issue, it was discussed within the software development team and a decision was made on how to best address it.

4.1.1 Non-applicable Issues

For certain issues, a decision was made to not address them due to either new insights from the semi-structured interviews or internal discussions leading to the issue. These issues are marked as "N/A" in Tables 4.1, 4.2, and 4.3. For example, the major usability problem *Add emphasis to IR instructions with bold* was found not to be applicable as distributed service providers relied on the images associated with the instructions rather than the text, which was discovered upon interviewing service providers. Other non-applicable issues include *Tab key creates whitespace rather than shifts focus* and *There is no defense against no result being entered for strip test data*. These issues were found to be non-applicable following internal discussions about issues within the distributed drug checking software.

Usability Problem	Addressed
Tab key creates whitespace rather than shifts focus	N/A
There is no defense against no result entered for strip test	N/A
Add emphasis to IR instructions with bold	N/A
Need a way to overwrite previous spectra	YES
Make retaking spectra better (Add a retry button, warn about the consequences of retaking)	YES
Color picker doesn't change upon selection	YES
No progress bar to see where you are at in the whole process (survey, background collection, sample collection, etc.)	YES
Ask to leave application for procedure PDF	YES
No feedback about the number of samples input	YES
Highlighting strip test dropdown has improper option highlighting (makes both text and background white)	YES
No indication of what will happen when "Next" is clicked on last IR instructions. Button should say "Collect Spectrum"	YES
Ambiguity given precision of data required on survey map	YES
Some people forget about background collection after first IR page	YES
Spacing and title of strip test dialog leads to confusion	YES
Larger text for size for IR instructions	YES
Arrows and numbers would clarify IR Instructions	YES
Pixelated icons on certain buttons with diagonals in their icon	YES
Inconsistent whitespace on page 3 of IR instructions because the picture is smaller	YES
IR Instructions seems cluttered	YES
Pop up client code right away due to OPS setting (hidden client code isn't useful)	NO
Not able to go back after clicking "Submit" button at very end, people need to know they can't go back after this point	NO
Kiosk should notify when there is a bad background scan	NO
No summary of information at the end of the process	PENDING
No indication of what to do once final QR shows up	PENDING

Table 4.1: Major usability problems found within the distributed drug checking software.

Usability Problem	Addressed
IR workflow needs adjusting (sample description and strip test info should pop-up first)	N/A
Start screen is confusing depending on tech literacy levels	YES
Standard info about survey	YES
Be more specific about what is wanted in the sample info description	YES
When a modal asks “Do you want to continue” the buttons should say “Continue” rather than “Yes”	YES
Off center client code button	YES
Some users have gotten confused by what is meant by “notes” in sample info dialog, be more specific about what kind of notes	YES
Inclusion of a reset and zoom button in the background and sample spectra	YES
When doing multiple samples make “Done” button say “Next” after IR spectrum collection	YES
Procedures PDF would be good to know at start of sampling process	YES
Add in some key tooltips	YES
Limitations only and not what info we can tell you	NO

Table 4.2: Minor usability problems found within the distributed drug checking software.

Usability Problem	Addressed
Disclaimer in results needs added context for distributed model	N/A
Analyst notes are the most important and should be at the top of the results	N/A
Add in instructions of where to find the results code (on business card) on results page	N/A
Examples of unexpected effects in survey would be nice to have	N/A

Table 4.3: Usability problems unrelated to the distributed drug checking software.

4.1.2 Pending Fixes

Two major issues have yet to be addressed but have been prioritized for future work; these issues are marked as "PENDING" in Table 4.1. For example, the major usability problems *No indication of what to do once final QR shows up* and *No summary of information at the end of the process* have yet to be fixed but will be in the future. This is because, at the time of writing, Substance and the distributed drug checking model are transitioning to a modified process for mailing in samples. Once this process has been finalized, instructions on how to proceed after the final QR code is shown will be added to the software, including a summary of the user inputs throughout the process.

4.1.3 Finding a Misleading Usability Problem

The major usability issue *IR instructions seems cluttered* led me to believe the IR instructions needed to be redesigned. Specifically, this issue is about the first and third pages of the IR instructions, the first of which is shown in Figure 4.2. As a result of finding this issue during the heuristic evaluation, I redesigned the IR instructions so that the images were hidden behind a button; the first page is shown in Figure 4.3.

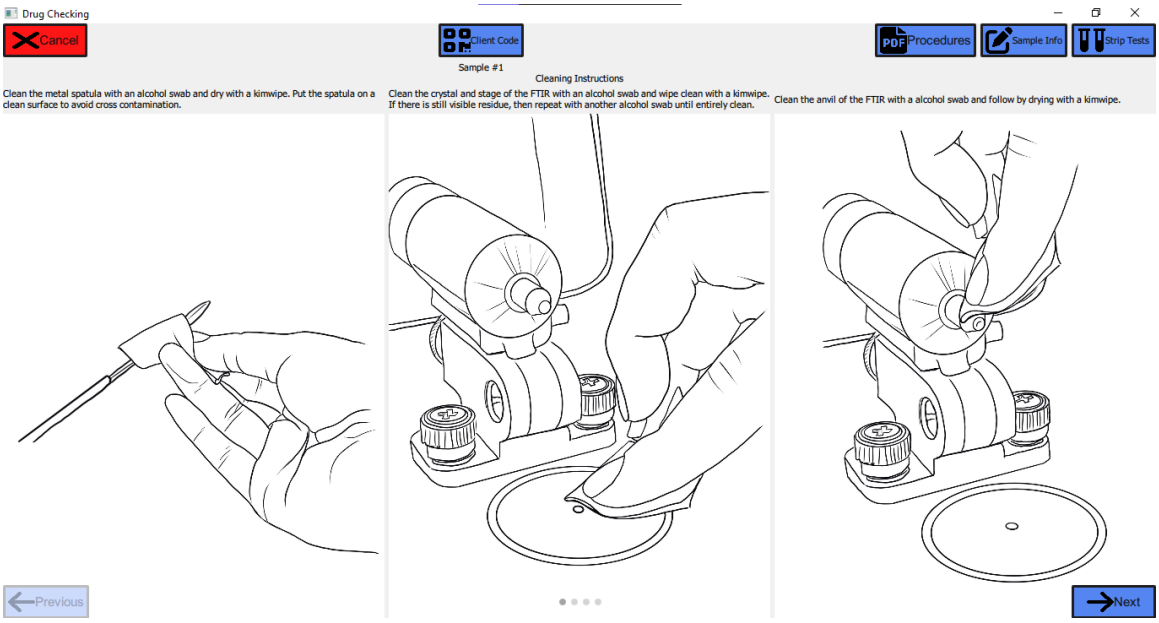


Figure 4.2: The first iteration of the IR instructions, found to be problematic due to the cluttered feeling of the page.

However, during the semi-structured interviews with service users, I found that the images played a crucial role in helping service users understand the instructions. For example, SU2

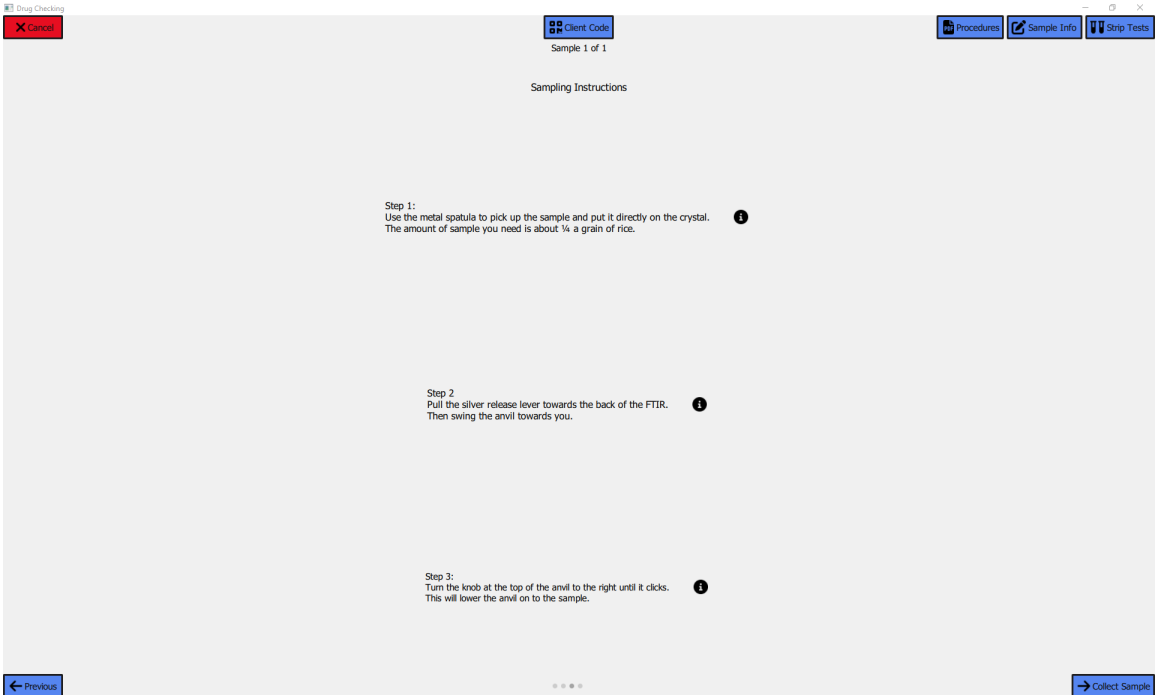


Figure 4.3: The second iteration of the IR instructions, with the images hidden behind a button: this version is less cluttered but was found to be less usable due to the images being hidden.

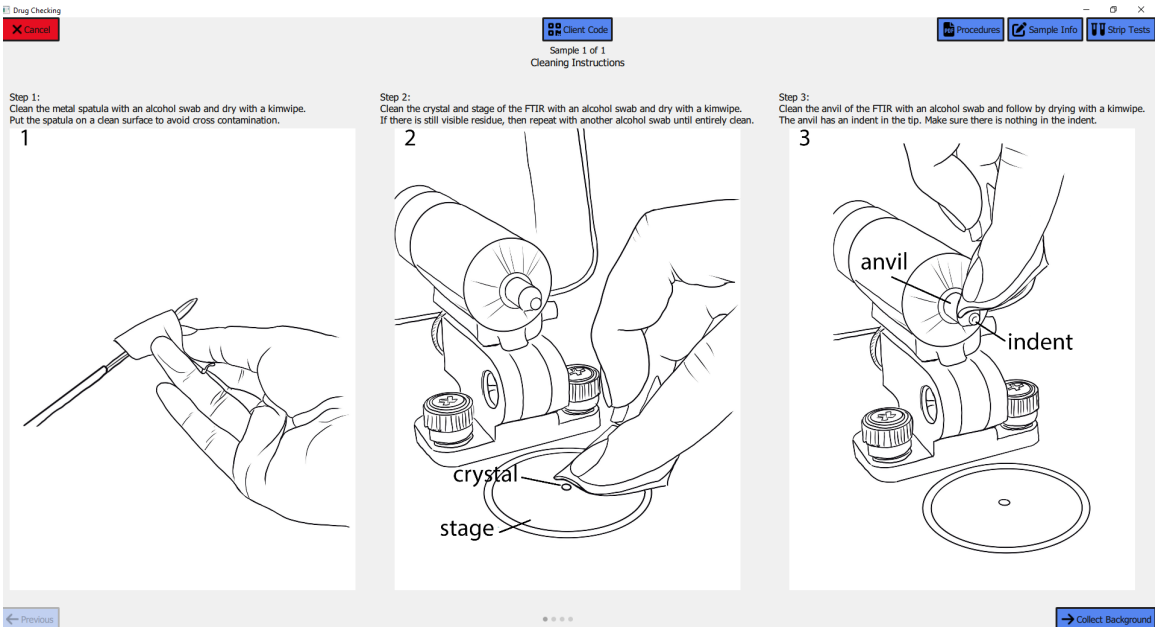


Figure 4.4: The final iteration of the IR instructions, with more whitespace and annotated images.

said, *"I think it would be easier [to have the images on screen right away]."* Furthermore, the service providers also found the images useful as a visual aid. SP2 stated, *"I don't read it anymore because I've done it enough now where I'm just like this is it. So that's why the [images] are perfect because that's all I kind of visualize now."* Therefore, in the final fix for this usability issue, shown in Figure 4.4, the images were brought back; however, they were given more whitespace to reduce the cluttered feeling, and they were annotated with numbers and arrows to show the order of operations.

4.2 Barriers and Facilitators Described by Service Providers

To answer my second research question of "What barriers and facilitators do the distributed drug checking sites face in their operation?", I analyzed the interview data from seven service providers who operate distributed drug checking sites. The service providers interviewed described 17 barriers and seven facilitators in total. In this section, I describe these barriers and facilitators, providing supporting quotations from the interviews where applicable. Table 4.4 lists the barriers and facilitators described by service providers, sorted by the number of service providers who mentioned them. Despite sorting Table 4.4 by the number of mentioning participants, I do not consider any of the barriers or facilitators to be more important than the others.

4.2.1 Barriers Described by Service Providers

The most commonly mentioned barrier faced by the distributed drug checking sites relates to **Staffing and capacity**, which was mentioned by all seven service providers. SP1 stated, *"at first . . . we weren't set up with enough staff for one or both of us to consider [drug checking] on the regular,"* which indicates how a lack of staffing can impact a distributed drug checking site's ability to run drug checking. Distributed drug checking may also face a barrier when, despite a site having several staff available, they cannot run drug checking due to a lack of capacity. SP3 stated this outright when asked the follow-up question, *"What's the decision making [process when deciding] to do drug checking or to not do drug checking?"*—they replied by simply saying ***"capacity."***

As two out of the three sites where interviews took place are overdose prevention sites (OPS), one of the barriers faced by service providers at such sites is **Responding to**

Group	Code Name	Number of Mentioning Participants
Barriers	Staffing and capacity	7
	Responding to overdoses	4
	Timeliness of obtaining results	4
	Security of the hardware	3
	Physical space	2
	Technological aptitude	2
	Lost record keeping artifacts	2
	Visibility	2
	Sample collection	2
	Neighbors	1
	Scheduling and/or structure	1
	Stigmatization	1
	Equipment setup	1
	Interest in drug checking	1
	Proximity to the community	1
	Access to results	1
	Political climate	1
Facilitators	Scheduling and/or structure	4
	Communication with Substance	4
	Minimal learning curve	4
	Correct location	3
	Technological aptitude	2
	Interest in drug checking	1
	Drug checking is informative	1

Table 4.4: Barriers and facilitators identified by service providers, sorted by the number of mentioning participants. Entries which are bolded were were also identified by service users.

overdoses due to overdose response taking priority over operating drug checking. This barrier was mentioned by four out of seven service providers, all of whom work within an OPS. This is illustrated by SP4, who stated, *"We are front-line workers, if I've got a bunch of people dropping . . . that's always going to be my priority."* Furthermore, SP3 compared their site with a non-OPS site, stating, *"because they're not attached to an OPS . . . people just come in so then they can just [do drug checking]."* This highlights how when operating within an OPS, there is a hierarchy of priorities where responding to overdoses takes precedent over performing drug checking.

As the distributed model of drug checking relies on the hub site analyzing data incoming

from the distributed sites, the **Timeliness of obtaining results** was cited as a barrier by four out of seven service providers. When describing the most significant limitations to the distributed drug checking model, SP7 described how sometimes getting a result back from the hub site could take up to *"four hours"*. SP6 expanded on that thought, saying, *"in general, [the hub location] has been pretty fast . . . [with] only two or three [samples] that took more than three or four hours."* Another example of how the timeliness of obtaining results acts as a barrier was described by SP1, who stated, *"20 minutes to get [a] partial result I'll find a lot people just don't have the patience to wait so then I have to go chase them down then next day or whatever and then that whole week that they wait . . . I mean the drug is already gone."* This highlights how the distributed model of drug checking is limited when the central hub site is unable to provide results in a timely manner.

Another barrier is the **Security of the hardware**, which was mentioned by three out of seven service provider participants. In this instance, the term hardware refers to the laptop and FTIR spectrometer used to perform distributed drug checking. SP1 and SP2 described how when three staff are all working, one can do office work, one can work the floor, and the final one performs drug checking. They then explained that they operate this way as they *"can't leave the [instrument] unattended"* nor can they *"leave [their] clients unattended."* Similarly, SP3 stated they would not *"feel comfortable leaving [the hardware out]."* This indicates how the distributed drug checking hardware must be supervised at all times, which can be a barrier to running drug checking if there are not enough staff available to do so.

Related to hardware security is the **Physical space**[1] in which the sites must operate, notably within the overdose prevention sites, which was mentioned six times. As exemplified by SP3, *"There's no way that you can set up the equipment and be doing drug checking in that space . . . there's times where our supervision of the equipment would be pulled and we wouldn't feel comfortable just leaving it in the space."* This indicates how the site SP3 operates in requires a *"separate quiet space free of guests of the service"* to set up the distributed drug checking equipment such that *"one flow-through channel"* exists.

I also identified several other barriers that were mentioned less often, being mentioned four or fewer times by two or fewer service providers. These include: **Technological aptitude**, which relates to a service provider's aptitude for interacting with technology; **Lost record keeping artifacts**; **Visibility** of drug checking among a service's regular guests and within the broader community; **Sample collection** or a low amount of samples being submitted for checking; **Neighbors** of a given service not appreciating being next to an OPS or not sharing harm reduction ideals; the lack of **Scheduling** time to operate

[1] A site's physical space can be a facilitator as well, as described by SP5, SP6, and SP7 in section 4.2.2

drug checking, or not operating it with a clear **Structure**; **Stigmatization** of people who use drugs and the service they make use of; **Equipment setup**; **Interest in drug checking**; **Proximity to the community**; **Access to results**; and **Political climate**.

4.2.2 Facilitators Described by Service Providers

The facilitator mentioned by the largest number of service providers (four out of seven) was having **Structure** and proper **Scheduling** of drug checking. Scheduling and Structure facilitate distributed drug checking by creating an environment where *"there shouldn't be any distractions (SP4),"* that is *"less chaotic (SP1)"*, and *"easier (SP7)."* However, when a distributed drug checking site lacks **Scheduling** and **Structure** of their distributed drug checking operations, this acts as a barrier.

Communication with Substance via phone call or Slack also helped to facilitate distributed drug checking, which was mentioned by four out of seven service providers. Often this communication was used to inform Substance that spectra would soon be available for interpretation. Communication of this sort helps to alleviate the barrier of **Timeliness of obtaining results**, as it allows Substance to be aware that spectra are incoming and to be prepared to analyze them. Communication could also be used to troubleshoot issues that were occurring with the distributed drug checking equipment.

According to four out of seven service providers, the distributed drug checking software had a **Minimal learning curve**, which acted as a facilitator to distributed drug checking. When asked about the intuitiveness of the software, SP5, SP6, and SP7 all agreed that the software was *"very easy [to use] (SP6)."* Similarly, SP4 stated, *"I have no issues with the software or the system. I find it actually quite easy to use."*

Described by three out of seven service providers was choosing the **Correct location**,[2] one which aided in drug checking. Service providers SP5, SP6, and SP7 described how they operate drug checking within their non-OPS harm reduction service, with the hardware being permanently set up in a private room within their service. They described how this allowed for flexibility in sample collection, with service users being able to join them in the private room or *"leave a sample (SP6)."*

Another facilitator was whether or not a service provider had an **Interest in drug checking**. This facilitator was only mentioned by a single participant (SP3), however, it was mentioned five times in total. SP3 quoted one of their team members who handled the DC operations, saying, *"I'm a super nerd and I love this stuff,"* referring to technol-

[2]Choosing the correct location helps to alleviate the barrier of physical space

ogy and chemistry. Despite also being a barrier to distributed drug checking, a service provider's **Technological aptitude** could act as a facilitator for others. When describing the intuitiveness of the distributed drug checking software, SP4 said, *"I find it actually quite easy to use [however,] there are other staff who do struggle a little bit more."* SP4 then went on to explain how this is because the other staff may not be *"as technically inclined,"* demonstrating how technological aptitude acts as both a facilitator and barrier to distributed drug checking.

Finally, the remaining facilitator (mentioned twice) was **DC being informative**, relating to the fact that DC provides both service providers and service users valuable information.

4.3 Barriers and Facilitators Described by Service Users

To answer my third research question of "What barriers and facilitators would prospective service users face in interacting with a self-service drug checking kiosk?", I analyzed the interview data from the five service users who interacted with the kiosk. The service users interviewed described four barriers and four facilitators in total. In this section, I describe these barriers and facilitators, providing supporting quotations from the interviews where applicable. Table 4.5 lists the barriers and facilitators described by service providers, sorted by the number of service users who mentioned them. Despite sorting Table 4.5 by the number of mentioning participants, I do not consider any of the barriers or facilitators to be more important than the others.

Group	Code Name	Number of Mentioning Participants
Barriers	Challenges interacting with the kiosk	5
	Security of the kiosk	3
	Timeliness of obtaining results	2
	Limitations of FTIR	2
Facilitators	Ergonomics	5
	Positive overall experience	5
	Minimal learning curve	5
	Correct location	4

Table 4.5: Barriers and facilitators identified by service users, sorted by the number of mentioning participants. Entries which are bolded were also identified by service providers.

4.3.1 Barriers Described by Service Users

The most commonly mentioned barrier by service users was **Challenges interacting with the kiosk**, which was mentioned by all five service users. This barrier relates to the challenges service users faced when interacting with the kiosk software, such as the on-screen keyboard, small screen and text size, and missing signifiers that signal more information. In total, 19 instances of service users facing a challenge with the kiosk software were identified during the interviews. One participant attributed these challenges to their lack of technological literacy, stating, *"I'm kind of a spaz at this (SU1),"* while attempting to type with the on-screen keyboard.

Similarly to how service providers worried about the security of their distributed drug checking equipment, service users described how the **Security of the kiosk** could be a barrier. This barrier was mentioned by three out of five service users, who described how they would be worried about the kiosk being stolen or vandalized. SU2 mentioned the security of the kiosk twice, the first time suggesting that it may need to be surrounded in bulletproof glass and *"anchor[ed] to the concrete."* However, despite worrying about the security of the kiosk, SU2 later stated that it would be safe if placed *"somewhere in plain view."* SU3 was worried that if a kiosk identical to the prototype was deployed that it may be targeted for theft, noting that it should be located where *"somebody isn't going to yoink it."* Similarly, SU5 stated that a drug checking kiosk should be located somewhere with *"security . . . so that it doesn't get stolen."* This highlights that regardless of the scenario, either within a distributed model site or if deployed as a self-service kiosk, there is a need for the hardware running the distributed drug checking software to be secured via physical means or in a place where supervision is present.

The third barrier faced by service users was the **Timeliness of results**, which was mentioned by two out of five service users. SU4 expressed concern that if a drug checking kiosk was available 24/7, that sometimes you would not obtain results right away as Substance would be closed and the spectrum collected by the kiosk would not be analyzed until the following day. While not directly related to the use of the self-service drug checking kiosk, yet still highlighting the importance of obtaining results in a timely manner, SU2 described how one drug checking service they had previously used *"took two or three days to get results"* back to them and how they found this detrimental to their experience using this service.

The final barrier faced by service users are the **Limitations of FTIR**, which was mentioned by two out of five service users. As the prototype kiosk uses FTIR spectroscopy

to perform drug checking, it is subject to the limitations of FTIR spectroscopy. The main limitation that worried service users was the detection of compounds present below roughly 5% by weight. The detection of such compounds is subject to the experience of the technician analyzing the spectra [16]. The quantification of low concentration compounds is difficult and any quantification data will not have the same accuracy as drug checking based on mass spectrometry. Upon learning of this limitation, SU2 and SU3 expressed that accurate quantitative results are the most beneficial to them. As opioid class drugs often have low concentration compounds present, such as fentanyl, this barrier is undoubtedly a concern for service users.

4.3.2 Facilitators Described by Service Users

Three out of the four facilitators identified were described by all service users. These are **Ergonomics**, **Positive overall experience**, and the kiosks **Minimal learning curve**. The fourth facilitator, choosing a **Correct location** for the kiosk, was described by four out of five service users.

The first facilitator, **Ergonomics**, relates to the physical design of the kiosk and how comfortable it is to use. Four out of five participants (SU1, SU2, SU3, SU4) had no negative comments regarding the ergonomics of the kiosk. The only participant to make suggestions regarding the ergonomics of the kiosk was SU5, who wished they *"had a higher seat"* or were *"standing . . . because people are more aware [standing up]."*

The second facilitator, **Positive overall experience**, relates to the overall experience of using the kiosk. All service user participants had a positive overall experience with the kiosk. This is nicely summarized by SU2, who stated that the kiosk prototype is *"pretty user-friendly,"* while other comments on the overall experience include: *"[it] ran pretty smoothly (SU4),"* *"the whole concept of a [drug checking kiosk] . . . is fabulous (SU3),"* *"easy-ish [to use] (SU1),"* and *"way easier [compared to a self-service checkout] (SU5)."*

The third facilitator, **Minimal learning curve**, relates to how easy it is to learn how to use the kiosk. Despite all service users facing at least one interaction challenge, three out of five service users (SU2, SU4, and SU5) stated they would have felt comfortable using the kiosk without assistance for the first time. Specifically, SU4 stated, *"I think I would have eventually figured it out,"* in regards to using it their first time. The remaining two of five (SU1 and SU3) stated that after being shown how to use the kiosk for the first time, they would feel comfortable using it the next time without assistance.

Chapter 5

Discussion

In this chapter, I discuss the results of the research presented within this thesis. I begin by describing how quality is assessed in qualitative research, discussing how standards of qualitative research are met in my research. I then reflect on my use of the heuristic evaluation method, discussing how using members of the Substance team, rather than distributed drug checking service providers, led to one of the major usability problems identified being found as misleading. Following this, I discuss the barriers and facilitators that were identified by both service providers and service users. Then, I recommend a number of improvements that can be made to the distributed drug checking software platform, namely the addition of a history feature and a visualization dashboard. I also suggest how additional features can be added to the self-service drug checking kiosk to provide more value to service users. Finally, I identify avenues for future work and the mention the limitations of this research.

5.1 An Analysis of Trustworthiness

As stated by Brinberg and McGrath [53], the validity of qualitative research *"is relative to purposes and circumstances."* While no singular method is guaranteed to produce trustworthy conclusions, there are several strategies by which the trustworthiness of qualitative research can be assessed [54]. The main quality criteria which can be used to determine the trustworthiness of qualitative research are credibility, transferability, dependability, confirmability, and reflexivity [55]. Within this section, I will discuss how the trustworthiness of my research was assessed using the criteria of credibility, transferability, dependability, confirmability, and reflexivity.

5.1.1 Credibility

Credibility refers to the *"the confidence that can be placed in the truth of the research findings"* [55]. Several strategies can be used to ensure the credibility of qualitative research, including prolonged engagement, persistent observation, triangulation, and member checking [55, 56]. Within the context of my research, I employed the strategies of prolonged engagement, persistent observation, and triangulation.

Prolonged engagement refers to the amount of time spent studying the research topic, such that a sufficient amount of trust can be built with the research participants and that misinformation introduced by the researcher and the participants can be mitigated [54]. To this end, I have been working within the sphere of drug checking since 2019, giving me ample time to understand the context of this research. Furthermore, the interviews conducted within this research were co-facilitated by Dr. Bruce Wallace, who has been with Substance since the project's inception and has worked with service providers within the distributed drug checking sites since before the model's rollout. Thus, I believe that together, Dr. Wallace and I have spent sufficient time studying the research topic to satisfy the prolonged engagement strategy.

Persistent observation refers to the researcher's ability to observe the research setting for sufficient time to identify which characteristics are most relevant to the issue being studied [54]. Initially, I had thought this project would solely involve the evaluation of the distributed drug checking software and the design of a self-service drug checking kiosk; however, as my studies progressed, I realized that there were contextual factors outside of the software that were important to the research topic. This realization came to me after conducting a pilot interview with SP1 and SP2, where they were more interested in discussing the contextual barriers and facilitators to distributed drug checking rather than the software itself. Therefore, I reworked my interview guide to allow for more open-ended discussion of what was most present in the participants' minds rather than attempting to steer the interviews towards solely discussing the software.

Triangulation refers to using different data sources, investigators, and methods of data collection [54]. Within my research, data triangulation was employed, with interview data being collected from service providers at three sites, two of which were OPS and one of which was a general harm reduction service. Collecting data from multiple types of sites allowed for identifying barriers and facilitators present across both types of sites and barriers and facilitators specific to a given type of site. As I was the sole investigator of this research, investigator triangulation was not employed as this would require using two or more

investigators to *"make coding, analysis, and interpretation decisions"* [54]. However, my final analysis was reviewed by my supervisors and committee member Dr. Bruce Wallace, who co-facilitated all service provider interviews.

5.1.2 Transferability

Transferability refers to the *"degree to which the results of qualitative research can be transferred to other contexts"* [55]. The main strategy which can be used to ensure the transferability of qualitative research is thick description [54]. Thick description refers to describing the research context and the participant's behaviour and experiences, such that the results are meaningful to an outsider [54]. According to Erlandson *et al*. [57], thick descriptions should be detailed enough that the reader can determine if the findings are transferable due to *"shared characteristics."* Upon reflecting on my research, I believe that the description of the research context is sufficiently detailed such that the reader can determine if the findings are transferable to other contexts. Furthermore, I believe that the description of the participants' experiences can be considered a thick description, as, where applicable, direct quotes from the participants support my findings. However, I recognize that the participants' descriptions could be improved through a more detailed description of their demographics as only simple demographics were collected, such as their gender and ethnic background (3.3).

5.1.3 Dependability and Confirmability

The criteria of dependability and confirmability, refer to the *"stability of the findings over time"* and *"the degree to which other researchers could confirm the findings of the research study"* respectively [55]. The singular strategy discussed by Korstjens, which relates to these criteria, is leaving an audit trail [54]. An audit trail refers to the documentation of the research process, including the data collection and analysis process [54]. Within this thesis, I describe both my data collection process and analysis process within Chapter 3; in addition, I also provide Appendices D–I which contain the interview guides, codebooks, and example quotations from the service provider and service user interviews.

5.1.4 Reflexivity

Reflexivity refers to the process of *"critical self-reflection about oneself as researcher"*[55]. The main strategy which can be used to ensure reflexivity is to keep a research journal or

diary [54]. Looking back on my research, I believe it would have beneficial to keep a designated research journal, unfortunately, this was not a strategy that I had considered until after my research was completed. While I would like to think that I have been reflexive throughout my research, had I kept a research journal I would have truly been able to reflect on my research process and how my own biases may have affected my research.

5.2 Reflecting on the Heuristic Evaluation Method

To identify usability problems with the distributed drug checking software platform, I conducted a heuristic evaluation with five members of the Substance team. During the planning phase of the heuristic evaluation, I decided that members of the Substance team would be used as heuristic evaluation participants, as they were familiar with the software platform and held similar domain knowledge to the target population of distributed drug checking service providers. However, as previously discussed in Section 4.1.3, the use of members of the Substance team led to one of the major usability problems being identified as misleading.

It is my belief that the use of members of the Substance team led to the identification of the misleading usability problem for one main reason. The Substance team members were very familiar with process of drug checking within the Substance hub site, to the extent that one could argue that they were experts in the process. Their expert level of knowledge led them to identify that the IR instruction page was cluttered with information they deemed unnecessary, as they already knew how to perform drug checking with an IR spectrometer.

However, the target population of distributed drug checking service providers are not experts in the process of drug checking with an IR spectrometer. Therefore, the target population would likely not identify the IR instruction page as cluttered with unnecessary information, as they would need to read the instructions or use the included images to help them with the process of drug checking. I later identified that service providers found the IR instructions page to be useful, as the images included on the page acted as a visual aid which helped them recall their training. Similarly, service users interacting with the prototype self-service drug checking kiosk found the IR instructions page to be useful, as it provided them both textual and visual information about how to use the IR spectrometer.

The discovery that both service providers and service users found the IR instruction page to be useful highlights the importance of conducting usability testing with members of the target population. It is likely that if usability testing had been conducted with members of the target population, the usability problem of “IR instructions seem cluttered” would likely not

have been prioritized as a major usability problem. Therefore, it is my recommendation that any future work regarding the usability of the distributed drug checking software platform and the self-service drug checking kiosk should be conducted with members of the target population, or at the very least, if making use of a convenience sample like I did, conduct a through analysis of the possible biases introduced by the sample.

5.3 Barriers and Facilitators Identified by Both Cohorts

Overall, there is a need for technologies to play a role in the overdose crisis. The technology studied within this thesis is a software platform that facilitates technician-less drug checking within a distributed model of drug checking [17]. To determine the barriers and facilitators associated with the software platform and a prototype self-service drug checking kiosk, I conducted semi-structured interviews with seven distributed drug checking service providers and five prospective service users. Both cohorts of interview participants identified barriers and facilitators to their respective forms of drug checking delivery. However, two barriers and two facilitators were common between cohort groups. These barriers are **Security of the hardware** and **Timeliness of obtaining results** and the facilitators are the **Minimal learning curve** and choosing the **Correct location** for drug checking.

5.3.1 Barriers Identified by Both Cohorts

The **Security** of the drug checking hardware was identified as a significant barrier by both service providers and service users. In the case of service providers, if instrument security was not realistic in these often hectic settings, the instruments would simply not be utilized and left in a secure locked cabinet, or access reduced if limited to a more secure but less public-facing area such as a locked office. In the prospective scenario of a self-service drug checking kiosk, security relates to theft and vandalism if the kiosk were to be set up in an unsupervised area. Glick *et al*. found that security was among many qualities to consider when selecting a setting for drug checking [58]. Other considerations Glick *et al*. identified include accessibility, judgment-free service, privacy, and confidentiality. Overall, the security of the drug checking hardware must be considered when selecting a setting for both distributed drug checking and the case of a self-service drug checking kiosk. While technological responses to the overdose crisis hold potential and the technical details may feasibly be addressed, there remain significant barriers to implementing these technologies within the challenges inherent in the sites responding to overdoses.

The other main contextual barrier identified by both cohorts was the **Timeliness of obtaining results**. While both cohorts positively appraised the software platform, the model was found to be limited if the results were not provided rapidly from the hub site. Others have identified the timeliness of obtaining results as a barrier to drug checking [59]. For example, Wallace *et al*. found that half an hour would likely be the upper limit for people to wait for drug checking [11]. While Bardwell *et al*. [60] reports between three and six minutes may be the upper limit for those experiencing withdrawal symptoms. While the distributed drug checking software may eliminate the need for a technician at each and every drug checking site, it is clear that the distributed model of drug checking is dependent on immediate access to results from the hub site technician to be most relevant to those accessing and providing the services.

5.3.2 Facilitators Identified by Both Cohorts

Both cohorts of interview participants identified facilitators of distributed drug checking; these were the **Minimal learning curve** of the software and choosing the **Correct location**, one which minimized security concerns and aided in the drug checking workflow. Identifying that the software platform has a minimal learning curve is important, as it shows that the software does not play a large factor in the uptake of distributed drug checking and does not pose a barrier to it. In the self-service drug checking kiosk case, the minimal learning curve means that a first-time user will likely be able to use the kiosk without prior training or instruction. As for the correct location, this is important as it shows that the location of the drug checking service plays a large role in the uptake of distributed drug checking. Previous research has found that the location of drug checking services is an important factor for service users; with many service users wanting discretion, sites such as OPS are deemed less discrete than other locations such as pharmacies [61]. Within my results, I found that the service providers operating within OPS settings face more barriers than those operating within a general harm reduction service. Nevertheless, this does not mean that OPS settings are not a suitable location for drug checking services; it merely highlights that more considerations should be made when implementing drug checking within OPS settings.

5.4 Improvements to the Distributed Drug Checking Software Platform

While the distributed drug checking software platform was positively appraised by service providers and was found to be usable, there are still improvements that can be made to the software platform. The improvements that I propose are the addition of a history tracking feature and a visualization dashboard. In the remainder of this section, I motivate the need for these additions and described my process for prototyping and partially implementing them.

5.4.1 Distributed Site History Tracking

During the semi-structured interviews, service providers made two mentions of **Lost record keeping artifacts**. These artifacts are used to record service user information, including client code, date, the expected substance, and a description of the substance. Service providers use this information to relay results back to service users. However, if these artifacts are lost, service providers are left unable to access results on behalf of a service user. SP1 described a situation in which this occurred: *"Twice now, I lost the paper . . . if [there] was something that I could just press save on and that number and code and it would save [those codes] labelled with a date . . . that would be fantastic."* Similarly, SP6 described a scenario where they forgot to write down a service user's code: *"The first time I was checking drugs, I didn't write down the client number . . . I was like, oh crap, like I can't look back [at] it."*

To alleviate the issue of lost record keeping artifacts, I recommend the addition of a history-tracking feature to the distributed drug checking software. When follow-up questions regarding a history feature were asked during the interview process, participants leaned towards a mobile option as this would help alleviate the barrier of **Equipment setup**. Knowing that a mobile option to check history was preferred, the most optimal place to host such a feature would be on the Substance online results platform, this is where I began to prototype such a feature, described below.

Prototyping and Implementing a History Tracking Feature

Starting in Figma,[1] I began by creating a mockup of the history feature, following the same style as the online results platform. Knowing that this feature would preferably be used on mobile devices, I began by mocking up the mobile view first. Following the mobile view mockup, I transferred the UI elements to a desktop view. The final mockups are shown in Figure 5.1.

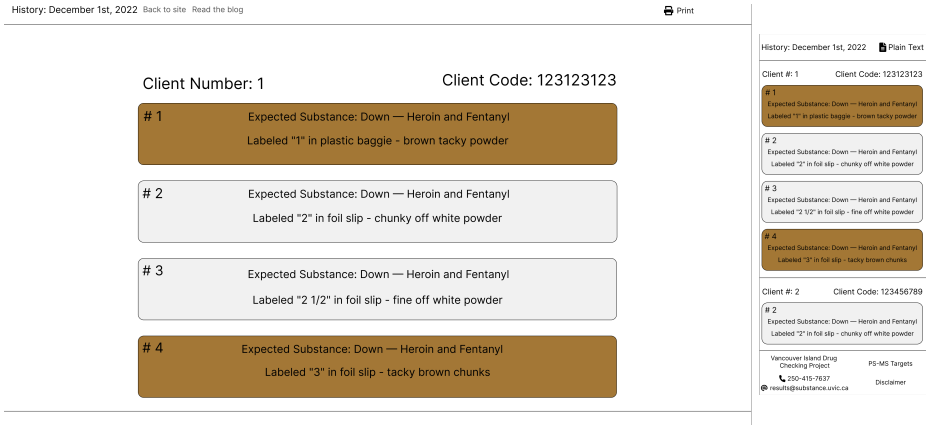


Figure 5.1: History feature mockups, showing the desktop view on the left and the mobile view on the right.

Following the creation of the mockups, I implemented the history feature within the online results platform. To display the history, the required information needed to be gathered from the database. Thus, I created a Django[2] view that would query the database for all entries from the previous two weeks that were associated with a given site. The data could then be acquired via a GET request to the view, which would return a JSON object containing the data. Once the data was acquired, it could then be passed to a Jinja[3] template, which would render the data into the HTML page. The implemented version of the history feature can be seen in Figure 5.2.

While the history feature was implemented, there is still work that needs to be completed before it can be fully deployed. The first of which is to add navigation to the history page from the online results platform, likely in the form of a button. The second is to guard the history behind a site-specific login, as the history page is currently accessible to anyone who knows the URL. This would allow service providers to access their own history and

[1] https://www.figma.com
[2] https://www.djangoproject.com/
[3] https://jinja.palletsprojects.com/en/3.1.x/

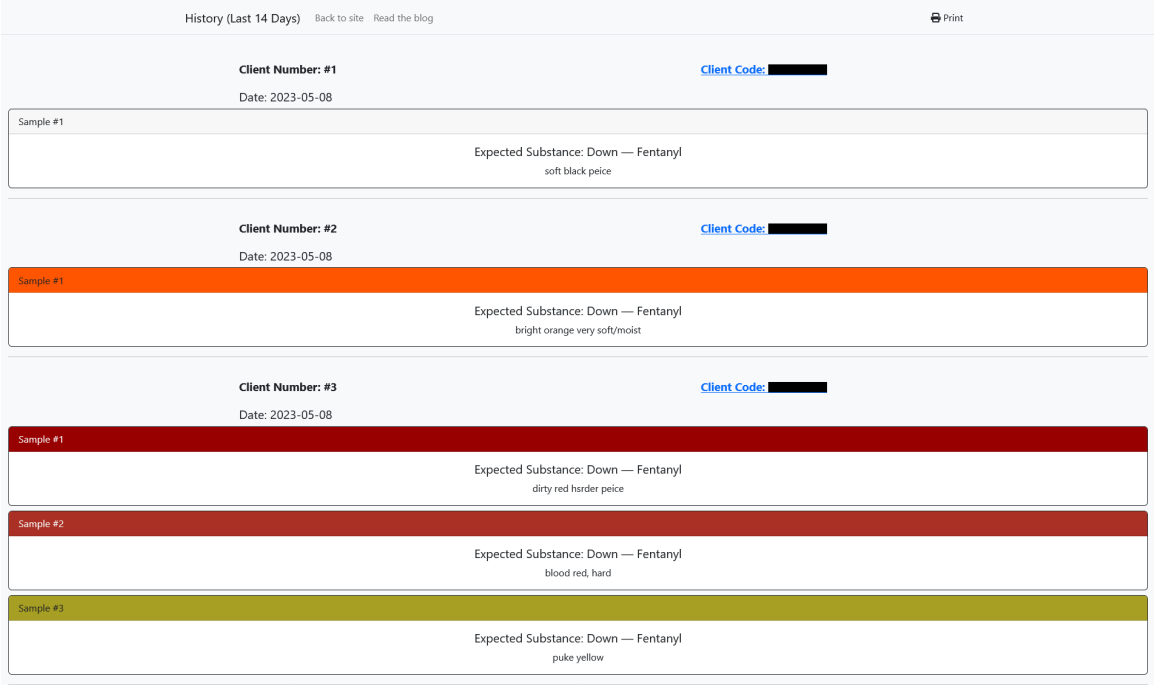


Figure 5.2: The final version of the history feature.

not the history of other sites. Finally, the history feature should be evaluated with service providers to ensure it is usable and useful.

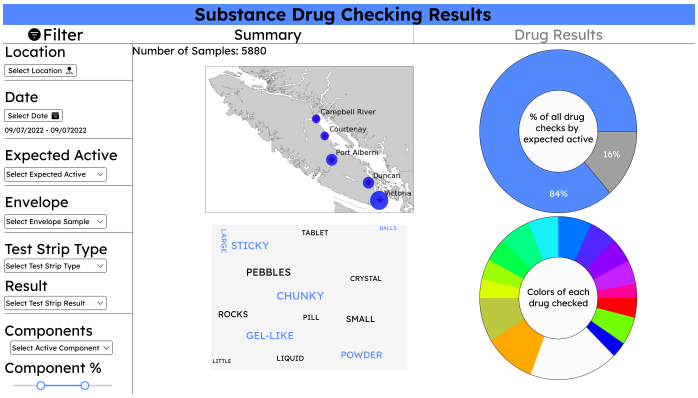
5.4.2 Visualization Dashboard

Another valuable addition to the distributed drug checking software platform would be a visualization dashboard, helping to bolster community engagement. Originally motivated by an informal interview held with SP1 and SP2 in June of 2022, a visualization dashboard would allow service providers to gather a sense of the substances being checked within their community, in addition to the reports provided by the Substance hub site [17]. Before the semi-structured interviews with service providers described in Section 3.2.1, I had already begun to prototype a visualization dashboard, described in the remainder of this section. Following this, feedback and further motivation were collected during the semi-structured interviews. One benefit of a visualization dashboard would be providing information to curious service users, as pointed out by SP6: *"When a lot of people are coming in, they're not just dropping off a sample. Like they're curious, right? . . . [it] is more of a visual representation. People want to see . . . what's been tested, how it looks, and what sort of results are being seen."* SP4 also mentioned that a visualization dashboard would be useful

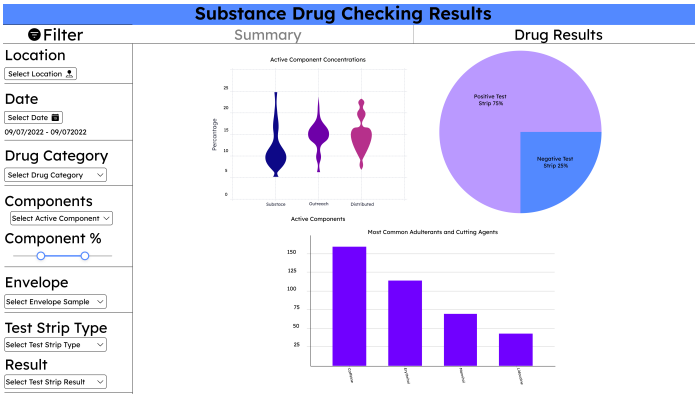
for people *"who just like don't understand what's going on in the drug community"* by showing them a broad range of drug checking results.

Prototyping and Implementing a Visualization Dashboard

I began the prototyping process for the visualization dashboard in the same manner as the history feature, by creating mockups in Figma. I gathered inspiration from the reports provided by the Substance hub site[4,5] and from the BCCSU Dashboard.[6] I then created mockups for the visualization dashboard, shown in Figure 5.3.



(a) The summary view of the visualization dashboard.



(b) The drug results view of the visualization dashboard.

Figure 5.3: Mockups of the visualization dashboard.

Following the creation of the mockups, I implemented the visualization dashboard using the Plotly Dash framework,[7]Dash Bootstrap Components,[8] and various Python libraries

[4]https://substance.uvic.ca/#reports
[5]https://substance.uvic.ca/monthly-reports
[6]https://bccsu-drugsense.onrender.com/
[7]https://dash.plotly.com/
[8]https://dash-bootstrap-components.opensource.faculty.ai/

including Pandas.[9] The first step in the implementation process was to query the Substance database for the required information; this was done via various Python methods that made SQL queries to the database. Following the gathering of the data, it was then passed to the Dash framework, which renders the required visualizations based on the filter options found on the left sidebar. Styling was then added to the dashboard using Dash Bootstrap Components. The implemented version of the visualization dashboard can be seen in Figure 5.4. While fully functional, the dashboard should be evaluated with service providers to ensure it provides value and includes all relevant information.

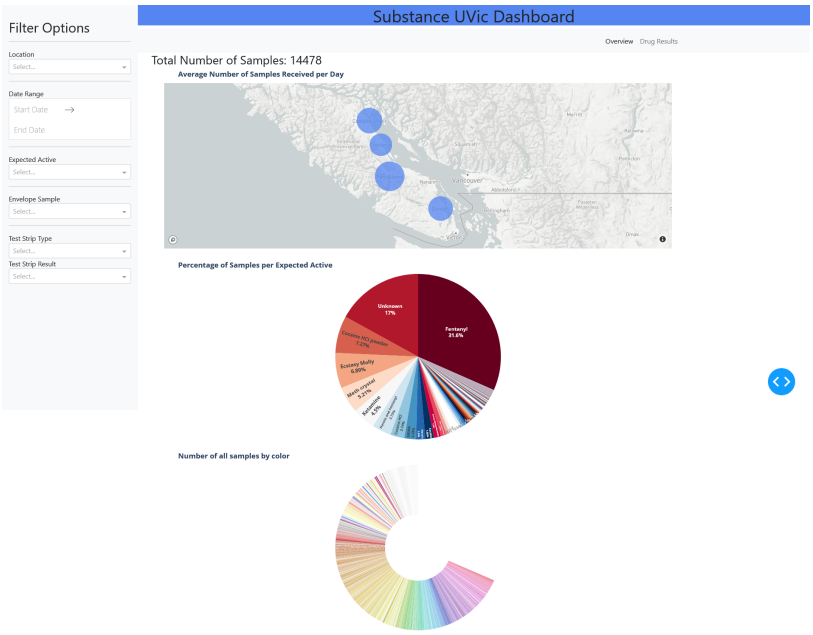
5.5 Providing Value to Service Users Through Additional Features

Service user participants expressed an interest in several software features not currently present in the prototype self-service drug checking kiosk. These features include a database of harm reduction and drug-drug interaction information, information regarding access to local services, and a summary of local drug market statistics. These features are discussed in more detail below.

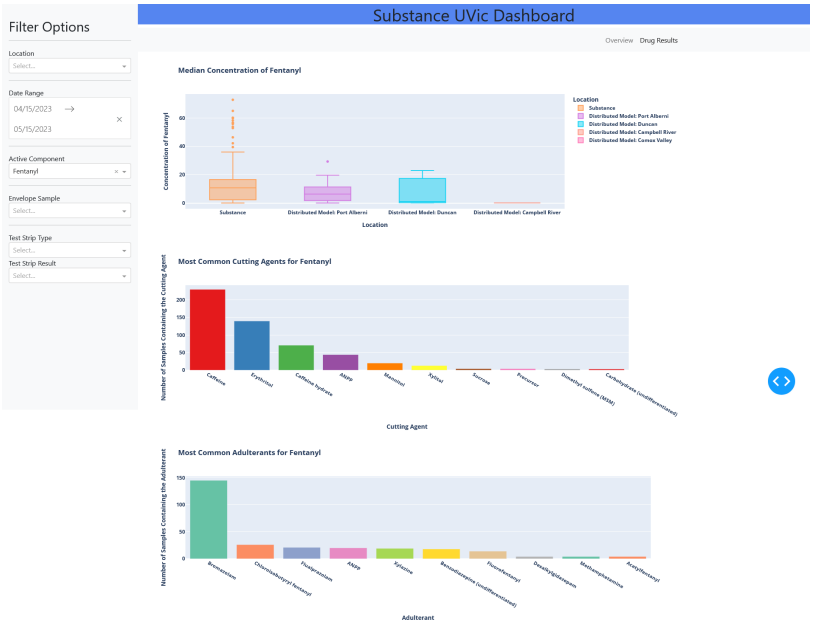
5.5.1 Harm Reduction, Drug-Drug Interaction Information, and Quantitative Results

All five service user participants expressed an interest in having a database of harm reduction and drug-drug interaction information available on the self-service drug checking kiosk. SU1 described such features as *"all we want,"* highlighting how access to harm reduction information is a priority for service users. SU2 compared such a feature to the *Compendium of Pharmaceuticals and Specialties: The Canadian Drug Reference for Health Professionals*, a reference book containing information on pharmaceutical substances. The information within the kiosk should be similar to what is present in the *Compendium of Pharmaceuticals and Specialties*, including information about the substance, its effects, and its interactions with other substances. SU2 noted that including information about interactions with other substances is important, as the common active ingredients within the illicit opioid supply do not interact well with certain pharmaceuticals. The example provided by SU2 was benzodiazepines poorly interacting with selective serotonin reuptake inhibitors.

[9] https://pandas.pydata.org/



(a) The summary view of the visualization dashboard.



(b) The drug results view of the visualization dashboard.

Figure 5.4: The final version of the visualization dashboard.

SU2 also described how it would be useful if a drug information database acted similarly to the *Compendium of Pharmaceuticals and Specialties*, with kiosk users able to click through pages of information, selecting which drugs they would like to gain information about.

The need for harm reduction information to be integrated into drug checking services

has been found in previous research [58, 11], emphasizing the need to inform the service user of the risks associated with their sample. Furthermore, previous research [58, 11] has highlighted that for drug checking services to be as effective as possible, they should present users with quantitative information about their sample, including the concentrations of active components. I found that service users expressed an interest in quantitative information about their sample, with four out of five participants expressing an interest in information such as the percentage of active components. My findings and previous research show that a self-service drug checking kiosk would be most useful to service users if it could provide quantitative sample information.

Implementing the prototype self-service drug checking kiosk described within my thesis relies on FTIR spectroscopy. While FTIR spectroscopy can provide quantitative information about a sample, it can be difficult to identify components that are less than 5% by weight [16], depending on the technician's abilities. However, quantitative information about a sample is possible for specific active components through statistical models trained on representative samples containing that active component [62]. Therefore, I recommend that any future implementation of a self-service drug checking kiosk be able to provide quantitative information about a sample and harm reduction information.

5.5.2 Information Regarding Access to Local Harm Reduction Services

In addition to a database of harm reduction and drug-drug interaction information, three out of five service user participants expressed an interest in having information about local services available on the self-service drug checking kiosk. SU3 described such a feature as a *"street survival guide,"* elaborating that this should be available both on the kiosk and as a takeaway item. SU4 described how such a feature would be useful as local services often change what service they offer on a nightly basis, and having access to that information would be useful. SU5 also agreed that access to information about local services available on the kiosk would be helpful.

While not the most innovative feature request, providing information about local services to kiosk users would allow service users to access a wider range of information rather than just their drug checking results. Speaking from the personal experience of observing what happens at the Substance hub site[10] and on internal communication channels, many service

[10]In some capacity I have worked with the project since 2019, before my time as a graduate student. These observations were guided in part by the experience and my experience during graduate school.

users and non-service user community members use Substance as more than a drug checking service. For example, many people will come into the Substance hub site to pick up naloxone kits, find a moment of respite, grab snacks and drinks when offered, and ask questions about various topics. Considering these observations, providing information about local services would be a valuable addition to the kiosk.

5.5.3 Summary of Local Drug Market Statistics

Along with harm reduction information and information about local services, three out of five participants expressed that the kiosk should include a summary of local drug market statistics. Two participants, SU3 and SU4, were familiar with Substance's weekly and monthly reports and stated that they should be included in the kiosk. While SU5 did not mention the reports Substance published but stated that the kiosk should include *"bad dope alerts,"* a common way of alerting people to strong and uncharacteristic drugs found in local supplies.

Service providers already requested to integrate a local drug market statistics feature in the form of a visualization dashboard, as discussed in Section 5.4. Thus, determining this is a wanted feature is not surprising, as it would allow service users to access the same information as service providers. Therefore, the inclusion of a local drug market statistics feature would be a valuable addition to the kiosk.

5.6 Future Work: Security and Timeliness of Obtaining Results

The work in this thesis stands as a starting point for research regarding a self-service drug checking kiosk. The main avenues for future work are alleviating the barriers of security and the timeliness of obtaining results.

Regarding the barrier of security, I propose that any future work regarding a self-service drug checking kiosk should build upon the work conducted herein by running a pilot program of a kiosk in a real-world setting. That is to say, a self-service drug checking kiosk should be deployed within various settings, including outreach vans, safe injection sites, safe consumption sites, general harm reduction organizations, and even other places people use drugs, such as nightlife venues. Locating kiosks in these places would allow for data collection regarding the security of the kiosk, including the frequency and severity of theft

and vandalism.

Furthermore, the pilot program should include methods to alleviate the barrier of timeliness; I propose the following two methods. One such method would follow Nielsen's usability heuristic of "Visibility of System Status," which states that any system should keep the user informed about its current status and provide any service user with an estimated waiting time until their sample is analyzed. The estimated time-to-results would be based on the number and type of samples ahead of a given sample. While this method would not speed up the time it takes for a sample to be analyzed, it would inform the user of an expected waiting time until they can access results. The second way to alleviate the barrier to timeliness would be an automated preliminary analysis performed by a suite of machine learning models [63]. This would allow the service user to receive preliminary results about their sample, possible examples of which include the drug class, main active component, and cutting agents.

5.7 Limitations

The research presented within this thesis is affected by several limitations. The primary limitation of this work is the localized nature of the interview participants, all of whom reside within a single geographic location. The effect of this limitation is that the findings presented within this thesis may not be transferable to drug checking services in other geographic locations, as different laws and regulations may govern them.

A secondary limitation of this research is that the interviews were analyzed by only myself; thus, I have introduced my personal biases into the analysis. However, this limitation is mitigated by the fact that I have been working with Substance in some capacity since 2019, in addition to having my analysis and results double-checked by my advisors and other members of the Substance team. The introduction of my biases may mean that if another researcher analyzes the interview transcripts, they may find different results. However, to my knowledge, this work is the first to examine the requirements of a self-service drug checking kiosk. Therefore, the findings presented within this thesis are a valuable starting point for future research. Furthermore, the findings presented within this thesis are supported by previous research, which has found similar barriers and facilitators to drug checking services [58, 11, 61].

The third limitation of this work is that the usability problems with the distributed drug checking software platform were identified via a heuristic evaluation, which is considered a "discount" or informal usability testing method [50]. This limitation is further exacerbated

by the fact that the heuristic evaluation participants were not real users of the distributed drug checking software platform, and instead were members of the Substance hub site acting as a proxy for actual users. As discussed in Section 4.1.3 and later in 5.2, this led to one of the major usability problems being identified as misleading. Participants that are not representative of the target population is a common limitation of heuristic evaluations [64], among other limitations such as the artificial nature of the testing situation, the fact that the results do not prove that a system works [64], they only highlight areas where improvements could be made.

Finally, service providers or users did not formally evaluate the two additions to the distributed drug checking software platform, the history feature and the visualization dashboard. The visualization dashboard received some feedback during the semi-structured interviews; however, the history feature has yet to be evaluated. Therefore, the usefulness and usability of these two additions still needs to be refined and evaluated in future work.

Chapter 6

Conclusion

There is a need for technology to play a role in combating the overdose crisis. Within this thesis, I evaluated one technological overdose response related to drug checking, a drug checking software platform. Based on the research conducted herein, I have made six main contributions to the literature on drug checking and overdose response technologies.

My first contribution is a set of identified usability problems with the distributed drug checking platform. The usability issues were identified by experienced drug checking technicians within the Substance organization who possess drug checking domain knowledge. Following their identification, these issues were prioritized and addressed depending on their priority. Overall, this contribution, while minimal compared to the others, improved the user interface design of the drug checking software platform and allowed the platform to be developed into a prototype self-service drug checking kiosk.

My second contribution is a set of barriers and facilitators described by distributed drug checking service providers. These barriers and facilitators highlight how the distributed model of drug checking holds promise for increasing access to drug checking outside of urban centers, but also how the model still faces barriers to implementing drug checking technologies within the sites responding to overdose.

My third contribution is recommendations for improving the distributed drug checking software platform by adding a history tracking feature and a visualization dashboard. While these recommendations do not alleviate the challenges inherent to implementing drug checking within the sites responding to overdoses, they can alleviate some of the remaining technological barriers distributed drug checking service providers face, such as lost record keeping artifacts and bolstering community engagement.

My fourth contribution is the identification of barriers and facilitators faced by prospective service users of a self-service drug checking kiosk. Overall, the prototype self-service

drug checking kiosk was well received by prospective service users. Despite its challenges, the kiosk was deemed a viable option for drug checking. Additionally, several barriers and facilitators faced by the service users were also identified by service providers. These include the barriers of **Security** and the **Timeliness of obtaining results** and the facilitators of the software's **Minimal learning curve** and a choosing a **Correct location** for drug checking, one which minimizes security concerns. The barriers and facilitators identified by both cohorts of participants highlight the importance of considering the needs of both service providers and service users when designing drug checking technologies.

My fifth and final contribution is design knowledge for a self-service drug checking kiosk in the form of requested features and a set of possible locations for a self-service drug checking kiosk. The requested features include:

- Harm reduction and drug-drug interaction information
- Access to local harm reduction service information
- A summary of local drug market statistics

I identified that these features would increase the perceived value of a self-service drug checking kiosk by providing service users with valuable information about their sample and results, access to local harm reduction services and the local drug market.

Within my thesis, I have presented a set of contributions which are important steps towards improving the distributed model of drug checking by improving the usability of the software platform, identifying barriers and facilitators of the software platform, and recommending improvements to the software platform. My contributions also include identified barriers and facilitators faced by prospective service users of a self-service drug checking kiosk and a set of design considerations for a future self-service drug checking kiosk. Nevertheless, while the contributions within this thesis are a step towards improving access to drug checking, there remain barriers that hinder widespread access to drug checking that are not solvable by technology alone and are inherent to the sites responding to overdose and the legal and political climate in which they operate.

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Appendix A

Interview Consent Form

Implementing Innovations in Drug Checking:
A Harm Reduction Pilot in Response to Illicit Drug Overdose

PARTICIPANT INFORMATION & CONSENT FORM

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Background and Purpose of the Study
The purpose of this study, a drug checking pilot project, is to better understand the usability, benefits, and drawbacks of distributed drug checking software as a potential harm reduction response to the overdose crisis. You are being asked to participate because you have expressed interest in discussing drug checking or are a harm reducution worker/technician experienced in drug checking and are over 19 years of age. If you are interested, we now invite you to participate in an interview about your views on drug checking. Your participation must be free and voluntary. You are free to stop at any time.

Location of Research
This research study will be done at the pilot project sites in Victoria and other communities on Vancouver Island.

Number of Participants
While the study will provide hundreds of drug tests the project also includes more detailed interviews with about twenty interested individuals.

Project Funding
This project is being funded by Health Canada's Substance Use and Addictions Program as well as the Vancouver Foundation.

What is Required if I Participate?
If you decide to participate in this part of the study, you will be interviewed by the researcher about your views on the usability, benefits, and drawbacks of distributed drug checking software connected to the storefront location in Victoria. The interview is expected to take less than an hour.

What are the Possible Risks or Inconveniences of Participating?
Due to the nature of the interview, there is potential for participation to cause you emotional discomfort, stress, or social risks such as loss of status or reputation. To prevent or to address these risks, you will be advised to only share what you are comfortable with sharing; you have the right to refuse to answer any question you do not want to answer without consequence.

What are the Possible Benefits of Participating?
We cannot promise any personal benefits. However, you may feel satisfied because you are taking part in research that will inform responses to overdoses and other harm reduction services.

Do I Have to Take Part?
You are free to choose to participate or not. If you decide not to participate, your access to the drug checking pilot project and any other services will not be affected in any way. By consenting, you have not waived any rights to legal recourse connected to research-related harm. If you decide to participate but change your mind during or after the interview, you can let the research team know. We will stop and you can withdraw without any consequences or explanation. If you do withdraw either during or after the interview, we will stop the interview and ask what you would like us to do with the information you shared, either 1) using what we already collected or 2) destroying what we collected.

Will I be Paid for Taking Part?
As a way to thank you for your time and participation, you will be given $25 as a thank you.This is not meant to influence your decision to participate. You will be provided the compensation before we begin the interview. You will keep the compensation even if you if you choose skip answering some questions or withdraw before the completion of the interview.

Confidentiality & How my Personal Information will be Used
In order to protect your privacy, your name will not appear in any documents that come out of this research. Any potentially identifying features will be removed prior to data analysis. Interviews are totally separate from the drug checking service and research and interviews are not linked to drug checking data. With your permission the interview will be audio-recorded and hand-written notes will be taken and you have the option to be interviewed without being audio-recorded. These recordings and the information you share with us will be kept confidential. Only the research staff will have access to this information. You should only share whatever information you are comfortable sharing. Your data will be safely stored in a locked cabinet at the University of Victoria for five years following the study after which any consent forms and data will be destroyed. Data from this study can be used in journal and conference articles, reports and presentations. Your consent to collect your information for the purpose of this research project will expire when you complete the study.

Disposal of Data
Your data from this study will be disposed of in the following manner:

Data Source	How Destroyed	When Destroyed
Interview Audiofiles	Deleted	Immediately following transcription.

Appendix B

Certificate of Ethical Approval

island health

Island Health

Island Health Research Ethics Board
Queen Alexandra Centre
Main Building, Room 205
2400 Arbutus Road
Victoria, BC V8N 1V7
Tel: 250-370-8620

Certificate of Ethical Approval for Harmonized Minimal Risk Behavioural Study

Also reviewed and approved by:

- **University of Victoria**

Principal Investigator:	**Primary Appointment:**	**Board of Record REB Number:**	**UBC REB Number:**
Bruce Wallace		**Board of Record:** Island Health	H20-03384

Study Title:
Implementing Innovations in Drug Checking: A Harm Reduction Pilot in Response to Illicit Drug Overdose

Study Approved: December 14, 2020 **Expiry Date: December 14, 2021**

Research Team Members:	Margaret-Anne Storey Bruce Wallace Dennis K Hore Bernie Pauly Richard Stanwick
Sponsoring Agencies:	- Canadian Institutes of Health Research (CIHR) - "Disseminating drug checking results in response to the overdose crisis " - Canadian Institutes of Health Research (CIHR) - "Integrating a low-barrier drug checking platform into public health responses to overdose" - Health Canada - "Implementing Innovations in Drug Checking: A Harm Reduction Pilot in Response to Illicit Drug Overdose " - New Frontiers in Research Fund - "Spectroscopy for the masses: Training the community to operate drug-checking technologies as a response to the overdose crisis"

Documents included in this approval:

Document Name	Version	Date
Protocol:		
HREB Protocol	V10	September 2, 2020
Consent Forms:		
Survey and service - consent	V4	January 7, 2019
Outreach model - consent	V1	September 2, 2020
Interview - consent	V3	November 1, 2018
Advertisements:		
Interview - recruitment email	V1	July 3, 2019
Outreach model - recruitment poster	V1	September 2,

Interview - recruitment poster	V2	2020 August 22, 2018
Survey and service - Recruitment poster	V7	December 21, 2018
Survey and service - Recruitment handbill	V3	December 21, 2018
Questionnaire, Questionnaire Cover Letter, Tests:		
Outreach model - instructions	V1	September 2, 2020
Outreach model - feedback form	V1	September 2, 2020
Interview guide - instrument	V2	August 22, 2018
survey - instrument	V2	January 7, 2019
Outreach model - instrument	V1	September 2, 2020
Outreach model - test report	V1	September 2, 2020
Other Documents:		
Institutional Approval Amended	N/A	August 9, 2020
Certificate of Approval	N/A	August 31, 2018
Ethics Approval for Amendment	N/A	May 14, 2020
Research Safety Plan	N/A	September 9, 2020

This ethics approval applies to research ethics issues only and does not include provision for any administrative approvals required from individual institutions before research activities can commence.

The Board of Record (as noted above) has reviewed and approved this study in accordance with the requirements of the Tri-Council Policy Statement: Ethical Conduct for Research Involving Humans (TCPS2, 2014).

The "Board of Record" is the Research Ethics Board delegated by the participating REBs involved in a harmonized study to facilitate the ethics review and approval process.

The application for ethical review and the document(s) listed above have been reviewed and the procedures were found to be acceptable on ethical grounds for research involving human subjects.

The Health Research Ethics Board of Island Health expects that researchers will follow the ongoing Public Health Agency of Canada's recommendations and Island Health policies regarding COVID-19. Please refer to the guidance and links at https://www.islandhealth.ca/research-capacity-building/research-ethics-approvals/covid-19-and-research-ethics-compliance for up-to-date information regarding research review at Island Health.

This study has been approved either by the Board of Record's full REB or by an authorized delegated reviewer.

Appendix C

Interview Recruitment Email

Email invitation to Recruiters

We are part of a University of Victoria study evaluating drug checking services. **We are seeking to hear from people about their thoughts on drug checking and experiences with the distributed drug checking software.**

Interviews are open to anyone 19 years of age or older, with thoughts on drug checking, including people who use/d substances, their family or friends, and/or people who make or distribute substances.

Participants will be provided $25 to take part in a face-to-face interview which will last less than an hour.

Participants will be asked about their thoughts on drug checking services as well as their experiences with substances. Participants will be advised to only share what they are comfortable sharing and have the right to refuse any question(s) they do not want to answer, and/or to withdraw from the study at any time. Participation is confidential.

Being interviewed is voluntary and there is no obligation to participate.

We will provide you with recruitment handbills which you can distribute to any interested participants. **Interested participants can contact the researchers directly via information provided on the handbill**.

If you have any questions, please get in touch with the researchers:
Bruce Wallace, [redacted]

Appendix D

Service Provider Interview Guide

Service Provider Interview Guide – Software

Hello, thanks for meeting with me today!

I would just like to remind you of your rights as a participant: Your participation must be free and voluntary, you can skip any question at any time, refuse to answer any question, or even end the interview or withdraw from the study at any time. In the final reporting no identifying information about you will be included; all data will be de-identified and reported in aggregate form that is expected to include direct quotes but these will have no identifiers attached to them.

This interview will also be audio recorded and later transcribed. After transcription the audio recording will be deleted immediately.

Do you consent to having this interview audio recorded?

Demographics

- What is your age?
- What gender do you identify with?
- What ethnic group or family background do you identify with?
- What community are you living in (Victoria, Campbell River, etc.)?

Background

- Can you describe your background as a service provider or in harm reduction?

Work Situation

- Which harm reduction service are you a member of?
- What is your current role and responsibilities at this service?
- Can you describe for me a typical shift working as a Harm Reduction WORKER/SUBSTANCE TECHNICIAN?
- What is your experience with the kiosk?

Gains and Pains

- **Are you familiar with what we on the team are calling the kiosk?**
- What is your initial opinion about the introduction of the drug checking kiosk?
- What do you see as the potential impacts of the kiosk?
- What could be the most significant limitations?

Version 1: June 6 2022

The term “kiosk” within this interview guide refers to the combination of FTIR and laptop **not** the kiosk described in Chapter 3.2.2

- What improvements does the kiosk potentially bring to the service?
- What new challenges could it introduce to the service?
- **For Harm Reduction Worker:**
    - When using the kiosk software do you find it intuitive?
    - Can you elaborate on which features are usable and which features could be improved?
    - Are there any missing features?
    - Are there any features that are not needed?
- **For technicians:**
    - In your opinion, does the introduction of having to interpret spectra from the remote sites have either a positive or negative effect on the quality of in-person service?
    - Does it bring about more stress during your technician shifts?
    - If so, how can this stress be mitigated?

- Is there anything else you would like to add?

Appendix E

Service Provider Codebook Exported from ATLAS.ti 8

Color	Name	Groundedness	Groups	Number of Groups	Comment
●	BARRIERS: Staffing/Capacity	20	BARRIERS	1	Descriptions of how staffing and capacity impact a sites ability to perform drug checking
●	Community Engagement	11		0	In relation to engaging the borader community outside of OPS service users
●	SOFTWARE FEATURE	10		0	Features that people want in the software
●	BARRIERS: Instrument Security	9	BARRIERS	1	How the security of the instrument is a concern
●	ARTIFACT: Logbook	8	ARTIFACTS	1	Descriptions of the logbook used to track service user information
●	Dashboard Usage	7		0	How people might use the dashboard
●	Overall Impression of DDC	7		0	
●	BARRIERS: Physical Space	7	BARRIERS	1	How the physical space within a site can act as a barrier
●	ARTIFACT: Bulletin Board	6	ARTIFACTS	1	Descriptions of the bulletin board used to share results
●	BARRIERS: Responding to OD	5	BARRIERS	1	Responding to OD takes priority over drug checking
●	BARRIERS: Timeliness of obtaining results	5	BARRIERS	1	How DC is impacted when results are not obtained in a timely manner
●	FACILITATORS: Interest in DC	5	FACILITATORS	1	How someones interest is DC acts as a facilitator
●	BARRIERS: Technological Aptitude	4	BARRIERS	1	Someones technological aptitude
●	FACILITATOR: Scheduling & Structure	4	FACILITATORS	1	How the presence of scheduling and structure to DC helps facilitate it
○	Messaging	3		0	The message and meaning of DC results
●	BARRIERS: Neighbours	3	BARRIERS	1	How neighbours of HR services can be a barrier to providing service
●	BARRIERS: Sample Collection	3	BARRIERS	1	Difficulties surrounding sample collection
●	BARRIERS: Scheduling & Structure	3	BARRIERS	1	How the lack of scheduling and structure to DC helps facilitate it
●	BARRIERS: Stigmatization	3	BARRIERS	1	The role stigmatization plays in hindering DC and HR services
●	BARRIERS: Visibility & Welcomeness	3	BARRIERS	1	A visible and welcoming DC service often makes people feel more willing to use DC
●	FACILITATORS: Technological Aptitude	3	FACILITATORS	1	Someones technological aptitude
●	FACILITATORS: Communication with Substance	3	FACILITATORS	1	Examples of communicating with Substance
○	Difference between HR and OPS	2		0	
○	P3	2		0	Transcription mistake, anythig with this code is said by participant 3.
○	P4	2		0	Transcription mistake, anythig with this code is said by participant 4.
○	Recognition rather than recall	2		0	One of Nielsens heurisitcs and how it relates to the DDC software
○	Relationships with Service Users	2		0	Examples of relationships between SPs and SUs
●	BARRIERS: Instrument ergonomics	2	BARRIERS	1	The physicall ergonomics of the FTIR and Laptop
●	BARRIERS: Interest in DC	2	BARRIERS	1	How someones lack of interest is DC acts as a barrier
●	BARRIERS: Lost artifacts	2	BARRIERS	1	When artifacts get lost this acts as a barrier
●	BARRIERS: Proximity to community	2	BARRIERS	1	How close a service is the community who needs it
●	FACILITATORS: Ease of use	2	FACILITATORS	1	How easy the DDC software is to use
●	TECH PREF: Preference for visual aids (Instructional page)	2	TECH PREF	1	
○	DC Impacts	1		0	The impacts of DC
○	DC within safe supply	1		0	How DC would work in safe supply model
○	Festival DC	1		0	How DC works at festivals
○	Information sheet usage	1		0	How people at services use the info sheets provided
○	People want to see the process	1		0	DC SUs want to see the process of how drug are checked and analyzed
○	Reason for checking	1		0	Why people might check their drugs
○	Recreational users	1		0	Descriptions of people who use drug recreationally
○	Reflection via interview	1		0	Instances of SPs reflceting about DC through the interview
○	TECH PREF: Laptop	1		0	When SPs prefer to use a laptop
●	BARRIERS: Access To Results	1	BARRIERS	1	People having difficulty accesing results
●	BARRIERS: Politics	1	BARRIERS	1	How politics can act as a barrier to DC
●	FACILITATORS: Informative	1	FACILITATORS	1	How DC can be informative
●	FACILITATORS: Physical Space	1	FACILITATORS	1	How a sites physical space helps them to facilitate drug checking
●	TECH PREF: Indifferent to mobile vs laptop	1	TECH PREF	1	No preference for mobile or laptop to access internet
●	TECH PREF: Preference for mobile	1	TECH PREF	1	When a SP prefers their mobile device

Appendix F

Example Service Provider Quotes

Number	Text Content	Codes
3:20	I1: And what about any sort of like physical objects that you're using while drug checking? Like other than the stuff obviously in the toolkit, like using like the uses of pen and paper to write down notes or things like that.P6: Mhm yeahI1: What do you normally include? P6:In our notes?I1: Yeah. Yeah. Yeah.P6: Like what are we taking down? I1: Yeah.P6: Date, sample number. So if it's like one, one, two, one, two, two, whatever that is. The client code. They're info if they want to. Yeah. Positive, negative results for a Fent and Benzo. So we're like recording a lot of stuff that it is asking for in the system on paper. We don't record what it looks like on paper. And then we try to generally like also record like the results on it just so we have like a quick. Right. So you don't have to go back through it and take that code and it would be cool if we could access the history.P4: Yeah.I1: Yeah. And then maybe that history could just give you a link to the exact results page.	ARTIFACT: Logbook
4:8	So do you keep a separate logbook of then like pencil and paper kind of deal of what of the people you've interacted with?P1: YepP2: Yes	ARTIFACT: Logbook
4:34	P2: We've got it on post-it notes everywhere. But that was easy because we keep it in the corner of the laptop right so it was always there so each day we'd have all the number written so we can back you know four days later and find the results you guys	ARTIFACT: Logbook
6:9	P4: I think that's fine. I think the only thing that like I feel could be smoother is almost just the after process. Like we kind of had to put together a way to3like make sure the right people were getting the right pose afterwards or the right results. So like I got a binder put together, but it's just those people pieces. Like when people are just dropping off samples and people are putting it in the safe, making sure all staff are kind of like taking the right steps so we know who is who, what sample is who, just those pieces.I2: How are they collecting samples? Like is it just on sticky notes or are they doing the filler in the form?P4: It depends. I don't think anyone but myself actually fills in the form. So most of the time I've got a pill bottle in there with just somebody's name on it. So which is fine.	ARTIFACT: Logbook
4:33	o you mentioned using pen and paper earlier to sort of write down [service user info], would that be sort of something like a feature like that in the software or do you prefer that physical–P1: That would be so nice actually because I, twice now, lost the paper because I share an office with three or four different people that come in and out, in and out, in and out. And all of a sudden my stuff gets shuffled and I lose it. If9it was something that I could just press save on that number and code and it would save it into an opposite folder or something so then it would be labelled with a date, say you know the testing from November the 7th and those would be all my saved numbers in there. That would be fantastic	ARTIFACT: Logbook, BARRIERS: Lost artifacts
4:35	So if there was someway that you know when I get finished and it shows me if I could just click save and pops it into a folder with that day that I am doing the drug testing, that would be just–	ARTIFACT: Logbook, SOFTWARE FEATURE
4:36	I1: Yeah so I think, what I envision with this is like, you know you have your date here, you have all your numbers, you could still even keep doing this as well–P1: I would probablyI1: –so you know someones name, but then you could see the client code and the colour you've entered, and the sample descriptionP1: And the date of itI1: Maybe makes it a little easier to track through these notes as well P1: YeahI1: Cool	ARTIFACT: Logbook, SOFTWARE FEATURE
	P4: So at first they were just writing it down, but then I actually created an actual spreadsheet.I2: That's really formal.I1: Yeah. That's the most formal. It seems like a lot of people are kind of doing something similar, whether that's on, you know, in a notebook or on a sticky note or whatever. But this is the most formal by far.P4: Yeah. Like I said, like we started here and I just couldn't do that. So I forget it might as well just create something. But I think figuring out this process was our biggest struggle.I1: Would it be useful to sort of have this sort of kept in the software as well?P4: Totally. Would you	

Appendix G

Service User Interview Guide

Service User Interview Guide - Software

Hello, thanks for meeting with me today!

I would just like to remind you of your rights as a participant: Your participation must be free and voluntary, you can skip any question at any time, refuse to answer any question, or even end the interview or withdraw from the study at any time. In the final reporting no identifying information about you will be included; all data will be anonymized and reported in aggregate form that is expected to include direct quotes but these will have no identifiers attached to them.

This interview will also be audio recorded and later transcribed. After transcription the audio recording will be deleted immediately.

Do you consent to having this interview audio recorded?

Demographics

- What is your age?
- What gender do you identify with?
- What ethnic group or family background do you identify with?
- What community are you living in (Victoria, Campbell River, etc.)?

Background with Technology

- How comfortable are you using technology and browsing the internet?
- What methods of accessing the internet do you use?
    - handheld device (cell phone, tablet)
    - computer (desktop, laptop)
- Have you used other kiosks before?
- Self-service checkouts at grocery stores for example
- Follow up with how their experience using other kiosks was
- Have you used other drug checking services?
- Follow up with experiences if they say yes
- How did you find out about our service?
- Do you visit the service center alone or with another person?

Life Situation

- What drugs are you likely to check at this service?

Version 1: June 6 2022

Decision Making

- Why are you checking these drugs?
- What key information do you hope to get from this service?
- What insights can the service provide that best inform your next steps?
- How often do you think you would have your drugs checked?
- Do you trust your drug checking results and the service provided?

Information Sources

- Who do you consult with and trust for advice and information on drugs?
- What sources of information about drugs do you wish you had access to?
- Are there other sources of information about drugs that you are able to access?
- What sources of information about drugs would you like to be made available in the kiosk?
- How would you like to access your drug checking results?

Gains and Pains

- What is your initial opinion about the introduction of the drug checking kiosk?
- Does the kiosk bring improvements to your experience using the service?
- Do you experience challenges when using the kiosk?
- What changes can be made to the kiosk so that it's easier to use?
- What changes can be made to the kiosk so that it's more useful to you?
- Is there a certain art, design style, or color palette that you would like the kiosk to use?
- Where should the kiosk be located in your opinion?
    - Should it be integrated as part of another service or should it be stand alone?
- Do you value this drug checking service?
    - If so, what do you value most?
- How important is it to you that this service is free?
- Would you feel comfortable using the kiosk without the assistance of a harm reduction worker?
- What makes you hesitant about this drug checking service?

- Is there anything else you would like to add?

Version 1: June 6 2022

Appendix H

Service User Codebook Exported from ATLAS.ti 8

Color	Name	Groundedness	Groups	Comment
●	Key Information	5		The key information someone like to get out of a drug checking service.
●	Drug checking familiarity	3		Examples of peoples familiarity with drug checking. Generally just what services they have used.
●	Participant 2	2		Transcription mistake, anythig with this code is said by the Participant 2.
●	Interviewer	1		Transcription mistake, anythig with this code is said by the interviewer.
●	Kiosk use case	1		Examples of use cases for the DC Kiosk.
●	Participant 5	1		Transcription mistake, anythig with this code is said by participant 5.
●	Interaction Challenges	19	Barriers	Challenges people faced while using the DC kiosk.Pain points people faced with the kiosk.Moments when people faced difficulting with the kiosk. This is likely the same as challenges.
●	Getting confused	4	Barriers	Moments when participants were confused by the DC kiosk
●	Exclusive Fullscreen	3	Barriers	Instances where the applicaiton being in exlcusive fullscreen would have avoided a mistake/challenge.
●	Timeliness of results	3	Barriers	Referring to the timeliness of getting results back.
●	FTIR Limitations	2	Barriers	Limitations of the DC kiosk
●	Incorrect Input	1	Barriers	When a participant puts an incorrect input in
●	Tech Literacy	1	Barriers	
●	Kiosk Security	4	Barriers, Location & Security	Mentioned in conjucntion with the location code, this code is applied when people spoke about the security of the kiosk when asked about where it should be located.
●	Learning Curve	9	Facilitators	Referring to when people talk about the learning curve associated with the DC Kiosk.
●	Ergonomics	5	Facilitators	Relating the the physical ergonomics of the kiosk.
●	Kiosk familiarity	5	Facilitators	Examples of peoples familiarity with self-service kiosks of any sort.
●	Overall Experience with kiosk	5	Facilitators	Participants descriptions of their overall experience with the DC kiosk.
●	Instructions clear	1	Facilitators	Examples of participants talking about the FTIR instructions being clear
●	No improvements needed	1	Facilitators	No kiosk improvements needed
●	The more accessible, the better.	1	Facilitators	If the kiosk is more accessible to people, the better off it will be.
●	Location	5	Facilitators, Location & Security	Examples of locations people think a self-service DC kiosk should be included in.
●	Extra Features	13	Interface Changes	Peoples answers to questions regarding extra features.
●	Interface changes	11	Interface Changes	Changes participants would like to see be made to the interface. Generally arouse from challenges they faced while using the kiosk.

Appendix I

Example Service User Quotes

Number	Text Content	Codes
1:17	This is just a very early prototype that we've created, but was it easy to use that it feels sort of uncomfortable on your hand touching the screen and the angle of the screen and things like that?Participant 1: No, it was fine.	Ergonomics
2:16	Interviewer: Yeah? And then just a couple more questions here. So did the angle of the screen and the overall ergonomics of the instrument hinder its use at all?Participant 2: Nope. Just the size of the font.	Ergonomics
3:18	Interviewer: Did the sort of screen angle and the overall ergonomics of the. . . That was manageable and it was okay?Participant 3: Yep. Okay. I thought so.	Ergonomics
4:11	Interviewer: Yeah. Overall, did, like, the screen angle and, like, the way everything is sort of put together, did that hinder the use at all?Participant 4: No, I think that was good. Like, it's a good spot, like, yeah, from where everybody was.Interviewer: It's like readable from that angle and everything?Participant 4: Oh, yeah.	Ergonomics
5:13	Did the screen angle or like the way that we've constructed this sort of hinder its use at all?Participant 5: It seems like it should be. . . I should have a higher seat. It would be taller. Right. It may be like right up there.Interviewer: Yeah, I've got some height on me for sure. Right, so being able to sit up higher might make it a little easier to use.Participant 5: Or standing.Interviewer: Or standing, yeah, if it was on a taller table maybe.Participant 5: Um, if this was like where ATMs are. . .Interviewer: Yeah, okay.Participant 5: Maybe I could. . . Because people are more aware of it, I think I'm more aware of my stand up.	Ergonomics
5:2	Participant 5: Oh, yeah, wash it right there.Interviewer: So the button is being hidden right now by this by this bar down here.	Exclusive Fullscreen
3:2	Interviewer: No. And then. . . I can just make that a little bigger there. Participant 3: Oh, I'm making it smaller.	Exclusive Fullscreen, Interaction C
3:10	Interviewer: Could you describe for me any challenges that you faced while using the prototype?Participant 3: Oh, it's just. . . When I tapped close to it, but not quite, and I ended up closing the window, remember? That was a little bit. . . And then I didn't know how to get back.Interviewer: Yeah. So maybe. . .Participant 3: That's sort of a minor technical difficulty. The buttons could be bigger. Right. As well.Interviewer: So. And what about the text size as well?Yeah. Always, I'm going to go with bigger. Bigger.	Exclusive Fullscreen, Interaction C
1:14	Interviewer: Would it be useful to have. . . Would it be useful to have information about like the local drug market from like a wider perspective?Participant 1: Sure, it could say, you know, benzos. Benzos have been in a lot of samples, xylazine, whatever. And you've got a little bit of whatever is coming up more often than not.	Extra Features
1:15	Interviewer: Yeah, yeah, yeah, exactly. Information about the effects of certain common cutting agents or something like that. Is that useful information you think?Participant 1: That's all we want.	Extra Features
2:18	Okay. And then what other features other than drug checking would be of use to you in this kiosk? So I have some examples that I thought of, but I'll let you know after.Participant 2: Harm reduction supplies, first aid supplies possibly. Right. Water. Okay. And then the population can get hydrated.	Extra Features
2:19	Interviewer: Yeah. So some examples that I've thought of are like a list of local services, harm reduction or drug information. So you get your result back and it tells you something you've never heard of before and you're able to look it up on here. Would that be?Participant 2: That would be good, yeah.Interviewer: That would be nice?Participant 2: Possibly. Well, that's also like both. Well, I guess CPS, like there was a database that linked it to a CPS.Interviewer: A CPS?Participant 2L You know, a CPS, A compendium of pharmaceuticals and sup- plements.Interviewer: Okay.Participant 2: A giant bible that pharmacists get every four years, right? So it's just thick and it contains every pill.Interviewer: Okay. So it's like a large database of drug information.Participant 2: Yeah. Something that you could maybe point and click so you can never retype it and get a left click or right click. Right. Explain what the drug is, right?Interviewer: Yeah. So like on the results screen, like maybe. . . Like what you guys do with the explanation of what the levamisole is.	Extra Features
2:21	Participant 2: What. . . Something, any interactions with some of the benzos that are used have interactions with other drugs. And that's something that we know of. There's benzos that don't work well with SSRIs. Yeah. We got unstable people as a result of the dope they're doing. It's just because of the dope that keeps them stable. They don't jive.Interviewer: Right. So having not only drug information about what the effects could be, but also the effects of any interactions that are possible with that substance.	Extra Features
2:22	Interviewer: The last one that I've sort of thought of is what I refer to as local drug market statistics. So things like the average concentration of fentanyl, sort of like the weekly reports or the monthly reports that substance. . .Participant 2: Kind of what we're doing with the numbering of the sites, right?Interviewer: Yeah. So having, you know, if we had a bunch of these, you know, in a city or something, then having basically like a report for that city. Yeah. Would you use something like that?8Interviewer: Absolutely. And what sort of information would you want to be present in a report like that?Participant 2: Um, strengths, anything that. . . Do you think that the dope guy, the local dope guy, that had a back page was a warning? What people are going on with, you know, warnings, bad date sheets for the drug, like all that stuff? And warnings, right?Interviewer: Right, so. . .Participant 2: Like things like localized violence and, you know, there seems to be waves sometimes of like stuff current, like on the block or. . .Interviewer: So like going beyond drug statistics and talking about community news. Yeah, like what's been happening in [inaudible] Some places, some places, the score are very peaceful. Some places that are, like, it can be scary. The plot can be a scary place. Yeah.	Extra Features
3:19	Participant 3: Just the information that it collects and the stat sheets and stuff that you guys put out. I think that would be. . .Interviewer: Right. So having a version of that on here like a weekly or monthly report or whatever.Participant 3: Yeah. Just to see	Extra Features