Informing illicit drug policy through economic evidence: using safer drug consumption facilities in Scotland as an example

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Abstract

Background: Illicit drug use continues to increase and impact individuals' health worldwide. Critical voices surrounding the performance of enforcement-led policies continue to grow internationally, as they have been shown to be ineffective in reducing drug-related harms and lead to high expenditure to society. Instead, some countries and voices advocate a human right and public health approach to drug policymaking. These policies include decriminalisation of drug users, and services or facilities to support them, such as safe drug consumption facilities (SDCFs). The case of the SDCFs in Scotland presents a timely and highly relevant focus for this PhD work, as its implementation in the UK remains politically contested. Such a facility allows individuals to consume illicit drugs under clinical supervision, representing a public health orientated alternative to punitive, criminalisation-based responses. Incorporating scientific evidence of the services is an essential element of an evidence-based policy, and more frequently, economic evaluation and health technology assessment are being incorporated into the assessment of public health and social policies. This thesis, therefore, explores and examines whether health economics methods can support a rational and sustainable approach to drug policy decision-making in Scotland, using SDCF as an example.

Methods: A multi-methods approach was taken to illustrate how health economic methods can contribute to the evidence base that informs policymaking in the Scottish context. This thesis is comprised of (i) a systematic review to understand what and how health economic methods were used to evaluate illicit drug policies worldwide, (ii) a literature review focused on the implementation of SDCFs in an international context. Two empirical studies were then developed, including (iii) a discrete choice experiment (DCE) that explored acceptability for different configurations of a SDCF by sampling potential service users (PWUD)' perspectives in Scotland; and (iv) the decision analytical modelling to estimate the short- and longer-term cost, benefits, and potential cost-effectiveness of a hypothetical SDCF in Glasgow, Scotland, integrating findings from the DCE study.

Results: The systematic review found that internationally, a large amount of the government budget has been allocated to enforcement policies, accompanied by a significant loss of productivity from people who have been incarcerated or have had overdose deaths. In the reviewed studies, public health policies were strongly supported by the evidence base, but evaluation was often conducted from a healthcare perspective, and limited research related to the enforcement-related policies (either criminalisation or decriminalisation). In Scotland, the DCE study found that participants preferred a SDCF that involved peer workers, provided drug checking service and inhalation spaces, and opened 24 hours a day, in comparison to one without peer workers, did not provide drug checking service and inhalation spaces, and opened daytime only. Among these features, peer involvement in the facility had a great impact on the willingness to travel to the SDCF. Participants were willing to travel up to nearly 1 hour to use a SDCF that involved peer workers compared to one without peer workers. A cost-effectiveness analysis was then undertaken to estimate the potential costs and outcomes of a hypothetical SDCF compared to the status quo (i.e. no SDCF) in Glasgow, Scotland. The findings of this modelling study suggested that implementing a SDCF would be cost-effective from a healthcare perspective. Over a 1-year time horizon, a SDCF would be cost-effective, with an estimated ICER at £1,378 per QALY gained (or £517,399 per death avoided) compared to having no SDCF available. In the lifetime cost-effectiveness analysis, implementing a SDCF remained cost-effective when incorporating referral benefits for service users engaging in long-term recovery treatment, with an estimated ICER at £2,640 per QALY gained (or £1,693 per life-year saved) compared to having no SDCF available.

Conclusion: This thesis demonstrates that health economic methods can strengthen the evidence base for drug policy decision-making in Scotland and the wider context. In the systematic review,

these methods were shown to provide multidimensional evidence of drug policies. It includes the assessment of the costs and cost-effectiveness of implementing polices to guide efficient resource allocation, quantified individual and societal preferences towards policies, and integration of broader societal considerations of implementing of drug policies. The DCE study provided robust evidence on the preferences of PWUDs, which are highly relevant for decision makers, highlighting which service features were most likely to drive engagement and thereby ensuring that SDCFs are designed in ways that maximise their impact. The cost-effectiveness modelling complemented this by quantifying the costs and outcomes associated with alternatives, offering decision-makers a clearer picture of value for money and the trade-offs involved in resource allocation. Overall, these analyses illustrate that applying economic methods in this policy space can produce actionable insights that directly support informed, transparent and evidence-based decision-making, moving illicit drug policy away from being shaped primarily by political or moral debates, and towards being grounded in rigorous evaluation of PWUDs' needs, costs and benefits, as well as broader social impacts and uncertainties that are central to policy decisions.

State of play

During the time of my PhD, between July 2021 and May 2025, the landscape of illicit drug policy was rapidly evolving in Scotland – the proposal of opening a safer drug consumption facility in Glasgow had been rejected many times by the Westminster UK Government since 2016, until the most recent Lord Advocacy Statement on the Glasgow pilot facility marked a significant shift in policy direction in 2023. After this statement, the Glasgow pilot facility was scheduled to open in 2024 (but then postponed to January 2025) with a fully confirmed service configuration. Meanwhile, a 5-year research project has been funded by the National Institute Health and Care Research to evaluate the Glasgow pilot facility that started in April 2025.

Policy changes have impacted my PhD, however, evidence in relation to safer drug consumption facilities in the Scottish context remains limited, particularly regarding the user preferences of SDCF service configurations, and the potential cost-effectiveness of implementing such a facility in Scotland. Against this backdrop, this PhD remains highly relevant. In addition, as this is an inherently political issue, the findings of this thesis must be interpreted within the context of the policy framework at the time.

Statement in ethics and language

Illicit drug use is a sensitive topic. Each drug-related death is avoidable and each is a person's life, with profound impact on families, communities, and society. While the language used in this thesis aligns with the terminologies often used in academic research in health economics and drug use research, it may not adequately reflect the severity of these losses.

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Lastly, I want to thank me for staying curious, upbeat, disciplined, and resilient in this PhD journey.

Author's Declaration

I declare that, except where explicit reference is made to contribution of others, that this dissertation is the results of my own work and has not been submitted for any other degree at the University of Glasgow or any other institute.

Yuejiao Duan

Contribution statements*

Chapter 1: The writing and development of this chapter was led by myself (YD), with oversights and suggestions from Dr Kathryn Skivington (KS), Dr Keila Meginnis (KM), and Professor Kathleen Boyd (KB).

Chapter 2: The conceptualisation and development of this chapter was led by myself, including literature search, data extraction, analysis, and drafting. The screening process was double-checked and validated by Dr Kathryn Skivington, Dr Keila Meginnis, Professor Kathleen Boyd, Septiara Putri (SP), and Hanin Kamaruzaman (HK).

Chapter 3: The conceptualisation and development of this literature review was led by myself, with oversights and suggestions from Dr Kathryn Skivington, Dr Keila Meginnis, and Professor Kathleen Boyd.

Chapter 4: The writing and development of methodology chapter was led by myself, with oversights and suggestions from Dr Kathryn Skivington, Dr Keila Meginnis, and Professor Kathleen Boyd.

Chapter 5: The conceptualisation of this project was led by myself, Dr Kathryn Skivington, Dr Keila Meginnis, and Professor Kathleen Boyd. Following the findings of the Chapter 4, I had internal discussion with my supervisors Dr Kathryn Skivington, Dr Keila Meginnis, and Professor Kathleen Boyd, and external discussion with my PhD advisory group Dr Kisten Trayner (KT), Dr Martin Anderson (MA), and Dr Rebecca Foster (RF) to define the list of attributes, potential participants of the DCE study. DCE choice sets were designed by myself using Ngene, and coding was double-checked by Dr Keila Meginnis. The DCE questionnaire was designed by myself and the import of choice sets from Ngene output into Sawtooth software was double-checked by Dr Keila Meginnis. The grammar, wording, and flow of DCE questionnaire received oversights and suggestions from Dr Kathryn Skivington, Dr Keila Meginnis, and Professor Kathleen Boyd, Dr Kisten Trayner, Dr Martin Anderson, and Dr Rebecca Foster, and Josh Dumbrell (JD). The ethical approval application for DCE study was written by myself and was reviewed and edited by Dr Kathryn Skivington. The participants recruitment and data collection were led by employed peer researchers Josh Dumbrell and Samantha Steele (SS). The data analysis was undertaken by myself, with some guidance on R coding from Dr Keila Meginnis. The drafting was reviewed and commented by Dr Kathryn Skivington, Dr Keila Meginnis, and Professor Kathleen Boyd.

Chapter 6: The conceptualisation and development of this project was led by myself, Dr Kathryn Skivington, Dr Keila Meginnis, and Professor Kathleen Boyd, with an external meeting with my PhD advisory group Dr Kisten Trayner, Dr Martin Anderson, and Dr Rebecca Foster to discuss the potential policy relevance and challenges in regard to data availability to conduct this project. The methodological design was led by myself, with oversights and suggestions from Professor Kathleen Boyd. The data analysis in Excel was undertaken by myself and reviewed by Professor Kathleen Boyd. The drafting was reviewed and commented by Dr Kathryn Skivington, Dr Keila Meginnis, and Professor Kathleen Boyd.

Chapter 7: The writing and development of discussion chapter was led by myself, with oversights and suggestions from Dr Kathryn Skivington, Dr Keila Meginnis, and Professor Kathleen Boyd.

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* *Note: Throughout each chapter, initials are used to refer to contributions made by supervisors and other researchers involved in the projects, as indicated in the brackets '()'.*

Conference presentations and other outputs

Presentations

Duan Y, Skivington K, Meginnis K, Boyd KA. How Has Economic Evidence Contributed to Illicit Drug Policy? A Systematic Review of Methodologies and Implications for Decision Making [abstract]. *Drugs Research Networks Scotland (DRNS) Annual Conference 2024 – Parallel Sessions*, 5th Jun 2024, Edinburgh, United Kingdom.

Duan Y, Skivington K, Meginnis K, Boyd KA. People Who Use Drugs' (PWUD) Preference Towards Service Design of a Safer Drug Consumption Facility (SDCF) in Scotland: A discrete choice experiment [abstract]. *European Health Economics Association (EuHEA) Conference 2024 – Parallel Sessions 9*. 3rd July 2024. Vienna, Austria.

Panel discussion

Duan Y, Skivington K, Meginnis K, Boyd KA. People Who Use Drugs' (PWUD) Preference Towards Service Design of a Safer Drug Consumption Facility (SDCF) in Scotland: A discrete choice experiment [abstract]. *Drugs Research Networks Scotland (DRNS) Annual Conference 2024 – Panel discussion*, 5th Jun 2024, Edinburgh, United Kingdom.

Government report

Nicholls J, Falzon D, Masterton W, McAuley A, Dumbrell J, Steele S, Perkins A, Carver H, Trayner K, Skivington K, **Duan Y**, Parkes T. Needs assessment and feasibility study for a safer drug consumption facility in Edinburgh. The City of Edinburgh Council. 2023.

Working papers for publication

Chapter 2 is planning for submission as follows:

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Chapter 5 has been submitted to *International Journal of Drug Policy*:

Duan Y, Skivington K, Meginnis K, Boyd KA. Using of a discrete choice experiment to support the service design of the safer drug consumption facility (SDCF) in Scotland.

Chapter 6 is planning for submission as follows:

Duan Y, Skivington K, Meginnis K, Boyd KA. Modelling the Potential Cost-effectiveness of a Safer Drug Consumption Facility (SDCF) in Glasgow, Scotland – a hypothetical analysis.

Abbreviations

ASC	alternative-specific constant
AIDS	acquired immune deficiency syndrome
BBVs	Blood Bone Virus
BCA	benefit-cost analysis
CBA	cost-benefit analysis
CCA	cost-consequences analysis
CEA	cost-effectiveness analysis
CEAC	cost-effectiveness
CHEERS	Consolidated Health Economics Reporting Standards
CHEQUE	Criteria for Health Economic Quality Evaluation
CIs	confidence intervals
CL	Conditional logit model
CMA	cost-minimisation analysis
COI	cost-of-illness analysis
CS	Compensating surplus
CUA	cost-utility analysis
CV	contingent valuation
DAISy	Drug and Alcohol Information System
DCE	discrete choice experiment
DUD	drug use disorder
ECDA	European Centre for Disease Prevention and Control
EMCDDA	European Monitoring Centre for Drug and Drug Addition
HAT	Heroin-assisted treatment
HCV	hepatitis C
HICs	high income countries
HIS	Health Improvement Scotland
HIV	human immunodeficiency virus
ICERs	incremental cost-effectiveness ratios
JDCs	Juvenile drug courts
LCM	Latent class model
LYs	life-year saved

MAT	medicine-assisted treatment
MCDA	multi-criteria decision analysis
MMT	methadone maintenance treatment
MNL	multinomial logit model
MRC	Medical Research Council
MXL	mixed logit model
MSIC	Medically Supervised Injecting Centre
MWTT	marginal willingness to travel
NESI	Needle Exchange Surveillance Initiative
NGOs	non-government organisations
NHS	national healthcare services
NICE	National Institute for Health and Care Excellence
NIMBY	'not in my backyard'
NSPs	needle and syringe programmes
NSB	net social benefits
OST	opioid substitutional treatment
PRISMA	Preferred Reporting Items for Systematic Reviews and Meta-Analyses
PSA	probabilistic sensitivity analysis
PWID	people who inject drugs
PWUD	people who use dugs
QALYs	quality-adjusted life years
RCT	randomised controlled trial
RI	relative importance
RIS	rounded important score
SDCF(s)	safer drug consumption facility(-ies)
SHTG	Scottish Health Technologies Group
SMC	Scottish Medicines Consortium
SROI	social return on investment
SSTI	skin and soft tissue infections
THN	Take-Home Naloxone
UN	United Nations
UNODC	United Nations Office on Drugs and Crime
WHO	World Health Organization

WTA	willingness to accept
WTT	willingness to travel
WTP	willingness to pay

Chapter 1: Introduction

1.1 Research in context

1.1.1 Matters of illicit drugs

Illicit drugs refer to those psychoactive substances that have been prohibited for non-medical use under international drug control treaties, typically including but not limited to cannabis, opioids, cocaine, amphetamine-type stimulants, and central nervous depressants (i.e. benzodiazepines) [1, 2]. They can be smoked, injected, inhaled or snorted into one's system, producing intoxicating experiences affecting neurotransmitters and behaviours of users, and can lead to a high dependence on the substance, in turn potentially causing harmful consequences [3].

The potential consequences and the extent of harmfulness vary according to the complex nature of drug use. **Figure 1** shows how three mechanisms of action (toxic effects, intoxication, and dependence) mediate the associations between drug use (that differs in drug dose, use pattern, and route of drug administration) and negative consequences of drug use for people who use drugs (PWUD) [2].

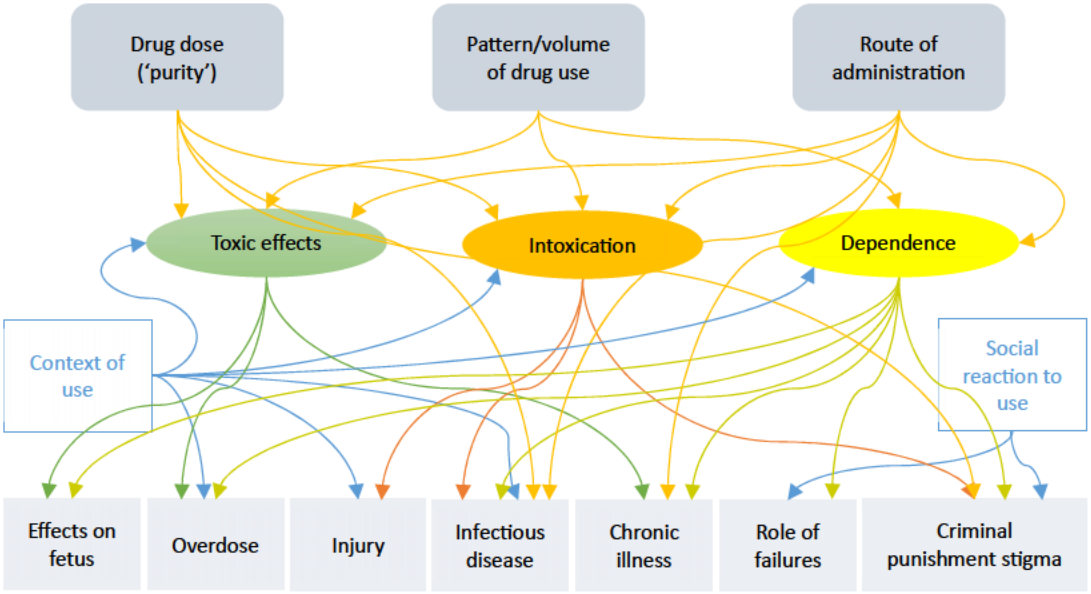


Figure 1. *How three mechanisms – toxic effects, intoxication, and dependence, are related to drug dose, use patterns, and route of drug administration, and in turn meditate the consequences of drug use for people who use drugs (PWUD), Source: [2]*[ii]

To explain this figure, for example, cannabis is considered to have fewer adverse effects on health and is less likely to be dependent than other drugs [4], but it can create considerable harm when it becomes regularly used in daily life (as shown in the figure that context of use and pattern/volume of use can lead to dependence) [5]. Drug dependence (or drug use disorders, DUD) is a condition in which there is uncontrolled use of a substance despite harmful consequences. Accordingly, cannabis use disorders would bring more people into drug treatment service [6-8] and cause road accidents (dependence lead to chronic illness and injury) [4, 9]. Furthermore, having drug dependence with one substance increases receptiveness to developing dependence on additional substances that implies the pattern of use can possibly include shifts across the lifespan and polydrug use to become

[ii] Reproduced from Babor TF, Caulkins J, Fischer B, Foxcroft D, Medina-Mora ME, Obot I, et al. Drug Policy and the Public Good: a summary of the second edition. Addiction (Abingdon, England). 2019;114(11):1941-50.

a common occurrence [10]. The co-use of heroin with fentanyl and other synthetic opioids (drug dose) for enhancement of the 'high' (intoxication) has contributed to sharp increases in morbidity and mortality in the United States of America (USA) during the past decade [11, 12]. Overall, the mechanisms illustrate that PWUD often have complex and evolving patterns of consumption, which has direct implications for the need for flexible and user-informed interventions that can adapt to shifting drug use behaviours over time.

1.1.2 World drug trend

Drug use continues to increase globally and impacts individuals' health. In 2022, approximately 292 million (or 1 in 18) people have used a drug in the past year, an increase of 20% over a decade ago, with cannabis being the most widely used drug, followed by cocaine, opioids, amphetamines, and 'ecstasy' [6]. The proportion of people who have ever used a drug is 4.6 times higher than the proportion of people diagnosed with DUD (64 million) [6] which suggests that most people who have ever tried a drug never proceed to DUD [2]. The risks of developing DUD have been found strongly associated with genetic factors, and interact with social and contextual factors that play an important role in exposure, initial, and regular use of drugs [13, 14] .

The United Nations Office on Drugs and Crime (UNODC) estimates that only about 1 in 11 people with DUD received drug treatment globally in 2022, a decrease from 2015, and the treatment coverage is much lower among women (1 in 18 in treatment) than among men (1 in 7) [6]. Injecting drug use is a facilitating driver of the global epidemic of hepatitis C (HCV), and people who inject drugs (PWID) are 14 times more likely to acquire human immunodeficiency virus (HIV) than the general population [6]. Notably, the global DUD mortality rate was estimated to be 1.84 deaths per 1,000,000 people (95%CI, -0.44 to 4.12) in 1990 and 13.09 deaths (95%CI, 10.74-15.43) in 2021, and the number of deaths were predicted to be continuously increasing to 38.45 (95%Crl, 30.48-49.33) in 2030 [15]. Despite the uncertainty reflected in the wide confidence and credible intervals, these estimates provide useful insight into the global trend in drug-related deaths. It suggests a growing global trend associated with illicit drug use, and such data highlights the significant scale and burden of the drug problem over time. In addition to this, the prevalence of DUD and associated disease burden (due to premature death and morbidity) have been significantly attributed to people who are opioid users, middle-aged men, and from high-income countries (HICs) [8, 16-19].

1.1.3 Illicit drug use in the UK and other high-income countries

The changing of social, economic and political contexts is associated with drug initiation and drug-related deaths in high-income countries (HICs) [20-23]. In North America, for example, excessive prescribing of opioids for pain management and subsequent restrictions on that prescribing has been suggested as one of the drivers for the increase in illicit heroin and synthetic opioid use in the USA and Canada [2, 24, 25]. In Nordic countries, the late implementation and long waiting times of drug treatment services have partly explained the drug-related deaths [26]. In the Netherlands, commercialised cannabis use may have promoted the drug's popularity among youth, tourists, and refugees for the purpose of recreational use (as considered 'lifestyle'), and provoked increases in alcohol, vaping, and e-cigarette use among adolescents and young adults [23, 27, 28].

Economic policy changes have also driven the drug use problems in the UK, but their impact is thought to have more acutely aggravated the situation in Scotland than in England and Wales [29]. In Scotland, the rapid rise in drug-related deaths has been explained as a consequence of policy changes in the 1980s that sequentially increased socioeconomic inequality among the Scottish population [30]. Such effects might remain over time because the increasing number of drug-related deaths has been attributed to middle-aged men who were born between 1960 and 1980 and lived in the most deprived areas [30-32]. Beyond economic impact, drug-related deaths have been

further exacerbated by worsening social determinants of health since 2010's austerity policies, e.g., poor housing, unemployment, and decreasing public services [33].

Across the UK, between 2010 and 2019, drug-related death rates have increased by 171% in Scotland, 149% in Northern Ireland, and 61% in England and Wales [34]. Holland *et al* indicate five potential factors that have contributed to this rise, including an ageing population of those who use drugs, increasing polydrug use, increasing homelessness and incarceration, changing patterns of socioeconomic deprivation, and cuts in funding for services that prevent drug-related deaths [34].

In Scotland, the latest report shows that the number of PWUD is in the range of 55,800 to 58,900, representing a prevalence rate of 1.62% amongst the general population aged 15 to 64 years [35]. Drug-related deaths have been constantly increasing in the past decades, with the highest record of 1,339 in 2020 [36]. Noteworthy, Scotland's drug death rate is over 3.5 times the rate for the UK as a whole, and also is the highest among other European countries [37]. Of the major Scottish cities, the age-standardised drug-related death rate was recorded highest in Glasgow City at 44.6 per 100,000 population and followed by Dundee City (40.2) between 2019-2023 [36]. Besides fatal overdose, there have been several major outbreaks of HIV among PWID in the cities of Edinburgh and Dundee in the 1980s, and a more recent outbreak remains uncontained in Glasgow City since 2015 [38]. These statistics highlight a substantial rise in drug-related deaths across the UK, with Scotland experiencing the most significant increase compared to the rest of UK. It may indicate the broader challenges such as social and political context, and characteristics of user population may play an important role.

1.2 Research gap

1.2.1 Evidence-based drug policy?

Whilst the opioid overdose crisis continues, priorities to address drug problems have been largely dominated by the implementation of legislation-related national drug control regimes across countries and regions of the world, with main effects that have been evaluated mostly in terms of drug crime and trafficking [39-41]. The United Nations (UN) treaties, or conventions, form the international law framework of the global drug control regime, which serves as a foundation for shaping national domestic law [42]. However, the performance of drug treaties has been consistently criticised, as they have been shown to be ineffective at reducing the number of people who use drugs and lead to high expenditure on law enforcement, which is associated with severe unintended harms (e.g., drug market violence in North America, Mexico and Brazil) [43-46].

A series of policy reforms attempted to act outside the framework of the UN treaties in the past decades, for example, legalised drug market in New Zealand, and supervised drug consumption facilities (SDCFs) in Canada [47, 48]. Advocates strongly argue for a human rights and public health approach in drug policies, which explains that drug use, drug use disorders and related health conditions are major public health concerns that should engage people to access treatment services they need to improve their health. The 2016 World Health Organization (WHO) report of the UN special session on the world drug problem emphasised that incorporating scientific evidence of treatment services for people with DUD and associated consequences is an essential element of an evidence-based drug policy [39].

Based on current scientific research, however, there is a limited understanding of the effectiveness and cost-effectiveness of drug policies that operate outside of the current UN international drug control framework. Especially, in some cases, the distinction between drug policy and drug-related healthcare intervention becomes ambiguous. The introduction of a new intervention, such as SDCFs, often requires legislative and policy reform, making the intervention implemented as part of political changes, rather than a solely public health programme. This issue is further explored in the

UK context in next section 1.2.2. Furthermore, while the number of published research articles on all areas of illicit drug use has been continuously increasing each year, such as causes, consequences, prevention, and treatment of illicit drug use, these are predominantly derived from the USA, Canada, Australia, and Europe [40]. Among them, drug policy evaluation constitutes only a small proportion, and research findings are not generalizable from one historical era to another because the drug problem and its social and political context can evolve over time, and vary between jurisdictions of one country [40].

1.2.2 Governing illicit drugs between the UK and Scottish Government

Since 1961, the United Kingdom (UK) joined the international agreement of UN treaties and successively introduced legal controls to criminalise non-medical psychoactive substance use. The UK's major drug law – Misuse of Drugs Act 1971, was established to classify drugs from A to C based on their relative harms and to define criminal offences for specified activities, including production, trafficking and supply of illicit drugs [49]. In the early 1960s, initial treatment strategies attempted to establish outpatient treatments and residential rehabilitation that promote drug cessation (abstinence). In the 1980s, the number of heroin-related deaths was recorded at over 100 for the first time [50]. The emergence of HIV/AIDS raised caution on the spread of infection to the wider drug injecting community, which decisively made a change in the UK political climate by promoting harm reduction services, i.e. needle exchange programmes and methadone maintenance therapy [51]. In the 2010s, drug policy again shifted away from harm reduction toward abstinence-based recovery under the conservative-liberal democrat government, alongside a rapid rise in drug-related death in the UK [51]. Meanwhile, the Psychoactive Substances Act 2016 was rolled out to criminalise the production and supply of any substance that *'is capable of producing a psychoactive effect'* [49].

Developing policy responses to drug problems can be complex, especially in the case of the UK, which consists of four nations with some powers devolved to the national governments. The devolution settlement between the UK Government (Westminster) and the Scottish Government is based on a distinction between devolved and reserved power, in ensuring that each policy is the clear responsibility of either government.

In terms of drug policy, the key legal frameworks are reserved to Westminster, while the Scottish Government has control over the criminal justice and health systems. For example, a proposal to allow Glasgow City Council to open a safer drug consumption room (SDCF) in response to the overdose death crisis had faced years of political and legal resistance from Westminster as drug law is reserved to the UK Government [52]. Until 2023, Scotland's Lord Advocacy made the announcement on a new prosecution policy (that service users and staff at SDCF would not be charged), that provided a legal workaround to avoid Westminster's restrictions under the Misuse of Drugs Act 1971 [53]. Fundamentally, the drug policy debate is consistently ongoing between the UK and Scottish Governments that can be explained in terms of social context, policy constellations, ethico-political bases and forms of power [54]. Furthermore, political debates between two governments have intensified due to the severity of drug problems in Scotland, which differ significantly from those in the rest of the UK (as specified in section 1.1.3).

In the Scottish policymaking context, responsibility for health and social care policies lies with the Scottish Government and NHS Scotland, overseen by Healthcare Improvement Scotland (HIS) [55]. Health Technology Assessment appraisals are overseen by two evidence directorates within HIS, known as the Scottish Medicines Consortium (SMC) that evaluates newly licenced medicines and the Scottish Health Technologies Group (SHTG) that responsible for non-medicine health technologies (i.e., tests, devices, procedures, talking therapies, digital healthcare, programmes or systems [56, 57]. Both directorates maintain independence from the National Institute for Health and Care Excellence (NICE) in England and Wales [58] and provide their own independent assessments for Health Boards in Scotland. In some cases where NICE guidance might still applicable

in Scotland, however, SHTG may choose to adapt NICE evidence and apply to the Scottish context under their framework [59].

1.2.3 Public expenditure in illicit drugs

Understanding the cost of drug-related actions is an important aspect of drug policy. Historically, political and funding priority has been given to drug law enforcement over other dimensions of drug control. While global enforcement costs are estimated at USD$100 billion per year [60], healthcare service funding remains small fraction of what is required. In 2011, the UN estimated that USD$1.5 billion per year would be sufficient to address harm reduction needs to end HIV transmission among PWID worldwide [61]. It is likely that this figure now significantly underestimates the current financial requirement given the continuously increase in drug use. Furthermore, 2019 data showed that only USD$131 million has been funded to harm reduction programmes – representing only 9% of the proposed global need [62], illustrating a persistent funding gap in public health interventions.

Meanwhile, the cost associated with treating drug-related harms continues to rise. The global spending on the drug-related deaths has been estimated to be USD$585,000 in 2017, representing a 177% increase compared to 2011 [62]. The data is now nearly decade old and may not reflect the current economic burden related to drug deaths. Furthermore, available data often lacks local specificity. The UK Home Office estimates that the expenditure on illicit drug use is approximately £10.7 billion each year, including 64% attributed to law enforcement, 8% to health service use and 28% to death-related costs [63]. Nevertheless, these figures were derived from England and Wales and may not be directly applicable to the Scottish context. Given that Scotland's drug-related deaths are substantially higher than the rest of the UK [37], the death-related costs are likely much higher in Scotland.

With the increasing burden of disease related to illicit drug use and the significant economic burden that it places on the healthcare system, governments have recognised the urgent need to respond. In 2021, the UK Government published its 10-year drugs plan and committed an additional funding of £533 million (bringing the total to £900 million) to invest in drug misuse treatments in England [34, 54, 64]. Scotland has allocated a total of £500 million to support the delivery of the National Drugs Mission Plan for 2022-2026 [65]. Such policies present significant shifts in investment, but it remains to be understood that what and how healthcare services should be delivered and whether they are cost-effective.

1.3 Research motivation

Illicit drug use continues to rise worldwide, posing substantial public health challenges, but the investment in effective health interventions for people who use drugs remains critically insufficient on a global scale [6]. This gap in service provision is particularly concerning given the rapid increase in drug-related deaths worldwide [8, 16-19, 36], which highlights the urgency for more effective responses from local governments. However, illicit drug use is viewed as a political issue rather than a solely health problem – the major public spending continues to support law enforcement that aims at criminalising users in most countries and the UK [60, 63], which has further hindered individuals from engaging in treatments they need and prevents the avoidable deaths.

Meanwhile, financial burden on healthcare system continues to increase due to the rising need for emergency treatments related to drug-related deaths and harms [62, 63], and this growing demand places significant pressure on already constrained healthcare resources. How decisions should be made regarding service delivery to effectively improve patient engagement and correspondingly reduce harms, and whether these investments could lead to greater savings in wider systems, such as cost reduction in law enforcement and acute emergency services, that needs to be further investigated.

There is an emergent advocate for evidence-based decision making in drug policies, because drug policy has been historically shaped more by political ideology than research evidence [41, 54]. A significant gap remains in the integration of economic evidence into drug policy decisions [41, 66]. Prior to my PhD study, I was involved in a systematic review project in updating the European Centre for Disease Prevention and Control/European Monitoring Centre for Drugs and Drug Addiction (ECDA/EMCDDA) guidance on the effectiveness of interventions for people who inject drugs [67, 68]. In this review, a small number of cost-effectiveness analyses were found. With some preliminary search at the early stage of my PhD, I noticed there was very limited and relatively out-of-date (published around 2000s) health economics research on drug-related interventions or policies, and majority of them focused on infectious diseases in relation to injection behaviours.

Given the ongoing political debate surrounding drug policy development worldwide and in the UK, there is a pressing need for evidence-based approaches to support informed decision-making. A significant gap remains in understanding how health economic evidence can contribute to evaluating drug policies and intervention programmes, particularly in Scotland, where drug-related harms continue to rise. The case of the supervised drug consumption facility (SDCF) in Scotland presents a timely and highly relevant focus for this PhD work, as its implementation in the UK remains politically contested. Such a facility allows individuals to consume illicit drugs under clinical supervision, representing a public health orientated alternative to punitive, criminalisation-based responses. Thus, this thesis uses SDCF in Scotland as an example, to illustrate whether health economic methods can support a rational and sustainable approach to drug policy decision-making.

1.4 Reseach aims and questions

The overarching research aim to this PhD thesis is to explore and examine the role of health economic methods in contributing to the evidence base that can be drawn on in policymaking in the Scottish context.

This thesis proposed 4 research questions:

i. What economic evidence has been used to inform what and how drug policies have been evaluated?
ii. What is the existing research evidence in relation to the implementation of a SDCF, evidence of effectiveness, and knowledge gaps that need to be addressed to promote the operation of SDCF?
iii. What is the most acceptable and attractive SDCF delivery model for PWUD in Scotland?
iv. What is the potential cost-effectiveness of implementing a SDCF compared to the status quo (i.e. no SDCF available) in Scotland?

1.5 Structure of the thesis

Chapter 2 is a systematic review that critically synthesises the full economic evaluations and other possible alternative frameworks and methods that have contributed to evaluating illicit drug policies worldwide, and critically analyses the opportunities and challenges of adopting these methods to assist drug policymaking.

Chapter 3 is a literature review that maps out emerging themes in relation to service models of supervised drug consumption facilities (SDCFs, and their components), evidence of effectiveness, and knowledge gaps that need to be addressed to promote the operation of the facilities. It generates a profile of existing literature on the topic of operating such facilities, serving as a foundation for further research in Chapter 5 and Chapter 6.

Chapter 4 is a methodology chapter that provides the rationale and justification of using a discrete choice experiment (DCE) and a cost-effectiveness analysis (CEA) in the analyses for this thesis.

Chapter 5 is a discrete choice experiment (DCE) that identifies the optimal design features of a SDCF in Scotland. It explores potential service users' preferences in the Scottish context before the government formally introduced any facilities. In this study, a DCE questionnaire was designed by incorporating the findings from Chapter 3, to engage with people who use drugs across three major Scottish cities: Dundee, Edinburgh, and Glasgow. Multiple choice models are used to investigate the preference weights, preference heterogeneity, and willingness to travel to use a SDCF, and predict facility uptake rates with hypothetical configurations.

Chapter 6 is an economic evaluation that estimates the potential cost-effectiveness of implementing a SDCF compared to having no SDCF available in Glasgow, Scotland, using international literature and local epidemiological data to develop decision analytical models in the absence of clinical trials in the Scottish setting. This hypothetical study developed a short-term decision tree to estimate the effectiveness of SDCF in preventing overdoses, followed by a Markov cohort model to forecast the lifetime benefit of referring SDCF service users to long-term recovery treatment. Additionally, an alternative facility configuration is further examined in the scenario analysis by integrating findings in Chapter 5.

Chapter 7 summarises the key findings of this thesis and reflects on the strengths and limitations. It then outlines contributions and key areas where further research is needed to address ongoing evidence gaps and methodological challenges. Finally, the conclusion is provided to the thesis.

Chapter 2 A Systematic Review of Economic Evidence on Illicit Drug Policies

2.1 Introduction

Contemporary drug policy that intends to resolve illicit drug use forms two dimensions, sometimes conflicting – through the law enforcement effort to reduce drug availability and criminalise those who use drugs (supply controls), and the public health approach that focuses on the health and well-being of the population (demand controls). **Table 1** summarises these two dimensions, detailing the explanation of each policy strategy and its relative goals in tackling illicit drug use.

Table 1. Government-level drug policy and their goals

Category		Explanation	Goals
Legal framework	Prohibition	Arrest sellers and traffickers; interfere with supply chain.	Reduce availability, control price.
	Penalty	Punishment for drug possession and use; identify users.	Prevent and stop drug use; identify and divert patients through criminal justice system into healthcare interventions.
	Legalisation	Removal of penalties for possession and personal use of a drug.	Establish legal drug market – manage where and how drugs are produced, sold, and consumed.
	Decriminalisation	Removal of criminalisation of small quantities drugs for personal use.	Treating drug use as a health and social issue.
Public health strategy	Prevention	Provide prevention and early intervention to those who might be at risk of developing drug use.	Reduce the circumstance and situations where people at risk of developing drug use.
	Harm reduction programme	Engage PWUD who actively take drugs into the services reducing harms.	Prevent negative health consequences of using drugs; improve health quality.
	Treatment or Recovery	Discourage PWUD using illicit drugs.	Stop drug use; prevent relapse; recover from harms.

In response to 2016 WHO's report on the world drug problem, the United Nations Offices on Drugs and Crime (UNODC) advocates for a rebalancing of enforcement and interventions towards public health approaches [39, 69]. So far, more than thirteen countries (mostly high income countries) have moved towards policies of drug decriminalisation that align with a public-health-led policy, e.g., Portugal [70, 71]. It suggests the growing recognition of a positive effect on both individuals who use drugs and society as a whole [71-73].

In some countries, however, publicly funded drug treatments have faced substantial disinvestment, e.g., in England, which further exacerbated health inequality for PWUD and the general population, because of a lower availability and accessibility of drug treatments [74, 75], accompanied by a limited workforce and capacity to provide adequate care in the services [74]. The attitude that perceives drug use as morally wrong has led to an enforcement-heavy drug policy in most countries, e.g., forced labour camp in China and imprisonment in Singapore for drug consumption. Yet, law enforcement has not only led to a significant proportion of expenditures being devoted to drug-related offenses in the criminal justice system [76, 77], but also has been demonstrated to be uncorrelated to drug use prevalence [78, 79], and may have unintentionally caused more harms to people who use drugs (PWUD) [73].

The recognition of ineffective enforcement policies has led to an increasing discussion, advocating that decision making in drug policy should be informed by research evidence concerning interventions that are most likely to reduce harm and improve health, social, and economic outcomes for individuals who use drugs, for their families, and for the broader community [80, 81].

Economic evaluation is a valuable tool to evaluate specific policy choices or major public investments, providing critical information on value for money to assist decision makers in resource allocation and priority setting. A full economic evaluation compares costs and outcomes of more than two alternative policies or interventions with results often presented as incremental cost-effectiveness ratios (ICERs) or cost per QALYs (quality-adjusted life years) [82]. Economic evaluations have been applied to appraise healthcare programmes, typically using one of the three most common frameworks: cost-effectiveness analysis (CEA), cost-benefit analysis (CBA), or cost-utility analysis (CUA) [82-84]. The 'Perspective' is an important concept in economic evaluation, which represents the view taken in the analysis, indicating which type of cost and outcomes should be included in the evaluation. For example, in the evaluation of medical technologies or interventions within a health care setting, the perspective of evaluation is usually the health care payer (who is the decision maker), thus it is generally considered to be straightforward to measure healthcare inputs (costs) and patient-centred outcomes at the time period of treatment [82].

Economic evaluation is not sufficient on its own to inform drug policies. Evaluating public health interventions/policies have been perceived as intrinsically challenging due to more stakeholder perspectives of relevance in economic evaluation, such as National Healthcare Service (NHS), personal social services, local government, or the general public. For example, health consequences of illicit drug use could be linked to the development of dependence, mental health disorders, blood borne virus, chronic diseases, overdoses, and premature deaths [16, 85, 86], as well as those non-health consequences alongside drug use situations, e.g., loss of productivity, homelessness, which can also impact on health [86]. These consequences accordingly result in considerable expenditure for PWUD, their families, the community, the healthcare system, and the rest of society [85-87]. Given the complexity, there is a wide debate whether to adopt a broader perspective (i.e. societal perspective) as the more appropriate approach, that measures all costs and consequence of given policies, emphasizing the maximization of social welfare [88, 89]. Cost-consequence analysis (CCA) is particularly useful in this context because it allows decision makers to consider a wide range of costs and outcomes that matter to multisectoral stakeholders [82-84]. This is especially valuable in public health, where interventions often generate multiple and interdependent outcomes that extend beyond the healthcare sector. Furthermore, such debate also highlights the need for broader forms of economic evidence (e.g., social return on investment, multi-criteria decision analysis, etc) that go beyond the traditional economic evaluation frameworks, which can provide policymakers with a comprehensive picture of the wider societal value of public health interventions/policies.

Despite growing interest in evidence-based drug policy, there remains a significant lack of studies that systematically review how drug policies have been informed by health economics research. Given the research gap, this systematic review is undertaken to uncover how economic evidence has contributed to drug policy worldwide, understand what methods (if any) have been used to inform policy questions, and then critically evaluate their usefulness in evaluating drug policy options. Thus, providing evidence-based information to inform the utilisation of economic methods in assisting drug policy decision-making in the future. The specific research questions are:

I. What drug policies have been evaluated across different jurisdictions; and what has economic evidence shown among those settings?
II. What methodologies have been used to evaluate these drug policies; and what are the opportunities/challenges of adopting different methodologies to assist drug policy making?

2.2 Methods

2.2.1 Search strategy

A literature search was conducted in 6 electronic databases: MEDLINE (Ovid), Cochrane Library, PsycINFO (Ovid), Web of Science (Core Collection), CINAHL, and EconLit. The searches covered all published work up to March 2023 without limited publication date and language. A combination of medical subject headings (MeSH) and keyword search terms were used to capture papers on people who use illicit drugs and government-level drug policy; then combined with economic terms which were adapted from the Scottish Intercollegiate Guidelines Network (SIGN) economic filter [90]. The search terms were developed in consultation with the University of Glasgow librarians. The full details of the search terms are provided in *Appendix 2.1*. In addition to the initial search, backwards citation searching was conducted to identify additional relevant studies from the reference list of included papers[91].

The grey literature was searched on Google, and targeted searches of relevant government and organization websites, including Canadian, Australian, and Scottish government websites, the European Monitoring Centre for Drugs and Drug Addiction, and Uniting (uniting.org). Searches were conducted in March 2023 without date limitation. For Google, combinations of key terms related to drug use and government-level policies were used (i.e., [substance abuse OR intravenous OR illicit drugs OR heroin OR cannabis OR illicit opioids OR substance-related disorders OR drug policy OR drug reform] AND [economic model OR economic analysis OR economic evaluation OR cost analysis]). Website searches were conducted using internal search functions where available and results were screened in order of relevance.

All references were imported into the reference manger tool EndNote X9™ to remove duplication, and Rayyan Review platform [92] was used to screen titles, abstracts and full-text.

2.2.2 Study selection

The population of interest was defined as people who use illicit drugs. Individuals who use/misuse prescription drugs (e.g., prescribed cannabis) to relieve symptoms or other substance use (i.e. alcohol and tobacco) were excluded. The drug policy of interest was referred to a course of action planned by the Government and delivered at national level. It could be either the legal framework or a healthcare strategy (as detailed in **Table 1**). The exclusions included interventions provided by private sectors (i.e. commercial addictive treatment), or community-level counselling services offered to address substance misuse, and studies evaluating treatments for general substance use that did not report treatment effects separately for illicit drug use. Three broad types of economic methodologies were considered, including full economic evaluation (e.g., CBA, CEA, CUA), partial economic evaluation (e.g., cost analysis), and other economic methodologies to assist decision making (e.g., social return on investment, multi-criteria decision analysis). Review articles and protocols for planned economic evaluations of government-level policy were excluded as not relevant to the full analysis, however if they were identified they were kept aside and included in summary of this systematic review. The full list of inclusion and exclusion criteria are detailed in **Table 2**.

All retrieved articles were screened by title, abstract, and full-text by multiple reviewers. Four reviewers (YD, KS, KM, and KB) independently screened the same 10% (*N*=338) of retrieved articles with title and abstract to test the robustness of inclusion and exclusion criteria. All disagreements were resolved by discussion between four reviewers, and no further changes were made to inclusion and exclusion criteria. After that, another two reviewers (HK and SP) independently screened the remaining 90% (*N*=3,046) of the articles with title and abstract, and conflicts were resolved by discussion between three reviewers (YD, HK, and SP). At the full-text screening phase,

two reviewers (YD and KB) individually screened 100% of the papers (*N*=110), with further discussion to resolve the disagreement on four papers (3.6%). The Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines was followed for this study [93].

2.2.3 Data extraction

The data extraction form was constructed in Microsoft Excel™ (Microsoft Corporation, Redmond, WA, USA) to capture data relating to study characteristics, economic parameters of interest and results by following the Consolidated Health Economics Reporting Standards 2022 (CHEERS 2022) [94]. All information relevant to the research questions were extracted from eligible studies by one reviewer (YD) into the spreadsheet, and independently checked by another reviewer (KB). The tables contained the information on the study settings, policy and comparators, evaluation method, economic components e.g., perspective, cost types, health outcome, and if a model was used then specifics of the model (e.g., model structure, time horizon), and economic results reported (e.g., ICER, net benefits, total costs); as well as the summary of the study results, including key findings and the results of sensitivity analyses (if available).

Retrieved papers were categorised as full economic evaluations if they were comparative analysis of alternative courses of action in terms of both cost (resource use) and consequences (outcomes or effects), or partial economic evaluation that measured intervention or disease costs but did not involve a comparison of alternatives [82]. Otherwise, they were categorised as non-economic evaluation studies that supported economic analysis of drug policy, for example, social return on investment, multi-criteria decision analysis, contingent valuation, discrete choice experiment [83].

Table 2. Inclusion and exclusion criteria

	Inclusion criteria	**Exclusion criteria**
Population	People who use illicit drugs.	People who abuse/misuse prescription drugs or alcohol or tobacco.
Intervention	1. Government-level policy (referring to a course of action planned by or considered relevant to the government/jurisdiction) includes a legal framework, harm reduction programme, and recovery treatment targeting illicit drug use. 2. Integrated care packages, e.g., drug intervention combined with psychological therapy. 3. Intervention pathway/referral, e.g., prison diversion programme. 4. Comparison of different service delivery models, e.g., oral vs. injectable methadone maintenance treatment. 5. Prevention for relapse.	1. Non-government policy, or healthcare policy planned by local authorities (referring to public bodies that are responsible for the delivery of local services, e.g., housing, social care). 2. Intervention provided by private sector, e.g., commercial service. 3. Treatments targeting multiple groups of population with multiple types of substance use that did not report treatment effects separately for illicit drug use.
Study type	1. Full economic evaluation 1) cost-benefit analysis (CBA) 2) cost-utility analysis (CUA) 3) cost-effectiveness analysis (CEA) 4) cost-minimisation analysis (CMA) 2. Partial economic evaluation: 1) cost comparison/cost analysis 2) cost outcome description 3) cost description 4) cost of illness study 3. Other methodologies assist economic analysis 1) social return on investment (SROI) 2) return on investment (ROI) 3) social impact assessment (SIA) 4) health impact assessment (HIA) 5) multi-criteria decision analysis (MCDA) 6) discrete choice experiment (DCE)	Study design not listed in the inclusion criteria.
Publication type	Research article; grey literature: government reports, white papers, thesis.	Conference abstract, study protocol, expert opinions/comments, book chapter, review.

2.2.4 Quality assessment

The 24-item Criteria for Health Economic Quality Evaluation (CHEQUE) tool [95] was used to conduct quality appraisal for included studies (full criteria see *Appendix 2.2*).

CHEQUE is a novel assessment tool published in Value in Health in 2023, which is developed as a scoring system to appraise methods and reporting quality of cost-effectiveness analysis separately. The authors of CHEQUE designed a best-worst scaling survey to estimate relative importance attributes for the quality assessment tool based on researchers' and practitioners' preferences [95]. The final tool contained 24 attributes considered most important for assessing quality of methods and 24 attributes considered most important for assessing quality of reporting. The final score of each attribute for evaluated articles was equal to '*rounded importance score*' times '*scoring weight assessment*'. The higher the 24-item scores indicated more complete items in the article, and thus, a higher quality. In evidence reviews for economic analyses, the CHEERS checklist has typically been used as a reporting guideline for economic evaluations, but as there is no formal 'quality assessment' tool it is often incorporated into the systematic reviews for quality appraisal [94]. Yet, it does not serve as a scoring tool, and a critique is that authors have tried to assign their own points or grading system to the CHEERS in an untested manner. The newly available and validate CHEQUE tool offers a new option for quality appraisal of economic analyses and was therefore adopted in the current study for quality assessment.

2.3 Results

2.3.1 PRISMA

The search yielded a total of 4,166 results from 6 electronic databases. Subsequent searches in grey literature through government and organisation websites resulted in an additional 16 results. Of the 4,182 articles screened after deduplication and excluding those that were ineligible, 110 were screened for full text, and the remaining 40 articles met inclusion criteria. A further 23 eligible articles were retrieved from backward citations, resulting in a total of 63 included articles in this review. Reasons of those excluded from final analysis were described in the PRISMA flow chart in **Figure 2**.

The identification of 23 additional articles through backward citation searching is a reflection of the challenging nature of reviewing policy-related research. Evidence regarding government-level policy is frequently published through technical government reports, white papers, and is often not indexed in academic databases. Also, intervention or policy names may be inconsistent across jurisdictions, and there is a risk that very recent or non-indexed local government reports could be missed and may not be captured through keyword-based database searches alone. The high yield from backward citation indicates the limitation of academic database searching for policy-focused evidence and the importance of backward citation searching for ensuring a compressive review.

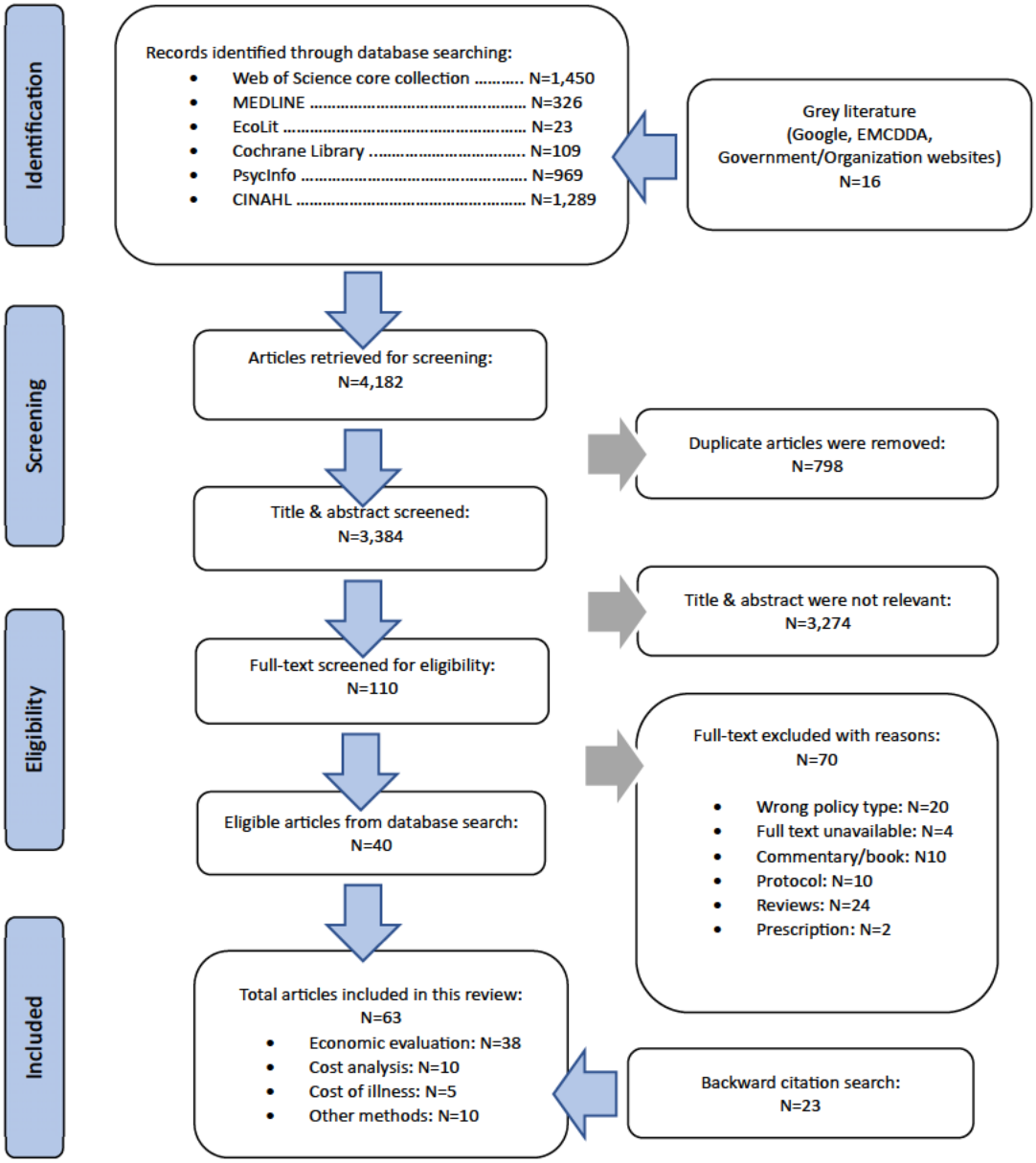


Figure 2. *PRISMA flowchart*

2.3.2 Quality assessment

The CHEQUE tool is specifically designed for full economic evaluations that compare both the costs and outcomes of two or more alternatives. Applying CHEQUE to costing studies or preference elicitation studies would bias the assessment score – as many of the criteria would be non-applicable, e.g., e.g., lacking clinical outcomes or comparative component that defines the CHEQUE criteria. Therefore, the CHEQUE was only used on the 38 full economic evaluations, as it is methodologically inappropriate tool to assess the remaining 35 non-economic evaluation studies.

The CHEQUE tool consists of 14 quality domains with varied rounded importance scores under each domain (see **Table 3**). Each domain is broken down into specific attributes (24 items in total, labelled M1-M24, where M denotes 'Method'), with the total scoring across domains summing to 100. For example, under the domain of *'Decision problem and scope'* (rounded importance score, RIS:11), two attributes are assessed – whether the analysis answers an important question for decision making, and whether the study objective (decision problem) is measurable. Further information on the remaining domains and attributes is provided in *Appendix 2.2*.

The total score of each article was the sum of each criterion (i.e. M1 to M24) by multiplying *'rounded importance score'* and its *'scoring weight'*. The *'scoring weight'* was given based on reviewer's judgement that whether each criterion was fulfilled in the article. As shown in **Table 3**, responses of *'yes'* to the criterion received a full score of 1.0 (highlighted in green), *'somewhat'* received 0.5 (highlighted in yellow), and *'no'* received 0.0 (highlighted in red). If a criterion was deemed not applicable (*N/A*), full credit was still awarded with a score of 1.0 (highlighted in blue) because research methods can vary regarding to study scope, perspective, or data availability, which do not indicate poor quality. The CHEQUE does not provide a threshold separating high- from low-quality cost-effectiveness evidence, so that in this review, a higher score indicates a greater adherence to key components of a high-quality study.

As shown in **Table 3**, the methodological quality of the 38 economic evaluation studies, assessed using the CHEQUE tool [95], was generally of high quality, with all studies scoring over 80 out of 100. Thirteen studies (34.2%) did not encompass all populations that were affected by the intervention – e.g., the general public lives near the safer drug consumption facilities could be potential impact by the facility implementation. Twenty studies (52.6%) failed to measure health outcomes using generic health metrics such as QALYs or DALYs, and instead measured them in natural clinical events (e.g., HIV cases averted). Twenty-seven studies (71.0%) adopted a short time horizon, mostly restricted to 1 year that were conducted alongside the clinical trials, and some did not incorporate modelling techniques to project long-term outcomes (36.8%). In modelling-based studies, only six studies (15.8%) validated their models, including assessments of model structure and underlying assumptions. Furthermore, over half of studies did not conduct probabilistic sensitivity analysis to account for uncertainty in input parameters (57.9%) and additional sensitivity analysis (e.g., scenario analysis) to explore alternative modelling choices or structural uncertainty (63.1%). Considerations of equity and distributional impacts were overlooked in the majority of studies (73.7%). Out of the 38 studies reviewed, 66% encompassed the population directly affected by the evaluated intervention (M5) and 75% reported some form of model validation (M13). Less than half of studies incorporated some elements: only 26% measured health outcomes in health metrics (M6), 29% adopted a long-time horizon (M7), 42% conducted probabilistic sensitivity analysis (M22), 37% conducted scenarios analysis for examining alternative modelling choices and assumptions (M23), and just 22% considered equality implications (M24).

Table 3. CHEQUE tool: methods quality of 38 economic evaluations

Domian	Attribute	Rounded importance score	Reference 111	112	113	114	115	116	117	118	119	120	121	122	123	124	125	126	127	128	130	131	132	133	134	135	136	137	138	139	140	141	142	143	144	145	146	147	148	149	Total
Decision problem and scope	M1	5	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	100%
	M2	6	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	100%
Intervention and comparator(s)	M3	4	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	100%
Perspective	M4	4	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	100%
Population	M5	1	1.0	1.0	1.0	1.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	66%
Outcome measures	M6	3	0.0	0.0	0.0	0.0	0.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	1.0	0.0	0.0	0.0	0.0	1.0	1.0	1.0	0.0	1.0	0.0	1.0	1.0	1.0	0.0	0.0	0.0	0.0	0.0	26%
Time horizon	M7	4	0.0	0.0	0.0	0.0	1.0	0.0	1.0	0.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	1.0	0.0	0.0	0.0	0.0	1.0	1.0	1.0	1.0	1.0	0.0	0.0	0.0	1.0	0.0	0.0	0.0	0.0	0.0	29%
Discounting	M8	2	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	100%
Modeling	M9	6	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	100%
	M10	8	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	100%
	M11	5	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	100%
	M12	3	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	100%
	M13	8	1.0	1.0	1.0	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	1.0	1.0	0.5	1.0	1.0	1.0	1.0	0.5	0.5	1.0	1.0	1.0	0.5	0.5	0.5	0.5	0.5	0.5	0.5	1.0	1.0	0.5	1.0	1.0	1.0	1.0	1.0	75%
Data inputs and evidence synthesis	M14	6	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	100%
	M15	5	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	100%
	M16	6	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	100%
Consequences	M17	5	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	100%
Utilities (preference measures)	M18	2	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	100%
Costs and resource use	M19	2	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	100%
Analysis	M20	4	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	100%
	M21	3	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	100%
	M22	3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	0.0	1.0	0.0	0.0	1.0	0.0	0.0	1.0	1.0	0.0	0.0	1.0	1.0	0.0	0.0	1.0	1.0	1.0	0.0	0.0	1.0	1.0	1.0	1.0	0.0	0.0	0.0	1.0	1.0	42%
	M23	4	0.0	0.0	0.0	0.0	0.0	0.0	1.0	1.0	1.0	0.0	0.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	0.0	1.0	0.0	0.0	1.0	1.0	1.0	0.0	1.0	1.0	0.0	1.0	1.0	0.0	0.0	0.0	0.0	0.0	1.0	37%
Equity considerations	M24	1	0.0	1.0	0.0	0.0	1.0	1.0	0.0	0.0	0.0	1.0	0.0	1.0	1.0	0.0	0.0	0.0	0.0	0.0	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.0	0.5	0.0	0.0	1.0	22%
Total		**100**	**85.0**	**86.0**	**85.0**	**81.0**	**86.0**	**84.0**	**88.0**	**84.0**	**91.0**	**81.0**	**83.0**	**89.0**	**85.0**	**83.0**	**84.0**	**84.0**	**87.0**	**87.0**	**92.5**	**88.0**	**92.0**	**88.0**	**85.0**	**85.0**	**95.0**	**95.0**	**91.0**	**89.0**	**92.0**	**84.0**	**95.0**	**95.0**	**91.5**	**85.0**	**85.5**	**85.0**	**88.0**	**93.0**	

CHEQUE indicates Criteria for Health Economic Qality Evaluation; DALY, disability-adjusted life-year; ICER, incremental cost-effectiveness ratio; N/A, not applicable; QALY,qality-adjusted life-year.

*Scoring weight: "yes"=1.0; "somewhat"=0.5;"no"=0.0. For "N/A", give full credit (weight=1.0).

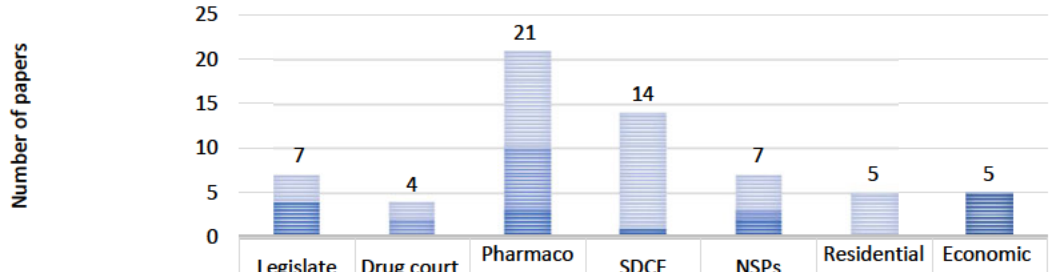
2.3.3 Narrative description

There is a variation in the number of publications across the included time period of 1997 to 2022, with a maximum of five in 2012 and 2018. As shown in **Table 4,** studies from the United States made up a large proportion of published papers (*N*=26, 41.3%), followed by studies from Canada (*N*=13, 20.5%), Australia (*N*=11, 17.5%), the United Kingdom (*N*=3, 4.7%).

Table 4. Number of papers by jurisdiction

	N	Percentage
United States	26	41.3%
Canada	13	20.5%
Australia	11	17.5%
United Kingdom	3	4.7%
Netherland	1	1.6%
New Zealand	2	3.2%
Spain	1	1.6%
Lithuania	1	1.6%
Mexico	1	1.6%
Taiwan	1	1.6%
Iran	1	1.6%
Indonesia	1	1.6%
Western Europe & North-America	1	1.6%
Total	***63***	***100%***

The categorization of drug policies and methodologies are presented in **Figure 3**. Most studies examined pharmacotherapy for illicit drug use (*N*=21, 33.3%), nearly a quarter of studies were related to supervised drug consumption facility (SDCF) (*N*=14, 22.2%), and few studies related to legislation (*N*=7, 11.1%) and drug court programmes (*N*=4, 6.3%). In respect to methodologies, the majority of studies adopted a full economic evaluation (*N*=38, 60.3%), the remaining studies were cost analysis (*N*=9, 14.3%), or used other applied economic methodologies (e.g., MCDA, *N*=10, 15.8%). Five (7.9%) cost-of-illness studies estimated the economic burden of illicit drug use to society. Moreover, the majority of the full economic evaluations were conducted evaluating pharmacotherapy (*N*=11, 28.9%), few studies focused on drug court programmes (*N*=2, 5.3%). Cost analysis was not found on the topics of legislation, SDCF, and residential rehabilitation.



	Legislate	Drug court	Pharmaco therapy	SDCF	NSPs	Residential rehab	Economic burden
Economic evaluation	3	2	11	13	4	5	N/A
Cost analysis	0	2	7	0	1	0	N/A
Other methodology	4	0	3	1	2	0	N/A
Cost of illness	N/A	N/A	N/A	N/A	N/A	N/A	5

SDCF = Supervised Drug Consumption Facilities; NSPs = Needle and syringe programmes.
N/A = not applicable.

Figure 3. *Number of papers by drug policy and methodology*

In the following sections, each study is presented and compared in different categories. First, the cost-of-illness is summarised in section 2.3.4, then cost analysis in section 2.3.5 and cost-effectiveness in section 2.3.6, followed by a summary of multi-criteria decision analysis in section 2.3.7 and contingent valuation in section 2.3.8.

2.3.4 Cost-of-illness from illicit drug use

Five cost-of-illness (COI) studies were included in this review, as summarised in **Table 5** [96-100]. They were published between 1998 and 2017, and were all conducted in high-income countries: Canada [96, 97], Australia [98, 99], and Spain [100]. Of the 5 COI studies, four considered the cost of productivity losses [96-98, 100], and one estimated the intangible costs for pain and suffering, and the personal resource used related to drug consumption [98]. All studies estimated costs that occurred to society, healthcare and the criminal justice systems, but the cost components under each category were varied.

In Canada, it was estimated that the social cost of all types of illicit drug use was $489.3 million (1992 $CAN) in 1992 [96]. Results showed the largest cost component was the costs of productivity losses ($292.4m, 59.8%), followed by enforcement-related costs ($133.9m, 27.4%) and healthcare costs ($39.2m, 8.0%). Another study in Canada investigated the social costs for opioid dependence only and calculated it at $5.1 million (1996 $CAN), which was explained mostly by enforcement-related costs ($4.4m, 87%), followed by productivity losses ($0.3m, 7.0%) and healthcare costs ($0.3m, 6.1%) [97]. The contrasting cost components between two studies may reflect differences in the substances considered – while illicit drug use in general was associated with substantial productivity losses, opioid-related harms may disproportionately engage the criminal justice system, driving up enforcement-related costs. Alternatively, these discrepancies could also arise from methodological choices, such as differences in scope, definitions, or valuation approaches, which highlights the importance of study design when comparing them within Canadian settings.

In Australia, similar results were found in two studies [98, 99]. In 1998-9, the total social cost of illicit drug use was $6075.8 million (1998 AUD), with the largest proportion occurring in enforcement-related costs ($2,500.4m, 41.2%) and followed by the cost of productivity losses ($1,336m, 22.0%) and healthcare costs ($59.2m, 1.0%) [98]. In 2002-03, the expenditure that Australian government spent on illicit drug policy was estimated to be $3.2 billion (2002 AUD), with the largest expenditure on law enforcement ($740.4m, 55%), and a minority of expenditure associated with treatment and harm reduction ($274.0m, 20%) [99]. The cost of incarcerating 2,200 illicit drug offenders was estimated $156 million, which was four times of the cost spent on 30,000 pharmacotherapy patients ($39 million) in 2002-03 [99].

In Spain, the estimated total social cost related to illicit drug use was €1,436-1,651 million (2012 EUR) in 2012, with a major expenditure on healthcare services (€687-901m) that consisted of the greatest cost in outpatient treatment for HIV/AIDS, followed by criminal justice system (€357m) and productivity losses due to hospitalisation and premature deaths (€230m) [100]. The value for the total cost of illegal drug use represented 0.14-0.16% of Spain's GDP in 2012; and the minimum value for healthcare costs related to drugs accounted for 1.1% of spending in the Spanish National Health System [100].

The variability was mainly caused by differences in the studied drug types, data availability to carry out the calculation, approaches to calculate these costs, and the different ways in which the healthcare system and social structure were organized across jurisdictions. Although these factors prevent direct comparison of estimates, a key pattern emerges that, in Canada and USA, law enforcement expenditure and costs of productivity losses accounted for the greatest share of economic burden in the early 1990s [96-99], whereas in Spain the distribution was more balanced in 2017 [100]. Such differences in cost distribution may underline the consequences of policy choices. During the 1990s, enforcement-led approaches drove high spending on criminal activities, and productivity losses related to incarceration. In contrast, Spain was one of the first countries in Europe to decriminalise drug use, and the adoption of a public health-oriented drug policy from the late 1980s shifted resources toward drug treatment and harm reduction, reducing the relative weight of enforcement in its cost profile [101].

Table 5. Cost-of-illness study (N=5)

Reference	Location	Type of drugs	Approach	Cost components						Time horizon	Discount rate	Result	%GDP
				Healthcare	Society	Criminal justice	Lost productivity	Intangible	Others				
Xie X. *et al.* 1998 **[96]**	Ontario CAN	All illicit drugs	Prevalence; Human capital	1. Hospital care 2. Ambulance service 3. Residential care 4. Non-residential care 5. Assessment/referral 6. Physician service 7. Prescriptions 8. Home care	1. Employee assistance programme 2. Administrative costs for transfer payments 3. Research, prevention, and training 4. Road accident	1. Police 2. Court 3. Adult correction services 4. Youth correction services	1. Morbidity 2. Mortality	-	-	1 year	6.0%	$489.29 million (1992 CAN$)	0.24%
Wall R. *et al.* 2000 **[97]**	Ontario CAN	Opiates	Prevalence; Bottom-up	1. Inpatient care 2. Emergency care 3. Outpatient care 4. Substance abuse treatment 5. general healthcare	1. Crime victimization	1. Police arrests 2. Court charges 3. Corrections	1. Paid work 2. Volunteer activity	-	-	1 year	3.0%	CAN$5.086 million (1996 CAN$)	0.20%
Collins DJ. & Lapsley HM. 2002 **[98]**	AUS	All illicit drugs	Incidence; Human capital	1. Medical care 2. Hospital care 3. Nursing homes 4. Pharmacotherapy 5. Ambulance	1. Road accidents	1. Police 2. Court 3. Prison 4. Property	1. Labour in workplace 2. Labour in household	1. Loss of life 2. Pain and suffering (road accidents)	personal resource used in abuse	1 year	2.2%	$6,075.8 million (1998 AU$)	1.04%
Moore TJ. 2008 **[99]**	AUS	All illicit drugs	Prevalence; Top-down	1.Drug treatment 2.Drug diversion 3.Pharmaceutical 4.Harm reduction	1. Social security and welfare 2. Road accident 3. Prevention (education)	1. Trafficking and border protection 2. Judicial resources 3. Legal expenses 4. Corrective services 5.Compensation and victim services	-	-	-	1 year	-	$3.2 billion (2002 AU$)	0.41%
Rivera B. *et al.* 2017 **[100]**	Spain	Cannabis Cocaine Heroin	Prevalence; Human capital	1. Hospitalisation 2. Primary & emergency care 3. HIV/AIDS care 4. Support programmes 5. Pharmacy costs 6. General state administration	1. Prevention (education)	1. Justice and penal	1. Premature deaths & inpatient stays	-	-	1 year	3%	€1,436-1,651 million (2012 EU€)	0.14% - 0.16%

2.3.5 Cost of drug policies

A total of 10 cost studies were reviewed in this section, as summarised in **Table 6** and **Table 7** [102-111]. The publication year ranged from 2009 to 2021. The US-based studies made up a large proportion (*N*=8, 80.0%), and the rest of studies were from Canada (*N*=1, 10%) and Mexico (*N*=1, 10%). Most of the studies were related to methadone or buprenorphine (*N*=6, 60%), followed by needle and syringe programmes (NSPs, *N*=1, 10%), juvenile drug courts (JDCs, *N*=1, 10%), and Medicaid insurance for people who use opioid in the US (*N*=1, 10%).

The costs in the included studies were assessed as claims [102, 103, 109], charges [104-106], or payments and reimbursement [107, 108, 110]. Most cost estimates were reported at a 1-year time horizon [102-104, 106, 107, 109, 110], while two were taken over longer time periods of 6 years and 15 years respectively [105, 108]. Over half of the studies included a comparison group to assess incremental costs between different treatment regimens [102-104, 109] and service providers [103, 106]. Cost components varied greatly between studies in which different estimation approaches were applied. The major cost components were healthcare cost related to medication, staffing, and infrastructure, and other costs that consisted of intangible costs (e.g., patient's time) [102, 103, 109, 110], transportation [102, 103], and childcare costs [102, 103]. The methodological differences between studies make it difficult to draw a general conclusion on whether certain treatment was costly or not, so the individual studies are briefly summarized and presented in the following subsections.

2.3.5.1 Methadone or buprenorphine

Six studies conducted cost analysis for methadone maintenance treatment (MMT) [102-107], four from the US [102-104, 107] and two from Cananda [105] and Mexico [106] (**Table 6**). Variation was observed between studies. First, the perspectives taken on who pays for treatment were different, i.e. from government [104, 105], patient [102, 103], public and private service providers [103, 106], and criminal justice system [107]. Second, evaluated implementation strategies differed, including inpatient and outpatient MMT [102], clinic-based or office-based MMT, office-based buprenorphine [103], and jail-based MMT [107], which have led to variations in identifying the cost components. For example, in the US, where a private healthcare system dominated, two studies undertook a patient perspective in which the intangible cost (i.e. patient's time) and non-healthcare costs (i.e. transportation costs and childcare expenses) were estimated [102, 103]. Similarly, one study compared the treatment costs between private and public healthcare perspectives in Mexico [106].

The costs of methadone or buprenorphine were greatly varied and not comparable across the studies, with the cost ranging from $19.2 (2005 USD) per patient per visit to $8,624 (2010 USD) per patient per episode in the US [104]. In the jail setting, the lowest cost was found that calculated at $689 per patient per episode (2011 USD) in Mexico [107]. Furthermore, the inpatient treatments were more expensive than the outpatient treatments [102-104] as more resources were used to provide hospitalisation. In addition, the treatments were more expensive from a patient perspective than the provider perspective while including intangible costs and indirect costs (e.g., transportation), no matter if delivered in a clinic ($293.6 vs. $147.4 per patient per month, 2006 USD) or in a physician's office ($274.8 vs. $220.0) [103]. Interestingly, treatments provided in the public sector were more expensive than in private service ($179 vs. $95 per patient per month, 2017 USD) in Mexico, which might be explained by the exclusion of intangible costs and indirect costs in the study [106].

Treatment costs varied greatly not only depending on the research context, perspectives, implementation strategies, but also the methods to estimate costs. The majority of studies (*N*=4) adopted a bottom-up estimation approach (that overall cost of treatment was calculated from individual level) using the data collection instruments – Drug Abuse Treatment Cost Analysis Program (DATCAP) [102, 104, 107], Addiction Severity Index (ASI) [103], and Treatment Service

Review (TSR) [103]. These instruments have been used by researchers to collect information for the treatment of problematic substance use. The DATCAP was designed to be used to collect resource use of a treatment programme [112]; ASI was designed to assess patients' needs for the treatment programme [113]; and TSR was used to assess the service provision to patients [114].

2.3.5.2 Needle and syringe programmes

One study evaluated 2 service delivery models of needle and syringe programmes (NSPs) in Florida, the US [109] (**Table 6**). It estimated treatment cost from a societal perspective where the intangible cost (i.e. volunteers' time working in the service), and indirect costs related to patients' transportation time, were included [109]. The result indicated that, over a year, the mobile NSPs were more expensive than fixed NSPs ($2415.7 vs. $729.7 per patient per year, 2017 USD), due to the largest proportion of the cost for a mobile NSP (62.1%) spent on purchasing and renovating the vehicle, in comparison to one integrated to an existing service ($25,707.4 vs. $17,018.9, 2017 USD).

2.3.5.3 Medicaid insurance

One study examined the cost of Medicaid insurance associated with opioid use disorder in the US [108]. Medicaid was signed into law in 1965 as a joint federal and state public health insurance programme that provides healthcare coverage to low-income individuals (that included people who access to substance abuse treatments) [115]. The included healthcare cost types were inpatient service, outpatient service, prescription medication, and cost of other healthcare services provided to patients (**Table 6**). The result showed that the total cost associated with opioid use disorder was $72.3 billion (2017 USD) over a 15-year time period, and most of the expenditures were related to non-opioid use disorder treatment costs for patients (e.g., wound care, A&E visits).

2.3.5.4 Other treatment services

One study compared the costs of 7 public funded treatments in Florida, the US, including outpatient and residential (for adult and adolescent separately), intensive outpatient, detoxification, and MMT [104]. Healthcare cost was the only cost component considered in the study (**Table 6**). Results showed that the adult outpatient programmes have the highest average episode cost per patient at $27,359 (2010 USD), and detoxification was the cheapest treatment at $2,303. The average time of stay in adult outpatient (49.1 weeks) was much higher than in detoxification (1.1 week).

2.3.5.5 Drug Courts and diversion programme

One study was conducted alongside a randomised trial to estimate the costs of juvenile drug court (JDCs) in the US [110] (**Table 7**). JDCs were initiated as the combination of intensive judicial leverage with substance use treatment that aimed to reduce substance use and criminal activity. The cost of preventing adolescents' criminal activity was broadly covered by expenditures to the healthcare system (costs of treatments), society (costs to victims), the criminal justice system, as well as indirect costs related to lost productivity and intangible costs (victims' pain and suffering). The total cost of JDCs over a 1-year time horizon was estimated to be $54,099 (2004 USD). This study indicated that reducing criminal activity was the largest contributor to the total economic benefit of JDCs compared to standard care.

One study evaluated the economic impact of California's Proposition 36 policy, which diverted nonviolent drug offenders from incarceration to substance use treatment [111] (**Table 7**). The study was conducted using state-level administrative data and a difference-in-difference analysis, and it showed that the policy resulted in a net government savings of approximately $2,317 (2009 USD) per offender over 30 months, mainly due to reduced incarceration costs. Overall, the policy was shown to be cost saving alternative to incarceration.

Table 6. Cost analysis of pharmacotherapies (N=8)

Reference	Location	Policy	Approach	Perspective	Cost components						Time horizon	Discount rate	Results
					Healthcare	Society	Criminal justice	Lost productivity	Intangible	Others			
McCollister KE. *et al.* 2009 **[102]**	Ohio USA	MMT	Bottom up (DACAP) alongside an RCT	Patient	1. Treatments costs 2. Physical exams 3. Treatment-related materials	-	-	-	1. Patient's time	1. Transportation 2. Childcare costs	1 year	-	$19.2[a] (2005 US$) $37.8[b] $235.0[c]
Jones ES. *et al.* 2009 **[103]**	USA	MMT	Bottom up (ASI&TSR) alongside clinical trials	Public& Private vs. Patient	1. Physician time 2. Nurse time 3. Counsellor time 4. Overhead 5. Adjustment for missed visits 6. Medication 7. Laboratory	-	-	-	1. Patient's time	1. Transportation 2. Childcare costs	1 year	-	**Provider:** $147.4[e] (2006 US$) $220.0[f] $336.3[g] **Patient:** $239.6[e] $274.8[f] $378.2[g]
Alexandre PK. *et al.* 2012 **[104]**	Florida USA	MMT	Bottom up (DACAP) Admi records	Gov.	1. Treatments costs 2. Physical exams 3. Treatment-related materials	-	-	-	-	-	1 year	-	$27,359[h] (2010 US$) $18,427[i] $8,784[j] $24,328[k] $2,303[m] $23,776[n] $8,624[p]
Zaric GS. *et al.* 2012 **[105]**	Ontario CAN	MMT	Top down Admi records	Gov.	1. Physician billing 2. Urine samples 3. Methadone 4. Pharmacy	-	-	-	-	-	6 years	3%	*$2,004 (2010 CA$)
Burgos JL. *et al.* 2018 **[106]**	Tijuana Mexico	MMT or buprenorphine	Top down Admi records	Private vs. Public	1. Capital costs 2. Personnel costs 3. Medicine costs 4. Other health service costs	-	-	-	-	-	1 year	-	**$95.0 (2017 US$) vs. $179.0

MMT : Methadone maintenance treatment; OST: Opioid substitution therapy
n/c: not clear
[a] Outpatient MMT, [b] Intensive outpatient MMT, [C] Inpatient MMT. US$ per patient per visit.
[e] Clinic-based MMT (MC), [f] Office-based MMT (MO), [g] Office-based buprenorphine (BO). US$ per patient per month.
[h] Adult outpatient, [i] Adult residential, [j] Adolescent outpatient, [k] Adolescent residential, [m] Detoxification, [n] Intensive outpatient, [p] MMT. US$ per patient for an average treatment episode.
*CAD$ per patient per treatment episode; **US$ per patient per month of OST

Table 6. (Continued.)

Reference	Location	Policy	Approach	Perspective	Cost components						Time horizon	Discount rate	Results
					Healthcare	Society	Criminal justice	Lost productivity	Intangible	Others			
Horn BP. *et al.* 2018 **[107]**	New Mexico USA	MMT (Jail based)	Bottom up (DACAP) Admin records	Criminal Justice system	1. Personnel 2. Supplies & materials 3. Contracted services 4. Buildings & facilities 5. Equipment	-	-	-	-	-	1 year	-	*$689 (2011 US$)
Leslie DL. *et al.* 2019 **[108]**	USA	Medicaid insurance	Top down Modelling with admin data	Government	1. Inpatient service 2. Outpatient service 3. Prescription 4. Other healthcare services	-	-	-	-	-	15 years	3%	$72.4 billion (2017 US$)
Bartholomew TS. *et al.* 2021 **[109]**	Florida USA	SSPs	Bottom up alongside trail	Societal	1. Capital costs 2. Operating costs 3. Personnel costs	-	-	-	1. Volunteers' time	1. Transportation time	1 year	-	$729.7[a] $2415.7[b] (2017 US$)

MMT: Methadone maintenance treatment
SSPs: Syringe service programmes
[a] Fixed site SSPs, [b] Mobile site SSPs. US$ per patient per year.
*US$ per patient per average treatment episode

Table 7. Cost analysis of Drug Court and diversion programme (N=2)

Reference	Location	Policy	Approach	Perspective	Cost components						Time horizon	Discount rate	Results
					Healthcare	Society	Criminal justice	Lost productivity	Intangible	Others			
McCollister KE. *et al*. 2009 **[110]**	Charleston County, USA	Juvenile drug courts	bottom-up; alongside a randomised trial	Societal	1.Treatment costs (integrated into drug court)	1.Victim costs	1.Offences	1.Career losses	1.Costs related to a victim's pain and suffering	-	1 year	-	$54,099 (2004 US$)
Anglin MD. *et al.* 2013 [111]	California, USA	Offender diversion	Bottom-up; routine data	Government	1. Drug treatment 2. General healthcare	-	1. Offences	-	-	-	30 months	-	$2,317 (2009 US$)

2.3.6 Cost effectiveness of drug policies

A total of 38 cost-effective studies were included in this review, as summarised in **Table 8-24**. Evaluated policies were legislative intervention [116-118], Drug Court programmes [119, 120], supervised drug consumption facilities (SDCF) [121-134], pharmacotherapy (methadone or buprenorphine) [135-142], needle and syringe programmes (NSPs) [143-146], heroin-assisted treatment (HAT) [147-149], and residential rehabilitation [150-154].

2.3.6.1 Legislation

Three studies evaluated cannabis policies in Australia during 2014 to 2017, including the legalisation [116] and decriminalisation [117, 118] for cannabis use. One study conducted a CBA [116] and two conducted the CEA [117, 118]. Cannabis legalisation was defined as the permission of possession, consumption, and sale of cannabis by laws, with regulations and restrictions. Cannabis decriminalisation was considered as an alternative to sentencing offenders in the criminal justice system, but giving caution, civil penalty, or warning for minor drug use. The study showed that different cannabis policies were efficient in resource use in Australia (**Table 8** and **Table 9**).

The cannabis legalisation produced a positive net social benefit (NSB) of $234.2 million (2007 AUD) per year; NSB of decriminalisation (status quo) was $294.6 million [116]. The difference between two NSBs was subtle, but legalisation appeared to be costly ($90.7m) and had less benefits ($318.8m) compared to decriminalisation (cost $80.1m; benefit $362.7m). The largest expenditure was personal costs of licensing ($31.1 million), and healthcare costs increased from $6.8m to $10.8m. In sensitivity analysis, minimal changes to NSB were observed when varying the costs of policies, but an increased personal wellbeing (enjoyment from cannabis consumption) and decreased negative impact on educational attainment resulted in a lager NSB. Another two studies evaluated the cost effectiveness of decriminalisation (referred to cautions, civil penalty, warning) compared to arrest (status quo) for minor drug use [117, 118]. They both indicated that the policy of charging offenders in the criminal justice system was more expensive and less effective than caution, civil penalty, and warning [117, 118]. For example, the Australian Government reported that average costs were $122 (2014 AUD) for waring, $264 for civil penalty, $318 for caution, and $1,918 for charge [117].

Study design and evaluation methods were varied across three studies (**Table 9**). A wide range of costs and outcomes were estimated for legalisation and decriminalisation (status quo) from a societal perspective [116]. The costs of policy broadly included the expenditure associated with plant grower, retailer and consumer, restriction or regulation, intangible costs (i.e. lost productivity), as well as costs occurred in the criminal justice and healthcare system. The outcomes of policies were measured as the number of persons with a criminal record, value of enjoyment from cannabis use, impact on educational attainment and subsequent earnings, road accidents (e.g., car crash related to cannabis use), consequence of increased cannabis use and tobacco use. Another two studies created a nationwide online survey to recruit cannabis offenders who received either a charge or a caution in the previous 3-9 months [117, 118]. The analyses compared decriminalisation and arrest (status quo) from a perspective that combined healthcare and criminal justice system. Therefore, the costs of the policy were considered to be the expenditure that occurred within these two systems, without costs related to lost productivity. The policy outcome was measured as the number of days using cannabis pre- and post-policy.

Table 8. Economic Evaluation of cannabis legislation – summary of findings (N=3)

Reference	Year	Location	Policy	Context	Study results	Sensitivity analyses
Shanahan M. & Ritter A. **[116]**	2014	NSW, AUS	cannabis legalisation	The analysis of cannabis legalisation at the forefront of implementation.	1. No substantive difference between the NSB for two policy options: the mean NSB was $294.6m/year for decriminalisation (status quo) and $234.2m/year for the legalisation (excluded potential government revenue). 2. The addition of government revenues resulted in a larger NSB for the legalized-regulated model.	1. The NSB increased when the negative impact of cannabis on educational attainment was halved, or removed completely. 2. The NSB for both the status quo and legalisation became negative when the value of wellbeing gained from cannabis was decreased to 50% or removed completely. 3. Minimal changes to the NSB when varying the costs.
Shanahan M. *et al.* **[117]**	2016	AUS	caution/ expiation/ warning	Gov. report	1. The charge group was more expensive than other 3 diversion programmes (cautions, expiation, and warning), and the diversion programmes were as effective in decreasing cannabis use and the number of illicit drugs used. *Note:* This is a government report that covered the results of reference [118] below.	Not available.
Shanahan M. *et al.* **[118]**	2017	AUS	caution	A major gap in knowledge surrounding the cost-effectiveness of police programmes (cannabis cautioning) for minor drug offences.	1. No evidence showed that receiving a caution led to more cannabis use and is less costly after accounting for any pre-existing differences between the groups, demonstrates that alternatives to arrest can save both time and money. 2. Average costs (net of fines) for the charge group ($733) was more expensive than that of the cautioning group ($388), without any additional benefit in reduced cannabis use in both groups.	Not available.

Table 9. Economic Evaluation of cannabis legislation – summary of methods (N=3)

Reference	Location	Policy vs. comparator	Evaluation method	Economic evaluation							Results*
				Approach	Structure	Perspective	Costs components	Outcome (or Benefit)	Discount rate	Time horizon	ICER or others
Shanahan M. & Ritter A. 2014 **[116]**	NSW, AUS	cannabis legalisation vs. status quo (illegal with diversion programs)	CBA	static	Monte Carlo	societal	(1) criminal justice system: policy, court and court diversion, prosecution/legal aid, corrective services (2) grower: growers permit, legal costs to negotiate contract, complying with NSW workplace laws and agricultural regulations, testing for potency (3) distributor/retailer: infrastructure costs, staffing, transportation (4) consumer: licence/course (5) enforce regulations: police, regulatory body (licensing/standards etc.), contract negotiation, black market, drug driving testing (6) healthcare costs: cannabis treatment, other health consequences (7) prevention programmes (8) personal: fines, legal defence costs, parents' lost productivity	(1) number of persons with criminal record & stigma from criminal record (2) value of the enjoyment from cannabis use (3) impact on educational attainment and subsequent earnings (4) accidents/injuries to 3rd parties (5) consequence of increased cannabis use (6) increased use of tobacco (7) attitudinal changes: cannabis use becomes more acceptable – use increases	0%	1 year	mean NSB: status quo: $294.6 millions legalisation: $234.2 millions
Shanahan M. *et al.* 2016 **[117]**	AUS	caution vs. civil penalty vs. warning vs. charge	CEA	nationwide online survey (non-random)	n/a	healthcare system & criminal justice system	(1) minute of police time (2) court case (3) day in prison (4) supervised bond per day (5) community service per hour (6) helpline per minute (6) treatment per minute (7) assessment and education per episode	(1) cannabis use days	n/a	pre/post-policy	average costs** (net of fines): $122 warning $264 civil penalty $318 caution $1,918 charge
Shanahan M. *et al.* 2017 **[118]**	AUS	caution vs. charge	CEA	nationwide online survey (non-random)	n/a	healthcare system & criminal justice system	(1) minute of police time (2) court case (3) day in prison (4) supervised bond per day (5) community service per hour (6) helpline per minute (6) treatment per minute (7) assessment and education per episode	(1) cannabis use days	n/a	pre/post-policy	average costs (net of fines): $733 charge $388 caution

AUS: Australia; NSW: New South Wales; CMA: cost minimization analysis; CBA: cost benefit analysis; NSB: net social benefit; n/a: not applicable.
*Willingness-to-pay threshold is not declared. **This is a government report that lack of details of study design.

2.3.6.2 Drug Court programmes

Two studies evaluated the Drug Court programmes [119, 120]. They both indicated that Drug Court programmes were efficient in resource use in the US [119] and UK [120]. The summary of study findings and methods are shown in **Table 10** and **Table 11**, respectively.

In the US, the Drug Court programmes produced a net cost saving of $5,446 (1999 $USD) per participant episode (in combination of terminators and graduates) [119]. The benefit-cost ratio for people who completed programme (graduates) was $3.83, that was higher than combing both graduates and terminators (who dropped out) with a benefit-cost ratio of US$2.71. Results showed that Drug Court programmes were associated with reductions in incarceration, mental health services, legal costs, and increases in earnings and child support payments [119]. In the UK, the Drug Court programme (referred as Drug Interventions Program) was also cost-effective as the results of reducing crime, improving quality-of-life and reducing subsequent drug use, which produced a net cost saving of $688 and average 0.052 QALYs gained, resulting in an ICER at £13,230/QALY [120].

Two Drug Court programmes were considered cost-effective compared to status quo (i.e. 'do nothing'). Both studies were undertaken from a societal perspective and conducted alongside observational studies, the cost components and policy outcomes were considered differently. In the US, programme expenditure and donated or subsidized resources used for programme were estimated (i.e. from criminal justice and 3rd party community services) [119]. Also, a broader treatment outcome was considered, including the reduction in costs occurred in healthcare system (i.e. mental health services), criminal justice (i.e. crime), society (i.e. domestic violence, traffic accidence), and also the benefits for patients themselves (i.e. child support, earning from employment) [119]. Instead, the UK-based study adopted a narrative societal perspective that included the costs related to programme itself and costs of police, and treatment outcomes that focused on reduction in cost of crime and QALYs [120].

Table 10. Economic Evaluation of Drug Court programmes – summary of findings (N=2)

Reference	Year	Location	Policy	Context	Study results	Sensitivity analyses
Logan, TK. et al. **[119]**	2004	Kentucky, US	Drug Courts	Estimation on a wide range of costs and benefits of drug court can be challenging.	1. Benefit-cost ratio for drug court graduates (who completed programme) was $3.83, considering both graduates and terminators (who dropped out) that benefit-cost ratio was $2.71.	n/a
Collins BJ. *et al.* **[120]**	2017	Wirral (England) UK	Drug Interventions Programme	The Drug Intervention Programme (DIP) was initiated in 2003-2004 as a UK government's strategy for combating problematic drug use.	1. Study indicated that DIP was considered both effective and cost-effective programme with an average net cost saving of £668 (£6,207 including one case of homicide). 2. The average QALYs gained from the DIP was 0.052. *Note*: DIP aimed to engage with drug-using offenders within the criminal justice system, and divert individuals into appropriate treatment services.	n/a

n/a: not available.

Table 11. Economic Evaluation of Drug Court programmes – summary of methods (N=2)

Reference	Location	Policy vs. comparator	Evaluation method	Economic evaluation							Results	
				Approach	Structure	Perspective	Costs components	Outcome (or Benefit)	Discount rate	Time horizon	Threshold	ICER or others
Logan, TK. et al. 2004 **[119]**	Kentucky, US	Drug Courts	CBA	Observational study (DATCAP)	n/a	Societal	1. Programme expenditures: personnel, buildings and facilities, and contractual service. 2. Donated or subsidized resources used by the programme (e.g., criminal justice, community agencies)	Reduction in costs related to: 1. Criminal justice system 2. Domestic violence 3. Mental health service 4. Traffic accidents Increase in: 1. Child support payments 2. Earnings from employment	0%	1 year	n/a	$5,446 $2.71 benefit-cost ratio
Collins BJ. *et al.* 2017 **[120]**	Wirral (England) UK	Drug Interventions Programme	CUA	Observational study	n/a	Societal	1. Staff costs 2. Drug testing 3. GP and prescribing costs 4. Administration costs 5. Costs for police or other management	1. Reduction in cost of crime 2. QALYs	0%	1 year	n/a	$688 (net cost saving)

n/a: not available.

2.3.6.3 Safer drug consumption facility

Thirteen studies evaluated supervised drug consumption facilities' (SDCFs) cost-effectiveness [121-133]; and one evaluated SDCFs' social values using social return on investment (SROI) [134]. Ten studies were conducted in Canada [121-130], three studies were from the US [131-133] and one from the Netherlands (*N*=1;7.1%) [134], with publication year ranging from 2008 to 2022. The findings of 13 economic evaluations are summarized in detail and categorized by publication year in **Table 12**, followed by a summary of research methods in **Table 13** and statistical models used in **Table 14**. The SROI were summarised in **Table 15**.

Of the 13 economic evaluation studies, twelve focused on supervised injecting rooms [121-124, 126-133], and one focused on a supervised smoking room [125]. Three studies provided an evaluation based on existing facilities in Downtown Eastside of Vancouver, Canada [121-123], which were the first government-sanctioned supervised injecting facility (called '*Insite*') in 2003, and an unsanctioned supervised smoking room sitting on the same street as '*Insite'* [125]. The other 9 studies estimated hypothetical SDCFs and their potential role in different cities, using the same service model as '*Insite'* [124, 126-133]. Of the 9 studies, six considered further expansions on the service model (i.e. extended opening time from 16 hours to 24 hours) and optimal numbers of facility in different Canadian cities [124, 126-130].

In Canada, SDCF was considered cost-saving and effective for preventing drug-related harms in Vancouver city [121-123, 125]. One study estimated that approximately 7,000 PWID resided in Vancouver City and assumed 21% of PWID accessed a facility [121]. It suggested that one SDCF prevented 1,191 new HIV cases and 54 HCV cases as a result of decreased needle sharing, associated with an incremental net savings of CAN$14 million and 920 life-years gained over 10 years. When the evaluation included a lager geographical area – Greater Vancouver Area, where residents include approximately 13,500 PWUD, the study showed that one facility could prevent 83.5 HIV infections and yield CAN$17.6 million in future HIV lifetime treatment cost savings [122]. A third study predicted that, each year one SDCF provided a societal benefit of over CAN$6 million, prevented 35 new HIV infections and 2.87 deaths associated with HIV infection and overdose [123]. The assumption was made in the context that approximately 5% of injections in Downtown Eastside were taken in the SDCF (**Table 12**). A supervised smoking room was considered cost effective in Downtown Eastside due to its low operating cost, with a benefit-cost ratio at 12.1 [125].

Six studies examined hypothetical SDCFs and their potential roles in other Canadian cities, including Montreal [124], Ottawa [126, 130], Toronto [127, 130], Victoria [128], and Saskatoon [129]. Results showed that opening up to 3 facilities in Montreal were able to prevent 32 HIV and 195 HCV infections each year, with cost-effectiveness ratios (ICERs) of CAN$204,637 per HIV averted and $33,582 per HCV averted, as well as a benefit-cost ratio at 1.03 [124]. In Victoria, opening 3 facilities was also considered cost-effective, with a cost-effective ratio ranging from CAN$167,908 to $211,239 per HIV averted and a benefit-cost ratio ranging from 1.3 to 1.0 [128]. In Saskatoon, establishing up to 4 facilities was considered cost-effective, that 15 HIV infections were averted each year with an incremental cost-effectiveness ratio to be CAN$145,520 per averted HIV and a benefit-cost ratio of 1.06 [129]. In Ottawa, two studies supported the establishment of at least 2 facilities, suggesting a benefit-cost ratio of 1.14 (only if the averted HIV and HCV infections were both considered) [126] and an ICER was CAN$22,648/QALY [130]. In Toronto, the study did not support the implementation of any SDCF because of a lower benefit-cost ratio of 0.85 (ICER at CAN$1,091,400 per HIV case prevented, and CAN$53,239 per HCV prevented), but results were reversed in sensitivity analysis which considered a higher needle sharing rate – in this case the benefit-cost ratio was 1.2 for two facilities [127].

In the US, three studies examined hypothetical SDCFs and suggested there to be potential cost savings in 3 different cities [131-133]. In San Franciso, the study predicted that one SDCF could save

US$2.33 for every dollar spent and with a net saving of US$3.5 million [131]. For each year, it could prevent 3.3 HIV and 19 HCV infections, 415 days of hospitalization due to skin and soft tissue infections (SSTI), and refer 110 people to medicine assisted treatment (MAT), as well as save 1 life every 4 years. In Baltimore, one SDCF could save US$4.34 for every dollar spent, prevent 3.7 HIV, 21 HCV infections, 374 days of hospitalization for SSTI, 5.9 overdose deaths, 108 overdose-related ambulance calls, 78 emergency room visits, and 27 hospitalizations for overdose, as well as refer 121 people into MAT [132]. In Rhode Island, one SDCF (integrated into syringe service) could save US$1,104,454 annually compared to syringe and needle programme only, prevent 1.9 overdose deaths, 261 ambulance runs, 244 A&E visits, and 117 inpatient hospitalizations each year [133].

Sensitivity analyses were conducted among most of studies (*N*=12,92.3%), with a purpose of measuring the effects on cost-effectiveness when key parameters inputted in models were changed. Six key drivers of the cost-effectiveness of SDCF were considered as needle sharing rate [121, 126, 130], number of injections [121, 122], cost of HIV treatment [121], facility costs [130-133], number of PWID [130], and number of PWID who use facility [130]. In the study, where number of overdoses was considered as a health outcome, the key drivers of cost-effectiveness were the percentages of injections resulting in overdose, followed by the percentages of overdoses outside of the facility that resulted in an A&E visit, the reduction in overdose mortality within 0.25 miles of the SDCF [133].

Evaluation methods were greatly varied across 13 studies (**Table 13**). Cost-effectiveness analysis (CEA) and benefit-cost analysis (BCA) were the dominate evaluation methods. Over half of studies used a combination of two (*N*=7,53.8%) [123-129], and the rest of studies used BCA (*N*=4,30.8%) [122, 131-133] or CEA alone (*N*=2,15.4%) [121, 130]. Most commonly used models were statistical models (*N*=10,76.9%) from previous needle exchange evaluation literatures (**Table 14**) [122-129, 131, 132], remaining studies used dynamic compartmental models (*N*=2,15.4%) [121, 130] and a decision tree (*N*=1,7.7%) [133]. A higher proportion of studies adopted the healthcare system perspective (*N*=9,69.2%) [121, 122, 124-130] than those taken from a societal perspective (*N*=4, 30.8%) [123, 131-133]. The perspective taken in economic evaluation defined the type of costs and outcomes (or benefits) to be considered. As such, only the costs directly related to the operation of the SDCF were estimated from a healthcare perspective, for example, facility upfront cost and operating cost, lifetime HIV and HCV treatment cost, and cost associated with non-fatal overdose (i.e. ambulance runs, A&E visits, and hospitalization). Otherwise, a broader cost estimation was taken using a societal perspective that estimated the value of prevented deaths, such as lost productivity [123, 132].

Clinical outcomes were measured across all studies. They were roughly similar among studies conducted in Canada, with major attention on HIV and/or HCV infections, owing to the relatively high HIV and HCV prevalence rate and needle-sharing behaviours amongst PWID in Canadian cities [121-130]. A broader range of outcomes was considered in the US setting, including averted HIV and HCV infections, overdose deaths, reduced SSTI, and increased MAT uptake rate [131-133]. Two studies (*N*=2,15.4%) calculated the life-years gain (LYs) [121] and the quality-adjusted life years (QALYs) [130] alongside clinical outcomes. Time horizon presented the duration of calculating the costs and health outcomes that an intervention would produce in the economic evaluation. Eleven studies adopted a 1-year time horizon [122-129, 131-133], the remaining three studies applied a 10- and 20-year time horizon [121, 124, 130].

One social return on investment (SROI) was conducted to evaluate the potential social value of a SDCF in Amsterdam, the Netherlands [134] (**Table 15**). The SDCF were integrated into a community service (called *'AMOC'*), with the purpose of targeting marginalized people who were immigrants and use illicit drugs in Amsterdam. The study found that SDCF created a positive social impact with a SROI ratio of 1.92:1, indicating an investment of €1 delivers €1.92 in social value over a 1-year time horizon. This study was taken from a societal perspective, and engaged with stakeholder groups

who may affected by the operation of SDCF (e.g., residents, local business). The cost components were identified as staff salaries (75% of total expenditure), 10% exploitation costs (i.e. activity in donating food and clothes), 10% material costs, and 5% cost for proving training to staff and volunteers in the service. The outcomes related to SDCF's implementation were measured as prison time avoided, reduction in HIV and HCV infections and overdose deaths, increase in psychological service engagement, and dropout rate of SDCF.

Table 12. Economic Evaluation of Drug Consumption Rooms – summary of findings (N=13)

Reference	Year	Location	Policy	Context	Study results	Sensitivity analyses
Bayoumi, AM. and Zaric, GS. [121]	2008	Vancouver CAN	SIF	1.PWID resided in Vancouver City: approx. 7,000 (Downtown Eastside: 5,000; other areas: 2,000) 2. assume 21% PWID access facility	1. The facility was associated with an incremental net savings of almost $14 million and 920 life-years gained over 10 years.	1. Cost-effectiveness of SIF was sensitive to average number of injections (non-unique injections), needle sharing rate, annual costs of HIV treatment, and operating costs of facility.
Pinkerton SD [122]	2010	Vancouver CAN	SIF	1.PWUD resided in Greater Vancouver Area: approx.13,500 (12,000-15,000) 2.HIV incidence: 1.6%	1. The operation of facility was predicted to prevent 83.5 HIV infections per year, and yielded $17.6 million in future HIV lifetime medical costs savings with 3% discount rate.	1. Results were sensitive to the number of injections per PWID per year, the proportion of these injections that were associated with borrowed syringes, number of syringes distributed via Insite's syringe exchange programme, number of non-Insite syringes that circulated per year.
Andresen MA & Boyd N [123]	2010	Vancouver CAN	SIF	1. 42% of Vancouver PWID resided in Downtown Eastside 2. Injections per year: 236,529 (Insite), 4,565,000 (Downtown Eastside)	1. When consider the HIV infection only, facility prevented 19-57 HIV infections each year, and cost savings range from $2.85 to $8.55 million each year, BC ratios ranging from 1.94 to 5.80, and CE ratios ranging from $26,000 to $79,000/HIV prevented; 2. when consider the HIV infection and deaths, the BC ratios ranged from 3.00 to 8.04;	n/a
Jozaghi E *et al.* [124]	2013	Montreal CAN	SIF	1. PWID resided in Montreal: 4,300 – 12,500 2. HIV prevalence: 18% 3. HCV prevalence: 68%	1. Addition of each SIF (max.3) would prevent an average of 11 HIV infections, 65 HCV infections each year; 2. 130-140 HIV reductions and 840 HCV reductions over 10 years for the first 3 SIFs, with cost effective ranged from $155,914-$204,638 per lifetime treatment for HIV, $33,582-$25,986 for HCV. BC ratio was also above 1 for the first 3 facilities over 10 years.	1. Sensitivity analysis employed different needle sharing rates: 45% and 25%, results indicated that behaviour changes were considered for 1st and 2nd SIFs only, the results showed that the number of HIV/HCV averted cases remained stable after operating three facilities.
Jozaghi E, & vandu. org. [125]	2014	Vancouver CAN	SSF	1. People who have smoked crack in Downtown Eastside: 5,000 2. 80% sharing rate of smoking paraphernalia	1. SSF was consider cost effective with a BC ratio of 12.1 due to low operating cost	1. Sensitivity analysis used 70% and 90% initial pipe-sharing rates.
Jozaghi E *et al.* [126]	2014	Ottawa CAN	SIF	1. PWID resided in Ottawa: 3,000-5,000 2. 37% of women and 31% of men shared needles.	1. Separately estimated cost per HIV and HCV case resulting in BC ratios below 1.0; but when the BC ratios considering both HIV/HCV are considered simultaneously, there is a financial justification for at least two SIFs: 1.14.	1. Sensitivity analyses conducted at different baseline sharing rates (9%-19%), shows that changes to the needle sharing rates influence the results in an important way.
Jozaghi E *et al.* [127]	2015	Toronto CAN	SIF	1. PWID resided in Toronto: 10,000-25,000	1. Results did not support the implementation of any SFIs in Toronto, the BC ratio was 0.85 for first facility; cost effectiveness values were $1,091,400 for HIV case prevented, and $53,239 for HCV prevented.	1. Sensitivity analysis was employed different initial needle-sharing rates: 10% and 30%; establishing at least two SIFs in Toronto is cost-effective, in the condition of higher needle sharing rates.
Jozaghi E *et al.* [128]	2015	Victoria CAN	SIF	1. PWID 1,500-2,000 2. HIV prevalence: 21% 3. HCV prevalence: 63% 4. Needle sharing: 10%-23%	1. For model1, the BC ratios were below unity for both HIV and HCV in all SIF scenarios; for model 2 the establishment of 3 SIFs were considered cost-effective, with BC ratios 1.3 (1 facility), 1.2 (2 facilities), and 1.0 (3 facilities) when considered HCV/HIV.	1. For model 1, sensitivity analyses conducted at different baseline sharing rates, suggested establishing an SIF based on HIV and HCV were not cost-effectiveness. 2. Sensitivity analysis was not conducted for model 2.

SIF: supervised injection facility; SSF: supervised smoking facility.

Table 12. (Continued.)

Reference	Year	Location	Policy	Context	Study results	Sensitivity analyses
Jozaghi E *et al.* **[129]**	2015	Saskatoon CAN	SIF	1. PWID resided in Saskatoon: 2,000 2. HIV incidence: 31.3 per 100,000 persons, 76.9% contributed to PWID	1. SIF establishment is cost-effective up to 4 facilities in Saskatoon. For the Model 1, the cumulative cost-effectiveness ranges from $145,520 (1facility) to $198,436 (4 facilities); the cumulative benefit-cost ratio for HIV range from 1.44 (1 facility) to 1.06 (4 facilities); the marginal cost effectiveness was not cost effective after 2 facilities, with $155,914/HIV prevented, and BC ratio of 1.35. 2. For the Model 2, results suggested that establishing SIFs up to 4 facilities were considered cost effective.	1. The sensitivity analyses was conducted with 34% and 14% needle sharing rates demonstrated that establishing SIF based on HIV averted may be cost-effective.
Enns, E. A. *et al*. **[130]**	2016	Toronto/ Ottawa, CAN	SIF	1. Toronto had a relatively low HIV prevalence among PWID compared to cities of comparable size 2. drug use in Toronto is geographically dispersed, Ottawa was geographically more concentrated	1. In Toronto, one facility results in an ICER of $10,763/QALY, the ICER was less than $50,000/QALY gained for up to 3 facilities and less than $100,000/QALY gained for up to 5 facilities; in Ottawa, one facility resulted for an ICER of $6,127/QALY, the ICER was less than $50,000/QALY gained for up to 2 facilities and less than $100,000/QALY for up to 3 facilities.	1. Two-way: results were sensitive to the effect of a SIF on sharing injection equipment, the costs of operating a facility and size of the population of people who inject drugs. 2. Probabilistic: at a $50,000/QALY threshold, in Toronto, the probability that setting up 3,4,or 5 facilities was the most cost-effective strategy was 17%, 21% and 41% respectively; setting up 1 facility was unlikely to be cost-effective (<5%); the probability that no facility was cost-effective was 14%; in Ottawa, the probability that establishing 1,2,or 3 facilities was the most-effective strategy was 10%. Setting up 4 or 5 facilities was unlikely to be cost-effective (<1%).
Irwin, Amos. *et al.* **[131]**	2016	San Francisco, USA	SIF	1. PWID resided in San Francisco: 22,500 2. Needle sharing rate: 1.1%	1. Establishing one SIF was considered cost-effective at a BC ratio of 2.33, and with net savings of $3.5 million.	1. Results are robust to changes in individual health variables, even when raising and lowering key health variables by 50%, the cost benefit ratio only varied between 1.86 and 2.73 and net savings from $2.3 to $4.5 million; factor affecting the overall cost-benefit ratio is the facility operating costs.
Irwin, Amos. *et al.* **[132]**	2017	Baltimore, USA	SIF	1. Heroin-related overdose deaths in Baltimore: 192-260 deaths 2. Heroin/Fentanyl	1. A total benefit of $7.77 million and a total cost of $1.79 million, yielding a BC ratio of 4.35 saved for establishing one SIF.	1. Sensitivity analyses were conducted for each outcome, and also the key variables, by lowering or raising the rate of 50%. 2. Sensitivity analysis indicated that the SIF's operating cost has a significant impact on the overall cost-benefit ratio, though less impact on the net savings.
Chambers, L.C. *et al.* **[133]**	2022	Providence, USA	SCS	1. Age-adjusted rate of overdose deaths: 30 deaths per 100,000 population in 2019 2. 2-year pilot site from July 2021 3. Whole population of 190,000	1. Each year, a SCS that includes syringe services is estimated to prevent 1.9 deaths; 261 ambulance runs, 244 ED visits, and 117 inpatient hospitalizations for overdoes care; the total savings would be approx. $1,104,454 annually. (accounting only for annual facility costs and short-term costs of emergency overdose care).	1. In sensitivity analysis, the most influential parameters were the percentages of injections resulting in overdose, following by the percentage of overdoses outside of the SCS that result in an ED visit, the reduction in overdose mortality within 0.25 miles of the SCS, the SCS annual operating costs, and the cost-of-living ratio comparing Providence to Vancouver; 3. In scenario analyse, by varying only the number of unique SCS clients per month, the difference in total short-term cost savings ranged from $176,462 (with 200 unique clients per months) to $8,992,390 (with 2100 unique users), comparing with syringe only.

SIF: supervised injection facility; SCS: supervised consumption service

Table 13. Economic Evaluation of Drug Consumption Rooms – summary of methods (N=13)

Reference	Location	Policy vs. comparator	Evaluation method	Economic evaluation							Results	
				Approach	Structure	Perspective	Cost components	Outcome (Benefit)	Discount rate	Time horizon	Threshold	ICER or others*
Bayoumi, AM. & Zaric, GS. 2008 **[121]**	Vancouver, CAN	SIF vs. status quo	CEA	dynamic; population level	compartmental model	healthcare	(1) annual facility cost (fixed) (2) annual cost of HIV treatment (3) annual cost of HCV treatment (4) annual cost of hospitalization (5) annual cost of MMT	life-years gained (included effects: HIV/HCV averted)	5%	10 years	$50,000/ life-year gained	$14m net saving 920 life-years gained
Pinkerton SD 2010 **[122]**	Vancouver, CAN	SIF vs. status quo	CBA	static	statistical model	healthcare	(1) lifetime costs of HIV treatment (2) annual facility costs	HIV averted	3%	1 year	n/a	$17.6m net saving 83.5 HIV averted
Andresen MA & Boyd N 2010 **[123]**	Vancouver, CAN	SIF vs. status quo	BCA/CEA	static	4 statistical models	societal	(1) annual operational cost of facility (2) lifetime cost of new HIV infection (3) value of prevented death: lost wages/productivity and medical costs (tangible cost only)	HIV averted and/or annual deaths prevented for HIV and/or overdose	3%	1 year	n/a	HIV only: BCA: 1.94-5.80 CEA: $26,000-$79,000/hiv pre HIV &deaths: BCA: 3.00-8.04
Jozaghi E *et al.* 2013 **[124]**	Montreal, CAN	SIF vs. status quo	BCA/CEA	static	statistical model	healthcare (taxpayer)	(1) lifetime costs of HIV/HCV HAART, (2) facility upfront and operating costs	(1) HIV averted (2) HCV averted	0%	1 year/ 10 year	n/a	CEA: $0.686m(HIV)/ $0.8m(HCV)/case prevented BCA: 1.35 (HIV/HCV)
Jozaghi E, & vandu. org. 2014 **[125]**	Vancouver, CAN	SSF vs. status quo	BCA/CEA	static	statistical model	healthcare (taxpayer)	(1) cost of facility (2) costs of lifetime HCV treatment (48w/24w)	HCV prevented	0%	1 year	n/a	BCA:12.1 CEA: $1,705 per lifetime treatment
Jozaghi E *et al.* 2014 **[126]**	Ottawa, CAN	SIF vs. status quo	BCA/CEA	static	statistical model	healthcare (taxpayer)	(1) lifetime costs of HIV/HCV (2) facility upfront and operating costs	(1) HIV averted (2) HCV averted	0%	1 year	n/a	BCA: 1.26 CEA: $436,560(HIV)/ $45,475(HCV)/ case prevented
Jozaghi E *et al.* 2015 **[127]**	Toronto, CAN	SIF vs. status quo	BCA/CEA	static	statistical models	healthcare (taxpayer)	(1) lifetime costs of HIV/HCV (2) facility upfront and operating costs	(1) HIV averted (2) HCV averted	0%	1 year	n/a	BCA: 0.8 $53,239(HCV), $1,091,400(HIV)/case prevented

CEA: cost-effective analysis; CBA: cost-benefit analysis; SIF: supervised injection facility; SSF: supervised smoking facility; n/a: not available. * Results were provided for opening one facility.

Table 13. (Continued.)

Reference	Location	Policy vs. comparator	Evaluation method	Economic evaluation							Results	
				Approach	Structure	Perspective	Cost components	Outcome (Benefit)	Discount rate	Time horizon	Threshold	ICER or others*
Jozaghi E *et al.* 2015 **[128]**	Victoria, CAN	SIF vs. status quo	BCA/CEA	static	statistical model	healthcare (taxpayer)	(1) lifetime cost of HIV/HCV treatment (2) value of a prevented death (3) facility upfront and operating costs	(1) HIV averted (2) HCV averted or (1) overdose death	3% (tangible costs: lost wages)	1 year	n/a	**Model 1**: BCA:0.1 CEA:$727,600(HCV)/$4,365,600(HIV)/prevented; **Model 2**: BCA: 1.3 CEA: £167,908 /per HIV prevented or BCA:1.03 CEA:$949,044/ death prevented
Jozaghi E *et al.* 2015 **[129]**	Saskatoon, CAN	SIF vs. status quo	BCA/CEA	static	statistical model	healthcare	(1) lifetime costs of HIV infections (2) facility upfront and operating costs	HIV averted	0%	1 year	n/a	**Model 1:** BCA:1.44 CEA:$145,520/ HIV prevented; **Model 2:** BCA: 1.40 CEA: $155,914/ HIV prevented
Enns, E. A. *et al.* 2016 **[130]**	Toronto/ Ottawa, CAN	SIF vs. status quo	CEA	dynamic; population level	compartmental model	healthcare	(1) facility upfront and operating costs (2) healthcare costs	(1) HIV averted (2) HCV averted (3) QALYs	5%	20 years	$50,000/ QALY $100,000 /QALY	Toronto: $10,763/QALY Ottawa: $6,127/QALY
Irwin, Amos. *et al.* 2016 **[131]**	San Francisco, USA	SIF vs. status quo	BCA	static	statistical model	societal	(1) facility upfront and operating costs (2) lifetime costs of HIV (3) lifetime cots of HCV (4) savings of SSTI-related hospital stays per year (5) savings of overdose prevented per year (6) savings of increased MAT uptake	(1) HIV averted (2) HCV averted (3) reduced SSTI (4) averted overdose deaths (5) MAT uptake	0%	1 year	n/a	2.33

CEA: cost-effective analysis; CBA: cost-benefit analysis; SIF: supervised injection facility; SSF: supervised smoking facility; n/a: not available. * Results were provided for opening one facility.

Table 13. (Continued.)

Reference	Location	Policy vs. comparator	Evaluation method	Economic evaluation							Results	
				Approach	Structure	Perspective	Costs components	Outcome	Discount rate	Time horizon	Threshold	ICER or others
Irwin, Amos. *et al.* 2017 **[132]**	Baltimore, USA	SIF vs. status quo	BCA	static	statistical model	societal	(1) facility upfront and operating costs (2) lifetime costs of HIV treatment (3) lifetime cost of HCV treatment (4) costs of hospital stay for SSTI (5) value of overdose deaths averted (6) cost savings of averted ambulance calls of a SIF (7) annual savings of reduced ER visits for overdose (8) annual savings of reduced hospitalization for overdose (9) annual healthcare and crime savings due to MAT uptake	(1) HIV averted (2) HCV averted (3) reduced SSTI (4) averted overdose deaths (5) non-fatal overdose (6) MAT uptake	3%	1 year	n/a	4.35
Chambers, L.C. *et al.* 2022 **[133]**	Providence USA	SCS in syringe service vs. syringe service only	CBA	static	decision tree	societal	(1) SCS operational costs; (2) costs of emergency overdose care (ambulance runs, ED visit, inpatient hospitalizations)	(1) overdose deaths;	0%	1 year	n/a	$1,104,454 net saving annually

CBA: cost-benefit analysis; SIF: supervised injection facility; SCS: supervised consumption service; n/a: not available. * Results were provided for opening one facility.

Table 14. Economic Evaluation of Supervised Drug Consumption Facility – Summary of statistical models

	Models	Variables	Reference
(1)	$New\ HIV\ infection\ case = INsd[1-(1-qt)^m]$	I: proportion of people are $HIV_{(-)}$ N: Number of needles in circulation s: rate of needle sharing d: percent of non-clean needles q: proportion of people who are $HIV_{(+)}$ t: probability of HIV infection from a single injection m: average number of sharing partners	[123-128, 131, 132]
(2)	$New\ HIV\ infection\ case = (1-\pi)\lambda(1-\theta)\beta\alpha$	π: HIV prevalence λ: rate of needle sharing θ:pertentage of non-clean needles β: percentage of HIV infected needles α: probability of HIV infection from a single injection	[123, 127-129]
(3)	$I = (1-\pi)Nbc(1-\theta)\alpha$	I: number of new infections π: HIV prevalence N: number of people who inject drugs b: number of injections of used syringe per people who inject drugs c: proportion of people who are $HIV_{(+)}$ θ: probability of clean needles α: probability of HIV infection from a single injection	[122]
(4)	$Decrease\ in\ hiv\ incidence\ = E/(E+s)$	E: number of needles used per client per year s: number of shared injections per client per year	[123]
(5)	$New\ HIV\ infection\ avoided = c(1-p)ar$	c: number of PWID in population p: HIV prevalence rate a: participation rate at Insite r: reduction of risk from participation	[123]

Table 15. Return on Investment – Supervised Drug Consumption Facility (N=1)

Reference	Location	Policy	Cost perspective	Stakeholders	Inputs	Outputs	Discount rate	Time horizon	ROI ratio	Summary of findings
Crescenzi, Sofia 2020 **[134]**	Amsterdam NL	SDCFs	societal	1. PWUD 2. healthcare system 3. neighbourhood 4. staff members 5. security staff 6. students 7. volunteers 8. public 9. administration 10. other organizations	in total: €1,687,613.59 1. salaries 75% 2. exploitation costs 10% 3. material costs 10% 4. partner org. 5%	1. prison time avoid: €2,596,464; 2. reduction of HIV: €0; 3. reduction of HCV: €2,176,000; 4. reduction of overdose deaths: €768; 5. psychological help: €282,880; 6. drop out: €-911,040	3.50%	1 year	1.92:1	1. Social impact was €3,246,931.00 2. SDCF created a positive social impact with a SROI ratio of 1:1.92, indicating an investment of €1 delivers €1.92 in social value.

ROI: return on investment.

2.3.6.4 Methadone or buprenorphine

Eight studies evaluated the cost-effectiveness of methadone or buprenorphine [135-142]. Four of them were conducted in the US [135, 136, 141, 142], two were from Australia [137, 138], one from Lithuania (*N*=1;12.5%) [139], and one from Indonesia (*N*=1;12.5%) [140]. The publication year ranged from 2000 to 2022. The (oral) methadone and buprenorphine have been used as pharmaceutical treatment for opioid-dependent patients (referred as opioid substitutional treatment, OST). Study findings and their sensitivity analysis are summarized in **Table 16**, and research methods are presented in **Table 17**.

Of the eight studies, four investigated the cost-effectiveness of methadone in relation to the length of treatment episode [139], service expansion [135, 140], and implementation setting [138]. Methadone was considered cost-effective across all studies. In the Lithuanian study, a total of 71 participants completed treatment, and the study showed that the 6-month methadone was cost-effective, which resulted in an ICER at EU€34,368/QALY [139]. It was effective in improving patients' quality of life from 0.52 to 0.56 for a 6-month treatment episode, with the largest improvement in patients' psychological health. The service expansion was examined in two countries [135, 140], with the emphasis on the role of methadone in preventing HIV infections. They both found that expansion of methadone was cost-effective, resulting in an ICER ranging from US$8,200/QALY-$10,900/QALY in the US and US$269/disability-adjusted life years averted in Indonesia. The service expansion increased HIV costs because engaged patients were more likely to be screened for HIV and to receive HIV treatment. Providing methadone in the prison setting resulted in an ICER of AUD$38 per additional heroin free day, in comparison to status quo (no methadone) in New South Wales [138]. The annual cost of prison-based methadone was estimated to be AUD$2.9 million ($3,234 per inmate per year). Two studies evaluated buprenorphine [136, 137]. One study showed that, buprenorphine could be a highly cost-effective treatment in the US if it was priced at $5 per dose, with an ICER of US$10,800/QALY to $17,700/QALY [136]. However, the adoption of buprenorphine was less cost-effective if compared to methadone expansion [135]. Similarly, methadone was found to be cheaper and more effective than buprenorphine in Australia, with an ICER at AUD$201 per additional heroin free day [137]. It estimated that the cost of methadone over 6 months was cheaper than the buprenorphine (AUD$37 vs. $459). Two studies investigated the cost effectiveness of OST with different treatment delivery methods [141, 142]. One study showed that immediate access to treatment was less costly and provided greater health benefits, in comparison to the standard care (which patients were required to provide documents of 2 or more failed treatment to access OST), with an ICER at US$73,255/QALY [141]. Also, OST was more cost-effective when it was provided in a detoxification centre compared to status quo (detox only), resulting in an ICER ranging from US$55,600/QALY to $78,500/QALY [142]. Sensitivity analyses were conducted by most six studies (*N*=6;75%) [135, 137, 138, 140-142] (**Table 16**). Cost estimation on pharmacotherapy was found to be highly sensitive to staff time [137, 138], the dosing time and medication costs [137]. The retention rate, percentage initiation, and referral to OST were of greatest significance on the cost-effectiveness of providing methadone or buprenorphine in detoxification centre [142].

Evaluation methods were varied across studies (**Table 17**). Most studies conducted a CEA alongside decision modelling [135, 136, 140, 141] or clinical trial [137, 138], and another two used a CUA alongside the observational study [139] and a CBA with decision modelling [142]. Study perspectives were taken from healthcare system [135, 137, 139, 142], government [136], society [140, 141], and prison [138]. Other than the direct costs, one study included transportation cost [139], another included criminal justice cost [141]. Most studies measured QALYs [135, 136, 139, 141, 142], and the remaining used clinical outcomes, for example, number of heroin-free days [137, 138] and HIV infections averted [140]. Longer time horizons, for example 10 or 30 years [135, 136, 140-142], were more frequently adopted across studies compared to short time horizons [137-139].

Table 16. Economic Evaluation of pharmacotherapy – summary of findings (N=8)

Reference	Year	Location	Policy	Context	Study results	Sensitivity analyses
Zaric GS. *et al.* [135]	2000	USA	Methadone expansion at 10%	To determine the cost-effectiveness of expanding methadone maintenance programmes, with role in preventing the spread of HIV.	1. Expanding the methadone coverage in the high HIV prevalence community (i.e. New York) would cost $8,200/QALY gained, and $10,900/QALY gained in the low HIV prevalence community (i.e. Los Angelas); 2. More than ½ benefits were gained by individuals who do not inject drugs.	1. Model parameters relating to behaviours, quality adjustments, death rates, treatment programme data, and costs, with wide ranges of values were varied, results showed that cost-effectiveness ratios were less than $20,000/QALY in all cases.
Barnett, PG. *et al.* [136]	2001	USA	Buprenorphine	Whether healthcare payers in the US willing to pay the buprenorphine as a maintenance treatment.	1. At a price of $5 or less per dose, buprenorphine was cost-effective under all scenarios; at $15 per dose, it was cost-effective if its adoption does not lead to a decline in methadone use, or if a medium to high value was assigned to the years of life lived by injection drug users and those in maintenance therapy; at $30 per dose, it would be cost-effective only under the most optimistic modelling assumptions.	n/a
Doran CM. *et al.* [137]	2003	AUS	Buprenorphine	Comparing buprenorphine with methadone within a RCT.	1. The treatment with methadone was found less expensive and more effective with a CE ratio of -$201 per heroin free days, compared to buprenorphine.	1. The cost drivers were the variations in dosing time, medication costs, and staff time spent in contact with patients.
Warren E. *et al.* [138]	2006	NSW AUS	Methadone at prison	The cost-effectiveness of prison methadone programmes was not assessed.	1. The total cost of NSW prison methadone was AUD$2.9 million annually, or $3,234 per person per year, and led to 84.72 additional heroin free days per year per inmate 2. Secondary analyses: ICER was $458,074/death avoid, ICER was $40,428/HCV infection avoid.	1. The cost of prison methadone was highly sensitive to the inclusion of costs associated with correctional officers' time, as major uncertainty in cost of prison methadone was related to staff time.
Vanagas G. *et al.* [139]	2010	Lithuania	Methadone for 6 months	Assess the cost-effectiveness of 6-months methadone in a primary care setting.	1. 102 patients were recruited in the study for a 6-month follow-up period 2. Total programme costs were €61,288.87, and 31% of costs were paid by a patient 3. 6-months methadone was effective in improving quality-of-life, but less effective in terms of cost per QALY.	n/a
Wammes JJ. *et al.* [140]	2012	West Jave, Indonesia	Methadone expansion	Costs and effects of expanding methadone maintenance treatment in Indonesia was warranted.	1. Expanding methadone coverage from 5% to 40% in 2019 would avert 2,400 HIV infections, with a cost effectiveness of $6,817/HIV averted.	1. ICER can increase to $2,676/HIV adverted if adopted a healthcare perspective; to $12,000/HIV adverted when effects of condom using or prevalence of injecting drug use was not considered.
Krebs E. *et al.* [141]	2018	California USA	OST with immediate access	Regulations for admission to methadone in California were stringent: require doc. of 2 or more failed treatments.	1. Immediate access to OST strategy provided greater health benefits (by 0.42) and was also less costly (by $78,257) than other polices.	1. With 99.6% of simulations suggested that the initial OAT with immediate access strategy would reduce costs and extend QALY gained.
Savinkina A. *et al.* [142]	2022	Massachusetts, USA	OST at detox centres	The traditional detox episode resulted in a high risk for relapse and overdose, but integration of pharmacotherapy into detox centres could be an effective and cost-effective strategy.	1. Provision of OST in detox centres with perfect linkage prevented 4.5% of fatal overdoses over 10 years, at an ICER of $55,600/QALY gained 2. With moderate linkage, provision of MOUD in detox prevented 2.3% of fatal overdoses over 10 years.	1. Perfect linkage was shown to be cost-effective 74.0% of the time at the $100,000 per QALY threshold 2. Moderate linkage was shown to be cost-effective 60.2% of the time at the threshold 3. Parameters of greatest significance on the results: retention rate on OST, percentage initiation and linkage to OST.

OST: opioid substitutional therapy; n/a: not available.

Table 17. Economic Evaluation of Pharmacotherapy – summary of methods (N=8)

Reference	Location	Policy vs. comparator	Evaluation method	Economic evaluation							Results	
				Approach	Structure	Perspective	Costs components	Outcome (or Benefit)	Discount rate	Time horizon	Threshold	ICER or others
Zaric GS. *et al.* 2000 **[135]**	USA	10% expansion methadone vs. SQ	CEA	Dynamic	Compartmental model	Healthcare	1. medicine costs 2. HIV care costs 3. Other healthcare costs	QALYs	3%	10 years	$20,000 per QALY	$8,200/QALY - $10,900/QALY
Barnett, PG. *et al.* 2001 **[136]**	New York Los Angeles, USA	Buprenorphine vs. SQ	CEA	Dynamic	Compartmental model	Government	1. Medicine costs 2. Other healthcare costs	QALYs	3%	10 years	$50,000 per QALY	$10,800/QALY - $17,700/QALY
Doran CM. *et al.* 2003 **[137]**	Adelaide Sydney AUS	Buprenorphine vs. Methadone	CEA	RCT	n/a	Healthcare	1. Personnel 2. Diagnostics 3. Medications 4. Capital and equipment 5. Ancillary services	Number of heroin-free days	0%	6 months	n/a	$201/heroin free day
Warren E. *et al.* 2006 **[138]**	NSW AUS	Prison methadone vs. SQ	CEA	RCT (DATCAP) (WHOQOL-BREF)	n/a	Prison	1. Administrative costs 2. Delivery of methadone 3. Dispensing costs of methadone	Number of heroin free days	0%	1 year	n/a	$38/additional heroin free days
Vanagas G. *et al.* 2010 **[139]**	Lithuania	Methadone 6M vs. SQ	CUA	Observational study	n/a	Healthcare Patient	1. Personnel 2. Buildings and maintenance 3. Medicine (patient) 4. Transportation	QALYs	0%	6 months	n/a	€34,368/QALY
Wammes JJ. *et al.* 2012 **[140]**	Indonesia	Methadone expansion vs. SQ	CEA	Dynamic	HIV transmission model	Societal	1. Service utilization 2. Capital costs 3. Patient costs	HIV infection averted	3%	10 years	$2,858 GDP per capita	$269/DALY averted ($6,817/HIV averted)
Krebs E. *et al.* 2018 **[141]**	California US	OAT with immediate access vs. with conditions	CEA	Static	Markov model	Societal	1. Drug treatment 2. Health resource use 3. Criminal justice costs	QALYs	3%	30 years	n/a	$73,225/QALY
Savinkina A. *et al.* 2022 **[142]**	Massach-usetts, US	OAT in detox vs. SQ (no OAT)	CBA	Dynamic & Population level	Simulation model	Healthcare	1. Costs of all OUD-related healthcare service utilization 2. Costs of OUD treatment 3. Costs related to overdose	QALYs	3%	10 years	$100,000 per QALY	$55,600/QALY perfect linkage $78,500/QALY moderate linkage

SQ: status quo; RCT: randomize controlled trails; QALYs: quality-adjusted life years; QALYMs: quality-adjusted life-months**;** CEA: cost-effectiveness analysis; CUA: cost-utility analysis; CBA: cost-benefit analysis; n/a: not available.

2.3.6.5 Needle and syringe programmes

Six studies evaluated the needle and syringe programmes (NSPs), including four economic evaluations [143-146] and two return on investment (ROI) studies [155, 156]. Most of studies were conducted in USA (N=4;66.7%) [143-145, 156] and a few were in Australia (N=2;33.3%) [146, 155]. Publication years were ranged between 1998 to 2012. The study results of economic evaluations and their methodologies are summarized in **Table 18** and **Table 19**, respectively. The findings of return on investment are presented in **Table 20**.

NSPs were considered to be cost-effective in preventing HIV infection and improving QALYs compared to status quo ('do nothing'), with an ICER ranged from $20,947-125,000 per HIV averted in the US [143-145] and $416-$8,750/QALY in Australia [146] (**Table 18** and **Table 19**). Two studies were conducted using statistical model [143, 144], and the rest of two used decision modelling [145] and an epidemiological model incorporated to observational study [146]. Although most of the studies adopted broader perspectives (i.e. societal), the measured cost components were restricted to healthcare costs of proving needle and syringe, and treating HIV/HCV only. Furthermore, most evaluations were undertaken over a 1-year time horizon. Key drivers of cost-effectiveness were identified to be the needle sharing rate and HIV prevalence among PWID, and frequency of injecting [144-146].

Two ROIs were undertaken the government perspective in the Australia [155] and the US [156]. Both studies showed that NSPs produced significant savings to government due to its relatively low operation cost (**Table 20**). Over a 10-year period, government could achieve a minimal net saving of AUD$255 million at a discount rate of 5% through preventing HIV and HCV infections [155]. Similar results were found that NSPs were cost saving in Philadelphia (US) at $2.4 billion and $624 million in Baltimore (US) over a 10-year period (not discounted) [156].

2.3.6.6 Heroin-assisted treatment

Three studies evaluated the cost-effectiveness of the heroin-assisted treatment (HAT) in the Netherlands [149], Canada [149], and the UK [147], with publication year ranged from 2005 to 2013 (**Table 21** and **Table 22**). Different heroin regimes were evaluated across studies, including a co-prescription of methadone and (inhalable or injectable) heroin [149], diacetylmorphine (heroin) [149], and injectable heroin [147].

In the Netherlands, co-prescribed methadone and heroin was associated with 0.058 more QALYs per patient per year and a mean saving of €12,793 per patient per year, in comparison to methadone only [148]. The higher treatment costs were compensated by lower costs of law enforcement (-€4,129) and damage to victims of crime (-€25,374) [148]. In Canada, diacetylmorphine was found to be cost effective compared to methadone, with an ICER at $86,956/QALY over a lifetime period [149]. Similarly, cost savings in diacetylmorphine were primarily because of cost reductions in related to criminal activity. In the UK, none of treatment methods were considered being cost-effective at the threshold of £30,000/QALY, with injectable methadone at £45,604/QALY, oral methadone at £65,845/QALY, and injectable heroin at £49,666/QALY from a societal perspective over 26 weeks [147]. The cost-effectiveness was being driven by the reduction in crime and savings in the criminal justice sector, rather than the healthcare sector. Sensitivity analysis suggested that if price of injectable heroin dropped to £2 per 500mg would result in a greater probability of being the most cost-effective options.

Of 3 studies, two conducted CEA alongside the RCT [147] and decision modelling [149], and one used CUA alongside RCT [148]. All of them were taken from a societal perspective, including not only health-related costs, but also the costs occurred in criminal justice sector [147-149]. Indirect costs (i.e. transportation) were included in one study only [148].

Table 18. Economic Evaluation of Needle and syringe programmes – summary of findings (N=4)

Reference	Year	Location	Policy	Context	Study results	Sensitivity analyses
Holtgrave DR. *et al.* **[143]**	1998	USA	Sterile syringes and needles	The numbers of syringes provided by syringes exchange programmes were not sufficient to prevent HIV among PWID.	1. The policy funding syringe exchange programme, pharmacy sales, and syringe disposal to cover all illicit drug injections would cost over $423 million per year; 1/3 of costs were paid for as out-of-pocket expenditures by PWID. 2. As coverage increases, the marginal cost per HIV infection averted also increases, indicating the reduced number of HIV infection prevented by additional expansions of service.	n/a
Laufer FN. **[144]**	2001	New York State USA	12 Syringe exchange programmes	To inform the policy-making in NYS, undertaking a cost-effectiveness analysis of Syringes exchange services operating in the state in 1996.	1. Syringe exchange programmes were estimated to prevent 87 HIV infections and cost $1.82 million, with a CE ratio of $20,947 per HIV infection averted.	1. Two key parameters were varied: the estimated number of shared injections per PWID per year and the HIV incidence among non-service users, resulted in a CE ratio of $21,957 per HIV infection averted for low sharing group ($18,596 per HIV infection averted for high sharing group), and $45,561/HIV averted at an HIV incidence rate of 2.41% ($9,624/HIV averted) at an HIV incidence rate of 11.49%.
Belani HK. & Muennig PA. **[145]**	2008	New York City USA	Needle and Syringe Exchange	Whether the programme merit further investment and expansion by exploring their cost-effectiveness.	1. Programme resulted in a total savings of $1.3 million per 1,000 clients, which was the cost associated with approx. 4 HIV cases averted.	One-way sensitivity analyses: 1. Programme to be cost saving if it was associated with a reduction in HIV seroprevalence greater than 0.008 2. Programme remained dominant over the plausible values of HIV seroprevalence among PWID.
Kwon JA. *et al.* **[146]**	2012	AUS	Needle-syringe programme	To evaluate the impact and cost-effectiveness of needle-syringe programme in terms of HIV.HCV infection among Australian PWID.	1. The needle-syringe programme was cost-effective in Australia with an ICER ratio of $416-$8,750/QALY (25-50% sharing rate) over 10 years. 2. It was estimated to prevent HIV/HCV infections with a gain of 48,000-145,000 QALYs over a lifetime horizon; estimated costs were approx. $245 million for the programme and total healthcare costs attributed to HIV/HCV were $2.8 billion and $5.1 billion, respectively.	1. The needle sharing rate was the most sensitive factor, followed by the frequency of injecting.

n/a: not available.

Table 19. Economic Evaluation of Needle and syringe programmes – summary of methods (N=4)

Reference	Location	Policy vs. comparator	Evaluation method	Economic evaluation							Results	
				Approach	Structure	Perspective	Costs components	Outcome (or Benefit)	Discount rate	Time horizon	Threshold	ICER or others
Holtgrave DR. *et al.* 1998 **[143]**	USA	Different coverage levels of sterile syringes vs. status quo	CEA	Statics	Statistical model	Societal	1. Costs of per syringe 2. Medical care and treatment costs for HIV/AIDS	HIV infection averted	3%	1 year	$100,000 per HIV case averted	$34,278/HIV averted
Laufer FN. 2001 **[144]**	New York state USA	Syringes exchange vs. status quo	CEA	Static	Statistical model	Societal	1. Syringe exchange programme costs 2. HIV treatment costs	HIV infection averted	0%	1 year	n/a	$20,947/HIV averted
Belani HK. & Muennig PA. 2008 **[145]**	New York City USA	Needle and Syringe Exchange vs. status quo	CEA	Static	Decision tree	Government	1. Average annual Medicaid HIV cost per enrolee 2. Programme annual cost per client	1. HIV infection averted 2. QALYs	0%	1 year	n/a	$125,000/HIV averted $130,000/QALY
Kwon JA. *et al.* 2012 **[146]**	AUS	Needle-syringe vs. status quo	CUA	Static	Cross-sectional study + compartmental model	Healthcare	1. Supplies 2. Operation costs 3. Healthcare costs for HIV/HCV	QALY	3%	10 years/ Lifetime	$50,000 per QALY	$416-$8,750/QALY (25-50% needle sharing rate), 10 years

n/a: not available.

Table 20. Return on Investment – Needle and syringe programmes (N=2)

Reference	Location	Policy	Cost perspective	Stakeholders	Inputs	Outputs	Discount rate	Time horizon	ROI	Summary of findings
Health outcomes Internationals & Drummond, MF. 2002 **[155]**	AUS	Needle and syringe	Government	n/c	1. Overhead and infrastructure costs 2. Operating expenditure on public needle syringe programmes 3. Subsidies to community pharmacies 4. Consumer costs	1. HIV treatment costs avoid 2. HCV treatment costs avoid	5% 3% 0%	10 years	$255m (5%) $302m (3%) $391m (0%)	There was significant savings to government from the investment in NSPs. 1. For HIV impact, in a 10-year period, government had achieved net savings of $373m (after deducting the value of investment), the NPV of which at a discount rate of 5% is $242m and at 3% is $287m; 2. For HIV and HCV combined impact, in a 10-year period, government had achieved net savings of $391m (after deducting the value of investment), the NPV of which at a discount rate of 5% is $255m and at 3% was $302m. 3. Sensitivity analyses: results in the study were robust, and that the ROI from NSPs was positive in all other tested scenarios.
Ruiz MS. *et al*. 2019 **[156]**	Philadelphia & Baltimore, USA	Syringe exchange programme	Government	n/c	1. Programme costs 2. Operating costs	1. HIV treatment costs avoid	0%	1 year/ 10 years	$2.6b (Philadelphia) $624m (Baltimore)	SEP was cost saving in Philadelphia and Baltimore. (HIV averted*lifetime costs of HIV treatment) 1. Annual saving of $243.4m in PA; and $62.4m in MD 2. In a 10-year period, lifetime cost savings of supporting SEPs were more than $2.4b in PA, and $624m in MD 3. Policy changed to support SEP with relatively low operation costs which was significant cost savings to public sector.

n/c: not clear.

Table 21. Economic Evaluation of Heroin-assisted treatment (HAT) – summary of findings (N=3)

Reference	Year	Location	Policy	Context	Study results	Sensitivity analyses
Dijkgraaf MG. *et al.* **[148]**	2005	NZL	Methadone + heroin	It was uncertain whether prescription or co-prescription of heroin is efficient from societal perspective.	1. Over 1 year, mean QALYs per patient were significantly higher for methadone + heroin group than methadone only group with a mean difference of 0.058; the mean total net savings amounted to €12,793 2. The cost of experimental group was higher than control group, but higher costs were offset by savings for criminal justice and victim damage.	Multi-way sensitivity analyses to investigate the robustness of the cost acceptability of experimental treatment (for WTP values up to $50,000): 1. Patients who with at least one previous abstinence attempt, had a lower range of cost acceptability for methadone + heroin treatment (89%-96%), compared to people without such attempt (96%-97%).
Nosyk B. *et al.* **[149]**	2012	Vancouver Montreal CAN	Diacetylmorphine (Heroin)	15%-25% of the most marginalized methadone clients do not benefit from treatment in terms of sustained abstention, and diacetylmorphine to be more effective than MMT.	1. People in MMT was predicted to spending 8.79 years (60% of their remaining life) in treatment, accumulated 7.46 discounted QALYs and generated a societal cost of $1.14 million. (lifetime) 2. People in the diacetylmorphine was predicted to spending 10.41 years (67% of their remaining life) in treatment, accumulated 7.92 QALYs and generated a societal cost of $1.10 million. (lifetime)	Probabilistic sensitivity analyses 1. At a societal willingness to pay of $100,000/QALY gained, diacetylmorphine was the cost-effective treatment option with 95% certainty, while MMT was the cost-effective treatment with 5% certainty. One-way sensitivity analyses 1. When the costs of criminal activity during relapse period was lower than the baseline model, the diacetylmorphine was not considered as to be cost-effective at a threshold of $100,000/QALY 2. Diacetylmorphine remained cost-effective at an ICER of $85,600/QALY gained at a healthcare perspective (excluded crime-related costs and out-of-pocket costs).
Byford S. *et al.* **[147]**	2013	England UK	Injectable heroin – diamorphine	The cost-effectiveness of diamorphine was uncertain.	1. Injectable heroin is cost-effective if include costs in justice sector, but oral methadone was more expensive and less effective, compared to injectable heroin and injectable methadone.	1. Threshold analysis suggested that the price of injectable heroin drop to £2 per 500mg would result in a greater probability of being the most cost-effective option at the £30,000/QALY 2. The cost-effectiveness was driven by savings in the criminal justice sector, rather than the healthcare or social service sector.

Table 22. Economic Evaluation of Heroin-assisted treatment (HAT) – summary of methods (N=3)

Reference	Location	Policy vs. comparator	Evaluation method	Economic evaluation							Results	
				Approach	Structure	Perspective	Costs components	Outcome (or Benefit)	Discount rate	Time horizon	Threshold	ICER or others
Dijkgraaf MG. *et al.* 2005 **[148]**	NZL	Methadone + heroin vs. Methadone	CUA	RCT	n/a	Societal	1. Programme costs 2. Healthcare-related costs 3. Criminal justice costs 4. Travel costs to programme	QALYs	0%	1 year	n/a	€220,569/QALY
Nosyk B. *et al.* 2012 **[149]**	Vancouver Montreal CAN	Diacetylmorphine (Heroin) vs. MMT	CEA	Dynamic	Markov cohort model	Societal	1. Treatment 2. Health resources use 3. Criminal activity & charges	QALYs	5%	1 year 5 years 10 years Lifetime	$100,000 per QALY	$86,956/QALY (lifetime)
Byford S. *et al.* 2013 **[147]**	England UK	Injectable heroin vs. injectable methadone vs. oral methadone	CEA	RCT	n/a	Societal	1. Intervention costs 2. Other service use: accommodation, hospital services, community services, criminal justice services 3. Criminal activity	QALYs	0%	26-week follow up	$30,000 per QALY	£49,666/QALY £45,604/QALY £65,845/QALY

n/a: not applicable.

2.3.6.7 Residential rehabilitation

Five studies evaluated the cost effectiveness of residential rehabilitation, with a publication year ranging from 1997-2007 [150-154]. The majority of studies were conducted in the US [150-153], and one was from Australia [154]. A summary of research findings and methods are presented in **Table 23** and **Table 24**.

The cost-effectiveness of residential rehabilitation was likely to be impacted by its implementation strategy (**Table 23**). In the US, residential rehab was considered to be cost-effective either incorporated with short-term outpatient care or provided alone [152, 153]. The length of stays in the residential rehabilitation had an important impact on treatment cost, for example, the longer time rehabilitation patient received (more than 21 days) the higher incremental cost-effectiveness ratio, with an ICER at $26,450 per treatment completed [150]. However, the patients with higher-severity substance use, the more likely that long-term residential rehabilitation became cost-effective, as readmission may result in a higher cost of repeated treatment [151]. In Australia, pharmacotherapy was consistently the most cost-effective treatment at AUD$5,000 per abstinence year, in comparison to residential rehabilitation (76.3 days) at $11,000 per abstinence year and a prison term at $52,000 per abstinence year [154]. If the completion rate in pharmacotherapy was above 95% due to the threat of a prison term for non-completers, then pharmacotherapy (under the incentive of potential imprisonment) may become the most cost-effective option [154].

As shown in **Table 24***,* two studies conducted a CEA using statistical models [150, 151]; two studies used BCA alongside observational studies [152, 153]; and one study adopted CCA using statistical model [154]. They were either taken from government perspective [150, 151] or societal perspective [152, 154]. Short time horizon was used across studies that ranged from 6 months to 1 year [150-154]. The years of abstinence was commonly used for outcome measurement [150, 151, 154]; employment status and criminal activity were included in two studies [152, 153]. Cost-effective threshold was not adopted across studies.

Table 23. Economic Evaluation of residential rehabilitation – summary of findings (N=5)

Reference	Year	Location	Policy	Context	Study results	Sensitivity analyses
Barnett PG & Swindle RW. *et al.* [150]	1997	USA	Residential rehab with different programme characteristic	Lack of studies on residential rehabilitation among veterans.	1. Additional staff per patient was associated with greater cost and no greater effectiveness. 2. Residential rehab that was longer than 21 days have a higher incremental cost-effectiveness ratio ($26,450/treatment 'success').	n/a
Shepard DS. *et al.* [151]	1999	Ohio USA	Short-term rehab/ Long-term rehab/ Intensive outpatient/ Regular outpatient	What public funded substance abuse treatments were cost-effective and which patient groups should be highest priority?	1. For patients with lowest-severity substance abuse, intensive outpatient was the most cost-effectiveness treatment (ICER$40,491/ abstinent year). 2. For patients with middle-severity substance use, short-term rehab was the most cost-effective treatment (ICER$73,323/abstinent year). 3. For patients with highest-severity substance abuse, long-term rehab was the most-effective treatment (ICER$55,013/abstinent year). *Note*: Short-term rehab was 30 days or less; long-term rehab was more than 30 days but less than 1 year; intensive outpatient was provided ≥ 3h/day for ≥ 3 days/week; regular outpatient was less frequent schedule than intensive outpatient.	n/a
French MT. *et al.* [152]	2000	Washing-ton USA	Residential rehab + outpatient care	Very little research focused on the performance of substance abusers in addiction treatments, and measurement of their effectiveness does not reveal cost savings to society.	1. Rehab plus outpatient care generated a benefit-cost ratio of 9.7 ($p<0.01$), indicated that each dollar spent in the treatment yielded an average of $9.70 in economic benefit to society.	n/a
French MT. *et al.* [153]	2002	Washing-ton USA	5 Residential rehabs	To justify the further investment in residential rehab.	Average total economic benefit was $21,329, leading to estimates of $16,418 for average net benefit and benefit-cost ratio was 4.34. *Note*: Three Intensive residential rehabs: 21-28 days for any publicly funded patients; Extended rehab: 60-90 days for more severe patients; and Long-Term rehab: 180 days for polydrug use patients.	n/a
Moore TJ. *et al.* [154]	2007	AUS	Pharmacothe rapy/ residential rehabilitation /a prison term	Research that compared the cost-effectiveness of different policy options that span treatment and law enforcement was little.	1. Pharmacotherapy was consistently the most effective intervention for a given amount of resources. 2. Imprisoning users was consistently the most expensive way for taxpayers to avert a year of heroin use.	1. Pharmacotherapy remined the best performing in all sensitivity analyses, followed by residential rehabilitation and then a prison term. 2. A hybrid model that combined pharmacotherapy with prison (for treatment non-completers) was more effective than prison alone, but completion rates would be at 95%-98% for this combined option to be the most cost-effective.

n/a: not available.

Table 24. Economic Evaluation of residential rehabilitation – summary of methods (N=5)

Reference	Location	Policy vs. comparator	Evaluation method	Economic evaluation							Results	
				Approach	Structure	Perspective	Costs components	Outcome (or Benefit)	Discount rate	Time horizon	Threshold	ICER or others
Barnett PG & Swindle RW. *et al.* 1997 **[150]**	USA	Residential rehab with different programme characteristics vs. Rehab	CEA	Statics	Regression model	Not clear	1. Staff costs 2. Facility costs 3. Ancillary costs 4. Administration costs	Not readmitted to hospital with 180 days of discharge from the treatment	0%	180 days	n/a	$5,007 per treatment 'success'
Shepard DS. *et al.* 1999 **[151]**	Ohio USA	Short-term rehab vs. Long-term rehab vs. Intensive outpatient vs. Regular outpatient vs. Detox	CEA	Static	Statistical model	Government	1. Average treatment reimbursement rate for substance abuse treatments*	Years of abstinent	0%	1 year	n/a	See *Table 11*
French MT. *et al.* 2000 **[152]**	Washing-ton USA	Residential rehab + outpatient care vs. outpatient care	BCA	Observational study (ASI)	n/a	Societal	1. Average treatment reimbursement rate for substance abuse treatments*	1. Medical conditions (days) 2. psychiatric conditions (days) 3. Employment 4. Drug and alcohol consumption (days) 5. Criminal activity (days)	0%	9 months	n/a	9.7
French MT. *et al.* 2002 **[153]**	Washing-ton USA	Residential rehab vs. outpatient care	BCA	Observational study (DATCAP)	n/a	Government	1. Programme costs 2. Other healthcare costs	1. Medical conditions (days) 2. psychiatric conditions (days) 3. Employment 4. Drug and alcohol consumption (days) 5. Criminal activity (days)	0%	6 months	n/a	4.34
Moore TJ. *et al.* 2007 **[154]**	AUS	Pharmacotherapy vs. Residential rehab vs. a prison term	CCA	Dynamic	Statistical model	Societal	1. Programme costs 2. Community corrections costs	Years of abstinent	0%	6 months – 8 years	n/a	$5,000 pharm; $11,000 rehab; $52,000 prison

n/a: not available.

2.3.7 Multi-criteria decision analysis for drug policies

Three multi-criteria decision analysis (MCDA) studies were conducted between 2018 and 2022 [157-159], evaluating different drug policy regimens for cannabis use [157, 159] and heroin use [158]. In practice, a broad spectrum of different approaches was developed to control illicit drug use across jurisdiction, but they could be generalised as four policy regimes, including: 1) absolute prohibition: production, distribution, possession and use are illegal under criminal law; 2) decriminalisation: removal of criminal penalties for the possession and personal use of certain illegal drugs, while production and distribution remain illegal; 3) state control: legal options are available for users to access, possess and use drugs, but legislative interventions may be applied to structure the market and shape the levels and type of use; 4) free market: production, distribution, possession and use are not subject to any regulatory policies, and drug market operates entirely based on supply and demand.

Three MCDA studies were conducted at national level of decision making that evaluated and compared multiple policy options based on suitable criteria (**Table 25**). As drug policy options often received a mix of positively and negatively valued consequences from multiple perspectives in different settings, varied groups of stakeholders were involved in these MCDA studies, including Government, health institute, non-government organization (NGO), academia, legal justice [157-159]. Three extra stakeholder groups were considered in New Zealand – activism, media, and industry [159]. Also, this study used evidence from different resources that was obtained from local healthcare bodies and databases of the US and Canada [159]. Expert opinions and group discussions with stakeholders were considered to be the evidence resource in other two studies [157, 158]. The number of cost criteria in the studies were ranged between three to four, including generate state revenue [157-159], budget impact of the policy [157-159], and costs of introducing and enforcing the policy [157, 158]. Five clusters of benefit criteria included among studies – health outcomes, social impacts, political impacts, public benefits, and crime [157, 158]. The benefit of expanding drug treatment was only considered in one study [159]. One study conducted a discrete choice experiment (DCE), thus participants chose their preferred policy from binary hypothetical scenarios [159]. Eight policy options were described by 5 criteria in the choice set, and weights were calculated based on stakeholders' choice. Other two used MCDA approach that allows participants to directly compare and assess each criterion via trade-offs on a scale from 0 to 100 [157, 158].

Three studies unanimously showed that state control was the most preferred policy option, and conversely absolute prohibition to be the lowest preferred policy option [157-159] (**Table 26**). Two outcome criteria strongly supported the state control over absolute prohibition for both cannabis and heroin use – social outcome and health outcome [157-159]. For cannabis use, highly valued social outcomes were improved community and family cohesion, enabled medical use; and the health outcome was the shift in use to lower-harm products (i.e., synthetic cannabinoids) [157]. In addition, reducing cannabis arrest was considered to be an important outcome of state control [159]. For heroin use, four criteria strongly supported state control over absolute prohibition were international development and security, the reduction of user harms, the shift in use to lower-harm products, and the improvement of product quality [158].

Table 25. Multi-Criteria Decision Analyse (MCDA) in cannabis/heroin legislation – summary of methods (N=3)

			Background		Methods					
Author	**Location**	**Policy**	**Context/ Decision-making level**	**Research purpose (or question)**	**Stakeholder type**	**No. of policy**	**No. of criteria**	**Cost criteria**	**Benefit criteria**	**Evidence**	**Approach**
Rogeberg O. ***et al.*** 2018 **[157]**	Western Europe & North-America	absolute prohibition vs. decriminalisation vs. state control vs. free market **(cannabis)**	Given the complexity of drug policy, MCDA is a new approach for appraising cannabis policy.	What would be the likely outcomes under the different policies considered, and which of these outcomes would be preferable to others – and by how much?	1. Government 2. Health institute 3. NGO 4. Academia	4	27 criteria within 7 clusters	1. Economic-2 2. Policy costs-2 (clusters only)	1. Health-5 2. Social-7 3. Political-2 4. Public-4 5. Crime-5 (clusters only)	expert-led delphic process	Allocate 100 points
Rolles S. ***et al.*** 2021 **[158]**	UK	absolute prohibition vs. decriminalisation vs. state control vs. free market **(heroin)**	The comprehensive evidence on positive/negative heroin-related social/health consequence was limited, which had led to historically skewed policy making towards a narrow focus on prevalence of use and drug-related death as dominant metrics, and reductions in these as the dominant policy goals.	What would be the likely outcomes under the different policies considered, and which of these outcomes would be preferable to others – and by how much?	1. Government 2. Health institute 3. NGO 4. Academia	4	30 criteria within 7 clusters	1. Economic-2 2. Policy costs-2 (clusters only)	1. Health-7 2. Social-7 3. Political-3 4. Public-4 5. Crime-5 (clusters only)	expert-led delphic process	Allocate 100 points
Wilkins C. ***et al.*** 2022 **[159]**	NZL	8 cannabis policy reform options (see **Table 24**)	A national referendum on the legal status of cannabis (use and supply) in NZL.	To inform the debate leading up to the NZL cannabis referendum by conducting an MCDA with a range of key national stakeholders to identify their preferences for cannabis reform outcomes and in doing so rank cannabis policy reform options.	1. Government 2. Health institute 3. NGO 4. Academia 5. Law enforcement 6. Activism 7. Media 8. Industry	8	5 criteria	1. Value of health and social harm 2. Revenue of reduced size of illegal market 3. Earn tax revenue	1. Reduce arrest 2. Expanding drug treatment	expert-led delphic process 1. 2016 New Zealand Drug Harm Index (NZ-DHI) 2. Data from U.S. Canada 3. New Zealand National Committee for Addiction Treatment (NCAT)	Incorporated DCE to weight criteria **Note:** used Potentially All Pairwise RanKings of all possible Alternatives (PAPRIKA)

Table 26. Multi-Criteria Decision Analyse (MCDA) in cannabis/heroin legislation – summary of findings (N=3)

Reference	Policy	Summary of findings	Sensitivity analyses
Rogeberg O. *et al.* 2018 **[157]**	1. Absolute prohibition 2. Decriminalisation 3. State control 4. Free market	1. State control was the most preferred and absolute prohibition was the least preferred regime, whereas a free market was preferred over decriminalisation for cannabis. 2. Four strongest factors favouring state control over absolute prohibition were improved community cohesion, reduced harms from more harmful substances (e.g., synthetic cannabinoids or 'spice'), medical use and family cohesion. 3. Important benefits of a state control regime relative to a free market was that state control was judged to reduce harm to users, protect children and the young as well as vulnerable groups, improve family and community cohesion, and generate state revenue; but state control regime costs more to implement, criminalises more users and may lead to some illicit supply that circumvents taxes and regulations.	The only preferences able to shift the preferred policy were the preferences for concerns relating to either crime or costs. The free market would become preferable to state control if the weight on crime was doubled or if costs was given 15 times its current weight. **Note:** It's done using wing weights. Changes in the wing weight can be assessed for either individual criteria or for clusters criteria.
Rolles S. *et al.* 2021 **[158]**	1. Absolute prohibition 2. Decriminalisation 3. State control 4. Free market	1. State control was identified as the preferred policy regime overall, free market was ranked second of policy regimes, decriminalisation was third, and last one was absolute prohibition. 2. Four criteria strongly support state control over absolute prohibition: international development/security, the reduction of user harms, the shift in use to lower-harm products and the improvement of product quality.	n/a
Wilkins C. *et al.* 2022 **[159]**	1. Prohibition with criminal penalties 2. Prohibition with fines ('like a speeding ticket') 3. Cannabis social clubs and home grow 4. Government monopoly and home grow 5. Not-for-profit trusts with home grow 6. Strict market regulation ('like tobacco') and home grow 7. Light market regulation ('like alcohol' and home grow 8. Unrestricted market ('like soft drinks') and home grow	1. Among 8 policy options, 'Government monopoly' received highest support (81%), followed by 'not-for-profit trusts' (73%) and 'strict market regulation' (65%). 2. Among 5 criteria (see **Table 23**), 'health and social harm' and 'reducing cannabis arrests' received the highest weightings; 'earn tax revenue' received lowest weighting. 3. 'Government monopoly' scored higher than second ranked 'not-for-profit trusts' because of its better performance on the highly weighted 'health and social harm' criteria (45.9% vs. 40.5%).	n/a

n/a: not available.

2.3.8 Contingent valuation in drug policies

Four contingent valuations (CV) were conducted to estimate the willingness to pay (WTP) for different drug policies in the US , Taiwan [160], Australia [161], and Iran [162], with a publication year range from 2000 to 2019.

As shown in **Table 27**, four studies proposed distinctive research objectives and evaluated different policies. In the US, a study attempted to estimate the differences between the mean WTP for two treatment strategies – a programme targeted to women who use drugs and another for all PWUD [163]. Results showed that the general public were willing to pay approximately US$39 (1996 US$) to both treatments, without statistically significant differences between strategies [163]. In Taiwan, the general public were estimated to be willing to pay between NT$81 to $95 per month for a drug treatment, while the benefits of treatment were estimated to be NT$12.8-$15 billion (2004 NT$) [160]. They were more willing to pay for treatments by increasing National Health Insurance premiums than donations. In addition, participants who had a higher household income and lower education level were more willing to pay more than those with a lower household income and higher education level [160]. In Iran, PWUD were willing to pay US$2 (±1) per day for methadone, which equal to 18% of their daily income, compared to participants who were willing to pay US$5 (±2) per day, which equal to 30% of their daily income. The WTP for methadone was fully cost-driven, but for abstinence-based residential treatment was associated with opinions and attributes (i.e. stigma environment in residential rehab) [162]. In Australia, PWUD (and their families) supported the policy of legalising minor cannabis offence, and they appeared willing to pay on average AUD$1,231 (2009 AUD) to avoid stigmatization due to criminal records for either themselves or a loved one [161]. Furthermore, participants who often used cannabis were willing to pay less than those who used cannabis infrequently, which may suggest that many in their social groups might use cannabis so that they were less concerned about the potential stigma [161].

Table 27. Contingent Valuation (CV) in drug policies – summary of findings and methods (N=4)

Reference	Location	Research purpose (or question)	Policy	Sample size	Cost payer(s)	Model estimating WTP	Socioeconomic variables	Research findings
Zarkin GA. *et al.* 2000 **[163]**	Triad & Brooklyn USA	To estimate the WTP for expansions to existing drug abuse treatments.	Drug treatment for all PWUD & for women who use drugs only	393	General public	Regression model	1. Household income (US$) 2. Education level	1. The mean WTP for both types of drug treatments were estimated to be approx. $37 per respondent.
Tang CH. *et al.* 2007 **[160]**	Taiwan	How much the general public was willing to pay for treatment that would be available either to themselves, or others?	Drug abuse treatments	1817	General public	Regression model	1. Household income (NT$) 2. Education level	1. Participants were estimated to be willing to pay between $81.0 and $95 per month for a drug abuse treatment, while the benefits of treatment were estimated to be $12.8 billion to $15 billion in 2004. 2. Participants was more willing to pay for treatments by increasing in NHI premiums than donations.
Shanahan M. & Ritter A. 2013 **[161]**	AUS	To value the willingness-to-pay to avoid stigma from a criminal record for the possession of a small amount of cannabis using a CV method.	Charge (criminal records for minor cannabis offenders)	875	Offenders, Family, loved ones	Regression model	1. Educational status 2. Household income 3. Employment status	1. Respondents were willing to pay on average $1,231 (AUD 2009) [$1,112-1,322] to avoid stigmatization by family, friends and neighbours due to criminal record for either themselves or a loved one.
Moghaddam SA. *et al.* 2019 **[162]**	Iran	To assess the association between economic index and attitudes about substance use and its treatment as indicators of tendency toward the two policies of interest.	Outpatient methadone clinic (MMT) & Abstinence-based residential facilities (RF)	109 (78 in MMT, 31 in RF)	Treatment payers	Regression model	1. Average surface area of residence (m^2) 2.Average monthly income (US$)	1. Participants were willing to pay US$2 (±1) per day for methadone maintenance clinic, which equal to 18% of their daily income, compared to participants who were willing to pay US$5(±2) per day, which equal to 30% of their daily income. 2. WTP for MMT was fully cost-driven, but for abstinence-based residential treatment was associated with opinions and attitudes.

2.4 Discussion

The purpose of this study is to understand how economic evidence has contributed to evidence-based drug policies. The need for the systematic assessment of drug policy options has previously been identified, and especially emphasises the important role of economic evaluation [41, 73, 164]. Previous literature has well recognized that applying traditional economic evaluation frameworks to assess public health policy raises multilayered challenges [83, 84, 165]. Given the complex nature of illicit drug use and the significant burden it imposes on individuals, families, communities, and the wider society, and the resources devoted to treating the negative health and broader consequences of drug use, not only the resource used (cost) and clinical effectiveness, but also the broader factors (e.g., spillover effects) of policy actions should be considered [83, 84, 165, 166]. As such, this review attempted to identify full economic evaluation and other possible alternative frameworks and methods that may have a role to play in the evaluation of illicit drug policy.

To our best acknowledge, this is the first study that comprehensively reviewed all cost-of-illness (*N*=5), cost studies (*N*=9), full economic evaluations (*N*=38), and other methodologies (*N*=10) in evaluating drug policies up to March 2023. A total of six types of drug policies were identified through this review, including legislation (*N*=7), Drug Court programme (*N*=3), pharmacotherapy (*N*=21), supervised drug consumption facilities (*N*=14), needle and syringe programmes (*N*=7), and residential rehabilitation (*N*=5). Due to the fact that policies relating to illicit drugs are often delivered outside of the health sector (i.e. in community or criminal justice sector) and potentially impact multiple societal population groups, the evaluation can be greatly varied upon their implementation settings in which specific aspects of drug problems are addressed. This has made it very challenging to simply conclude that what alternative policy action works better than another in what circumstance. This section is comprised of three major components: economic burden (cost-of-illness), cost and cost-effectiveness of drug policies/interventions (partial and full economic evaluations), and quantitative preference studies (MCDA and CV). A summary of findings in relation to the study results and their applied economic methods is presented in **Table 28** and **Table 29**.

2.4.1 Economic burden of illicit drug use

As COI studies show, drug control has been a costly endeavour for governments – with a significant amount of budget allocated to law enforcement (i.e. direct non-medical costs) and a great loss of potential economic contribution from people who have been incarcerated, experienced sickness leaves from work, or had premature deaths (i.e. indirect costs) [96-99]. Furthermore, illicit drug use has placed a heavy financial burden on the healthcare system (but far less than law enforcement), causing significant costs related to unplanned emergency services for drug overdoses (i.e. ambulance call-out, acute hospitalization) [96-99], and treatment of infectious diseases such as HIV/AIDS, hepatitis C that are often associated with intravenous drug use [100]. The COI results are highly sensitive to cross-national differences in drug policies, service availability, pattern of enforcement, all of which impact the types of costs incurred across different sectors and lead to data inconsistencies when calculating costs between studies. For example, due to the illegal status of drugs almost worldwide, data availability could be more difficult to obtain or correctly collect compared to other substance-related studies (i.e. alcohol and tobacco) [167]. In addition, the approaches used to calculate the costs are highly heterogeneous across studies, which further make cross-national comparisons difficult. Key challenge is they do not provide a framework for comparing alternative policies that limited guidance on which interventions/policies are efficient and worthwhile investing in. Besides, they still provide useful information to policymakers in terms of the overall economic burden and highlight the scale of costs incurred in different sectors. This makes cost of illness studies useful for drawing policy attention and helping policymakers justify the need for investment in new interventions to reduce the burden accordingly [168, 169].

Table 28. Summary of overall findings on illicit drug policies (N=63)

Categories	Methods	Data sources	Economic impact	Key findings
Economic burden	5 COI	Prevalence- or incidence-based routine data	n/a	Drug control policy (criminalisation) has placed a significant burden on the criminal justice system, which is far greater than the economic burden on the healthcare system caused by infectious diseases and unplan emergency service for overdoes.
Cost and cost-effectiveness of drug policy				
A: Law enforcement policy				
A_1: Legalisation	1 CBA	1 Modelling study incorporated secondary data	Cost saving	Cannabis legalisation is cost-saving compared to diversion programme due to less people have criminal records and experience stigma, increase recreational value and government revenue, but increase cannabis and tobacco uses, but legalisation has no substantive difference when compared to decriminalisation.
A_2: Decriminalisation	2 CEA	2 Self-report online surveys	Cost saving	Cannabis decriminalisation is cost-saving compared to criminalisation, because of reduced expenditure in justice sectors, and does not increase cannabis use. Health effects were not included in the evaluation.
B: Public health policy				
B_1: Drug Courts and diversion programme	1 CBA 1 CUA 2 Cost analysis	2 Natural experiments 1 RCT 1 Administrative data	Cost saving and cost-effective	Drug court is cost-effective compared to decriminalisation because of reduced expenditure in justice sectors and to society, and an increase in individuals' QALYs. It becomes more cost-effective if individuals complete the programme compared to those who do not.
B_2: Methadone and buprenorphine	6 CEA 1 CUA 1 CBA 8 Cost analysis	7 Modelling studies 5 RCTs 3 Administrative data 1 Natural experiment	Cost-effective	Methadone expansion is highly cost-effective in high HIV prevalence areas; buprenorphine is less cost-effective than methadone due to its high price. The cost-effectiveness of methadone in prisons is sensitive to staff time; in detox centres, it is sensitive to referral uptakes. Health effects of pharmacotherapy include the reduction in HIV infection and drug use, and improvement of individuals' QALYs.
B_3: Needle and syringe programmes (NSPs)	3 CEA 1 CUA 1 Cost analysis	4 Modelling studies incorporated secondary data 1 Clinical trail	Cost saving and cost-effective	NSPs are cost-effective in preventing HIV/HCV infections and improving individuals' QALYs, compared to not providing NSPs. The number of sharing needles is a sensitive factor to cost-effectiveness, followed by the frequency of injection.
B_4: Heroin-assisted treatment	2 CEA 1 CUA	2 RCTs 1 Modelling studies incorporated secondary data	Cost-effective	HAT is cost-effectiveness in improving QALYs compared to methadone, but highly driven by its price, and savings in justice sectors.
B_5: Safer drug consumption facilities (SDCFs)	2 CEA 2 CBA 2 BCA 7 BCA and CEA	13 Modelling study incorporated secondary data	Cost saving and cost-effective	SDCFs are cost-effective in preventing HIV/HCV and other injection-related infections, overdose deaths, and referral uptakes, compared to do not provide it. The result is sensitive to individuals' injecting behaviours and HIV/HCV prevalence.
B_6: Residential rehabilitation	2 CEA 2 BCA 1 CCA	3 Modelling studies incorporated secondary data 2 Natural experiments	Cost-effective	The cost-effectiveness of residential rehab is sensitive to its implementation strategy. Compared to rehab and a prison term, pharmacotherapy is more cost-effective in increasing days (or years) of abstinence.
Quantitative reference - Values towards drug policy	3 MCDA 4 CV	3 Expert-led Delphic process 4 survey-based	n/a	State control was the most preferred policy option, and conversely absolute prohibition to be the lowest preferred policy option. Two outcome criteria strongly supported the state control over absolute prohibition for both cannabis and heroin use – social outcome and health outcome. Willingness-to-pay for drug policies is diverse between countries and populations.

COI: cost-of-illness, CBA: cost-benefit analysis, BCA: benefit-cost analysis, CUA: cost-utility analysis, CEA: cost-effectiveness analysis, CCA: cost-consequence analysis, MCDA: multi-criteria decision analysis, CV: contingent valuation, RCT: randomised controlled trial. n/a: not applicable.

Table 29. Summary of methods on evaluating illicit drug policies (N=63)

	Opportunities	Challenges
COI	Quantifies the scale of the economic burden; useful for demonstrating the societal impact of illicit drug sue and justifying the need for policy attention or investment in interventions.	Does not evaluate interventions or alternatives; limited policy guidance on resource allocation.
Cost analysis	Assesses and compares direct costs of drug policies/interventions; helpful for budget planning.	Policies/interventions outcomes are not included; limited for informing decision-making.
CBA/BCA	Allows comparison across sectors by expressing all outcomes in monetary; aligns with societal perspective and welfare maximisation.	Monetisation of health and social outcomes can be controversial and methodologically challenging; results sensitive to assumptions about valuation.
CUA	Captures health-related quality of life; enables comparison with other interventions via QALYs.	Narrow focus on health outcomes; may overlook important social, legal, or community impacts of drug policies.
CEA	Compares cost per clinical outcome (e.g., cost per HIV prevented) of alternatives; often feasible with available data.	Outcome-specific; results not easily comparable across interventions or sectors; may overlook broader non-health consequences.
CCA	Transparent presentation of multiple outcomes alongside costs; accommodates broad perspectives including health and non-heath impacts to multisectoral stakeholders.	Lacks a single decision rule; places burden on policymakers to weigh trade-offs; less useful when explicit ranking is needed.
MCDA	Explicitly incorporates multiple objectives and stakeholder preferences; facilitates transparent trade-offs between outcomes.	Requires subjective weighting; results may vary by stakeholder group.
CV	Captures societal and public preferences for non-market outcomes; can value intangible effects (e.g., stigma reduction).	Hypothetical bias and validity concerns; requires careful survey design; may not fully capture complex drug policy contexts.

COI: cost-of-illness, CBA: cost-benefit analysis, BCA: benefit-cost analysis, CUA: cost-utility analysis, CEA: cost-effectiveness analysis, CCA: cost-consequence analysis, MCDA: multi-criteria decision analysis, CV: contingent valuation

2.4.2 Cost and cost-effectiveness of drug policies

Following the economic burden of illicit drug use to the society, in this section, the discussion is concentrated on the results of partial and full economic evaluations, understanding what policy actions have been implemented to reduce the economic burden across sectors of society and whether government funds are efficiently used to implement these policies.

Although the economic burden is heavily dominated in the criminal justice sector, fewer evaluations have been conducted on law enforcement policies (solely focused on cannabis use) [116-118] and where it overlapped with health interventions, such as Drug Court programmes [110, 119, 120], in comparison to public health interventions [102-109, 121-156]. Economic research in relation to absolute prohibition, the drug market, or studies comparing the economic efficiency of different law enforcement policies to reduce drug use and supply are completely absent. The importance of examining the nature of the drug market, including its structure and dynamic, the drug purity and price elasticity, and their relationship with drug-related harms are increasingly distinguished in the area of illicit drugs [41, 170] and other substance use, i.e. effectiveness and cost-effectiveness of minimum unit pricing (MUP) policy for alcohol control [171-173]. While reviewed policies vary in their cost-effectiveness, evidence supports those that decriminalise people who use illicit drugs and divert into healthcare services (**Table 28**: Policy A_{1-2} and B_1). The decriminalisation (by giving cautions, warnings, and civil penalties) or legalisation of cannabis use effectively reduces expenditure in the criminal justice sector by decreasing arrests, court proceedings, and incarceration related to drug offences; reduces stigma towards users (as no criminal act recorded) and increases government revenue through taxation [116-118]. The Drug Courts programmes are estimated to lead to substantial reduction in costs in the criminal justice sector and society (e.g., decrease traffic accidents) and achieve health improvement [110, 119, 120].

Public health policies are strongly supported by the evidence base [102-109, 121-156], particularly those that prevent harms related to intravenous drug use, e.g., HIV/HCV infections (Policy $B_{2-3,5}$), improve general health by proving pharmaceutical-level heroin (Policy B_4), and stop people from using drugs (policy B_6). In those studies, CEA and CUA were frequently applied and provide comparisons between alternatives. As mentioned, however, illicit drugs impact a wide group of people in society, but reviewed studies largely restricted policy impact to patient-centred clinical outcomes in the healthcare system and may overlook important dimensions of policy consequences – spillover effects. Furthermore, the literature has indicated the increasing interest in outcome measurements that go beyond QALYs to take account of intersectoral stakeholders [83, 84, 174] and limited usefulness of generic preference-based measures [175-177]. However, a few challenges remain in doing so. First, *'explicit values are involved in the choice of individual outcomes'* [178]. The evaluation perspective is crucial in determining which costs and outcomes of interventions are analysed in economic evaluation and reflect who is interested in allocating resources for what alternative policy options and to achieve what outcomes. It represents the distinct social or political values between different sectors of society and also the conflicts of interest between them (more reflections in next section 2.4.3), thus lack of consensus on outcomes to be measured. For example, treatment costs and clinical outcomes related to pharmacotherapy (Policy B_2) are evaluated from a healthcare perspective; or social costs and consequences of providing heroin-assisted treatment (Policy B_4), including the costs related to criminal activities, treatment costs, and transportation costs to the healthcare service are concerned in the societal perspective [147-149]; or state revenue, cost reduction associated with criminal justice, and prevalence of drug use in the population for legalising cannabis use is more of interests from a government perspective (Policy B_1). In this review, only one study compared the cost-effectiveness between law enforcement and public health policies. This was in the Australian setting, and showed that pharmacotherapy with 95% completion rate (with prison sentence threatened for non-completers) is the most effective and least costly

intervention in reducing drug use compared to residential rehabilitation and a prison term, separately [154].

Furthermore, stigmatisation, or pain and suffering (e.g., coldness due to homelessness) associated with illicit drug use are often neglected from analyses. It is because of the difficulties to measure those outcomes, but it also seems to reflect that PWUDs' well-being appears to be lower valued than other outcomes that have a large impact on population health, e.g., HIV/HCV. The willingness-to-pay (WTP) is frequently used in economic analysis when a market price is not available – one CV study was included in this review, indicating that individuals are willing to pay on average $1,231 (AUD 2009) to avoid stigma from a criminal record for the possession of a small amount of cannabis use in Australia [21]. This information could help researchers assign a monetary value to intangible outcomes and then incorporate WTP results in economic evaluations.

Evidence on policy effectiveness can be controversial. It would be challenging to determine the effects (consequences) of substantial policy change where experimental studies are often not conducted. The absence of randomised controlled trials (RCTs) of drug-related intervention (or policy) is because of ethical considerations (i.e. the difficulty of randomising either individuals or sites to receive or not receive the treatment); and that RCTs are less suitable for complex interventions (i.e. the difficulty of isolating treatment effects without their implementing context) [179, 180]. Reviewed studies commonly adopted modelling incorporated with secondary data in economic evaluation to forecast potential consequences of such policy changes in their settings, but one may question the uncertainties around the secondary data which would make it difficult to draw any firm conclusions from a simulation. For example, prediction on the cost-effectiveness of legalizing a SDCF compared to the standard care can be very challenging, as facility effectiveness heavily depends on implementation context and system-level interactions (e.g., treatment effects can be varied among geographical locations with different epidemiological characteristics) [131-133]. Where experimental design is feasible, economic evaluation alongside natural experiment is one of the recommended practices [83, 180, 181], although the natural experiment is often questioned by its potentially biased estimation of causal effects of the intervention, thus may be lowering the quality of effectiveness and cost-effectiveness (detailed discussion see Chapter 3, taking SDCF as an example).

2.4.3 Quantified reference towards drug policies

As discussed, the direct treatment costs and effectiveness are the main (and often only) criteria taken into account in the traditional cost-effectiveness analysis (commonly expressed as cost per QALY), often neglecting effects beyond that, such as indirect costs related to drug policies and patients' loss of productivity identified from COI studies. These overlooked effects can lead to an unfair view of the actual cost-effectiveness of drug policies.

Given the complexity of drug policies and a wide range of outcomes of interest to intersectoral stakeholders, the MCDA provided decision-makers with a framework for evaluating alternative courses of action that require the consideration of multiple criteria, some of which may be in conflict with each other [83]. In this review, three MCDA studies evaluated cannabis policies and heroin policies, involving multiple stakeholders such as government, health institutes, NGOs, academia, law enforcement sector, activism, media, and industry, and evaluated a wide range of costs and benefits (criteria) associated with sectors of society [157-159]. However, further research is required for two reasons. Although reviewed studies indicated that state control was strongly preferred over absolute prohibition, considerable gaps remained in regard to understanding of full consequences of the different law reform options as outcome levels of MCDA were projected rather than precisely estimated. For example, the results of economic evaluations can be integrated as one of the criteria in the MCDA framework. As discussed earlier, however, the consequences and cost-effectiveness of drug policies were largely underexplored based on the exiting evidence. In addition to this, some

have also criticised the methodological challenges of MCDA, such as weighting approach and validation, multi-stakeholder discussion, and quantifying the impact of uncertainty, difficulty interpreting the MCDA output [83, 182].

There is some evidence reflected the general public's preferences for drug policy interventions [160-163]. The general public showed their willingness to pay for treatment programmes, with varying values across countries, and socioeconomic factors such as income and education levels that influenced WTP values. Avoiding the stigma of a criminal record for cannabis use motivated higher WTP for the decriminalisation policy of possessing a small amount of cannabis compared to criminalisation. Overall, studies show that social attitudes played an important role in shaping drug-related policies.

2.4.4 Methodological considerations

Given the discussion in section 2.4.1-3, this review highlights that each economic method offers useful insights but also faces challenges when applied in the field of illicit drug use (**Table 29**). COI studies are valuable for quantifying the scale and distribution of the economic burden of drug use across sectors and for drawing policy attention, however, by adopting a descriptive approach and lacking comparators, they provide limited guidance for decisionmakers on policy/intervention choice. In terms of economic evaluations, a key methodology challenge arises in relation to the choice of analytical perspective. CEA and CUA were most commonly applied among reviewed studies, but they are frequently restricted to a healthcare perspective to meet payer requirements (e.g., NHS) and comparing interventions against a status quo or 'do nothing' comparator. While this facilities assessments of efficiency within the healthcare sector, such evaluations are constrained by their limited ability to capture broader social, criminal justice, and community-level consequences that are also important elements to impact decision-making. Furthermore, the adoption of QALYs as the primary outcome measure may inadequately reflect outcomes that are particularly relevant in the policy context, such as reductions in stigma, improved safety, and community wellbeing, thereby limiting the extent to which CUA results align with wider policy objectives (or benefits).

CBA/BCA were often adopted in where a broad perspective was taken, enabling comparisons by monetising diverse health and non-health outcomes across sectors. While this approach offers greater scope to reflect the intersectoral impacts of drug policy interventions, the valuation of health, social, and criminal justice outcomes in monetary terms remains methodological challenging and ethically contested. More descriptive approaches such as CCA are attractive because they present a broad range of intersectoral outcomes alongside costs, but they can be limited to their lack of a clear decision rule when difficult trade-offs are needed. As such, the Medical Research Council (MRC) guidance has suggested that the use of multiple economic evaluation frameworks (e.g., CBA and CCA) in a societal perspective would provide decision makers with a comprehensive and multi-perspective guide to the cost-effectiveness of interventions [180].

Approaches like MCDA and CV offer opportunities to integrate multiple dimensions of value and stakeholder perspectives, making them useful in contexts where drug policy decisions are contested and multilayered. These methods are particularly relevant in contexts where policy choices extend beyond health outcomes and where perspectives of affected communities (e.g., general public) are incorporated. At the same time, their reliance on strong assumption, robust elicitation techniques, and substantial data requirements presents challenges for routine application in policy settings.

Overall, this review finds that the majority of studies conducted an economic evaluation with a narrow healthcare perspective, which may undervalue interventions/policies by failing to account for the 'spillover effects' in the criminal justice and social care sectors that are often part of policy goals. Given the strengths and limitations, no single method is sufficient to fully capture the complexities of drug policies and a mix of methods should be applied in a complementary way to

assist decision-making [83]. While CEA and CUA remain useful for decisions focused on efficiency within the healthcare sector, the evidence of cost-effectiveness alone cannot determine whether the policy should be adopted or not. Approaches that account for wider societal outcomes and stakeholder perspectives can further provide policymakers with richer and balanced information, for example, public opinion, contested values, and priorities of people who use drugs play a role in decision-making.

2.4.5 Strengths and limitations

Despite growing interest in evidence-based drug policy, to our best knowledge, this is the first study that has comprehensively reviewed the economic evidence in relation to illicit drug policies, including cost-of-illness, full economic evaluation, cost analysis, and other methodologies in assisting decision-making. Given the complex nature of illicit drug use and the significant burden it imposes on individuals, families, communities, and the wider society, the current study not only attempts to synthesis the evidence in regard to resources devoted (cost) and clinical effectiveness of treating the negative health consequences of drug use, but also the broader consequences (i.e. spillover effects) of policy actions have been (or not been) considered in the existing health economics research.

This study has a few limitations. First, heterogeneity among reviewed studies, in terms of policy options, target populations, and outcome measures, has made direct comparison difficult and limited the ability to conclude that what alternative policy action works better than another in what circumstance. Furthermore, implementation contexts across countries or regions can also affect the generalisability of findings. Second, publication bias may further affect the evidence base, for example, drug policy changes are often introduced in response to political and social pressures, thus research funding or agenda may be diverted more by political priorities than the scientific inquiry, potentially leading to selective evidence.

Another limitation is the quality and design of reviewed studies. Most of the evaluations are observational or simulation-based, with limited use of control groups or real-world data, raising concerns about evidence robustness. Long-term impacts of drug policies are often not captured among reviewed studies, making it difficult to assess the sustainability or long-term outcomes of policies. Although the CHEQUE tool provides a structured framework for assessing the quality of economic evaluations, its methodological assessment is heavily weighted towards the domains of modelling techniques (particularly through items M9-M13, M22-M23). It lacks sufficient criteria tailored to the appraisal of trial-based economic evaluations without incorporating modelling. This limits its sensitivity and may lead to an incomplete or skewed assessment of studies that do not employ the decision-analytical or mathematical modelling, thereby undermining its effectiveness in capturing the full methodological rigour of diverse economic evaluations.

2.4.6 Future direction for research

Drug policy implementation varies from one country to another, reflecting different expectations, aspirations and resources in different social and political settings. In the past decade, attitudes towards illicit drug use have been evolving partially as a result of policy change in some countries, such as Dutch '*coffee shops*' in the Netherlands [183], Commissions for the Discussion of Drug Addiction in Portugal [184], and the use of cannabis for medical reasons in the United States [185] and Thailand [186]. Meanwhile, there are growing calls for drug policy reform in other countries. In Spain, major government budget was spent on healthcare services with a dramatic reduction in the criminal justice sector [100], in line with multiple Spanish drug law amendments enacted in 2010 [187]. In 2023, British Columbia (Canada) began a three-year pilot programme of decriminalising small amounts of drugs for personal use [188], which might have lightened the burden in the criminal justice sector, with more resource re-allocated to the healthcare system [189].

While these countries are progressively moving towards drug policy reform and advocating for decriminalisation, the reviewed literature in the current study does not fully address questions related to the cost-effectiveness of the drug policies. More questions remain for future research. First, it would be useful to conduct more economic analysis to learn the potential cost and consequences of these legislative policies in illicit drug use. Such analyses could inform policymakers about the cost-effectiveness of alternative drug policies that support evidence-based decisions. Second, while reducing illicit drug use is an intrinsically desirable societal goal, it is most likely – given the evidence reviewed in the current study – that a dual approach may be worth to further investigated, whereby both policy options (enforcement of legal while supportive of individuals' wellbeing and holistic recovery approach) as complementary components to a wider strategy in the future. There have been no such studies to date so any countries which do adopt a dual approach or consider testing it, could build in an analysis (e.g., economic evaluation alongside an observational study or a natural experiment) together evidence on this approach. Third, further work is warranted to develop and apply broader approaches, such as quantified preference methods (e.g., MCDA and CV) that better capture wider societal considerations, ensuring that economic evidence speaks directly to the complex, contested, and multilayered nature of drug policy decision-making.

Chapter 3 The Consideration and Challenge of Implementing a Safer Drug Consumption Facility (SDCF): a review of the literature

3.1 Introduction

The European Monitoring Centre for Drug and Drug Addiction (EMCDDA) defines safer drug consumption facility (SDCF) as '*protected places for the hygienic consumption of pre-obtained drugs in a non-judgemental environment and under the supervision of trained staff*' [190]. The initial purpose of establishing a SDCF was to tackle high HIV prevalence related to those specific high-risk individuals who inject drugs in public spaces [190]. In 1986, the first officially approved SDCFs in Switzerland as a reaction to the ongoing HIV/AIDS epidemic among people who inject drugs (PWID) [191]. SDCFs were then introduced in many other countries. Switzerland and the Netherlands scaled up the number of SDCFs, ensuring a nationwide coverage of facilities for PWID in the 1990s; Australia and Canada established their SDCFs in cities with a high proportion of PWID in the early 2000s, i.e. Sydney and Vancouver [190]. To date, there are over 200 legalised SDCFs in operation mostly across the Global North in 14 countries: Australia, Belgium, Canada, Denmark, France, Germany, Iceland, the Netherlands, Norway, Portugal, Spain, Switzerland, Ukraine, and the USA [192].

The logic model of how the SDCF is intended to work is shown in **Figure 4** [193], which elaborates on four components: assessment and intake, supervised consumption area, other service areas, and referral. Accordingly, the outcome objectives of facilities are proposed in three main aspects, including to 1) identify and establish contact with PWUD; 2) prevent the immediate risk of using drugs, improve general health, and reduce public nuisance; 3) promote drug treatment engagement, with an overall goal to increase PWUD's long-term survival and social integration.

The service provision in SDCFs have expanded massively and functioned in varied ways to serve different purposes across different settings, such as the supervised smoking facilities for crack cocaine and other simulants use in Canada, and facilities provide injecting, inhalation and intranasal use in the Netherlands [193, 194]. As such, the facilities are named differently across jurisdictions, for example, 'overdose prevention centres', 'supervised injection facilities', 'supervised consumption services', 'safe injection sites', 'safe consumption sites', 'safer injection facilities; and the term 'drug consumption rooms' is commonly adopted in the scientific literature for the description of this broad type of facility [190]. The 'supervised drug consumption facility (SDCF)' is an official term used by the Scottish Government [195].

The implementation of SDCFs still remains limited. First, conflict of interests between punitive drug law and harm reduction principles [196] (as discussed in Chapter 1&2) and the "not in my backyard (NIMBY)" phenomenon, limit some countries' ability to open SDCFs [197]. Second, even where SDCFs have been opened widely, accessibility of the facility could be one of the biggest obstacles for some PWUD, e.g., the location of the facility and the model of care it provides [196, 197]. Third, despite that no overdose death has ever happened in any facilities worldwide [193, 195], the concerns about SDCFs' effectiveness in preventing harms at a population-level are frequently raised [198].

This literature review seeks to map out emerging themes in relation to SDCF service models (and their components), evidence of effectiveness, and knowledge gaps that need to be addressed to promote the operation of SDCFs. It aims to generate a profile of existing literature on the topic of operating SDCFs, as a foundation for further research in Chapter 5 and Chapter 6. As such, this

review does not attempt to systematically synthesize findings or assess the quality of individual studies, rather it addresses the following questions:

I. How are SDCFs designed and implemented worldwide?
II. What is known about stakeholders' perspectives in relation to SDCFs' service design and implementation?
III. What are the outcomes or consequences of implementing SDCFs?
IV. What is known about public perceptions of implementing SDCFs in the Scottish context?

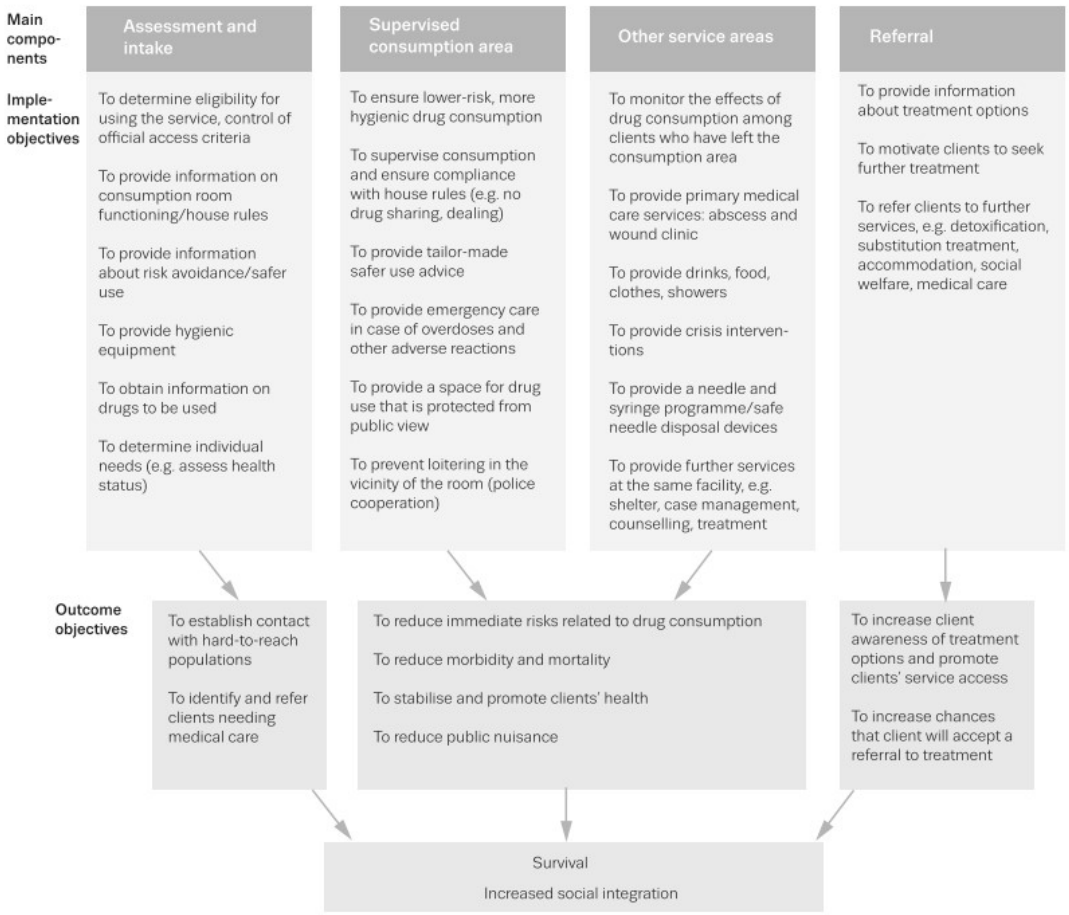


Figure 4. *Service programme of a SDCF, adapted from EMCDDA 2018, source: [193]*[iii]

3.2 Methods

An electronic search for available literature was run on 18 December 2022. Searching was conducted using the database MEDLINE(Ovid) with no restriction for publication date. Search strategy is shown in **Table 30**. Grey literature was also searched on Google.

A total of 330 articles were retrieved by the search and no duplication was found using the Mendeley Reference Management Software [199]. The Rayyan Review platform [200] was used to screen titles, abstracts and full-text. Sixty-two papers were considered relevant to the research questions after full-text screening, but author only selected and summarised the most up-to-date review studies, and key papers not included in these reviews.

[iii] Adopoted from EMCDDA European Monitoring Centre for Drugs and Drug Addiction. Drug consumption rooms: an overview of provision and evidence (Perspectives on drugs) 2018 [updated 07.06.2018. Available from: https://www.euda.europa.eu/publications/pods/drug-consumption-rooms_en.

Table 30. Searching strategy – literature review

	Searching terms	No. of papers
1	"fixing room*".mp.	1
2	"overdose prevention site*".mp.	35
3	(("supervised consumption" or "supervised injection" or "safe* consumption" or "safe* injection" or "drug consumption room*" or "medical supervised injection") adj (center or centre or site* or facility or facilities or room* or program)).mp.	307
4	1 or 2 or 3	330

3.3 Results and Discussion

3.3.1 Operating models

This section summarises and compares existing facility models that have been implemented worldwide in **Table 31**.

3.3.1.1 Stand-alone SDCFs

The stand-alone model provides a narrow range of services that primarily focuses on drug consumption behaviours. These SDCFs are often located near to places that are known as having prevalent illicit drug use. The service includes the provision of hygienic injecting equipment, advice on health and safer drug use, intervention in case of emergencies (e.g., oxygen and naloxone), external referral pathway to addiction treatments, and an area where service users stay for a while under observation after drug consumption. There are two well-studied stand-alone services in scientific research – one is the Medically Supervised Injecting Centre ('*MSIC*') that has been opening in Sydney, Australia since 2001 [201], and another is the *'Insite'* that has been opening in Vancouver, Canada since 2003 [202].

The typical stand-alone facility follows a three-step admission procedure: 1) Reception staff determine whether potential users are eligible for accessing the facility; 2) Eligible users then need to read and sign a declaration that they are aged 18 years or older; 3) Users who first-time visit the facility have to make a registration on reception, and later they can attend the facility anonymously with a unique registration number. Sterile equipment is distributed to users who enter the consumption rooms. After injection or inhalation, users can leave drug-taking booths and visit professionals who are available in another space to provide information and/or referrals to addiction treatments in external agencies.

There might be some variations of service provision between stand-alone facilities. For example, *'Insite'* offers drug testing service onsite and safer supply service that provides medical grade heroin and fentanyl to people who at high risk of overdose [203]. While in the '*MSIC*', users can use the service only if they meet the specific criteria, i.e. individuals must have a history of injecting drug use, not be accompanied by children, and not intoxicated [204].

3.3.1.2 Mobile SDCFs

The mobile model contains some of the functionality of the stand-alone model but without a fixed site. They are generally built into a specifically fitted-out van that comprises serval injection booths, with first aid equipment for reversing overdose and other adverse health events, including naloxone kits, antidote, and defibrillator. The operating rules of mobile facilities are consistent with fixed site SDCFs (e.g., supervised injection).

This type of facility more commonly exists in European countries, and the service can be differentiated in accordance with users' needs [205-207]. In Spain, the mobile unit (Bus) has been operating since 2005, and relocated serval times in areas where drug dealing was reported [205]. The German mobile facility offers spaces for both injection and nasal use [207], the Spanish and Danish mobile facilities only allow injection consumption [206, 207]. In general, the care provided

in the mobile SDCFs includes information on safe injection practice, naloxone, sterile injecting equipment, and informal psychological support, and external referral pathways [205-209].

In the UK, the first and widely known unsanctioned mobile SDCF was operated by Peter Krykant in Glasgow City between September 2020 and May 2021 [208, 209]. It had two injection seats and ran 4 days per week (10am to 3pm) with high demand. In addition, it provided food and clothing distribution, wheelchair replacement for users with limited mobility, and offered assistance to find veins to inject [209].

3.3.1.3 Integrated SDCFs

In comparison to stand-alone and mobile facilities, the vast majority of SDCFs are embedded within a wider range of services. They are mainly located in existing harm reduction programmes (or social service) alongside a series of services, including general medical care, drop-in service with needle and syringe programmes (NSP), Blood Bone Virus (BBVs) testing, counselling, and welfare support (i.e. housing); and users can also be referred to more extensive services if necessary.

Integrated SDCFs intend to establish a 'one-stop-shop' service model that provides access to multiple services on top of supervised drug consumption within the same location. For example, a SDCF is opened to target immigrants and refugees whose disadvantaged situation in society often leads to drug problems in the Netherlands, with poor health conditions and being homelessness [210]. Therefore, the service configuration requires multi-level functions to meet service users' needs – a SDCF is not only a hygienic place for drug consumption, but also a shelter that provides food, a bed, and general healthcare service (e.g., wound care) [207, 210]. Some SDCFs focus more on engaging PWUD with healthcare services – the SDCF is integrated into existing medical service and is more likely to identify and refer clients who need medical care, increase clients' awareness of treatment options and promote access to services [207].

Two recently opened public-hospital-based facilities is located in Paris and Strasbourg, France [211]. In Paris, the SDCF comprises 12 booths for injection and 4 booths for inhalation, with time limits of 20 minutes for each consumption, and provides medical and social consultations and referral to external drug treatments [211].

3.3.1.4 Unsanctioned SDCFs

The unsanctioned SDCFs refers to any facility not formally legalised through agreement or approval of relevant authorities or local government. They are usually run by current or former drug users (peer-led facility) but variously tolerated by police, so far have been reported in Scotland [208], the Netherlands [210], Canada [212-214], the USA [215], and Australia [216].

The establishment of such facilities is largely in response to overdose deaths [208, 212, 215], HIV/HCV transmission and public injecting [208, 210, 213, 216], and harms associated with smoking [212, 214] in countries (or cities) without supportive legislation and regulations. The facility can be provided in a mobile van [208, 210], a tent [214], space within existing organisations, and has been documented in renovated bathrooms [215]. They are often set up near public injecting areas [212, 213, 216]. Service provision and facility rules can be different in regard to their purposes, e.g., smoking of drugs is not allowed in some facilities because there is a lack of ventilated equipment in an underground facility [215].

3.3.1.5 Summary

A comparison of different facility models is summarised in **Table 31**. In general, integrated and stand-alone SDCFs have similar services provided to users. The major difference is that integrated SDCFs operate within a space with a broader range of services; however, stand-alone SDCFs solely focus on drug consumption behaviours (e.g., provide sterile equipment, information on injection practices), so that service users with other healthcare requirements have to take a referral pathway

to the external services that outside of SDCFs. In comparison to the stand-alone model, an integrated facility is potentially more likely to meet PWUD's complex needs through providing ancillary services in one location. It is important to consider, however, what existing services are feasible to integrate with SDCFs. The mobile facility functions as a simplified stand-alone model that aims to reach to the population who are less likely to travel long distances to use the service. Benefits of mobile SDCFs include confidentiality, offering flexibility of operating hours and locations, ability to respond to changes of drug use patterns/locations and to be more accessible for rural PWUD; but its limitation is also consistently criticised such as low capacity, limited ability to offer ancillary services [217].

A review study has found some variation in PWUD's preference between different facility models, with a tendency of preferring a SDCF model that either integrated with harm reduction programmes, community health centres [217] or a stand-alone model solely focusing on supervised drug consumption. Mixed opinions have been found expressed regarding where SDCFs should be integrated, for example, in a formal medical setting, which largely arise concerns about a potential stigmatising environment and relationships with clinical professionals [217]. To balance benefits and limitations of each model, several studies suggest a hybrid SDCF model that has a permanent location alongside a mobile one for outreach [218, 219]. This recommended model centred on concerns that drug use is complex and ever changing, and that hybrid SDCFs can be responsive to such changes.

To summarise, existing studies have provided insightful information, but the optimal facility design and implementation strategy are ultimately dependent on local context and local preferences, with an essential understanding of legal barriers to fulfil those preferences.

Table 31. Comparison of SDCF service model types

		Stand-alone SDCF	**Integrated SDCF**	**Mobile SDCF**	**Unsanctioned SDCF**
Facility goal		Focus on SDCFs' fundamental principle: supervise PWUD using drugs.	Extend SDCFs' functions by attaching facility with exist services.	Simplify stand-alone SDCFs based in a mobile van with unfixed location.	Emergency response to drug-related harms without legislative approval.
Target population		PWUD, with a particular focus on high-risk behaviours of injecting (and in some cases, inhaling or smoking) drugs.	PWUD who has complexity needs (e.g., SDCFs integrate into social agency where homeless PWUD can be beneficial from).	Most marginalised PWUDs: unwilling or unable to attend fix-site facility (e.g., long travel distance).	Any PWUD as it is usually peer-lead low-threshold service.
Model components	Drug consumption booths	√	√	√	√
	Ancillary services	× (often include external referral)	√	× (limit external referral)	× (limit external referral)
Advantages		Not Available	• Multiple services in one site • Existing relationships between PWUD and potential social services • Potential for more public support than a standalone model	• Flexibility of opening hours • Flexible location • Confidentiality • Ability to response changes of drug use patterns/locations • More accessible for PWUD live in rural areas	• Flexibility of opening hours • Flexible location • Confidentiality • Ability to response changes of drug use patterns/locations • More accessible for PWUD live in rural areas
Disadvantages		• Not acceptable for stakeholders who do not believe standalone model would address drug problems	• Might not be able to coverage users' needs within one facility	• Limited capacity due to long waiting time for service • Limited ability to offer ancillary service • Lack of supervised smoking in some cases	• Limited capacity due to long waiting time for service • Limited ability to offer ancillary service

SDCF: supervised drug consumption facility, PWUD: people who use drugs.

3.3.2 Facility components

Investigating good practices for service delivery in SDCFs might be helpful to increase the service access and address the implementation issues. This section explores essential considerations on design components of SDCFs among published feasibility studies, including facility structure, rules and regulations, staff model, and ancillary services, as summarised in **Table 32**.

3.3.2.1 Structures

Preference on facility structures has been investigated in numerous qualitative studies with PWUD and other relevant stakeholders [217, 220-223]. Studies report that, to increase service accessibility, multiple SDCFs may be required for cities with multiple areas with concentrated drug use and purchasing, or places that PWUD frequently access, e.g., health facilities, emergency services, public transportation and social services [217]. An appropriate location of SDCFs to deal with demand would eliminate two concerns. First, local residents and businesses expressed concerns about long queues outside the facility might cause public disorder problems [217, 220, 221]. Second, most PWUD are unwilling to travel a long distance to access SDCFs in Canada and the USA – they stated that they preferred to walk or take the bus for less than 15-30 minutes [220-222]. Free transportation to SDCFs is suggested in a Canadian study to overcome travel barriers [217], but could raise legal challenges to do so in other jurisdictions.

Preference for opening hours has been reported in Canadian studies, including 24 hours a day and 7 days a week, 8am to 4pm for daytime hours, 7pm to 9am for overnight [217, 223]. Kryszajtys *et al*'s 2022 scoping review suggests to have a minimal waiting time to access to facilities because of withdrawal symptoms, but the amount of acceptable waiting time was not investigated [217]. Furthermore, review study shows that most PWUD preferred a facility equipped with both smoking and injecting spaces due to mix pattern of drug use, but felt that these spaces should be in separate rooms to avoid the exposure to different routes of drug consumption. Other facility structures such as privacy, chill-out rooms, and physical accessibility were also considered to be important space layout for people with different drug use preferences.

3.3.2.2 Rules and regulations

A scoping review conducted in 2021 has given a comprehensive summary of stakeholders' opinions about a variety of operation rules and regulations [223]. It reported that stakeholders generally expressed their support on rules that allow assisted injection and all forms of drug consumption. Opinions were mixed on rules of on-site drug sharing (PWUD may be exposed to a risk environment when drug sharing is permitted) and age restriction.

Gender-specific models (women-only hours or spaces) were suggested in some studies [224, 225], to reduce risk of violence, gendered discrimination, and legal liabilities of pregnant women using SDCFs (e.g., charges of child endangerment). Rules and regulations were investigated in two review studies [224, 225], including discussion related to pregnant users, intoxicated users, users receiving opiate substitution treatment (OST), number of visits per day (or number of injections per visit), mandatory supervision, children on-site, but more research is needed to examine the potential outcomes associated with certain rules and regulations.

3.3.2.3 Staffing and ancillary service

One study explored the composition of staff among potential service users and other stakeholders, reporting that people generally support SDCFs hiring nursing staff and peers with living and lived experience of drug use [217]. Additional staffing preferences were recommended by potential service users, their families, and the general public, such as security (staff protection, safety of neighbouring community, etc), outreach workers (engage PWUD with SDCFs), and liaisons (to external services) [217].

Three Canadian studies suggested a number of ancillary services that were considered important to provide alongside the SDCFs [217, 225, 226], such as drug checking, opioid prescription, blood-borne virus testing, health and social services (see details in **Table 32**). The decision on additional services could be impacted by the SDCF models, for example, PWUD can benefit from a healthcare-centre-based SDCF with provision of general healthcare service and/or drug treatment. However, one study found that some PWUD thought accommodating both drug treatment and SDCF under one roof might be triggering them to drop out of drug treatment, because they afraid of being in close proximity to SDCF could distract them from continuing their treatment [217].

3.3.2.4 Summary

The facility components are primarily collected from two scoping reviews [217, 223], and summarised in **Table 32**. A greater number of studies included in these reviews are conducted in Canada, and a few in the USA, Australia, and European countries (e.g., France, Portugal, and Ireland). They provide plentiful information regarding facility design and implementation strategy through interviews with various stakeholder groups (e.g., PWUD and clinical staff).

It is difficult to give a concise conclusion of optimal SDCF service design due to diverse perceptions across individuals and settings; for example, smoking booths might be an important facility component for those who frequently smoke crack cocaine compared to those who mainly inject drugs [217]. Second, the discussion has been focused on location (where SDCF could located) and potential ancillary services that could be provided alongside the SDCFs, and the staffing mode. The idea and tolerable travel time, waiting time, and visiting time (e.g., frequency to use facility per day) for PWUD remain largely underexplored. Research is needed to understand whether the time PWUD spend on travelling and waiting for the facility to open impacts their willingness and satisfaction with using the facility. Third, there may be a difference between willingness and actual experiences.

Most of the primary studies included in the reviews were conducted as a feasibility study [217, 223], which indicated that perceptions (willingness) of facility design were collected before facility implementation; and they may change after using the service (experience). In comparison to existing SDCFs (in section 3.3.1), there are some variations between what PWUDs expect to be offered in SDCFs and what is actually offered; for example, some PWUD would prefer a SDCF provides assisted injection which is hard (or impossible) to achieve in most of the countries due to law and legislation [223]. Overall, the SDCF service design is highly context-dependent and requires a clear understanding of potential and/or actual users' preferences regarding design features that best meet their needs.

Table 32. Summary table of facility components for supervised drug consumption facilities (SDCFs)

	Components	Options or description
Structures	Location	• Area with high levels of drug use and drug dealing • Area closes to essential services (e.g., A&E, healthcare centre, social service, etc)
	Hours of operation	• 24 hrs/7days • Daytime (8am-4pm) • Overnight (7pm-9am)
	Access	• Travel time: How long does it take for individuals to travel to access the facility? E.g., <15-30 mins • Waiting time: How long do individuals need to wait in the facility before using injection booths?
	Space allocation	• Injecting booth • Inhalation booth
	Interior layout	• Chill-out rooms or private cubicles
Operating mode	Staffing	• Security staff • Clinical staff (doctor, nurse, counsellor) • Staff with living /lived experience • Outreach workers
Rules and Regulations	Support female drug users	• Women-only opening hours • Women-only space
	Age restriction	18 years old and over – Youth lack of knowledge on drug consumption
	Visiting time	How long can users stay in the facility? How many visits are allowed per day? How many times of drug consumption are allowed per visit?
	Mandatory supervision	Aftercare prevents overdose
	Users on treatments	Should PWUD on drug treatments be allowed to access DCRs?
	Assisted injection	Assist on drug consumption may be required because of disability or other reasons
	Sharing drugs	Sharing between users
Ancillary services	Drug checking	Prevent harms associated with consuming an unknown substance
	Harm reduction education	Information on drug-related harms
	BBV testing and relevant treatments	Prevent BBV transmission
	Supplies on basic living needs	• Food, clean clothing, etc
	General healthcare services	• Wound care, chronic health condition management, etc
	Drug treatments	• Detoxification, opioid antagonist treatments, withdrawal services, etc
	Social support	• Housing, employment, volunteer opportunity, etc

3.3.3 Key stakeholders' views

3.3.3.1 Overview of stakeholder views

Policy decisions are not always made based on the best available and up-to-date scientific evidence [54, 227]. In the case of implementing SDCFs, for example, Scotland has campaigned for seven years to obtain legal approval to open a pilot facility in 2024 [228], even though an increasing amount of scientific research has demonstrated their effectiveness [229, 230]. One of the key challenges in the development of SDCFs is that they are inherently political, with public and political support difficult to secure. The perceptions and concerns of those potentially affected – such as local residents and business owners where a facility could be located, play an important role in the policymaking process, particularly when scientific evidence may not fully address those concerns and broader social impact [231-233].

A qualitative study with 20 interviewees suggests that people generally support SDCFs on solving problems of drug-related harms for PWUD, but also reject to situate a SDCF near their particular community or in any residential areas [234]. Similar perspectives are reported in needle exchange services that NIMBYism (not in my backyard) is considered to be driven by a 'culture' of stigma and discrimination [235]. Some local residents are concerned that a SDCF could encourage drug use or lead to more PWUD gathering near the facility and their neighbourhood, linked with concerns about safety and community wellbeing [236]. Conversely, some supportive views were found among local residents and businesses owners in Sydney (58%-70%) and Ontario (60%) where SDCFs have been operating for many years; and they deemed that there was less drug use and syringe waste in the public area after the facility was implemented [237-239]. Regarding divided views across studies, researchers claimed that public perspectives on operating SDCFs commonly fluctuated according to whether there is a facility in their community – people who live in areas where they do not have a SDCF and are being asked about the hypothetical, and are often concerned that it might enable drug use [236, 240, 241].

In regard to care modes of the facility, considerable sceptical views have been expressed that SDCFs would not bring additional benefits to existing harm reduction services but cause extra problems [241], e.g., a fireman was interviewed in a Canadian qualitative study and he questioned about the inhalation space in the SDCFs – '*You're not getting, you know, AIDS, or any other communicable disease from smoking, you're getting it from needles, so why would you need a safe smoking site?*'. Moreover, some police officers suggested that there would be an unfair discrepancy if people were allowed to smoke illicit drugs in a facility while cigarette smokers would not be given the same consideration, and other issues related to the aspect of staff safety (e.g., prevent staff exposure to second-hand crack smoke) [241]. A qualitative study conducted in four US counties highlights concerns raised by policymakers, suggesting SDCFs should not get priority over expanding existing harm reduction programmes and other services that improve and support access to health care (especially the drug treatments) [240].

To conclude, engagement with stakeholder groups is very important for opening a new SDCF throughout the planning and implementation phases. Among reviewed studies, in general, the general public (e.g., local residents, businesses) paid more attention to the impact of the facility to the surrounding community; while people who were directly involved in the facility operation (e.g., staff, policymakers) generally expressed concerns about the facility design, such as linkage and referral pathway, service rules and regulations. While SDCFs may differ under various geographic context and local policy, their core goal as a harm reduction intervention is to reduce unhygienic environment exposure and risk of overdose death, which may also provide benefits for the whole society. Previous studies suggest that carefully presenting the potential benefits of SDCFs, including for the general public themselves, may be helpful for eliminating

misconceptions and reducing concerns, thereby increasing support [231, 232]. Also, focusing on service components that address the preferences of those who the facility is intended to serve may improve the acceptance and uptake among them and then effectively reduce the drug-related harms.

3.3.3.2 Scottish context

Discussion on SDCFs has been continuing for years in Scotland, with major attention on the legal barriers under the Misue of Drugs Act 197 and stakeholder perceptions of implementing such facilities in the Scottish context. Three qualitative studies have been done to investigate different stakeholder groups' perspectives (or attitudes) towards SDCF [242-244]. Nicolla *et al* and Trayner *et al* suggest that opening SDCFs in Scotland is strongly supported by PWID, their families and decision makers [242, 243]. However, evidence also identified key obstacles to SDCFs' implementation in the local context, primarily related to Scotland's unique political and legal context with the UK Government (as described in Chapter 1), as well as the persistent stigma surrounding problematic drug use among the general public [242, 244].

Nicolla *et al* have found decision makers' concerns and insights about the barriers of successful implementation [242]. First, legislative uncertainty is seen as the biggest barrier. PWUDs have expressed that police presence at SDCFs can be a significant barrier for them to use the facilities because of fear of harassment or arrest (Scottish policy context discussed in section 1.2.2). Second, it is not clear how SDCF would impact other drug-related interventions within a wider service sector – concerns were raised about opportunity costs and initial costs of setting up SDCF on a wider intervention system budget. Third, arguments have appeared around *'approaches to evidence'*. Decision makers suggested that available international evidence integrated with local evidence would be sufficient to justify a pilot adoption. Fourth, language in framing SDCF plays an important role, in that a non-stigmatised environment could help establish support from public. Shorter *et al* reports that the first unsanctioned mobile SDCF in the UK (Glasgow City) had a total number of 894 supervised injections and nine overdoses were successfully recovered between 2020 and 2021 [209]. This research revealed a distinct drug-using pattern and population characteristics compared to international evidence, and provided several recommendations on the necessity of engaging with potential service users to better tailor their needs into service implementation and the importance of creating an unstigmatized environment in the Scottish context. Furthermore, an unsustainable funding and staffing model was highlighted as the main obstacle to continue operating the mobile facility [209]. Nicolla *et al* indicates that decision makers are also aware of how SDCF might be delivered locally, including considerations around facility location and staffing model [242]. Otherwise, Nicolla *et al* and Trayner *et al* both suggest that all groups of people (i.e. PWUD, families, and policy makers) expressed their concerns around SDCF being accessible, safe, and a welcoming space [242, 243], and how the facility could be designed and delivered to highly engage with PWUD [242].

3.3.3.3 Summary

Despite efforts to increase public knowledge about substance use and the mechanism of treatment, research shows that concerns persist among some members of the public, especially regarding the establishment of SDCFs in their local area and the perception that such facility may enable dug use in the their community [231, 244]. The locality concerns, rooted in long-standing stigmatization towards PWUD, present a particular challenge to improve public support not only for implementing SDCFs, but also other harm reduction interventions [234, 235]. Previous study suggests that the potential strategy to increase public acceptance is to highlight the wider community benefits for people who have been indirectly affected by drug-related consequences (i.e. potential reduced injections in public areas) [244]. Otherwise, those who generally support the implementation of SDCFs are more focused on practical considerations, such as facility design and implementation strategy.

3.3.4 Consequences of implementing SDCFs

A number of review studies have comprehensively summarised the effects of implementing SDCFs [245-249]. A brief summary is given in **Table 33**, showing that use of a SDCF is associated with multiple consequences. It presents the availability of existing evidence that have been examined in qualitative and quantitative research.

Table 33. Treatment outcomes

	Outcome objectives	**Outcome indicators**	**Evidence**	
			Qualitative	**Quantitative**
Well-being impact	Stigma	-	√	×
	Homelessness	-	√	×
	Unemployment	-	√	×
	Child/pregnancy support	-	√	×
Health impact, at: Individual-level/ Population-level	Morbidity & mortality	Overdose deaths	×	√
		Injection injuries	√	×
		Blood-borne virus	×	√
		Ambulance call-out	√	√
		Acute hospitalization	×	√
	High-risk behaviours	Sharing needles, other tools	√	×
		Frequency or patterns	√	×
	Treatment referral & uptake	Engage with drug treatment	√	√
		Psychological therapy	√	×
		Social support	√	×
Community impact	Public order and safety	Drug use in public space	√	×
		Publicly-discarded syringes	√	×
		Crime and public nuisance	√	×

Note: a '√' indicates that evidence is available for the corresponding outcomes category, regardless of whether a treatment effect was found, and a '×' indicates that evidence is unavailable; '-' indicates not applicable.

Qualitative studies suggest a wide range of benefits including improvements in personal well-being, health outcomes, and positive impacts on the wider community. Evidence from qualitative studies provides in-depth insights into experiences and perceptions, such as non-stigmatised environment in the SDCF has improved social inclusion of PWUD, but such benefit is difficult to be quantified in the quantitative research.

A large amount of quantitative studies have been conducted to investigate facilities' effects in improving health outcomes at both individual level and population level, including the reductions in mortality, morbidity, and high-risk behaviours, as well as the increment in treatment engagement and public safety [245-249].

A detailed summary of the ten identified primary studies that evaluate SDCFs' impact on overdose deaths is shown in **Table 34** and **Table 35**. Most primary studies related to SDCFs are designed as natural experiments (i.e. prospective or retrospective cohort studies), or simulation studies that project population-level benefits, using findings from primary studies, and then can be compared to costs (see economic evaluations reviewed in Chapter 2). Although quantitative studies consistently draw positive conclusions on the effectiveness of SDCFs, there continue to be concerns about whether they are methodologically rigorous enough to allow for casual inference about SDCFs [198]. The large absence of randomized controlled trials (RCTs) is because ethical considerations (e.g., the difficulty of randomising either individuals or sites to receive or not receive this treatment); and RCTs are also practically challenging for complex interventions (i.e. the difficulty of measuring facility effects by controlling their implementing context) [179, 180].

Table 34. Health impact of SDCFs – Overdose deaths, N=6

Ref.	Location	Service	Period	*N*	Occasions	Drug types & route	Study design	Control group	Results
Van Beek *et al.* 2004 **[250]**	Sydney AUS	MSIC	18 months May 2001 - Oct 2022	3,747	56,861	61% inject heroin 30% inject cocaine	Prospective	-	• 409 drug overdoses among 267 individuals were treated in service (7.2 per 1,000 visits). • Frequent SDCF use was positively associated with experiencing a nonfatal overdose within the SDCF (AOR= 6.1; 95% CI 4.3–8.6). • N=973 frequent users; N=2741 infrequent users. *Note:* A client was categorized as a frequent attender if his/her total number of visits was in the top quartile of the visit frequency distribution (i.e. 11 or more visits in 18-month time) to the Centre.
Kerr *et al.* 2006 **[251]**	Vancouver CAN	Insite	18 months Mar 2004 - Aug 2005	4,764	243,701	79.2% injection 20.8% collect tools, etc.	Prospective	-	• 336 overdoses among 285 individuals, 1.33 per 1,000 visits. • 201 (71%) overdoses related to heroin, 36(13%) cocaine, etc.
NICHECR 2007 **[252]**	Sydney AUS	MSIC	72 months May 2001 - Apr 2007	9,778	391,170	62% inject heroin 14% inject cocaine	Time series	No SDCF area in city	• 2,106 overdoses, 5.4 per 1,000 visits. • 6,243 referrals, 16 per 1,000 visits. • 20,409 ambulance call-out.
Milloy *et al.* 2008 **[253]**	Vancouver CAN	Insite	24 moths Dec 2003 - Dec 2005	1,090	3,083	Injection	Prospective	-	• non-fatal overdose events (9.76%), 97.6 per 1,000 visits. • SDCF attendance for more than 75% of injections was not associated with an increase in non-fatal overdoses (OR = 1.05). *Note:* >=75% ALL or Most; <75% few or non
Salmon *et al.* 2010 **[254]**	Sydney AUS	MSIC	96 months May 1998 - May 2006	20,409	-	Opioid-related injection	Time series	No SDCF area in city	• Average monthly ambulance attendances at opioid-related overdoses declined in the immediate vicinity of the SDCF (by 68%) compared to 61% in the rest of the state during SDCF operating hours (p = 0.002). *Note:* 2.1km^2 immediate MSIC area; 3.6km^2 MSIC vicinity; 1.5km^2 neighbouring MSIC.
Marshall *et al.* 2011 **[255]**	Vancouver CAN	Insite	60 moths Jan 2001 – Dec 2005	290*	-	-	Time series	No SDCF area in city	• Of 290 overdose deaths, a third (89, 30.7%) of deaths occurred in city blocks within 500 m of the SDCF. The fatal overdose rate in this area decreased by 35.0% after the opening of the SIF, from 253.8 to 165.1 deaths per 100,000 person-years (p=0.048). By contrast, during the same period, the fatal overdose rate in the rest of the city decreased by only 9.3%, from 7.6 to 6.9 deaths per 100,000 person-years (p=0.490).

***N*:** total number of unique individuals use SDCFs; **Occasions**: total number of visits that include multiple visits from each unique individual; '-' denotes not applicable or not available; *no. of drug deaths.

Table 34. (Continued.)

Ref.	Location	Service	Period	*N*	Occasions	Drug types & route	Study design	Control group	Results
Latimer *et al.* 2016 **[256]**	Sydney AUS	MSIC	36 months Sep 2012 - Aug 2015	189,203	-	Fentanyl injection	Retrospective	-	• The number of fentanyl injections increased by 1000% during time period. Crude relative risk estimates demonstrated that fentanyl injections had approximately four and a half times the risk of resulting in overdose than injections involving either heroin or other Rx opioids (RR = 4.6; 95%CI 3.8– 5.5). Specifically, fentanyl injections had two times the risk of overdose than heroin injections, and eight times the risk of overdose than opioid injections, to result in overdose (RR = 2.2; 95%CI 1.8– 2.7; and RR = 7.9; 95%CI 6.7–9.5 respectively).
Kennedy *et al.* 2019 **[257]**	Vancouver CAN	Multiple services	10.5 years Dec 2006 - Jun 2017	811	-	-	Prospective	Infrequent users	• 112 (13.8%) died during the study period, corresponding to a mortality rate of 22.7 deaths (95%CI 18.7-27.4) per 1,000 person-years, including overdose n=19 (16.7%), 3.9 overdose deaths per 1,000 person-years 95%CI 2.3-6.0. • Frequent SDCF use was inversely associated with risk of all-cause mortality after adjusting for potential confounders: frequent use vs no AHR:0.46, 95%CI 0.26-0.80, p<0.006. *Note: frequent use at least once per week*
Scheim AI *et al.* 2021 **[258]**	Toronto CAN	Multiple services	14 months Nov 2018 - Mar 2020	701	-	48.1% fentanyl simulants	Prospective	Infrequent users/ never used	• More frequent SDCF use was not statistically significantly associated with overdose when compared to either no SDCF use or less frequent use. Association between SDCF use frequency and overdose was notably smaller among SDCF clients compared to associations between SDCF clients and non-users (e.g., all/most versus none: aPR, 1.43 [95% CI, 0.93 to 2.21]; all/most versus some: aPR, 0.94 [95% CI, 0.75 to 1.17]; all/most versus few: aPR, 1.15 [95% CI, 0.89 to 1.48]). *Note: frequency of use, few <=25%, some 26-74%, all or most >=75%* **may not comparable between users vs. non-users*
Robinson *et al.* 2024 **[259]**	Ontario CAN	Multiple services	100 months Dec 2013 - Mar 2022	-	-	-	Time series	no SDCF areas in city	• This study did not find significant mortality or morbidity effects associated with SCS at the population level in Ontario.

***N*:** total number of unique individuals use SDCFs; **Occasions**: total number of visits that include multiple visits from each unique individual; '-' denotes not applicable or not available; *no. of drug deaths. RR: risk ratio, (a)PR: adjusted prevalence ratio.

Table 35. Health impact of SDCFs – Treatment referral and uptake, N=4

Ref.	Location	Service	Period	*N*	Study design	Control group	Results
Wood *et al.* 2007 **[260]**	Vancouver CAN	Insite	Dec 2003 - Mar 2005	1,031	Prospective	-	• Logit regression shows there was a significant increase in uptake of detoxification services in the year after vs. the year before the SDCF opened (aOR = 1.32; 95% CI 1.11–1.58). Detoxification service use was associated with more rapid entry into MMT (AHR = 1.56; 95% CI 1.04– 2.34) and other forms of addiction treatment (aHR = 3.73; 95% CI 2.57– 5.39). Among those who enrolled in detoxification, the rate of SDCF use declined in the month after enrolment compared to the rate of SDCF use in the month prior to enrolment (24 vs. 19 visits, p = 0.002).
Kimber *et al.* 2008 **[261]**	Sydney AUS	MSIC	May 2001 - Oct 2002	3,715	Prospective	-	• Frequent use of the SDCF was positively associated with drug treatment referral (aOR = 1.6, 95%CI = [1.2–2.2]), but was not significantly associated with treatment uptake (aOR = 0.8; 95%CI =[0.4-2.0]). Other factors associated with receiving referral to detoxification program: majority heroin injection (aOR = 1.9, 95%CI = [1.2–2.2]), and obtaining a high school diploma (aOR = 1.6, 95%CI = [1.2–2.2]). Factors associated with treatment entry: prostitution (aOR = 2.6, 95%CI = [1.1– 5.8]) and daily injection (aOR = 2.3, 95%CI = [1.1–5.2]). A psychiatric history was negatively associated with entry into treatment (aOR = 0.2, 95%CI = [0.5–0.7]). *Note: frequent use - more than once per month*
DeBeck *et al.* 2011 **[262]**	Vancouver CAN	Insite	Dec 2003 - Jun 2006	1,090	Prospective	-	• Weekly attendance at the SCS (aHR = 1.33, 95%CI = [1.04–1.72]), interviews with an addiction counsellor (aHR = 1.54, 95%CI = [1.13–2.08]) were independently associated with initiation of addiction treatment. The cumulative incidence of entry into addiction treatment was 57.21% (95%CI = [50.9–63.5])
Gaddis *et al.* 2017 **[263]**	Vancouver CAN	Insite	Nov 2010 - Dec 2010	1,316	Prospective	-	• Among the subsample of 554 people who reported recently using the SDCF (in past 6 months), weekly use of SDCF (aOR = 2.86, 95%CI 1.92-4.28) was associated with initiation of detoxification programme. (aOR = 8.15 95%CI: 5.38-12.34) whole sample).

***N*:** total number of unique individuals use SDCFs; aOR: adjusted odds ratio; aHR: adjusted hazard ratio; CI: confidence interval.

A meta-analysis was not possible to conducted in this review because the primary studies varied substantially in their design, populations, settings, and outcome measures. Such heterogeneity implied that the date could not be meaningfully pooled to generate a single summary estimate of effect. Thus, these methodological and contextual difference limit comparability and reduce the validity of statistical synthesis. Instead, the findings were narratively synthesised to capture the breadth of evidence and highlight consistent themes across diverse context.

The evidence on the effectiveness of SDCFs is not only limited in the robustness of research design, but also the geographical locations that SDCFs are suited. First, the evaluations are restrictedly conducted in two settings – Canada and Australia, with a major focus on *'Insite'* and *'MSIC'* which are the first sanctioned facilities in each country; investigation on the existing facilities that opened in European countries is unavailable.

Second, there are some overlaps on the study period, design, and data employed across studies, with later studies using a control group and/or longer time series, but conflicting results compared to previous evidence [247]. For example, the most recent time series analysis, published in 2024, did not find significant mortality or morbidity effects associated with SDCF's implementation at the population level in Canada [264].

Third, uncontrolled or unobserved factors may possibly bias results, as SDCF presents a complex intervention that its effectiveness might be affected by contextual factors. For example, treatment effectiveness may be associated with dominant drug types during different time periods within one location, which has reflected on the transition from evaluating how effective SDCF can prevent opioid-related overdose deaths to fentanyl-related overdose deaths in Australia and Canada [256, 258]. Moreover, none of these studies explore how effective SDCFs are at preventing harms related to non-injection drug use, even though supervised smoking facilities have been operated in some countries for a long time.

Fourth, the effect size of a SDCF in the community is uncertain. Some studies compared the overdose deaths pre- and post- implementation [250, 251, 253, 256], and the rest either compared to a comparable area without SDCF [252, 254, 255, 264] or only compared frequent SDCF users with infrequent users within the facility [257, 258]. A retrospective population-based study, conducted by Marshall *et al*, is considered as a realistic estimation, as it determined that 500 meters radius of the SDCF had the greatest effect on overdose mortality according to the observation that approximately 70% of service users lived in such geographical scope [255]. Moreover, service users' heterogeneity is merely investigated across studies, e.g., whether drug-related harms are better averted among individuals who are more vulnerable (e.g., long injecting history or poor health status). Also, reduction of deaths inside the SDCF does not necessarily mean the reduction in mortality in SDCF users, so that whether SDCF impact users' consumption behaviours outside the facility is unknown and further complicated the effectiveness evaluation.

There is clear evidence that attending SDCFs can support engagement with wider treatment services. Studies have found positive associations between SDCF use and referrals to, or uptake of, services such as detoxification, methadone maintenance treatment, and substance use treatment [260-263]. Factors that were shown (from multiple studies) to be independently associated with the initiation of treatment were frequently using SDCFs and daily injection [260-263], but psychiatric history of SDCF users was negatively associated with entry into the drug treatments [261]. Further research is needed to investigate whether different facility design, e.g., operating hours, staffing model, plays a role in referral efficiency. In previous studies, it is found that the low-threshold service models (i.e. shelter-based) played a considerable role in enhancing referral uptake compared to providing referral from a medicalised services, as initial appointment delays, travel time, and office waiting time all negatively impact help-seeking behaviours [265, 266].

3.4. Conclusion

This literature review provides a comprehensive summary of existing practices on facility models, service components, critical views from stakeholders, consequences related to SDCFs, as well as the consideration and challenges of opening SDCFs in the Scottish context. In this review, research evidence has consistently shown that SDCFs' successful implementation depends on careful consideration of the demographic, socio-economic, and geographic differences across countries and cities and requires a clear understanding of stakeholders' preferences regarding service design. Thus, the insight learned from international literatures in this literature review will be further explored in Chapter 5 and Chapter 6 to inform a facility design in the Scottish context, with the aim of supporting the successful implementation of SDCFs.

Chapter 4 Research Methodology

4.1 Introduction

Building on the policy landscape and research findings discussed in previous chapters, this chapter provides a rationale for the methodological approaches applied for two empirical studies that follow. It outlines the justification for a discrete choice experiment (DCE) aimed at eliciting potential service users' preferences for a SDCF, and a cost-effectiveness analysis (CEA) evaluating the potential costs and effectiveness of implementing such a facility in Scotland. Two studies are interlinked, addressing key policy questions in regard to the acceptability and affordability of implementing a SDCF in the Scottish context. Correspondingly, they support the overarching aim of this PhD thesis that is to illustrate the role of health economic methods in contributing to the evidence base that can be drawn on in policymaking in the Scottish context.

4.2 Discrete choice experiments

4.2.1 Framing the research scope

Based on the findings in Chapter 3, the design and delivery of a SDCF are highly context-specific, and their successful implementation depends on aligning service configurations with the needs and preferences of multiple stakeholder groups. In Scotland, PWUD, their families, and policymakers highlighted that key factors, such as accessibility (e.g., location, staffing models) and the overall atmosphere of the facility, are central to whether individuals would consider using such facilities [242, 243]. However, it also found that the implementation of SDCFs remains inherently political, with ongoing concerns and perceived social impacts among the general public that have not yet been fully addressed [231-233].

With lessons learned, **Table 36** summarises the important roles that five stakeholder groups may play in policymaking, and presents the potential research questions that can be proposed to support the implementation of SDCFs in Scotland, along with key considerations and challenges of engaging each stakeholder group in the research studies. To conclude, families of PWUD are affected by their loved one's drug problems and can offer valuable insights, but they are not direct service users and may be limited by their emotional vulnerability and caregiving responsibilities to participate in the study. The general public plays an important role in policy acceptance and implementation, often shaped by concerns such as NIMBYism. Their preferences are important to understand societal support for SDCFs, but engagement may be limited by low motivation or perceived irrelevance. The frontline workers, who interact most directly with PWUD, are well-suited to assess effective practice in the SDCF, but time constraints and concerns about confidentiality can pose barriers to their involvement. Lastly, policymakers have the authority to support or reject the implementation of SDCFs, but political sensitivities and competing priorities may challenge their participation.

People who have a living experience of illicit drug use were decided to be the key research participants of interest, given their role as primary service users of a potential SDCF. Their involvement can help ensure that SDCF is practical, accessible, and better aligned with their actual needs. This decision was further confirmed with the following discussions with the supervisory team and PhD advisory group (KT, RF, MA) in August 2022. Although participant recruitment can be challenging for PWUD, given the complex and unstable circumstances they often face, such as being afraid of stigma, confidentiality concerns, and legal risks, it may also encourage greater trust and use of the facility by fostering a sense of empowerment and inclusion. Furthermore, incorporating patient preference in policymaking has been considered an enhancement to the effectiveness of healthcare services by improving their adoption, satisfaction, and adherence [267]. In particular, the

Scottish Government actively advocates the importance of integrating PWUD's knowledge into the design and implementation of drug policy and interventions [268].

4.2.2 Rationale of applying DCE

In health economics, the typical information regarding the value (or preferences and demand of) that an individual places on products and services is derived from the market or revealed preference data, by looking at observable transactions. However, in the healthcare sector, revealed preference data is often limited, which can be largely explained by three reasons. First, individuals rarely directly face market price while accessing public resources or private insurance; second, the relationship between clinical professionals and patients often involves decision-making by the healthcare providers, meaning observed choices may not fully reflect patients' preferences; and third, healthcare interventions are still in development or not yet available, so the market data (as referred to revealed preference data) do not exist [269]. In the absence of a functioning market for public health interventions, e.g., in the case of SDCF, it is not possible to observe service users' preferences through their behaviours when service does not exist. Thus, it indicates the rationality of asking individuals about their preferences in hypothetical scenarios – this is known as stated preferences.

In regard to stated preference, Contingent Valuation (CV) and discrete choice experiment (DCE) are two methods that have been increasingly used in recent years, offering many different possibilities in the context of decision-making [82, 83]. Chapter 2 identified only four CV studies and a single DCE (embedded within a MCDA framework) in the published literatures, indicating a limited use of stated preference methods in this research area. Among these studies, the use of CV reflected the focus on estimating monetary valuations, using a single scenario to estimate the value that individuals willing to pay for a certain treatment or policy. Given the findings of Chapter 3, however, the identified research gap in the Scottish context is the absence of preference-based evidence on the optimal design of a SDCF. DCEs evaluates the relative importance of different SDCF features and the trade-offs individuals are willing to make between the features, which aligns with the aims of this thesis.

DCE is commonly applied while incorporating patients perceptions in the healthcare decision-making process, e.g., individual (shared decision-making), policy (patient experts on panels) and commissioning (incorporating patient preferences in technology evaluations or health state valuation) [270, 271]. This technique involves the creation of hypothetical markets that can be constructed to suit relevant research questions, and generation and analysis of choice data. It is based on the assumption that utility (i.e. a quantified value to patient) for interventions, services, or policies can be described by their attributes (i.e. characteristics). For example, in a DCE survey, respondents are required to choose between two or more alternatives, as described by a set of attributes with varying levels, and a number of choices given by respondents. Details on the process of conducting the DCE are described in section 5.2.

Furthermore, DCE elicits the trade-offs and the relative importance of each attribute , which can then be used to infer the willingness to pay (WTP) for attributes. WTP refers to the maximum amount of money an individual is willing to spend to obtain a good or service [272]. Trade-offs can help researchers understand which attribute (i.e. characteristic) participants value the most and help design a service that is acceptable to them. In addition, the WTP can be used to model how alternative configurations may impact the service uptake (or use) which provides more information on how service design choices can enhance engagement. Alternatively, CV involves asking individuals directly about their maximum WTP for a specific health intervention or outcome, using a single hypothetical scenario. This approach provides a straightforward monetary valuation and is relatively easy to design and integrate, but it is often criticised for its ability to explore tread-offs between multiple attributes of a health service [273]. Thus, DCE provides richer information than CV, especially in the healthcare context, because it allows multiple factors such as service

components, effectiveness, side effects, waiting time, and cost to vary independently. This allows researchers to understand how different attributes effects patients' decisions.

Table 36 presents examples of payment vehicles for estimating WTP across different stakeholder groups. For families, the general public, and policymakers, an increase in tax is an appropriate and realistic payment vehicle, because they are more likely to support a SDCF implementation through public funding mechanisms; and willingness to work is a suitable measure for frontline workers, reflecting their direct involvement and contribution in terms of time and effort in the SDCF. Given the ethical and practical challenges of using direct monetary measures for PWUD, the willingness to travel (to an improved design feature of a SDCF) is considered the most appropriate alternative method for deriving their willingness-to-pay. This approach avoids placing financial pressure on a potentially vulnerable population while still capturing the value they place on service configurations.

While DCEs offer a structured framework to elicit preferences in the absence of market data, their use is underpinned by a number of limitations that require critical reflection in this policy context. DCEs assume that individuals are able to understand and trade-off between hypothetical attributes in a consistent manner, and that stated choices provide a reasonable approximation of preference that would be expressed in real-world settings [274]. While developing a DCE in Chapter 5, these assumptions will be challenged by the complexity of service configurations, the vulnerability of the population of interest, and the impact of structural and legal barriers that might not be fully captured with choice tasks. Furthermore, DCE results may also be sensitive to framing effects, including how attributes and choice context are presented, which can impact participants' perceptions and respondent [275]. To tackle these challenges, particular efforts will be made during the design and development of the DCE, for example, validate the attributes selection with people who have lived/living experiences, pilot survey to test the feasibility of conducting DCEs among the population, and employ peer researchers to assist participant recruitment (see details in section 5.2).

4.2.3 Other considerations

Previous qualitative studies (as reviewed in Chapter 3) will be used to inform the design of DCE. These studies, either interview or focus group, provided in-depth understanding of individuals' perceptions towards SDCF's service design in a global context. As summarised, SDCFs' design and implementation strategy are largely varied across countries and cities, in response to the local demographic, socio-economic, and geographic characteristics, and the understanding of users' demand. Thus, applying a DCE will complete previous qualitative evidence, by quantifying how much individuals value different SDCF features and the trade-off they are willing to make for their preferred features. As a result, it will help local authorities to make a financially viable SDCF that would be used by PWUD in the Scottish context.

Approach like multi-criteria decision analysis (MCDA) is considered for its strength in integrating multiple stakeholder perspectives. For example, in Chapter 2, it provides information in contexts where policy decision is contested and multilayered. An MCDA could be applied to compare alternative SDCF models across criteria such as safety, accessibility, cost, community acceptability, legal feasibility, and health or non-health outcomes and to engage with multiple stakeholder groups who might be impacted by SDCF implementation (e.g., as listed in **Table 36**). In this PhD thesis, however, where the primary objective is to elicit individual-level preferences of PWUD that could be directly inform SDCF's design and implementation. A DCE is methodologically better aligned.

Table 36. Potential considerations and challenges of recruiting different stakeholder groups in the research studies.

	PWUDs	Families	General public	Frontline workers	Policymakers
Why are they important?	• Potential service users. • Understand their needs. • Improve service effectiveness. • A human rights-based approach – recommended by Scottish gov [268], aligns with social justice that recognising the need to reduce stigma and ensure equitable access to healthcare and support for PWUD.	• They are seriously affected by their loved one's drug using situation. • '*A family-inclusive approach for people effected by drug use is vital and can have significant benefits for those around them*' [268].	• Public view plays an important role in policy making NIMBYism: not in my backyard). • They might be directly or indirectly impacted by the implementation of SDCFs.	• They have most contact with PWUD, in a unique position to provide services. • Be able to identify good practice in reducing harms.	• They decide if proposing a new service. • They are governing innovation through subsides (or set budget) and provide support for policy that sends powerful signals to investors.
Potential research questions	• To understand PWUD's preferences on service models. • Preference heterogeneity – what attributes (and levels) are preferable to what certain subgroups of PWUD who may share the same characteristics. It helps to understand multiple and complex needs across the group in the Scottish context.	• To understand their preferences on important features of SDCFs, and whether there is a SDCF model that they believe most appropriate to PWUD.	• To understand their preferences on different features of SDCFs. • To investigate whether there is a SDCF model (combination of their preferred features) that general public would support its implementation in the community.	• To understand their preferences on important features of SDCFs, and whether is a SDCF model that they believe most appropriate, as frontline workers play a key role in providing services and they have most contact with PWUD.	• To understand whether there is preferred SDCF model from decision-makers' perspectives, and eventually what models they are more likely to advise (combination of preferred features), or they do not recommend the service.
Barriers to recruitment	• Vulnerability (i.e. fear of potential stigma). • May be unable to do questionnaire remotely. • Recruitment requires gatekeepers.	• Vulnerability (e.g., emotional burden and trauma). • Lack of time or caregiving responsibility.	• Low motivation to engage. • Lack of understanding of the issue or relevance to their life.	• High workload and time constrains. • Concerns about confidentiality or professional consequences.	• Political sensitivity. • Time constrains and competing priorities.
Limitations	• Not many of them. • Confidentiality and legal risk. • Representation and reliability of data.	• Not the service users.	• They are less important than other groups of people while designing a service (not have interacted with the service).	Not applicable	• Not many of them.
Feasible payment vehicle	• Willingness to wait • Willingness to travel	• Willingness to pay increased tax supporting service operation	• Willingness to pay increased tax supporting service operation	• Willingness to work	• Willingness to pay increased tax supporting service operation

4.2.4 Theoretical framework

The DCEs are developed based on Lancaster's theory of value [269] – which assumes that any good (or service) can be described by its characteristics (attributes), and individual has a preference for and derive utility from underlying attributes of the good (or service). The theoretical underpinning for analysing DCE data is Random Utility Theory [272], that states individual obtains utility (or well-being) derived from consuming the good, thus it presumes that people prefer the choice proving the highest value (utility) to them. For example, the individual n was given J alternatives in a choice set, he (or she) chose alternative i if and only if the utility for alternative i is greater than j: $U_{ni} > U_{nj}$ $(\forall_{j\neq i}, j = 1, \dots, J)$.

The utility he (or she) obtains from alternative i is modelled as:

$$U_{in} = V_{in} + \varepsilon_{in} \tag{1}$$

The utility function (1) comprises two components: a systematic component V_{in} (observable attributes) that individual n associates with alternative i; and ε_{in} is the random component (unobservable factors) associated with individual n for alternative i. Thus the probability that individual n choose alternative i amongst J alternatives is estimated as:

$$\begin{aligned} P_{in} &= Prob\big(U_{in} > U_{jn}, \forall_{j\neq i}\big) \\ &= Prob\big(V_{in} + \varepsilon_{in} > V_{in} + \varepsilon_{in}, \forall_{j\neq i}\big) \\ &= Prob(\varepsilon_{jn} - \varepsilon_{in} < V_{in} - V_{jn}, \forall_{j\neq i}) \end{aligned} \tag{1.1}$$

Due to the probability is considered a cumulative distribution, the probability that each random term $\varepsilon_{jn} - \varepsilon_{in}$ is lower than the observed quantity $V_{in} - V_{jn}$. Given the definition, ε_{in} is unknown to researchers and treated as random terms. As the joint density of the random vector $\varepsilon_n = \langle \varepsilon_{n1}, \dots, \varepsilon_{n2} \rangle$, this cumulative probability can be rewritten as:

$$\begin{aligned} P_{in} &= Prob\,(\varepsilon_{jn} - \varepsilon_{in} < V_{in} - V_{jn}, \forall_{j\neq i}) \\ &= \int_{\varepsilon} I(\varepsilon_{jn} - \varepsilon_{in} < V_{in} - V_{jn}, \forall_{j\neq i}) f(\varepsilon_n) d\varepsilon_n \end{aligned} \tag{1.2}$$

Where $I(\cdot)$ is the indicator function equalling 1 when the expression in parentheses is true and 0 otherwise. This is a multidimensional integral over the density of the unobserved portion of utility, $\int(\varepsilon_n)$ [276]. As such, different choice models are estimated from different specifications of this density, which is based on the different assumptions about the distribution of the unobserved component of utility (ε_{in}). The following section provides more detailed explanation on how to estimate the error component when specifying different models.

4.2.5 Choice models

As mentioned, different choice models were derived from different specification of the density of unobserved factors, $\int(\varepsilon_n)$ [276], so that the different assumption can be made according to different distributions were assumed for each type of model.

A number of commonly used discrete choice models are described in **Table 37** [277]. Conditional logit model (CL) and multinomial logit model (MNL) are often used interchangeably in the literature, as they rely on the same statistical assumptions that assume a linear relationship between the attributes of alternatives. They are simplest choice models, but restricted to independent and identically distributed (iid) errors which lead to an unrealistic assumption of independence of irrelevant alternatives (IIA). The IIA indicates that the ratio of choice probabilities of any two alternatives is not affected by the presence or absence of another alternative in the choice set, but choice making may not adhere to it in real world. In addition, CL and MNL are used to estimate

mean preference weight (β) amongst the sample population, that assume all participants have the same preferences.

Mixed logit model (MXL) can account for preference heterogeneity across the sample population, and it can estimate the distributions of the preference weights. Thus, it requires a larger sample size, and researchers should be careful with interpretating the distribution of parameters.

Latent class model (LCM) can estimate preference heterogeneity by assuming the sample population consists of distinct latent classes (or segments), and each class shares the same preferences. However, the selection of the number of latent classes can be subjective based on researcher's judgment. Also, it might be challenging for researchers to explain study results with specified classes to audiences. Lastly, a larger sample size may be required to accommodate the increase in the number of parameter estimation as the number of classes increases.

Hierarchical bayes model (HB) can estimate the preference weights for each individual in the sample, so that it fully accounts for potential issue of preference and scale heterogeneity. As such, the overall preference should be making inferences from using standard deviations (variation of preferences across individuals), rather than using a standard error around an overall estimate of preferences [277].

Overall, there are no consensus on which choice model should be used. Justification on choice of models must take into account the study design and sample size.

Table 37. Discrete Choice Models

	Advantages	**Limitation**
Conditional logit (CL)	1.Simplicity: simplest model that easy to make estimation and interpretation.	1.Homogeneous preference: assume all individuals have same preferences. 2.Independence of Irrelevant Alternatives (IIA): the relative choice probabilities between two alternatives are not affected by the presence or absence of other alternative in the choice set – choices may not adhere to it in real world. 3.Linearity assumption: assume a linear relationship between the attributes of alternatives and the log-odds of choosing an alternative. 4.Limited flexibility: do not account for complex interactions among attributes or across choice scenarios.
Multinomial logit (MNL)	*Note*: CL and MNL are used interchangeably; they rely on the same statistical assumptions about the relationship between choice and the variables used to explained choice.	
Mixed logit (MXL, or referred as random parameters logit, RPL)	1.Heterogenous preference: allow model parameters (β) to vary across individuals. 2.Scale parameter(μ): consider the variation of preference weights. *Note*: An extension of CL and MNL models.	1.Data requirement: require larger sample size than CL/MNL. 2.Parameter interpretation: require assumptions about distribution of parameters across individuals.
Latent class (LC)	1. Heterogenous preference: require researcher to specify appropriate number of classes to group individuals who sharing the same preference.	1.Avalibility: may not be available in software packages. 2.Number of classes: selecting the appropriate number of latent classes can be subjective. 3.Interpretation and assumption: the user of study results may question the findings with specified classes.
Hierarchical bayes (HB)	1.Individual level: estimate preference weights for each individual. 2.Scale heterogeneity: each individual can have difference relative preferences, and the absolute values of the preference weights can vary freely across individuals.	1.Availabililty: may not be available in software packages. 2.Data requirement: more choices assign to each individual to obtain individual-level preference estimation;

Source: **[276, 277]**

4.3 Economic evaluation

4.3.1 Framing research scope

A systematic review was conducted in Chapter 2 to critically synthesise the economic evidence of illicit drug policies worldwide and appraise the methodologies adopted to evaluate the drug policies. In the review, a total of 13 economic evaluations were found relevant to SDCF, suggesting the potential cost-effectiveness of SDCFs in preventing a range of drug-related harms (for more details see section 2.3.6.3), but the transferability of the existing evidence to the Scottish context is questionable. First, most of the studies were conducted in North American cities with large geographical scopes, a large number of people who use drugs, and where the drug use profile differs from that of Scotland. Second, the transmission of infectious diseases (e.g., HIV and HCV) due to needle-sharing behaviours was the dominant clinical outcome considered across those economic evaluations. Third, the existing analyses are limited to a single service model ('*Insite*' in Canada) and narratively consider the service opening hours and expansion of facility numbers.

In Chapter 3, the reviewed studies further highlighted the concerns raised by policymakers regarding the financial implications of implementing a SDCF on a wider intervention system budget in Scotland, particularly the potential opportunity cost and the investment required to sustain the SDCF [242]. The importance of financial affordability was also mentioned in Glasgow pilot facility proposals [229, 230]. In Scotland, the evaluation of SDCF implementation should prioritise its potential to reduce drug-related deaths, reflecting the key Scottish policy priority outlined in the Scottish National Drugs Mission Plan: 2022-2026 [65]. The rapid growth of drug-related deaths is currently one of the leading causes of accidental deaths and has contributed to a significant decline in life expectancy in Scotland [278]. Furthermore, the proposed Glasgow pilot SDCF has also been promoted as an intervention to engage people with a long history of injecting drug use and support their transition into long-term recovery. These outcomes and benefits should be central to cost-effectiveness analyses of the SDCF in the Scottish context [230].

Overall, the existing evidence has limited transferability when applied to the Scottish setting due to a range of contextual differences in population characteristics, outcome measures, local preferences towards service delivery models, and policy focus. An economic evaluation is needed regarding the potential cost-effectiveness of implementing a SDCF in Scotland.

4.3.2 Rationale of applying CEA

Economic evaluation forms an integral part of public health intervention evaluation, contributing to the evidence of cost-effectiveness. It compares the costs and effectiveness of alternative courses of action, which are assessed to ensure that maximum health gain is achieved from the finite available resources [82]. There are different economic evaluation methods. Cost-benefit analysis (CBA) presents all costs and benefits (and/or consequences, including health outcomes) in monetary value. For example, in section 2.3.6, opening up 3 SDCFs in Montreal (Canada) was able to produce a benefit-cost ratio of 1.03 [124], which means that for every $1 of cost, society gains $1.03 of benefits (expressed in Canadian dollars). Cost-effectiveness analysis (CEA) compares costs with natural health outcome units, such as life-years saved and number of cases averted. For example, the incremental cost-effectiveness ratio of a needle syringe programme was $20,947 per HIV averted compared to the status quo [144]. Cost-utility analysis (CUA) is a special form of CEA where the costs and benefits are expressed as the cost per quality-adjusted life-year (QALY). QALY is a single measure of quality of life and survival. CUA enables the comparison of different healthcare interventions, allowing resources to be allocated efficiently [279]. Cost-consequence analysis (CCA) allows measures of both welfare and quality of life more broadly than health-related quality of life (i.e.,

QALYs), which can take into account many other items that the Local Authorities are likely to find important, e.g., employment status and community safety.

In this PhD thesis, the Scottish policy context and the data availability in terms of SDCF's benefits directly informs the methodological choices made throughout this economic evaluation. While adopting a societal perspective for public health intervention was considered appropriate in NICE public health guidance [279] and MRC complex intervention guidance [180] and in main findings of systematic review in Chapter 2, this analysis still adopts an NHS perspective that reflects the limited evidence in regard to SDCF's broader societal impacts (as reflected in Chapter 3) and also the policy-driven considerations in Scotland. CEA was employed to estimate the costs and outcomes of implementing a SDCF, with a particular focus on outcomes that are most important to current Scottish policy priorities, including overdose deaths, referral uptakes to long-term treatment engagement, and life expectancy. Although drug use and its consequences generate substantial burden beyond the health sector (as discussed in Chapter 2), the decision to adopt a NHS perspective was informed by several factors. First, as detailed in section 3.3.4, the available empirical evidence is limited in scope and methodological consistency, making robust estimation highly uncertain at this stage. Second, societal costs and outcomes of implementing a SDCF may associate with local drug use characteristics, and therefore difficult to parameterise in a pre-implementation model without local data. As highlighted contextual factors in Chapter 1, the choice of an NHS perspective aligns with the immediate objectives of Scottish policy priorities, where reducing drug-related deaths has been framed as an urgent public health problem and where funding for SDCF implementation sit primarily within the healthcare system. Furthermore, PWUD in Scotland experience exceptional risks of premature deaths, homelessness, and focusing on these outcomes allows the model to address the most pressing harms in Scotland. Infectious diseases (e.g., HIV/HCV) were not included in the model due to substantial uncertainty regarding their causal interfere to SDCF implementation within the Scottish context. Although reductions in injecting-related risk behaviours have been observed in some settings, the incidence of HIV and HCV is observed to be largely impacted by complex, long-term dynamic injecting behaviours, and concurrent harm reduction interventions in the local context (as discussed in section 3.3.4).

It is acknowledged that a narrow healthcare perspective results in limitations, especially in its inability to fully capture a broad costs and benefits. Nevertheless, these limitations will be addressed through sensitivity analyses and through a discussion in Chapter 6. Moreover, the early modelling framework is designed to be iterative, allowing incorporating real-world data from the natural experiment as it becomes available. In this context, the selection of primary outcomes and perspective reflects a policy-relevant priorities and data availability. While this may be narrower than the societal perspective suggested in the NICE public health guidance [279], it remains directly applicable to inform decision-making in the Scottish policy context.

4.3.3 Decision-analytical models

A decision tree and a Markov model were adopted to simulate both short-term and long-term health and economic consequences of implementing SDCF in Scotland. The decision tree allows for modelling immediate consequences, i.e. overdoses and the associated costs of emergency service usage. The Markov model captures long-term costs and outcomes of treatment engagement via the SDCF referral service, including four health state transitions over time: relapse, continued drug use, recovery, and mortality. The modelling structure effectively reflects patients' natural addiction behaviours and the dynamic patterns of engagement with treatment services, which are well-suited to capturing the treatment outcomes that are relevant to the Scottish policy context. In Chapter 2, reviewed studies frequently employed complex mathematical models or dynamic epidemiology models to simulate the population-level HIV/HCV transmission among people who inject drugs (see **Table 14** in section 2.3.6.3). They required highly detailed epidemiological and behavioural data that

are often context-specific and not always available or generalisable to new settings, and typically these studies focused on infectious diseases as primary outcomes, which are not the central focus of the current evaluation. As such, a framework combining a decision tree and a Markov model is considered a more appropriate modelling approach, aligning with the policy questions and the types of data currently accessible in the Scottish context. Details on the process of developing decision-analytical models and input parameters are described in section 6.2. The NICE public health guidance [279] is used to guide the development of Chapter 6, reflecting its role as a technical standard for appraising non-medicine health technologies, and were applied with specific considerations for the Scottish context, as detailed in section 1.2.2.

Chapter 5 Exploring People Who Use Drugs' (PWUD) Preference Towards Service Design of a Safer Drug Consumption Facility (SDCF) in Scotland: A discrete choice experiment

5.1 Introduction

In Scotland, a massive scale-up of harm reduction programmes have been offered since the 1980s, such as needle and syringe programmes (NSPs), opioid substitution therapy (OST), and Take-Home Naloxone (THN). However, several factors have been seen to limit their effectiveness. First, Scotland has a much lower rate of people in treatment (35-40%) compared to England (60%) because of disfavoured treatments and service delivery (e.g., patients often complain about a stigmatising environment in treatment services) [280]. Second, a heightened risk of overdose is associated with patients' actively disengagement from the service without finishing their treatment episodes [280]. Overdose deaths are highly correlated with the time periods of discharging from hospital admission, community or inpatient drug treatment, and the weeks after a non-fatal drug overdose [281]. Especially, a meta-analysis demonstrated a 3 to 8 times increased risk of overdoes death in the first 2 weeks after release from prison compared to the subsequent 10 weeks [282]. Third, taking drugs alone is a risk factor for people who die at home in Scotland – 79% of people who had a drug-related death lived in their own home and 58% of them lived alone in 2016 [37]. At last, public injecting is identified to be a key risk factor that people who inject drugs (PWID) experience overdose death without witnesses [283], and also associated to the recent HIV outbreak in Glasow City [284, 285]. Government reports estimate that, in central Glasgow, approximately 400-500 people inject drugs in public areas on a regular basis [285]. It is noteworthy that some people are reluctant to carry naloxone kits with them or have it in an overdose situation, as they consider the kit can potentially attract police attention [286]. This finding is consistent with Needle Exchange Surveillance Initiative (NESI) report that the proportion of people carrying naloxone is much lower than the naloxone prescribing rate during 2013 to 2020 [287].

Given the extent of harms, providing promising intervention to the population is essential to reinforcing a better harm reduction policy in the Scottish context. In 2018, Scottish Government published a reformed 10-year drug strategy, emphasizing that *'taking a human rights-based and public health approach'* to ensure people affected by drug issues are fully supported by best possible care and treatment [268]. In the strategy, safer drug consumption facility (SDCF) is recognised as the innovative and *'person-centred'* harm reduction service [268] and supported by the Scottish Government in their 2021 report [195].

SDCFs have been implemented in many countries since the 1980s as an effective harm reduction facility by providing a safe, hygienic environment for people consuming pre-purchased drugs [288]. They often aim to establish a low-threshold and high-tolerance space where multiple services may also be offered so that PWUD can make their own choice to engage [288]. The systematic reviews suggest evidence supporting their effectiveness and potential cost-effectiveness in preventing a range of drug-related harms [246, 248, 289].

The introduction of SDCF for Scotland has been explicitly supported by charities and advocate organisations who support the drug policy reform [290], yet SDCFs have been the subject of extensive legal and political debate over the past years [291, 292]. Based on recent evidence, the population of PWID, their families and strategic decision makers generally expressed support for opening SDCF in Scotland [242, 243]. The first mobile SDCF opened between September 2020 and May 2021 in central Glasgow, and this was an unsanctioned service (illegally operated) yet was never

closed by police; nor did it appear to bring negative consequences to the community. This illegal service indicated the possibility to run such a service in Scotland legally [209]. Although the Lord Advocacy announced the statement on a pilot SDCF in Glasgow in September 2023 [53], it is still uncertain how SDCFs would best fit the Scottish context, as extensive evidence has suggested mixed preferences among PWUD towards facility design locally and internationally [243, 293].

To inform the implementation of SDCF, it is crucial to understand the optimal design of service which would best satisfy PWUD's demand for SDCF and as result to be more likely to improve access. An approach to understand individuals' preferences is to use stated preference methodology – discrete choice experiments (DCEs) and Contingent Valuation (CV). Building on the findings of Chapter 2, a key methodological gap in the literature is the limited use of DCEs in illicit drug policy, with the few existing studies largely restricted to CV. While these CV studies provide useful insights into overall acceptability and willingness to pay, they offer limited information on how specific service features impact preference. In the Scottish context, Chapter 3 highlighted the absence of preference-based data to inform the optimal design of a SDCF, especially in relation to features that may impact uptake (or use) among PWUD. Thus, DCEs are well suited to addressing these gaps, as they can provide information on the relative importance of different features and the trade-offs individuals are willing to make between them (see Chapter 4 for methodological justification).

DCEs are a stated preference methodology, such that researchers can design a survey and identify behavioural responses of individuals to a hypothetical new treatment service which have not yet been introduced. In the survey, individuals are presented with competing scenarios describing different policy options (i.e. SDCF configurations) and then asked to make a choice indicating their preferred choice between the options. DCEs have been increasingly applied to assist healthcare decision-making in the past decades [271, 294]. It is a quantitative method that allows for engagement with critical stakeholders to investigate stated preferences for healthcare goods or services, as well as exploring potential trade-offs that stakeholders are willing to make between characteristics of those goods or services [274]. Advantages of adopting DCEs for the design of a healthcare service are that it is a stepwise method to select and tailor attributes (and levels) into a hypothetical setting, and encouraging stakeholders to thoroughly assess the characteristics of healthcare service at a detailed level, thereby improving the accuracy of service design within a given context [270].

This is the first DCE study to explore the acceptability for different configurations of SDCF by sampling potential service users (PWUD)' perspectives in Scotland. It aims to engage with PWUD to provide insights on the most acceptable and attractive SDCF to better understand preferred delivery models, and feed these preferences into government planning, in advance of Scotland formally introducing SDCFs. This study addressed the following questions:

I. What are the preferences of PWUD regarding the important design features of a SDCF?
II. How do PWUDs' preferences for various design features differ among subgroups?
III. How do PWUDs make trade-offs between different design features of a SDCF? i.e. what are PWUDs willingness to pay (in time) for improved design features of a SDCF?

5.2 Methodology

5.2.1 Guidelines for study design and reporting

This study followed ISPOR guidelines of developing experimental designs [295] and reporting research practices [296] for stated health preference research. They identified and presented 10 important steps in producing a good discrete choice experiment, including: 1) research question; 2) attributes and levels; 3) construction of tasks; 4) experimental design; 5) preference elicitation; 6)

instrument design; 7) data-collection plan; 8) statistical analyses; 9) results and conclusions; and 10) study presentation [296].

5.2.2 Identification on attributes and levels

A literature review was conducted, which supported the identification of attributes, and their levels. Findings of the review were summarized, and the detail was reported elsewhere (see Chapter 3). A final list of attributes and their levels was preliminarily drawn from the results of literature review, and the revised selection was made within the research project team, advisory group (KT, RF, MA), and also in consultation with those with lived experience of substance use via email (peer researcher: JD) and informal group discussions. Attributes and levels were chosen that were meaningful to the targeted PWUD and could be realistically influenced by policy changes.

A total of 6 attributes were considered to be relevant to the SDCF service delivery model, that identified as location, staffing, space allocation, drug checking service, opening time, and travel time. The final list is shown in **Table 38**.

Table 38. Attributes and levels of the discrete choice experiment (DCE)

Attribute	Level	Description
A1: Location	L1: Stand-alone SDCF	Facility opens in areas that are close to other drug-related services or areas known for high levels of illicit drug use.
	L2: Medicalised SDCF	Facility integrated into existing healthcare centres, i.e. hospital.
	L3: Embedded SDCF	Facility sets up in existing charity organisations.
	L4: Mobile SDCF	Facility operates in a mobile van.
A2: Staffing	L1: Involve peer workers	People with personal experience of using drugs are employed in the facility or not.
	L2: No peer workers	
A3: Space allocation	L1: Provide inhalation space	Facility provides inhalation space alongside injection space or not.
	L2: No inhalation space	
A4: Ancillary service	L1: Provide drug checking service	Facility provides drug checking service or not. Drug checking service can get service users' drug samples chemically analysed and provide a result about the drug sample.
	L2: No drug checking service	
A5: Opening time	L1: 24 hours	Facility can operate at different times.
	L2: Daytime (i.e. 8am-4pm)	
	L3: Overnight (i.e. 7pm - 9am)	
A6: Travel time	L1: 01 minute	Time it takes to access the facility.
	L2: 09 minutes	
	L3: 19 minutes	
	L4: 29 minutes	

SDCF: safer drug consumption facility.

5.2.3 Experimental design

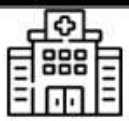
The total possible combinations of the levels of 6 attributes were extremely large if using a full factorial design ($4^2 \times 2^3 \times 3$). Instead, a total of 36 choice sets were generated in Ngene 1.0.2 for pilot testing, using a D-efficient design with priors set to 0. After pilot testing, the experimental design was updated using Bayesian efficient design, and priors were updated using findings from a multinomial logit model (MNL) obtained from pilot participants (see coding in *Appendix 5.1*).

To reduce cognitive burden, each participant was randomly given 9 distinct choice sets (as allocated into 4 blocks) and each choice set composed of two SDCF alternatives and an opt-out option (i.e., would not choose any of SDCF). Including an opt-out option reflects the real-life possibility that people may choose not to use a SDCF when making this choice in the real world. An example of one choice set is presented in **Figure 5**. Sawtooth Lighthouse Studio® 9.14.2 was then used to administer the DCE as well as the follow-up questions. The complete questionnaire can be seen in *Appendix 5.2*.

Each participant randomly received one block with 9 different choice sets and identical follow-up questions. The questionnaire consisted of 5 sections. The section 1 included a brief introduction of a SDCF and its design features. Section 2 contained the DCE choice tasks. Section 3 to 5 included follow-up questions, including participants' drug use history, attitudes towards SDCFs, and socio-economic characteristics.

Imagine a Drug Consumption Room was available, which option would you prefer?

(1 of 9)

Characteristics	Option A	Option B	Option C
Location	 Embedded drug consumption rooms	 Medicalised drug consumption rooms	I wouldn't choose any of these
Staffing	 No peer workers	 Involve peer workers	
Space allocation	 Provide inhalation space	 No inhalation space	
Drug checking service	 No drug checking service	 Provide drug checking service	
Opening time	 Overnight (7pm-9am)	 Daytime (8am-4pm)	
Travel time	 29 minutes	 1 minute	

Please select your most preferred choice:

Option A..... ☐ Option B..... ☐ Option C..... ☐

Figure 5. Example choice set

5.2.4 Sample size

Given the fact there is no general standard on the ideal sample size for DCE, the Orme and Johnson [297] sample size calculation equation (2) was used for this study:

$$N > 500c/(t \times a) \quad (2)$$

Where N was the number of respondents, t was the number of tasks, a was the number of alternatives per task (not including the opt-out), and c was the largest number of levels of the attribute (i.e. 4 levels attributes in this study – location and travel time). For this DCE study, therefore, the estimated sample size was 112 respondents $[N > 500 \times 4/(9 \times 2)]$. This was a simple estimation to help researchers making an initial determination on sample size, as DCEs do not have an explicit guideline for sample size calculation. DCEs highly rely on questionnaire quality, which was the reason that attributes and levels were chosen through extensive preliminary research, and the survey was pilot tested with PWUD before main data collection, described further in section 5.2.12.

5.2.5 Participant recruitment

The target population was people who have living experience with illicit drug use across 3 major Scottish cities: Glasgow, Edinburgh, and Dundee. Participants were recruited from third sector homelessness services (Simon community Scotland, Dundee parish nurses, where potentially eligible participants would be) in Scotland. The research team engaged with potential organisations, and secured agreement to recruit from their service. Participants were identified using various strategies, depending on what the organisation felt was the most appropriate, i.e. through key workers, voluntary discussion sessions (where the peer researchers would be situated within the service and be available to provide information about the research, and answer questions about participation). Peer researchers with lived experience were employed to collect data, as they have built a network/relationship with PWUD and have received full training and experience of this type of recruitment. In some cases, these researchers accompanied outreach workers from the third sector organisations that they were working with and recruited from other places, i.e. street.

Participants were given the participant information sheet and had a chance to read through it, talk to the peer researcher about the study and their participation, and then provided informed written consent. Participants were given £10 via cash or bank transfer (in their preferred way) to thank them for their time completing the questionnaire.

This study also used snowball sampling [298] to allow participants to suggest potential participants to take part in the research – for example, at the end of the questionnaire participants were asked if they know of other PWUD who might be interesting in participating.

5.2.6 Involvement of peer researchers

Peer researchers are individuals who have lived experience relevant to the subject being studied and are involved in the research process, and benefits of involving them in policy, health services, and research have been gradually recognised in previous literatures [299-301]. Peer researchers were able to provide knowledge of current and emerging issues within drug-using networks on the basis of their participants within the drug use communities and experiences of the political and health service contexts [302].

5.2.7 Data collection

Two versions of questionnaire were designed for this study: paper based, and an electronic version (generated by Sawtooth software) stored on a tablet. Participants could decide to read through the participant information sheet and consent form with peer researchers, or read it on their own. Peer

researchers would assess participants' capacity to give consent – i.e. whether they can understand participant information sheet, be able to ask relevant questions, and complete the questionnaire. As such, informed consent was obtained through an electronically protected consent form; or it was obtained from a paper-based questionnaire. By clicking *'next'* on the digital version of the questionnaire, or by checking a box in the paper version, the participant consented to the study.

The questionnaire included sensitive questions, such as participants' illicit drug use history, and the method of drug consumption. In the participant information sheet and consent form, it clearly stated that participants' responses would be anonymous, and that providing information on illicit drug use would not implicate themselves for offense. Their identifiable personal details were not collected at any stage of data collection.

Questionnaires were completed in person and administered by trained peer researchers using the Offline Surveys (Sawtooth 9.14.2) platform. Pilot data was collected between September to October 2023, and remaining data was collected between November to December 2023. Peer researchers underwent thorough training on the study questionnaire and software use, conducted by the PhD researcher. During data collection, peer researchers either read questions out-loud and recorded participants' responses, or participants were able to read and answer the questionnaire on their own. The questionnaire was expected to take 15-20 minutes to complete.

All data that was collected from questionnaire was stored in the authenticated storage space at the University of Glasgow.

5.2.8 Ethical approval

The study and survey instrument have been reviewed by the College of Medical, Veterinary & Life Science Ethics Committee, the University of Glasgow. Ethical approval was obtained on 28th June 2023, and the project no.200220329 (see *Appendix 5.3*). The questionnaire was anonymous, and no personal identifying information was collected.

5.2.9 Data analysis

5.2.9.1 Utility function

All variables, other than the travel time, were dummy coded. Based on utility function (Equation (1) in section 4.2.3), therefore, the utility that a PWUDs got from alternative i can be estimated in the following equation:

$$U_i = ASC + \beta_1 * Medicalised + \beta_2 * Embedded + \beta_3 * Mobile + \beta_4 * Peer\_worker + \beta_5 * Inhalation\_space + \beta_6 * Drug\_checking\_service + \beta_7 * Overnight + \beta_8 * 24\_hours + \beta_9 * Travel\_time + \varepsilon_i \quad (3)$$

Where U_i was the utility derived from choosing a service model of SDCF ($i = A\ or\ B$); $\beta_1 - \beta_9$ represented the marginal utilities of levels for all attributes describing the service configurations; ASC (alternative-specific constant) for alternative i captured the mean effect on utility of all factors that were not included in the model [276]. When ASC is included, the unobserved proportion of utility, ε_i, has zero mean $E(\varepsilon_{in}) = 0$ [276]. As the DCE included an opt-out option, the ASC was coded to be 0 for *would not choose any of SDCF* (option C), and 1 for either SDCF models A and B.

Given that dummy coding was used to analyse data, one level of each attribute was set to be reference level (constrained to be 0), so that the effect of included levels are interpreted relative to the reference level; improvement from the reference level will yield a positive β value, whereas levels which are less preferred compared to the reference level will yield a negative β value. The *Travel_time* attribute was coded as a continuous variable and was expected to be negative, as respondents were expected to prefer shorter travel times when accessing the SDCF.

5.2.9.2 Application of choice models

The types of discrete choice models are described in section 4.2.4. Data analysis typically starts with a simple MNL model, and gradually adds complexity. A MXL is then used to analyse the data to explore preference heterogeneity. LC and HB models are also performed as additional analysis practice for this PhD work (see *Appendix 5.4*).

In the MXL model, distribution assumptions were specified for each attribute to capture variation in preferences across individuals. Attributes that include location, staffing, space allocation, ancillary service, and opening time were modelled with a normal distribution, allowing for both positive and negative preferences. Travel time was specified with a log-normal distribution to constrain the coefficient to be negative, reflecting the assumption that higher travel time reduce utility.

5.2.9.3 Relative importance

The coefficients (or marginal utilities) can also be used to compare relative importance (RI), or preference weights, that capture the relative weight each attribute has towards decision making, as a percentage of the total influence across all attributes. The RI of each attribute (i) is determined by the range of the level coefficients as a proportion of the sum of ranges across all attributes (K) [303].

$$RI_i = \frac{max(\beta_i) - min(\beta_i)}{\sum_{k=1}^{K}(max(\beta_k) - min(\beta_k))} \quad (4)$$

5.2.9.4 Willingness to travel

To estimate the trade-offs that respondents were willing to make between attributes of SDCF, marginal willingness to travel (MWTT) can be estimated using different approaches [304]. In this DCE chapter, MWTT was calculated as the result of a MXL model in preference space, using delta method (Apollo package in R), as:

$$MWTT_{attribute} = -\left(\beta_{attribute} \Big/ \beta_{Travel\_time}\right) \quad (5)$$

MWTT is calculated as the ratio of the coefficient of each attribute ($\beta_1 - \beta_8$) to the coefficient on the time attribute (β_9). Results can be interpreted as the length of time participants were willing to travel to use a SDCF for an attribute improvement relative to the reference level.

Participants' willingness to travel (WTT) for combined attributes of SDCF design features can be estimated using compensating surplus model. The CS can show the change in travel time that would make a participant indifferent between the status quo (i.e. no SDCF available, $v_j^0 = 0$) and hypothetical intervention scenarios with specified combination of SDCF design features. Compensating surplus (CS) were calculated as:

$$CS = -\frac{1}{\beta_{travel\_time}}\left(v_j^1 - v_j^0\right) \quad (6)$$

Where v_j^1 and v_j^0 were the expected utility of a hypothetical SDCF model and status quo, respectively.

5.2.9.5 Prediction on uptake rates

To predict the service uptake rate, the probability of choosing a service model of SDCF (i), P_{in}, was calculated as:

$$P_{in} = \frac{e^{V_{in}}}{\sum_{j\in[1,J]} e^{V_{jn}}} \quad (7)$$

Where V_i was the utility score of the alternative i. Probabilities were used to compare the predicted uptake rate of a distinct SDCF design verses opting-out (would not choose any of SDCF).

5.2.10 Pilot testing

Prior to implementing the main study, a complete version of the DCE questionnaire was tested for feasibility of participant recruitment to data analysis.

5.2.10.1 Phase I: Cognitive pilot

The cognitive pilot was conducted within the research team, advisory group, and peer researchers to provide comments on the questionnaire. All comments were taken into consideration, and amendments were made to ensure that the questionnaire was comprehensive and appropriate, and that the questions were well defined and presented in a consistent manner.

5.2.10.2 Phase II: 'Soft Launch'

The second phase of pilot study was to inform the priors required for experimental design, an important step in a DCE study. The questionnaire was piloted on 21 participants in the City of Edinburgh between September and October 2023.

A MNL model was used to analyse the data. The results revealed that, compared to opt-out (would not choose any SDCF), participants were in favour of SDCF in Scotland – out of 189 (21 x 9) choice observations, they chose a SDCF 128 times (67.72%) compared to opt-out 61 times (32.28%). Furthermore, none of the participants consistently chose opt-out in all 9 choice sets, which indicated the participants were trading off between the choices.

The validity of experiment was confirmed by pilot testing, as results demonstrated the feasibility of conducting DCEs in this participant group and informed some essential 'priors (β)' that were used to update the experimental design. Thus, the questionnaire itself was not changed in the next phase of data collection, but the experimental design (combination of attributes/levels) was updated using Bayesian priors. The data from the pilot stage were included in the final analysis. Pilot data is presented in *Appendix 5.5*.

All data analysis was conducted in R Studio (V.2023.03.1) using Apollo package [305].

5.3 Results

5.3.1 Socio-demographic characteristics

A total of 77 participants were recruited across 3 major Scottish cities, including 27 in Dundee, 25 in Glasgow, and 25 in Edinburgh. A comparison of the socio-demographic profile across 3 cities, and of the total sample with that of a comparable population from the Drug and Alcohol Information System (DAISy) is presented in **Table 39**.

Results showed that, compared to the PWUD from DAISy, the sample was comparatively older, and was also relatively over-represented by people who reside in an unstable accommodation status (i.e. 61.0% vs. 8.6% live in temporary residence). There was also variation based on the city that they were recruited from; a relatively higher proportion of participants lived in a rental house or flat in Dundee (63.0%) and Glasgow (44.0%), and majority of participants lived with unstable housing in Edinburgh (92.0%). Similarly, more than half of total sample were male (64.9%), but the proportion of males was slightly lower in Edinburgh (44.0%) than Glasgow (84.0%) and Dundee (66.7%). Otherwise, all participants were white, and the majority of them had a weekly income less than £100 in the last 6 months across 3 cities (48.1% in Dundee vs. 52.0% in Edinburgh vs. 48.0% in Glasgow).

Table 39. Participants' characteristics and corresponding population of PWUD statistics, 2023, *N =77*

	Dundee *n=27(%)*	**Edinburgh** *n=25(%)*	**Glasgow** *n=25(%)*	**Total sample** *N =77(%)*	DAISy 2022-23[a],%	Z-test*
Gender						
Male	18 (66.7%)	11 (44.0%)	21 (84.0%)	50 (64.9%)	71.1%	-1.19
Female	9 (33.3%)	13 (52.0%)	4 (16.0%)	26 (33.8%)	28.8%	0.96
Non-binary	0	1 (4.0%)	0	1 (1.3%)	n/a	n/a
Age						
Age 18-29	3 (11.1%)	3 (12.0%)	2 (8.0%)	8 (10.4%)	27.4%c	-3.33*
Age 30-39	6 (22.2%)	5 (20.0%)	8 (32.0%)	19 (24.7%)	34.2%	-1.75
Age 40-49	11 (40.7%)	9 (36.0%)	9 (36.0%)	29 (37.6%)	26.7%	2.14*
Age 50-59	5 (18.5%)	8 (32.0%)	6 (24.0%)	19 (24.7%)	10.1%	4.19*
Age 60 and over	2 (7.4%)	0	0	2 (2.6%)	1.6%	0.69
Ethnicity						
White	27 (35.0%)	25 (32.5%)	25 (32.5%)	77 (100%)	73.3%	n/a
Residence						
Unstable housing	10 (37.0%)	23 (92.0%)	14 (56.0%)	47 (61.0%)	8.6%	15.71*
Rental house or flat	17 (63.0%)	2 (8.0%)	11 (44.0%)	30 (39.0%)	77.7%	-8.04*
Weekly income (last 6 months)						
< £100	13 (48.1%)	13 (52.0%)	12 (48.0%)	38 (49.3%)		
£101-£200	8 (29.6%)	8 (32.0%)	7 (28.0%)	23 (29.9%)	n/a	n/a
> £200	6 (22.2%)	4 (16.0%)	6 (24.0%)	16 (20.8%)		

[a]DAISy: Drug and alcohol information system, 2021-2023 **[306]**;
[b]n/a = not available or not applicable;
[c]27.4% includes people who aged under 18.
*p-value<0.05

5.3.2 Drug profile

Participants were asked about their experience with drugs in the last 6 months (see *Appendix 5.6*). In the overall sample, the most commonly used drugs were cannabis (71.0%), crack (66.2%), cocaine (64.9%), and benzodiazepines (63.6%). The prevalent drug consumption behaviours were reported to be using more than one drug at a time sometimes (32.5%), smoking or sorting drugs (87.0%), using drugs 2-3 time a day (31.2%), taking drugs in public places (59.7%), and taking drugs with other people's company (84.4%).

Variations were observed comparing between different cities and gender groups (*Appendix 5.6*). Cannabis was the most commonly used drug in Dundee (66.7%), benzodiazepine in Edinburgh (80.0%), and cocaine in Glasgow (84.0%). The majority of people used drugs once a day or less in Dundee (59.2%), 1-3 times a day in Edinburgh (72.0%), and more than 2 times a day in Glasgow (64.0%). Participants recruited from Glasgow were less likely to use more than one drug at a time (i.e. 52.0% reported sometimes or never), and injection was their primary method of using drugs (72.0%). Conversely, a higher proportion of participants reported that they always used more than one drug a time in Dundee (25.9%) and Edinburgh (28.0%) compared to Glasgow (20.0%); and smoking or snorting were dominant methods of drug consumption (88.9% in Dundee, 92.0% in Edinburgh). Between gender groups, most female reported using cocaine (73.1%) and less frequently used more than one drug at a time (50.0%). Smoking/snorting was the main method of taking drugs (88.5%) with a low frequency of drug use once a day (38.5%) compared to males. Instead, males' consumption behaviours had no distinguishing features, i.e., the proportion of males reporting different levels of drug use experience tended to be similar.

In the overall sample, most participants reported experiencing mental health issues (46.8%), have not had overdose (70.1%), obtained equipment from need and syringes programmes (50.6%), were prescribed opioid substitution treatment (68.8%), and carried naloxone while using drugs (59.7%) in the last 6 months. Across the 3 cities, more than half of the participants reported experiencing mental health issues in Edinburgh (56.0%) and Glasgow (52.0%), and more than half reported that they had not had any medical problems in Dundee (55.6%).

5.3.3 Attitudes towards the SDCF

The attitudes towards SDCF were generally positive (see *Appendix 5.7*). Out of 77 participants, seventy (90.9%) supported the introduction of SDCF in Scotland, and sixty-five (84.5%) thought PWUD would attend if a facility was available. There was a considerable proportion of participants concerned about the legal issues with using the facility (*N*=31, 40.3%), and the rest were either not concerned (*N*=33, 42.9%) or were indifferent (*N*=13, 16.9%).

Within an open-ended question asking about the essential elements of a SDCF, participants highlighted their concerns about using a SDCF safely and legally – i.e. *'Will I be allowed to take my drugs into the rooms without the police arresting me'*, and *'As long as the police were nowhere near DCRs I think more people would use them'*. Some further attributes were also mentioned, i.e. that SDCF is comfortable, safe, provides privacy, and that they provide something beyond a place to use drugs such as social opportunities or activities.

Out of 693 observations (77 respondents x 9 choice sets), participants chose a SDCF facility 461 times (66.5%) compared to the opt-out 232 times (would not choose any of SDCF, 33.5%). Twenty participants (26.0%) always made the choice to use a SDCF regardless of the different levels of the attributes, and only one (1.3%) always chose not to use SDCF.

5.3.4 Preference weights for attributes of SDCF

The initial MNL and MXL models in preference space showed that some of the design attributes were statistically significant, implying the attributes impacted the decision to use a SDCF (**Table 40**). The use of both models served complementary purpose and reflected a robust modelling strategy to explore both average preferences and preference heterogeneity among participants.

In both model 1 and 2, the design features 'involve peer workers', 'provide drug checking service', and '24 hours' were preferred over to the corresponding reference levels of 'no peer workers', 'no drug checking service', and 'daytime'. Involving peer workers in the SDCF was the most important attribute compared to other design features.

In model 2, the attribute of 'provide inhalation space' was statistically significant with a positive coefficient, indicating that participants had a stronger preference to use a SDCF with inhalation space compared to one provided injection space only. As expected, the coefficient for travel time was negative and significant, indicating that a longer travel time was associated with a lower preference to use a SDCF – marginal utility for using a SDCF decreased by 0.011 unit for every additional minute of travel to the facility in model 2. There was insufficient evidence to conclude preference in terms of location, and overnight opening time ($p>0.05$). In addition, the results from model 2 suggested preference heterogeneity as indicated by highly significant standard deviations on the coefficients of 'provide inhalation space', 'provide drug checking service', '24 hours' and the constant term.

The constant term (ASC) was negative and statistically significant in both models. Theoretically, it may suggest that participants had a tendency to prefer no SDCF (opt-out) over SDCFs, all else equal, but the interpretation of a negative ASC is confounded by the coding of the reference levels in the utility function (see equation (3) in section 5.2.9.1). As the constant term was used to capture the mean impact of unobserved factors that not included in the deterministic utility function, it accounts for differences in the baseline attractiveness of alternatives, beyond the defined attributes and levels. Thus, a negative ASC may imply that: 1) participants disfavoured the reference categories; 2) they were considering attributes not captured in this study; 3) or reflect that there were external factors that meant participant were more likely to opt-out, for example, one possibility could be that SDCF is still considered illegal under the UK law although Scotland plans to open a pilot facility. Direct interpretation that on average participants would prefer no SDCF should not be given too

much weight. Additional investigation was conducted to create interactions between socio-demographic characteristics and ASC, exploring whether opting into a SDCF was associated with participants' gender, accommodation status, age, weekly income, and the city of residence. However, no significant associations were found.

Table 40. Estimates in preference weights for multinomial logit and mixed logit model, 2023, *N=77*

	Model 1 – Multinomial logit (MNL)	*Model 2 – Mixed logit model (MXL)*		*Relative importance (RI)†*
Location	Coeff. (s.e.)	Coeff. (s.e.)	SD (s.e.)	
Stand-alone (Ref.)				
Medicalised	0.221 (0.157)	0.232 (0.199)	0.372 (0.300)	
Embedded	0.177 (0.133)	0.148 (0.165)	0.174 (0.149)	12.0%
Mobile	-0.111 (0.200)	-0.176 (0.272)	-0.640 (0.404)	
Staffing				
No peer worker (Ref.)				
Involve peer workers	0.702***(0.122)	0.953***(0.174)	0.188 (0.337)	28.0%
Space allocation				
No inhalation space (Ref.)				
Provide inhalation space	0.268 (0.178)	0.668*(0.314)	0.989***(0.280)	19.6%
Ancillary service				
No drug checking (Ref.)				
Provide drug checking service	0.533*** (0.153)	0.677***(0.204)	-0.709**(0.245)	19.9%
Opening time				
Daytime (Ref.)				
Overnight	0.077 (0.155)	-0.016 (0.196)	0.512 (0.301)	11.4%
24 hours	0.385**(0.145)	0.373*(0.196)	0.851***(0.260)	
Travel time (continues var.)	-0.008*(0.004)	-0.011***(-0.006)	-0.014 (-0.017)	9.1%
ASC (choosing a SDCF)	-1.010***(0.294)	-1.092*(0.484)	-2.106***(0.275)	
Log likelihood	*-715.31*	*-624.99*		
AIC	*1450.62*	*1289.98*		
BIC	*1496.03*	*1380.80*		

†Relative importance was calculated based on Model 2.
ASC: Alternative Specific Constant, it captured the mean effect of unobserved factors when choosing alternative of SDCF; AIC: Akaike Information Criterion; BIC: Bayesian Information Criterion.
*denotes statistical significance at 5% level, **1% significant level, and ***0.1% significant level.

5.3.5 Preference heterogeneity

Subgroup analyses were conducted to explore whether preference for various design features differ by participants' geographical locations, gender, age, accommodation status, weekly income, and drug profile. Given the small size of this study, the MNL was used in the analyses, and the interaction term was added one by one each time to avoid model overspecification and multicollinearity, and also to improve interpretability of the results (e.g., did age impact preferences for travel time?).

Statistically significant differences in preference were only observed for the geographical locations (*Appendix 5.8*). In Edinburgh, participants preferred a SDCF that involved peer workers (Coeff: 0.025, p<0.001), but were less likely to choose a SDCF that provides inhalation space (Coeff: -0.241, p<0.05), and operates 24 hours a day (Coeff: -0.204, p<0.01) compared to Dundee and Glasgow. It should be noted that the results must be interpreted with caution due to the small sample size.

5.3.6 Willingness to travel

Marginal willingness to travel (MWTT) values of all attributes are reported in **Table 41**. MWTT was calculated as the ratio of the coefficient of each attribute to the coefficient on the time attribute, e.g., $MWTT_{Medicalised} = -(\beta_{Medicalised} / \beta_{Travel\_time})$. The MXL in preference space model with independent random coefficients for all the attributes except the constant (ASC) and travel time were used to estimate the MWTT. The standard errors were estimated using the delta method [305].

Results showed that the involvement of peer workers at the facility had a great (and positive) impact on the willingness to travel to the SDCF. It implied that participants were willing to travel up to nearly 1 hour to use a SDCF that involves peer workers, in comparison to one without peer workers (MWTT: 55.30 mins, s.e.: 24.03, 95%CI: 8.20 to 102.40). Moreover, participants were willing to travel more than half an hour to use a SDCF that provides drug checking service compared to one without (MWTT: 37.74 mins, s.e.: 18.94, 95%CI: 0.62 to 74.85). However, there was insufficient evidence to conclude MWTT in terms of location, space allocation, and opening time (95%CI included zero).

A sensitivity analysis was performed to compare different estimation approaches in *Appendix 5.9*, i.e. standard approach of specifying the coefficients and deriving WTT as the ratio of two coefficients (estimation in preference space); or estimating the WTT directly at the estimation stage (estimation in WTT space) [304]. In preference space models, estimation started with a sample MNL model to provide a baseline of average MWTT without allowing coefficients to be varied. This was then followed by an initial MXL model that of travel time was defined as lognormally distributed parameter (as travel time was generally disliked) and other attributes were normally distributed (as allowing positive or negative deviations), so the MWTT was calculated as a ratio of two random distributed coefficients. However, results of MXL in **Table 40** showed that the standard deviation for travel time coefficient was statistically insignificant, indicating unobserved heterogeneity in terms of time sensitivity. In this case, travel time was treated as a fixed parameter in the subsequent MXL model, and MWTT distribution reflected only the heterogeneity of non-time attributes which avoided complex distribution assumptions associated with ratios. In addition, a MXL in WTT space was estimated to calculate MWTT directly as a further robustness check. By comparing these four model specifications, the results showed very similar goodness of fit across the models and suggested the robustness of MWTT estimation in this DCE study. The MXL model in preference space with fixed travel time presented the slightly better fit across models and therefore is reported as the main result in **Table 41**.

Table 41. Marginal willingness to travel (MWTT), in minutes

	Model 3 – MXL in preference space	
	Mean (s.e.)	**95%CI**
Standalone (ref.)		
Medicalised	14.63 (14.36)	[-13.52, 42.77]
Embedded	9.72 (11.65)	[-13.13, 32.56]
Mobile	-5.8 (16.64)	[-38.41, 26.82]
No peer workers (ref.)		
Involve peer workers	55.30 (24.03)	[8.20, 102.40]
No inhalation space (ref.)		
Provide inhalation space	29.30 (16.80)	[-3.63, 62.24]
No drug checking service (ref.)		
Provide drug checking service	37.74 (18.94)	[0.62, 74.85]
Daytime (ref.)		
Overnight	-6.69 (13.52)	[-33.19, 19.80]
24 hours	15.46 (14.56)	[-13.08, 43.99]
Log likelihood	*-662.99*	
AIC	*1359.97*	
BIC	*1437.17*	

AIC: Akaike Information Criterion; BIC: Bayesian Information Criterion.

5.3.7 Predicted SDCFs' uptake rates

To better understand how long participants were willing to travel for a specific facility model, the willingness to travel (WTT) for combined attributes of hypothetical SDCF models was estimated using the compensating surplus model as written in equation (7). The estimation was based on the marginal utilities from Model 2 – MXL. Results are presented in **Table 42**, indicating the highest willingness to travel up 151 minutes (approx. 2.5 hours) to Facility C, followed by 117 minutes (approx. 2 hours) to Facility B and 55 minutes (approx. 1 hour) to Facility A.

A further estimation was conducted to simulate how SDCFs with different design features might be affecting participants' uptake rates. Given the proposed SDCF models shown in **Table 42**, assuming a 30-minute walking distance to facilities, the predicted probabilities for each facility's uptakes were calculated compared to the status quo (no SDCF available). Results showed that the probability of participants attending Facility A was approximately 57% compared to the status quo (43%); attending Facility B was approximately 72% compared to the status quo (28%); and attending Facility C was approximately 79% compared to the status quo (21%).

Table 42. Willingness to travel (WTT) for hypothetical SDCF facilities and their estimated uptake rates (%)

	MU*	Facility A	Facility B	Facility C
Location	0.000	Standalone	Standalone	Standalone
Staffing	0.953	Involve peer workers	Involve peer workers	Involve peer workers
Space allocation	0.668	Include inhalation space	Include inhalation space	Include inhalation space
Ancillary service	0.677	No drug checking service	Provide drug checking service	Provide drug checking service
Opening time	0.373	Daytime	Daytime	24 hours
ASC	-1.010			
Maximum WTT (in minutes)		**55.55**	**117.09**	**151**
Uptake rates (vs. no SDCF)**		**57%**	**72%**	**79%**

*MU: marginal utilities estimated from Model 2 mixed logit model.
**Uptake rates were calculated assuming each facility required a 30-minute travel time.

5.4 Discussion

5.4.1 Main findings

The purpose of this study is to engage with PWUD who lives in Scotland, to identify the optimal design features of a SDCF delivery model. It attempts to understand service users' preferences in the Scottish context before the government formally introduces the facilities, which aligns with the Scottish Nation Drugs Mission Plan 2022-2026 [307] that emphasizes the importance of involving people with lived and living experience of problematic drug use in the design, implementation, and assessment of drug policy. A pilot SDCF has been given approval to operate in Glasgow City in 2024, and published research studies have been conducted in the Scottish context regarding perceptions towards SDCFs (see section 3.3.3.2). A service design that incorporates the perspective of potential users may lead to the development of SDCFs that are better suited to the expectations and needs of users. Accordingly, it may increase the possibility of user engagement and therefore increase the overall reach and impact of services as shown in other studies in the field [308, 309].

The study results highlight that peer involvement is considered the most important design feature. Participants were willing to travel up to 1 hour to use a SDCF staffed with peer workers. Previous studies also found a strong preference for peer involvement in SDCFs among PWUD in Canada and suggested that this type of facilities was well utilised [310-312]. The importance and benefits of peer involvement in developing and delivering substance use intervention are well documented in the literature, suggesting increased service satisfaction and retention, improved relationships with service providers and social supports, and significantly promoted service outcomes [313, 314]. Peer involvement is a cost-effective and cost-saving strategy integrated into behavioural health services

(i.e. targeting mental illness), shown to be associated with a lower cost of care due to reduced emergency services [315] and psychiatric rehospitalizations [316]. However, recent research identified several challenges involving the peer workforce in harm reduction programmes in the UK. First, the unequal payment between peer workers and salaried employees is a key reason for discontinued involvement [317]. Second, the unclear job role of peer workers within the service could lead to a vague boundary and responsibility of co-working with staff members [318]. Interestingly, peer workers tend to advocate for a leadership role in the service, rather than working strictly under the direction of a staff member of the service provider [317, 318]. Similarly, previous studies suggest that the feasibility of running a peer-involved SDCF requires further considerations, such as additional funding and resources to achieve the task shifting from specialised health professionals to individuals with less training [310, 319].

Participants also favoured SDCFs that provided both inhalation and injection space verses those with injection space only. This preference reflects the mixed pattern of drug consumption behaviours participants reported in the current study and from reports related to wider substance use situation in Scotland [36, 320]. Although SDCFs have traditionally been designed to prevent harms associated with injecting behaviour, they are evolving to address harms that arise from different routes of drug use. It is common practice in Canada and Australia, to manage people who smoke and inject drugs in separate isolating facilities; conversely, in European countries, smoking space is usually integrated with injecting space under one facility [321]. It may imply different perceptions of reducing harms for relatively less risky drug consumption (i.e. smoking) and concerns about an overcrowded service [321, 322]. However, the most recent report has shown that smoking drugs have overtaken injection as the leading route of drug use involved in overdose deaths in the US in 2022, which suggested a transition from injection heroin to smoking illegally manufactured fentanyls (IMFs) [323]. A similar trend has been observed in British Columbia, Canada, where inhalation overtook injection in 2017, and most opioid overdose deaths are now being caused by smoking [324, 325]. In Scotland, it is well understood that overdose deaths are strongly associated with injecting heroin [36, 326], and efforts have been made to encourage PWID to smoking or snorting heroin by providing foil since 2014 [327]. Despite the perceptions that inhalation is less risky than injection, the preference for non-injecting space reported in the current study should not be ignored, especially with fast-growing literature suggesting a shift of drug consumption behaviours worldwide and its underestimated harms [323, 325, 328, 329]. To be noticed, in Scotland, a significant growing number of people reported cocaine use between 2021-2023 compared to other prevalent drug types (although heroin is still in dominance), with smoking accounting for a large proportion [306].

Participants also exhibited preference for SDCFs that offers a drug checking service over those that do not. Several studies have been conducted to understand stakeholders' perceptions, potential advantages and challenges regarding designing and implementing community-based drug checking services in Scotland [330-333]. The most favoured model for drug checking service is integration into the third sector (not-for-profit), with others indicating a preference for drug checking embedded with SDCFs or mobile vans, and the least preferred model being the NHS substance treatment [332]. The current DCE study also attempts to understand the preference towards SDCFs' location, but the sample size is too small to draw a conclusion. Even so, it would appear to make sense that potential service users would feel less stigmatised and more willing to use drug checking in the service in which they are already using drugs (i.e. SDCFs), as reflected in previous work [331]. In Scotland, the potential benefit of implementing drug checking services in the SDCFs might be that it could influence people's attention on drug contents, such as 'street benzodiazepines'. However, there is still uncertainty with regards to the implementation strategies, for example, service users' waiting time to get results and availability of equipment and expertise [332].

Lastly, participants preferred SDCFs that open 24 hours a day compared to ones that open during daytime only. The delivery of a facility on the daily basis requires financial resource and a sustainable

workforce. A survey conducted in 2021 revealed that Scotland has been facing significant challenges with staff shortages in drug and alcohol treatment services, with highest vacancy rates in psychological therapists (18.3%), followed by medical roles (16.4%) [334]. The shortages are particularly related to the issues with funding and compensation, lack of career development opportunities, overwhelming caseloads within the services, and perception of lack of attention to staff wellbeing [334]. Some existing SDCFs open with extended (or flexible) hours, while 24 hours operations are still rare (see section 3.3.1). Even if feasible to run a facility 24 hours a day, careful consideration of service users' preferences is also required. In the current study, the subgroup analysis found that participants recruited from Edinburgh, when compared to those from Dundee and Glasgow, tended to choose a SDCF that opens during the daytime. This finding is explained by results of focus groups in Edinburgh City Council's report that participants indicated a preference towards early morning opening time over 24 hours [322], which suggests several factors that may possibly impact on the preferences amongst PWUD, for example, drug consumption behaviours can differ across the geographical context due to drug availability differ in the local drug markets.

5.4.2 Strengths and limitations

This is the first DCE study, to our knowledge, to measure PWUD's preference towards SDCFs' service design. It provides useful information to decision-makers about PWUD's perspectives on SDCFs before Glasgow pilot facility can be formally assessed and evaluated in Scotland. To complement previous peer-reviewed qualitative studies, this DCE study statistically quantifies how much participants value different design features of a hypothetical SDCF, and allows us to understand how much participants are willing to trade their time for their preferred facility design features. Furthermore, this study incorporated peer researchers' insights at questionnaire development stage and obtained their assistance on data collection, which have strengthened the credibility and authenticity of conducting research within PWUD community. For example, peer researchers helped to make the DCE questionnaire more user friendly in terms of wording. Also, they were able to engage with PWUDs in a more meaningful way, through community services or on the streets, supported by their shared lived experience. In addition to this, in-person data collection by peer researchers meant participants were assisted, where necessary, in reading through the questionnaire, supporting completion by those who may not have otherwise participated.

There are a few limitations to this study. First, given the limited budget and time restriction of this PhD work, qualitative data were not able to collected to assist the attribute selection process (i.e. focus group, in-depth interviews, or nominal group technique are often recommended in literatures [335]). Instead, the list of attributes was identified through conducting a literature review (section 3.3.2) and then selected through the discussions between research group and experts in the substance use research and practice field. To address selection bias, comprehensive early-stage preliminary work was placed on validating the attribute selection with advisory group and people who have lived and living experiences with drug use through emails and informal group discussion, i.e. by organising visits to community services and speaking to people (as detailed in section 5.2.2).

Second, even though peer researchers were involved to help with participant recruitment, the achieved sample size of 77 participants does not provide sufficient power to capture the preferences for some attributes (i.e. location and overnight opening time). Also, it limits the possibility of investigating the possible effects of differences in sociodemographic indicators between the sample population and the trade-offs between travel time and other attributes (i.e. space allocation, ancillary service, and opening time).

Third, it is possible that participant selection bias affected preference. The sample population of the study comprises more PWUD who are relatively older and in unstable living situations than the population recorded in the Scottish DAISy dataset [306], but it may adequately represent most

marginalised subpopulations who are not registered in substance use treatment services and would be the priority of SDCFs.

Fourth, a high proportion of participants recruited from Dundee City reported non-injection routes of drug use (i.e. smoke/snorted: 88.9%, and oral: 48.1%), which may lead to a stronger preference towards inhalation space in the SDCF compared to injection subgroups. However, it is expected that PWUD use multiple types of drugs in their daily life, and the second and third frequently used drug types in Dundee were crack (55.6%) and benzodiazepines (51.9%), both of which were primarily consumed by inhalation.

5.4.3 Implications for policymaking and future research

This study provides useful information on PWUDs' preferences towards SDCFs' design features, and leaves unresolved questions for future research. Unfortunately, due to the limited sample size, the current study cannot conclude the preferences for SDCF's location. Further research could explore the acceptability of the facility location for not only the potential service users, but also the people who may be impacted by the establishment of SDCFs, i.e. the general public. A DCE study conducted in Canada shows that the general public dislikes having a SDCF located in their neighbourhoods, with a high willingness-to-accept (WTA) value of approximately $11,500 (CAD) per person [336]. It suggests a set of factors that could improve public acceptability for SDCFs, for example, when SDCF reduces costs to the healthcare system, reduces discarded needles in the neighbourhood, effectively prevents overdose deaths, and provides compensation to residents impacted by the establishment of SDCFs. In Scotland, the general public expressed a higher willingness-to-pay (WTP) for abstinence-based treatments rather than needle exchange or methadone maintenance (WTP ranged from £8.27 to £16.10), with over half of participants unwilling to pay anything for the drug treatments [337]. The long-standing problems with stigmatizing PWUD in society [338, 339], to some extent, may also explain a strong preference for peer involvement among PWUD in the current study.

Second, future work should focus on SDCF's implementation and sustainment in a dynamic manner. This DCE study may capture a snapshot of preferences at the current time period. In the past decades, however, the consistently evolving service provision in SDCFs across other jurisdictions has implied a multidimensional and changing drug culture, as discussed earlier. It is a challenging task for decision-makers to decide how SDCFs should be designed and implemented in a sustainable way that takes into consideration service users' shifting drug use behaviours over time. It may indicate that constant stakeholder engagement at operation stages is essential for ongoing facility implementation success.

Third, this study also highlights the necessity for future research to explore the potential impact of SDCFs on preventing harms associated not only with injecting drug use (e.g., overdose, wound care), but also with other routes of drug use (i.e. smoking, snorting). Furthermore, it is not known the costs and benefits of implementing a SDCF in Scotland. In order to optimize the implementation, the economic evaluations incorporating the findings of this DCE study might be helpful for decision-makers to weigh the costs and benefits of different facilities prior to their implementation.

Chapter 6 Modelling the Potential Cost-effectiveness of a Safer Drug Consumption Facility (SDCF) in Glasgow, Scotland – a hypothetical analysis

6.1 Introduction

In 2016, Glasgow City Health and Social Care Partnership initially sought approval for the piloting of a safer drug consumption facility (SDCF) in Glasgow, Scotland [229]. Their proposal particularly emphasised the potential beneficial impact of such a facility towards the ongoing HIV outbreak among people who inject drugs (PWID) in public areas of Glasgow city centre [229]. It took until September 2023, when the Lord Advocate issued a formal Statement of Prosecution Policy to support full implementation of the SDCF [53], for a pilot facility to become a reality (known as '*The Thistle*' formally opened in Glasgow City in January 2025) [340]. A revised proposal was published in 2023, promoting the implementation of '*(a) SDCF alongside a number of services for the target population…, with pathways into longer term recovery*', slightly expanding the role of the facility into engaging people who use drugs (PWUD) with broader health and social care services [230].

A similar shift in attention has also been seen across other jurisdictions with evolving SDCF implementation practices, as discussed in more detail in Chapter 3. The premise for SDCFs is that PWUD often require sustained care support to address or support their multiple and complex needs, particularly reflecting the high burden of comorbid medical conditions [341], social and economic disadvantages [342], and considerable barriers faced to accessing healthcare services, including stigma and discrimination from clinical professionals [343].

Deciding on what components of the facility are essential to tackle problematic drug use within geographical and social contexts presents significant challenges for healthcare providers, local authorities and governments. The adoption and implementation of SDCFs in Scotland potentially require more attention on combating the overdose epidemic and increasing service utilization [36, 280]. Whilst the pilot facility was given the go-ahead in Glasgow, discussion on the possibility of implementing SDCFs in other Scottish cities have already taken place, i.e. Edinburgh [322]. As discussed in Chapter 3, SDCFs across the globe have varying facility configurations, aligning with differing drug use profiles and local priorities [344]. Evidence also suggests mixed preferences towards facility design locally and internationally [345, 346], which was further corroborated in the DCE findings reported in Chapter 5.

The economic consideration related to operational costs and outcomes (i.e. effectiveness of intervention) is usually a key factor that drives decision-making about whether to allocate scarce healthcare resources to invest in new interventions [279]. To support a SDCF's policy adoption, economic evaluation can serve as a useful tool to help support a value case – by estimating the costs and effectiveness of a proposed SDCF in comparison to the alternative course of action (i.e. no SDCF available), determining whether SDCF offers better health outcomes for the same or less costs and ensuring resource are used efficiently (as discussed in section 4.3). Furthermore, incorporating different facility configurations in the evaluation provides decision-makers with information about whether additional configurations add more value in improving the service uptakes and correspondingly the health outcomes, how much resource is required upfront, and whether they are cost-effective or not. Lastly, the recent closure of 10 SDCFs in Canada due to lack of funding from Ministry of Health has highlighted the potential challenges towards supporting SDCFs' sustainability [347].

According to the National Institute for Health and Care Excellence (NICE) public health guidance for incorporating health economics [279], a review of existing economic evaluation (including critical appraisal and quality assessment) should be collated and analysed to justify the necessity of conducting further economic analysis. In other words, the economic evaluation is warranted if existing economic analysis is not generalisable to the current context [279]. Thus, Chapter 2 was conducted to systematically review the economic evaluations on the topic of drug policies, and the existing research evidence on the SDCFs was summarised in section 2.3.6.3, suggesting their cost-effectiveness in providing a range of benefits. Further justification on the necessity of conducting a cost-effectiveness analysis for introducing a SDCF in the Scottish context is given in section 4.3.1.

The purpose of this chapter is to provide prior knowledge on the cost-effectiveness of introducing a SDCF before it is formally evaluated in Scotland. To our knowledge, this is the first analytical-modelling-based analysis using previously published evidence to estimate the potential cost-effectiveness of a hypothetical SDCF compared to having no SDCF in Scotland. Additionally, the findings of a DCE study in Chapter 5 were integrated to enable the evaluation to model how cost-effectiveness might vary with changes in service uptakes and patterns of use resulting from different facility configurations.

The specific research questions are:

I. What are the potential costs of implementing a SDCF compared to the status quo (i.e. no SDCF available) in Glasgow?
II. What are the potential benefits/effectiveness of the SDCF in terms of preventing overdose deaths, increasing referral uptakes to long-term treatment engagement, and increasing life expectancy of PWUD?
III. What are the incremental costs and effectiveness of the SDCF compared to status quo (i.e. no SDCF available)?
IV. What are the potential costs and effectiveness of different scenarios of SDCF configurations?

6.2 Methods

6.2.1 Guidelines for study design and reporting

This study was prepared and reported in accordance with the Consolidated Health Economic Evaluation Reporting Standards (CHEERS) [348] and the good practice guidelines in decision-analytical modelling [349]. The framework of developing decision-analytical modelling was recommended under three key themes: 1) determining the scope and mathematical structure of the model; 2) data identification methods and how uncertainty should be addressed; and 3) internal and external consistency (e.g., relates to the combination of model structure, assumption and data inputs) [349].

6.2.2 Study design

A cost-effectiveness analysis was conducted to estimate the costs and effects of implementing a SDCF versus the status quo (i.e. no SDCF available) in Glasgow City. It was designed as a hypothetical study because there are no data on SDCF available in the Scottish context, so previously published literature and other relevant Scottish date were the main source of developing decision analytical models and input parameters.

A decision analytical model were developed to simulate a cohort of the population who attended SDCF to use drugs over a 1 year time horizon, and could then referred to medication-assisted treatment (MAT) for long-term recovery, in comparison to the status quo (see section 6.2.4 for more details on model structure). MAT refers to the use of medication (e.g., methadone or buprenorphine)

alongside psychological and social support that is responsible for the delivery of recovery-oriented care [350].

The study population was PWUD, including those who take injection and/or non-injection routes. Glasgow City was defined as the setting where hypothetical SDCF would be located, as its drug death rate was recorded highest among other major Scottish cities (at 44.6 per 100,000 population) [36].

The National Health Service (NHS) perspective was used to calculate costs, quality-adjusted life-years (QALYs), life-year saved (LYs), and incremental cost-effectiveness ratios (ICERs) associated with each alternative. Taking an NHS perspective in cost-effectiveness analysis means that the evaluation includes only the costs and outcomes relevant to NHS Scotland, with a specific focus on informing the decision-making for publicly funded healthcare in the Scottish context. An incremental cost of less than £20,000-£30,000/QALY was considered as an cost-effective use of NHS resources because this is the willingness to pay threshold used by NICE, indicating that interventions below this threshold are generally seen as offering good value for money within a fixed NHS budget [351].

As discussed in section 4.3.2, taking a NHS perspective is considered sufficient to reflect the current available evidence, with the purpose of providing preliminary information on the potential costs and outcomes before the SDCF is formally evaluated in the ongoing natural experiment in Scotland [352]. This initial evaluation can provide early estimates of costs and outcomes, identify data gaps, incorporate stakeholder preferences, and simulate potential pathways of impact, helping to target the subsequent natural experiment better, make it more methodologically robust, and inform key factors that should be closely monitored during the evaluation stage. The choice of outcome measures in 1-year time horizon reflects the policy prioritise to reduce drug-related deaths and related emergency healthcare service in Scotland. In lifetime model, using QALYs as outcome measure reflected the changes in health-related quality of life and survival, and incorporated potential outcomes that haven not yet been considered in previous studies, e.g., health benefits of taking MAT, avoid coldness and unhygienic environment. However, it still might be limited to capture many of the important non-health benefits of using a SDCF, for example reduced stigma, improved feelings of safety and social wellbeing that are important to Scottish PWUD (as discussed in Chapter 2 and 3). Nevertheless, the selection of primary outcomes and perspective reflects a policy-relevant priorities and data availability, and it remains directly applicable to inform decision-making in the Scottish policy context.

The model is split into a short-term decision tree to stimulate individuals' attendance in SDCF over 1 year, followed by a longer-term Markov model to estimate referrals to MAT and lifetime mortality and quality of life outcomes. Thus, outcomes were measured in short term model for 1 year and then extrapolated over the lifetime for all individuals active in the model over a 64-year time horizon (up to the time most individuals in the population had died). Lifetime outcomes were discounted at 3.5% annually, which means that the costs and benefits occurring in the future are given less weigh than those occurring in the present, in line with NICE recommendations [351]. Costs were valued at 2025 price in GBP Sterling (£). The following sections detail the design of the model and model inputs for the treatment effects, quality of life and costs.

6.2.3 Defining the intervention arm

The intervention was to provide a SDCF compared to the current practice – 'no SDCF available'. As discussed earlier in Chapter 3, various types of SDCF service models have been implemented across the world. This study used a stand-alone SDCF (as described in section 3.3.1.1) as the standard service model to estimate its cost-effectiveness for two reasons: 1) it is the most common model adopted worldwide, the Glasgow pilot facility has adopted a stand-alone service model and it is the most likely model to be used in other UK city contexts [230], and 2) existing evidence in relation to

the effectiveness of SDCF pertains to stand-alone models (referred to standard SDCF model hereafter; details in SDCF effectiveness in section 3.3.4).

The comparator 'no SDCF available' used in this analysis was the current practice of care in Scotland, defined as the absence of a legally sanctioned SDCF. It was selected because it accurately reflects the current legal and service delivery context in Scotland, where the implementation of a SDCF represents the policy change. Using this comparator allows the analysis to calculate the incremental costs and outcomes to the introduction of a SDCF over the current practice of care, providing useful information to decision-makers considering the initial service adoption. In addition to the base-case, an alternative SDCF service model was further examined in the scenario analyses, incorporating findings of potential service users' preferences in the Scottish context from Chapter 5 (referred to as optimal SDCF model thereafter). This comparator was designed to capture a preferred service configuration that are identified in Chapter 5 and are expected to impact service uptake and treatment outcomes. Incorporating the 'optimal' SDCF model allows the evaluation of whether and what extend a preference-informed service model add additional value compared to standard SDCF model. This is highly relevant in the Scottish context, where maximising engagement among PWUD is vital in achieving reduction in harms [280].

Two alternative service models are compared in **Table 43**. The standard SDCF model was defined based on existing models of SDCF, such as a facility that opens 12 hours per day and 7 days per week and accommodated 8 booths for service users to use illicit drugs. Without available data suggesting how people would use the facility in Glasgow, this study made an assumption that SDCF has a capacity of serving 1 person per hour on average. Based on previous studies, annual visits to Canadian '*Insite*' were numbered 243,701, indicating 3 visits per hour [$243{,}701\ visits/(365\ days \times 18\ opening\ hours \times 12\ booths)$] [353]. SDCF staff included medical doctors, nurses, social care workers, and peer workers.

As per the regulations in existing SDCFs (see section 3.3.2.2), it is assumed that the model would align with these, including that individuals who were on drug treatments were not allowed to use SDCF, as overdose deaths were found to be highly correlated with the time periods of discharge from community or inpatient drug treatment [281].

The alternative 'optimal' SDCF model design shared some similarities with the standard model, but provided a longer opening time (i.e. 24 hours) with a larger capacity of serving more service users per day, and also provided drug-checking services on-site – which were the key features identified in the DCE in Chapter 5 as preferred by current Scottish PWUD.

Table 43. Comparison of two alternative SDCF service models

	Standard SDCF model	**Optimal SDCF model**
Number of spaces	8 booths	
Opening hours	9am – 9pm, 7 days per week	24 hours, 7 days per week
Capacity	Each user stays in facility for 1 hour one average.	
Staffing	Medical, nursing, social care and peer support staff.	
Rules and regulations	Individuals who on drug treatments were not able to use SDCF.	
Ancillary services	Not available	Drug checking service

6.2.4 Model structure

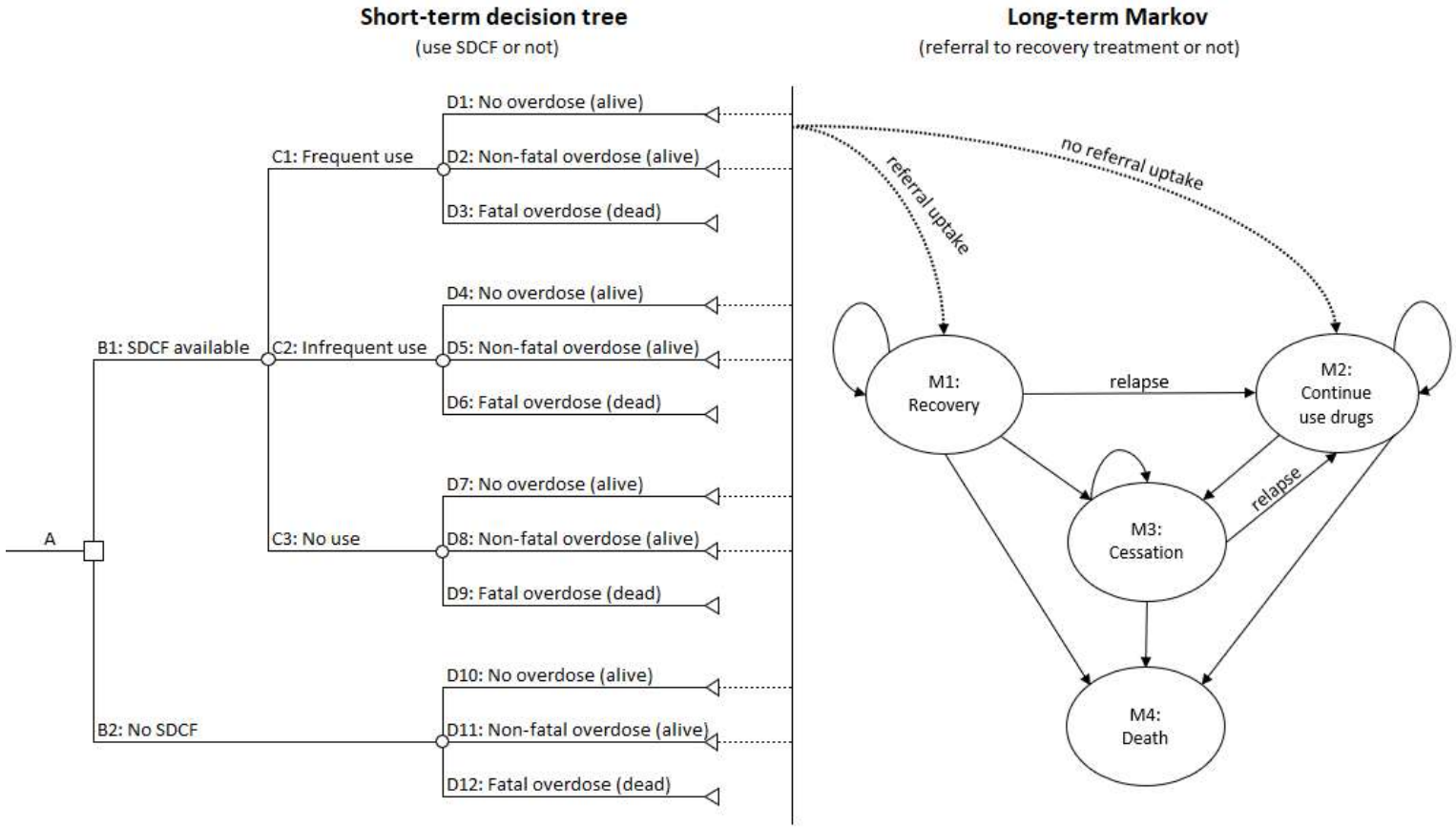
A short term, and lifetime model was developed in Microsoft Excel™ (Microsoft Corporation, Redmond, WA, USA), as shown in **Figure 6**. Transition branches in the decision tree and states in the Markov model were defined and are further explained in *Appendix 6.1*.

The short-term analysis used a time horizon of one year, with a decision tree structure to map the immediate costs and outcomes (i.e. overdose and related use of emergency service), allowing for a clear comparison of short-term costs and immediate health outcomes between the SDCF and no

SDCF alternatives. A one-year time horizon was selected for the decision tree because it corresponded with the way existing trial data (mostly observational studies from Canada and Australia, see section 3.3.4) reported outcomes on an annual basis, and enables capture of the immediate short term indicators – overdose and reduced hospital emergency service use.

Figure 6 illustrates the two alternatives and decision tree pathways. The intervention arm was SDCF available (B1), which was compared to the status quo of having no SDCF (B2). In either arm, they both led to three potential outcomes for PWUDs: no overdose (alive), non-fatal overdose (alive), and fatal overdose (dead), and incorporating varying degrees of users' engagement levels in the treatment arm – frequent use (C1), infrequent use (C2), and no use (C3) that potentially impacted the probabilities of three outcomes compared to status quo. Frequent use was defined as weekly attendance at SDCF (i.e. ≥ 1 visit per week); infrequent use was defined as less than one visit per week (i.e. < 1 visit per week). Previous studies demonstrated that frequent use of SDCF was positively associated with initiation of MAT compared to infrequent use [262], but not associated with fatal and non-fatal overdoses compared to either infrequent use or no use [258]. Individuals who survived at the end of a one-year time horizon transition into the long-term Markov model.

The Markov model simulated individuals' movement during a one-year cycle between four health states: recovery in MAT (M1), continued use of drugs either in SDCF or elsewhere (M2), cessation (M3), and death (M4). Individuals who left the decision tree and took up a referral entered M1 state, and those who did not take a referral entered M2 state, thereby two states had different transition probabilities to cessation and death. Those who stayed in M1 can drop out of treatments and relapse to continually use illicit drugs (M2), and also those who were in cessation can relapse to use illicit drugs (M2). In addition, individuals can stay in M1-3 for a period of time until they move to the next state. Of note, people who uptake MAT (M1) were assumed to no longer use any illicit drugs during the treatment episodes (thus, they were not able to use SDCF), and those who were relapsed (M2) can no longer move back to MAT (M1).



Note: SDCF=supervised drug consumption facility;
M1=recovery in medicine-assisted treatment (MAT);
M2=continue use illicit drugs in SDCF or elsewhere.

Figure 6. *Model structure: a short-term decision tree followed by the long-term Markov model*

6.2.5 Modelling the treatment effects

Table 44-47 present input parameters and their ranges for probabilistic sensitivity analysis (PSA). Parameters were identified and selected from multiple sources. The priority was given to Scottish-specific data sources to ensure contextual relevance, such as open datasets available from Public Health Scotland and statistical reports from the Scottish Government [36, 243, 255, 306, 351, 354-379], as well as the result of the DCE study in Chapter 5. Where national data was unavailable, evidence from peer-reviewed literature identified in Chapter 2-4 was used to obtain robust estimates. In the absence of either, international studies were used, e.g., the USA, although the potential limitations in transferability were acknowledged. To enhance the validity of the final parameter set, all parameters were cross-checked for internal consistency and coherence with other selected input data and existing evidence. A detailed justification for parameter selection is provided in *Appendix 6.2*.

There is usually uncertainty associated with input parameter values of an economic model, which may have been derived from source studies. As such, PSA was undertaken to reflect the uncertainty in model parameters and to provide decision makers with a more robust basis for interpreting the cost-effectiveness results [380]. It strengthens the transparency and credibility of the evaluation by explicitly showing the level of confidence in the output of the analysis, which may have been derived from selected sources. Details of how the PSA was conducted for this study are provided in section 6.2.9.

The baseline model began at the age of 36 years, the median age of PWUD was recorded in the Drug and Alcohol Information System (DAISy) in 2022/23 in Scotland [306] (see **Table 44**). Age distribution of the population of PWUDs in Scotland was reported right-skewed in multiple datasets as an aging cohort of population [306, 320], thus median age was considered appropriate to use in the current analysis. DAISy included a broader group of people who took non-injection routes, making it a representative reflection of the focused population. In addition, Scotland's drug deaths were recorded highest in the age group of 35-54 in 2023 [36], which further supported that a median age of 36 years was appropriate for reflecting the population at risk. The probability of an individual dying at any given age was derived from the 2025 UK National Life Table [370].

6.2.5.1 Transition probability in decision tree

Without available data related to service users' engagement levels in Glasgow, for the standard SDCF model, the assumption was made based on the findings from a national bio-behavioural survey conducted in Scotland, suggesting that 83.0% (179/216) of PWID were willing to use a SDCF in Glasgow city centre [243] (**Table 44**). Further calculations on the proportions of frequent and infrequent users were based on previous published observational studies [190, 247, 250] that showed around 25.0-29.0% of individuals frequently used SDCF for all or most of their injections. To make a conservative estimate, the proportion of frequent users was 20.75% by using the lowest estimate point (83.0%×25.0%), and the remaining proportion of infrequent users and non-users would be 62.25% and 17.0%, respectively. For the optimal SDCF model, the proportion of frequent use was derived from the DCE findings that 26.0% of individuals always choose to use a SDCF model no matter how it was designed, 1.3% of individuals who never chose to use a SDCF model, and the rest of individuals were assumed to be of infrequent use (see section 5.3.3).

A time series study conducted in Canada showed that the overdose death rate in the 500 meters radium decreased by 35.0% after the opening of '*Insite*', from 253.8 to 165.1 deaths per 100,000 population (p=0.048), and 9.3% reduction beyond the 500 meters radium (p=0.49) [255]. This study was considered the most realistic estimation because of its robust research design compared to other studies, representing 1) a long period of observational time between 2001 and 2005; 2) the control group was an area of the city with similar drug prevalence; 3) the effect size of 500 meters radiation was measured according to the observation of approximately 70.0% service users lived in

such geographical scope. A more detailed discussion related to facility effectiveness was provided in section 3.3.4. The prevalence of non-fatal overdose was derived from a systematic review and meta-analysis that assessed a total of 67 studies, indicating a 26.0% probability of non-fatal overdose among PWUD [356]. The current study assumed identical probabilities of fatal overdose, non-fatal overdose, and no overdose across treatment and control arms, assuming inherent risks at each time individuals use drugs.

The proportion of emergency overdose services (i.e. naloxone provision, ambulance call-out, A&E visit, and hospitalisation) and treatment referral uptakes were derived from a 5-year clinical trial on Sydney '*MSIC*' [363]. The proportions related to the status quo (i.e. no SDCF) were estimated based on previous peer-reviewed studies and published Scottish data. For example, the joint probability of overdose required ambulance call-out was calculated based on a UK study related to naloxone distribution that multiplied the proportion of witnessed overdose (0.85, 95%CI: 0.32-0.94) and the proportion who called an ambulance (0.60, 95%CI: 0.30-0.80) [364]. The proportions of A&E visits and hospitalisation were calculated based on the published data from Public Health Scotland [366, 371]. The referral uptake of drug treatment was unavailable, thus assumption was made based on the percentage of referral PWUD to smoking cessation services in the DAISy dataset [306].

Table 44. Model input parameters – transition probability in decision tree

Input parameter	Base case	Distributional parameters for probabilistic sensitivity analysis*	Source
Median age of PWUD	36		[306]
Drug-death rate in Glasgow City	44.6 per 100,000 people	Beta: 1272.0, 2851218.0	[36]
Age-specific mortality rate in the UK			[370]
Transition probability in decision tree			
Treatment arm: SDCF available			
Proportion of being frequent use_standard	20.75%	Beta: 14.21, 20.03	Calculated, based on [243]
Proportion of being infrequent use_standard	62.25%	Beta: 14.21, 20.03	
Proportion of being no use_standard	17.0%	Beta: 20.58, 100.48	
Proportion of being frequent use_optimal	26.0%	Beta: 18.24, 51.91	Calculated based on Chapter 5
Proportion of being infrequent use_optimal	1.30%	Beta: 24.66, 1872.42	
Proportion of being no use_optimal	72.70%	Beta: 6.10, 2.29	
Drug-death rate reduction within 500 meters of SDCF	35.00%	Beta: 3.33, 6.18	[255]
Drug-death reduction beyond 500 meters of SDCF	0%		[255]
Prevalence of non-fatal overdose among PWUD	26%	Beta: 213.27, 606.98	[356]
Proportion of overdose required ambulance run in SDCF	0.79%	Beta: 92.0, 11640.0	[363]
Proportion of overdose required A&E visit in SDCF	0.79%	Beta: 92.0, 11640.0	[363]
Proportion of overdose required hospitalisation in SDCF	0.79%	Beta: 92.0, 11640.0	[363]
Percentage of MAT referral uptake	16.00%	Beta: 21.0, 109.0	[368]
Status quo: no SDCF			
Proportion of overdose required ambulance call-out	9.60%	Beta: 22.50, 211.91	[364]
Proportion of overdose required A&E visit	6.50%	Beta: 915.0, 13185.0	[366, 371]
Proportion of overdose required hospitalisation	1.50%	Beta: 123.0, 7877.0	[372]
Percentage of MAT referral uptake	8.80%		Assumption, based on [306]

*Distributional parameters – Beta: alpha, beta; lognormal: log of mean, standard error; Gamma: alpha, lambda.
PWUD: people who use drugs; SDCF: safer drug consumption facility; MAT: medicine assisted treatment.

6.2.5.2 Transition probability in Markov model

Limited evidence was found related to drug cessation (**Table 45**). A cohort study examined the long-term cessation (5 years abstinence) among 794 patients with a history of injecting drug use presenting in primary care in the City of Edinburgh, Scotland, between 1980 and 2007, suggesting a gradually increasing probability of achieving cessation while receiving opioid substitution treatment [362]. This finding was consistent with previous studies that state cessation was positively associated with a longer duration of drug treatment [381]. Untreated natural recovery from problematic drug use was affected by multiple factors, such as age, social environment, and personal motivation [357, 382, 383]. The probability of natural recovery from problematic drug use ranged from 5% (cocaine dependence) to 55% (cannabis dependence) [384-386]. It was unknown how well the findings from these studies could be reflecting the natural recovery in reality, especially since polydrug use became prevalent, thus a conservative estimation of 22% per annum (opioid dependence) was used in the current study. Meanwhile, there is a probability that individuals experience relapse, and move between cessation and drug use in the model. A large American cohort study showed that the probability of relapse to continued use of drugs was 39.2 per 100 person-year during a 12-year follow-up [377]. Overdose-caused mortality rates while receiving MAT and untreated were derived from a systematic review and meta-analysis [365].

Table 45. Model input parameters – transition probability in Markov model

Input parameter	Base case	Distributional parameters for probabilistic sensitivity analysis*	Source
Transition probability in Markov model			
Retention rate in MAT	75%	Beta: 6.0, 2.0	[373]
Hazard ratios of cessation in MAT			
Year 1	0.73	Lognormal: 0.52, 0.04	[362]
Year 2 to 10	0.89	Lognormal: 0.59, 0.12	
Year 11 to 15	0.95	Lognormal: 0.61, 0.12	
Year 16 and over	0.91	Lognormal: 0.60, 0.12	
Probability of natural recovery (cessation without MAT)	22.0%	Beta: 19.0, 68.0	[357]
Probability of relapse	0.324	Beta: 17.0, 35.0	[377]
Drug-death rate while receiving MAT	0.0024	Beta: 138.0, 57278.0	[365]
Drug-death rate while untreated	0.0240	Beta: 42.0, 1717.0	[365]

*Distributional parameters – Beta: alpha, beta; lognormal: log of mean, standard error; Gamma: alpha, lambda.
MAT: medicine assisted treatment.

6.2.6 Utilities

Quality of adjusted life years (QALYs) was calculated to measure the health outcomes (**Table 46**). The utility value (defined as a numerical measure of an individual's quality of life associated with a specific health condition) of a current drug user was adopted from a large sample size study (n=2,898) in Scotland that the median age of population was 34 years old (IQR: 29-39), with an estimated utility value of 0.73 based on the EQ-5D questionnaire [367]. The study result was very similar to previous published international literature, with reported values ranging from 0.67 to 0.80 [359, 379, 387-389]. Improvement in utility for those who took drug treatment and were in recovery was 6.5% [359]. Individuals who achieved long-term cessation were assumed to have a utility value that was equal to the general population [354], and those who experienced overdose were assumed to have a utility value of 0.68 compared to those who did not overdose in the last 12 months [379]. Individuals who did not experience any overdose events were assumed to maintain a utility value at 0.73. So far, the benefits of using SDCF for people to use drugs in a warm, clean, and safe space were not quantified by any studies (as discussed in section 3.3.4), thus incorporating such treatment effect was hypothetically based on a cross-sectional survey conducted in London (the UK), suggesting one-year homelessness was associated with a loss of 0.117 QALYs [355], thereby individuals who use drugs in public areas were assumed to have a utility value of 0.613 (0.73-0.117).

Table 46. Model input parameters – utility values

Input parameter	Base case	Distributional parameters for probabilistic sensitivity analysis*	Source
Utility values			
MAT users	0.777	Beta: 4.79, 1.37	Calculated, based on [359]
Cessation	0.900	Beta: 54.42, 6.05	[354]
Non-fatal overdose	0.680	Beta: 6.08, 2.86	[379]
Did not have overdose	0.730	Beta: 8.48, 3.14	[367]
Use drugs in SDCF	0.730	Beta: 8.48, 3.14	[367]
Use drugs in public areas	0.633	Beta: 8.54, 4.95	Assumption [355]

*Distributional parameters – Beta: alpha, beta; lognormal: log of mean, standard error; Gamma: alpha, lambda.
SDCF: safer drug consumption facility; MAT: medicine assisted treatment.

6.2.7 Cost parameters

Variable costs of implementing a SDCF included staff salary for speciality clinicians, psychiatric consultants specialised in substance use, nurses, peer workers, sterile equipment for drug use, and drug checking service; and the costs associated with emergency services for overdoses, including naloxone, ambulance call-out, A&E visit, and hospitalisation (**Table 47**).

Table 47. Model input parameters – costs and resource use

Input parameters	Base case (unit cost)	Resource use	Distributional parameters for probabilistic sensitivity analysis*	Source
Staff salary				
Specialty clinicians	£31.6 per hour	1.0	Gamma: 25.0, 0.04	[375, 376]
Psychiatric consultant (substance use specialised)	£54.9 per hour	1.0	Gamma: 25.0, 0.04	
Nurse	£26.3 per hour	1.0	Gamma: 25.0, 0.04	
Peer workers	£12.6 per hour	1.0	Gamma: 25.0, 0.04	
Sterile equipment for drug use	£3.4 per needle	1.0	Gamma: 25.0, 0.13	Calculated, based on [361]
Drug checking service	£393.5 per sample	1.0	Gamma: 25.0, 15.74	Calculated, based on [358]
Emergency services for overdoses				
Naloxone (Prenoxad®)	£27.72 per kit	1.0		[390]
Ambulance call-out	£254 per run	1.0	Gamma: 25.0, 10.16	[360]
A&E visit	£267 per visit		Gamma: 25.0, 10.68	Calculated, based on [372, 374]
Hospitalisation	£5,952 per night	2.0	Gamma: 25.0, 238.08	
Annual cost of MAT	£6,306 per person	1.0	Gamma: 25.0, 252.25	Calculated, based on [378]
Modelling parameters				
Cycle length	1 year			
Annual discount rate	3.5%			[351]

*Distributional parameters – Beta: alpha, beta; lognormal: log of mean, standard error; Gamma: alpha, lambda.
MAT: medicine assisted treatment.

Naloxone and the associated price were based on the naloxone (Prenoxad®) 1mg/ml pre-filled syringes for injection [390]. Staff salary was derived from the Scottland NHS staff pay 2025 [375, 376]. Cost per A&E visit for drug-related overdose were calculated based on Scottish health service costs data [374], and the cost per ambulance call-out was derived from the Unit Costs of Health and Social Care [360]. The unit cost per hospitalisation stay was derived using 'top-down' costing approach based on Scottish health service costs data [360], by dividing the total annual hospital

expenditure by the total annual length of hospitalisation stays. This approach can provide a higher estimate compared to patient-level ('bottom-up') costing approach, because it tended to include indirect costs, e.g., management, capital, and support services onto the patient activity. Consequently, a higher unit cost may increase the contribution of inpatient utilisation to total costs, and the incremental cost would be more sensitive to this parameter, potentially making the SDCF appear more cost-effective.

Other costs were adopted from published peer-reviewed costing studies, including sterile needles and syringes [361], drug checking service cost [358], and the annual cost of MAT [378]. All costs were adjusted to 2025 price in GBP Sterling (£).

6.2.8 Cost-effectiveness analyses

In the base case analysis, the point estimate of each input parameter value was used. The short-term costs and effectiveness were estimated by mapping out all possible pathways that a hypothetical cohort could experience following the attendance of a SDCF over 1 year, in comparison to the status quo (i.e. no SDCF available). Each branch of the three represented a potential outcome, with probabilities assigned to reflect the likelihood of each event occurring. Costs were attached to the resource use associated with each branch, while effectiveness was expressed as probability of drug-related death and QALYs. The expected costs and outcomes of each intervention were then calculated by multiplying the costs and effectiveness of each branch by their corresponding probabilities and summing across all possible pathways. This gave an overall expected costs and effectiveness for each intervention option, which can then be compared to estimate the incremental cost-effectiveness ratio (ICER).

The total lifetime costs and effectiveness were estimated by simulating a hypothetical cohort as it transitioned between defined four health states over time. For each cycle, individuals occurred the relevant costs (e.g., intervention, or healthcare utilisation) and health outcomes associated with the transition state they occupied. These values were then calculated across all cycles to estimate the total lifetime costs and LYs. QALYs were subsequently derived from the utility values assigned to each state, capturing both survival and health-related quality of life. A lifetime horizon of 64 years with a yearly cycle length was used, and a half-cycle correction was applied.

Scenario analyses were then conducted to understand the potential cost-effectiveness of a different SDCF configuration (i.e. optimal SDCF model) compared to the status quo (i.e. no SDCF available). In addition, by hypothesising a potential service usage of SDCF per annum, the changes in the number of overdose deaths, emergency services for overdoses (i.e. ambulance call-out, A&E visits, and hospitalisation) and their associated costs were calculated.

6.2.9 Probabilistic sensitivity analysis

To understand the effects of uncertainty around the input parameters, cost-effectiveness results were further assessed in the PSA, using Monte Carlo simulation to random sample input parameters 1,000 times [380]. In the analysis, input parameters were sampled according to their distributional assumptions, for example, gamma distribution for costs, beta distribution for probabilities or utilities, and lognormal distribution for relative risks (as shown in **Table 44-47**). Particularly, gamma distribution was applied to cost parameters, as costs are non-negative and typically right-skewed, making the gamma distribution well-suited to capture their variability. Beta distribution was used for probabilities and utility because these parameters are bounded between 0 and 1, which aligns with the properties of the beta distribution. Lognormal distribution was employed for relative risks and rate ratios, as these parameters are strictly positive, meaning the log transformation produces a symmetric distribution that is statistically appropriate.

The parameter distributions were estimated based on the mean, standard error, or reported 95% confidence intervals (CIs) when available, to ensure that uncertainty reflected the strength of the evidence from source studies. Where standard error or 95% CIs were not reported, it was assumed to equal 20% of the mean value of the parameter [380]. This is commonly applied in cost-effectiveness analysis to represent uncertainty while in the absence of data, to capture the potential variability in parameter estimates [391]. The results were visualised on cost-effectiveness planes to illustrate how uncertainty in individual parameter impact model outcomes, and decision uncertainty was then presented by the cost-effectiveness acceptability curve (CEAC), showing the probability of cost-effectiveness as a function of the willingness to pay for an additional QALY.

One-way sensitivity analysis is another useful method to understand the impact of input parameters on the ICER, however, limited by varying a single parameter while making all others constant at a time [380]. Given the limited data availability and necessary reliance on various data assumptions, PSA was considered a better choice to capture the joint uncertainty of all parameters simultaneously. It is considered as the 'gold standard' for uncertainty analysis in decision modelling for health economic evaluation by providing a more informative information for decision-making, i.e., probability of SDCF being costs-effectiveness rather than a series of isolated point estimates [380].

6.3 Results

6.3.1 Base case analyses

6.3.1.1 Short-term model

The analyses were conducted in Microsoft Excel™ (Microsoft Corporation, Redmond, WA, USA). Study results are summarised in **Table 48-50**, and detailed calculation breakdown is provided in *Appendix 6.3*.

In **Table 48**, the estimated annual drug death rate was 31.6 per 100,000 people when implementing a SDCF in Glasgow, which represented a reduction of 13.0 (a 29% risk reduction) in comparison to the status quo (i.e. no SDCF). The total QALYs were estimated to be 0.71 for SDCF users compared to 0.66 for individuals who do not use the SDCF, respectively. It suggested a slight improvement in quality of life for SDCF service users because of the reduced probability of overdoses and avoided use of drugs in public areas. The cost of implementing a SDCF was £126.2 per person per visit, including variable costs (i.e. staff salary and sterile equipment for drug use) and emergency service costs (i.e. naloxone, ambulance call-out, A&E visit, and hospitalisation), compared to costs of having no SDCF at £59.2 per person per visit. Overall, the implementation of SDCF reduced the probability of drug deaths and provided a greater quality of life for service users (0.05 QALY gained) at an incremental cost of £67.0 compared to the status quo (i.e. no SDCF), predicting an incremental cost-effectiveness ratio (ICER) at £517,399 per death avoid or £1,378 per QALY gained within a 1-year time horizon. At a willingness-to-pay (WTP) threshold of 20,000-30,000/QALY [351], the SDCF was considered highly cost-effective compared to status quo. According to the value of prevented fatality (VPF), the societal willingness to pay to avoid one death was reported to be £2.5 million in the UK, suggesting SDCF represented good value for money in terms of lives saved [392].

Table 48. Base case results – short-term model

	SDCF available	***Status quo***	***Incremental (Δ)***
Short-term health outcomes			
Probability of drug death, per 100,000 population	31.6	44.6	-13.0
Utility values, QALYs	0.71	0.66	0.05
Total shot-term cost, per person	£126.2	£59.2	£67.0
Short-term ICERs			***£517,399 per death avoid*** ***£1,378 per QALY gained***

SDCF: supervised drug consumption facility; QALYs: Quality-adjusted life years; ICERs: incremental cost effectiveness ratios; LYs: life-year saved.

6.3.1.2 Lifetime model

In the lifetime model, the referral benefits of frequently attending SDCF were incorporated, assuming service users would be more likely to initiate drug treatments (i.e. MAT), which may have positive effects on drug-related overdose deaths (**Table 49**).

Results show that the total lifetime cost of implementing a SDCF (£3,842, 95%CI: 805 to 83,376) was higher than the status quo (£1,664, 95%CI: 143 to 36,809), corresponding to an incremental estimated lifetime cost of £2,178 (-668 to 55,126) at a 3.5% discount rate. The estimated lifetime LYs of implementing a SDCF (34.8 LYs, 27.8 to 45.0) was also higher than the status quo (33.5 LYs, 25.5 to 39.7), suggesting 1.3 (0.7 to 7.2) life-year saved. Similarly, the QALYs gained with the SDCF implementation (14.27 QALYs, 8.9 to 18.3) was higher than status quo (13.47 QALYs, 8.4 to 17.3), yielding 0.83 (0.43 to 2.84) QALYs in total. Overall, the ICER of a SDCF was £1,693 per life-year saved or £2,640 per QALY gained compared to the status quo (i.e. no SDCF) at a lifetime horizon.

Table 49. Base case results – lifetime model

	Cost	***Δ Cost***	***LYs***	***Δ LYs***	***QALYs***	***Δ QALYs***
Status quo	£1,664		33.5		13.47	
SDCF available (standard model)	£3,842	£2,178	34.8	1.3	14.27	0.83
Lifetime ICERs					***£1,693 per life-year saved***	
					£2,640 per QALY gained	

SDCF: supervised drug consumption facility; QALYs: Quality-adjusted life years; ICERs: incremental cost effectiveness ratios; LYs: life-year saved.

To present results reflective of the Glasgow population context (**Table 50**), in terms of preventing overdose deaths and saving costs for overdose-related emergency services, this study assumed a total number of visits to the SDCF was 8,000 times per year. The assumption was based on the information received from the service manager of Glasgow '*The Thistle*' that over 200 people have used the service, over 2,000 supervised injections have happened in the SDCF since it opened in early January (Information obtained due to a visit to Glasgow pilot facility on 24th May 2025). As such, by supervising 8,000 service users annually, the SDCF was estimated to prevent 1 overdose, 183 ambulance call-outs, 118 A&E visits, and 21 hospitalisations in a year, associated with a cost saving of £335,748 per year.

Table 50. Base case results – overdose-related outcomes and associated emergency services costs

	SDCF available	***Status quo***	***Incremental (Δ)***
Annual number of visits in SDCF	8,000	-	-
Overdose-related outcomes (no.)			
Drug-deaths within 500m radium	2.5	3.6	-1.0
Ambulance call-out	16.4	200.0	-183.6
A&E visits	16.4	135.2	-118.8
Hospitalisations (2 days)	10.4	32.0	-21.6
Costs of overdose emergency services			
Ambulance call-out	£4,169	£50,804	-£46,635
A&E visit	£4,382	£36,100	-£31,718
Hospitalisations (2 days)	£123,948	£381,343	-£257,395
Total costs	£132,499	£468,247	-£335,748

SDCF: supervised drug consumption facility; QALYs: Quality-adjusted life years; ICERs: incremental cost effectiveness ratios; LYs: life-year saved.

6.3.2 Alternative SDCF model scenario

Scenario analysis was conducted to examine an alternative SDCF model, incorporating reported preferences towards SDCF configurations among Scottish PWUDs in Chapter 5. Optimal SDCF model was a facility that opened for a longer time and provided drug checking service onsite, which was expected to have a better treatment effects and also higher costs. For example, the assumption was

that a longer opening time would increase the supervised drug consumption and accordingly reduce the unwitnessed overdoses, and providing drug checking service onsite would reduce the probability of overdose by preventing consume unknown drugs.

Results show that the lifetime cost of the standard SDCF model and optimal model were £3,845 and £4,533 (95%CI: 1,246 to 86,436), respectively (**Table 51**). In comparison to the status quo (i.e. no SDCF), a greater QALY was provided by standard SDCF model (0.83 QALY gained) and optimal SDCF model (0.86 QALY gained, 0.39 to 3.20). Similarly, service users' life expectancy was also improved by standard SDCF model (1.29 LYs) and optimal SDCF model (1.34 LYs, 0.62 to 7.31) compared to the status quo. Overall, both alternative services were considered cost-effective at £20,000-30,000/QALY threshold within a lifetime horizon. The incremental cost-effectiveness ratios (ICERs) were estimated to be at £1,692 per QALY gained (or £2,640 per life-year saved) for the standard model and £2,139 per QALY gained (or £3,337 per life-year saved) for the optimal SDCF model at a lifetime horizon.

To investigate whether the extra features of optimal SDCF model offer sufficient value compared to standard SDCF model, the marginal ICER was approximately £19,958 per QALY gain (or £12,731 per LY saved). This suggests that the standard SDCF model represented a strongly cost-effective option, while upgrading to an optimal SDCF model only gave a small extra health benefit (0.03 QALY or 0.05 LY), but still be acceptable given the WTP threshold at £20,000-30,000/QALY.

Table 51. Scenario analyses

Service model	***Cost***	***ΔCost***	***LYs***	***ΔLYs***	***QALYs***	***ΔQALYs***	***ICERs***
Status quo (ref.)	£1,664	-	33.50	-	13.47	-	
Standard SDCF model	£3,842	£2,178	34.79	1.29	14.30	0.83	***£1,692 per LY saved*** ***£2,640 per QALY gained***
Optimal SDCF model	£4,533	£2,869	34.84	1.34	14.33	0.86	***£2,139 per LY saved*** ***£3,337 per QALY gained***
Marginal comparison (standard vs. optimal)		£691	-	0.05	-	0.03	***£12,731 per LY saved*** ***£19,958 per QALY gained***

SDCF: supervised drug consumption facility; QALYs: Quality-adjusted life years; ICERs: incremental cost effectiveness ratios; LYs: life-year saved.

6.3.3 Probabilistic sensitivity analysis

The probabilistic sensitivity analysis (PSA) was performed across all input parameters as well as the alternative service model scenarios in order to understand the robustness of model conclusions and to identify any notable differences when facility configurations were changed (**Figure 7-8**).

Results were obtained from 1,000 Monte-Carlo simulations for the PSA. The mean costs, effects, and cost-effectiveness outcomes across all 1,000 simulations represent the probabilistic outcomes. Each simulation generated an incremental effectiveness estimate (i.e. QALYs gained, or LY saved) and an incremental cost of the SDCF service models, which were plotted on cost-effectiveness plane A and B to illustrate the uncertainty. As shown in **Figure 7**, uncertainty in incremental outcomes is reflected in the spread of points along the x-axis, and uncertainty in incremental costs is shown by the spread along the y-axis. The majority of simulations for two service models lie below the WTP thresholds, with a large degree of overlap between the two of them. The incremental effectiveness was largely dense between 0.5 to 1.5 QALYs in the cost-effectiveness plane A and 1.0 to 2.2 life-year saved in the cost-effectiveness plane B.

The cost-effectiveness acceptability curves (CEAC) represent the proportion of simulations below the WTP threshold, indicating the probability of the treatment being cost effective under different

WTP thresholds [393, 394]. As shown in **Figure 8**, the maximum acceptable ceiling ratio (λ) represents society's willingness to pay on the x-axis, and the probability of intervention being considered cost-effective is shown on y-axis. For both scenarios, the SDCF had an over 90% probability of being very cost-effective at a WTP threshold of £20,000-30,000/QALY compared to the status quo (i.e. no SDCF), with the standard SDCF model slightly more favourable than the optimal SDCF model that confirmed the robustness of lifetime cost-effectiveness analysis.

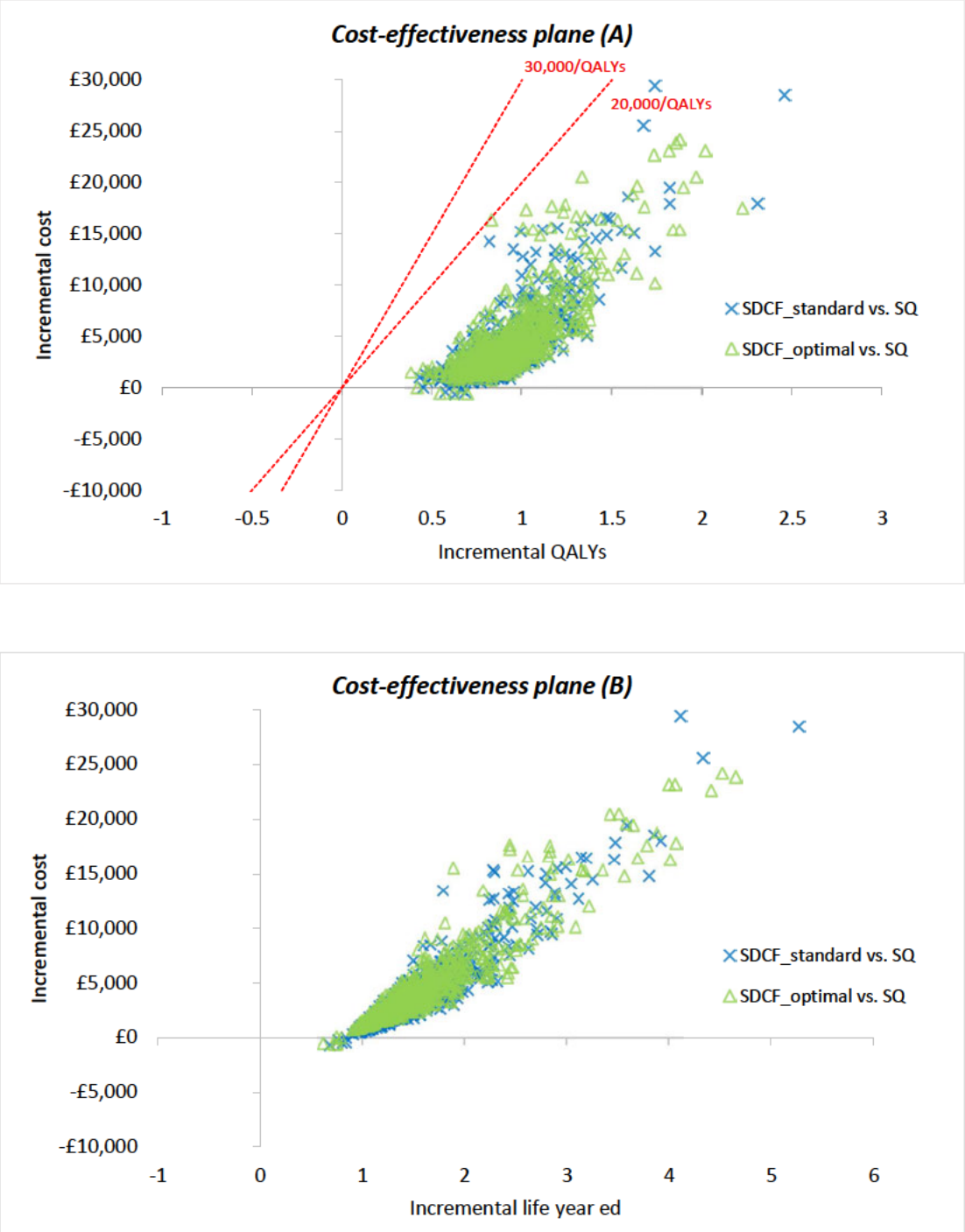
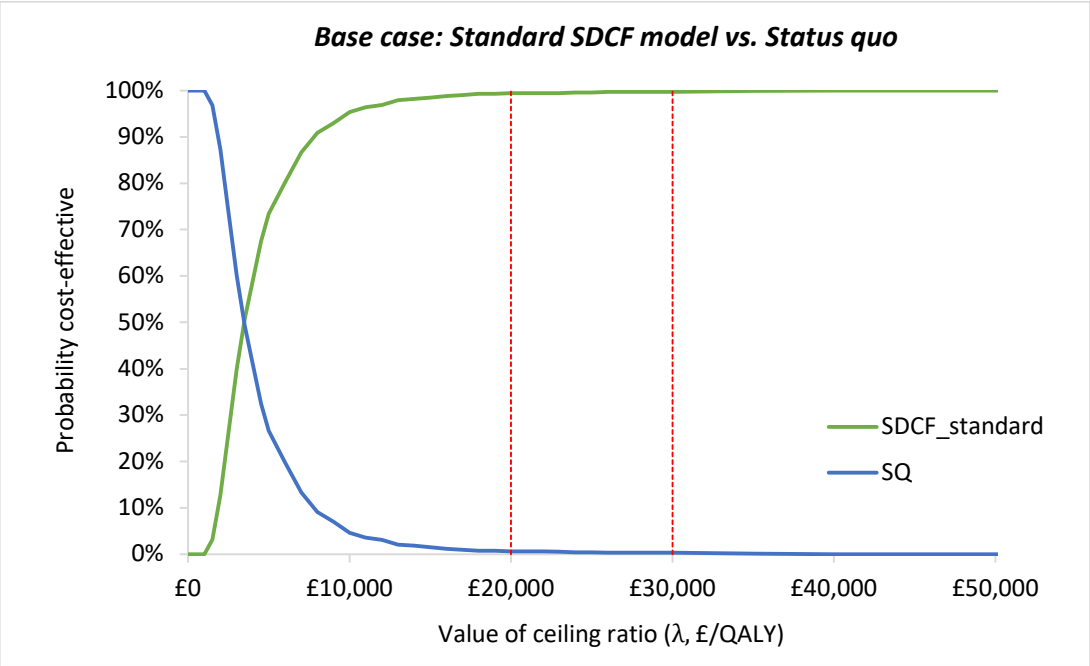


Figure 7. *Cost-effectiveness plane (A) and (B)*



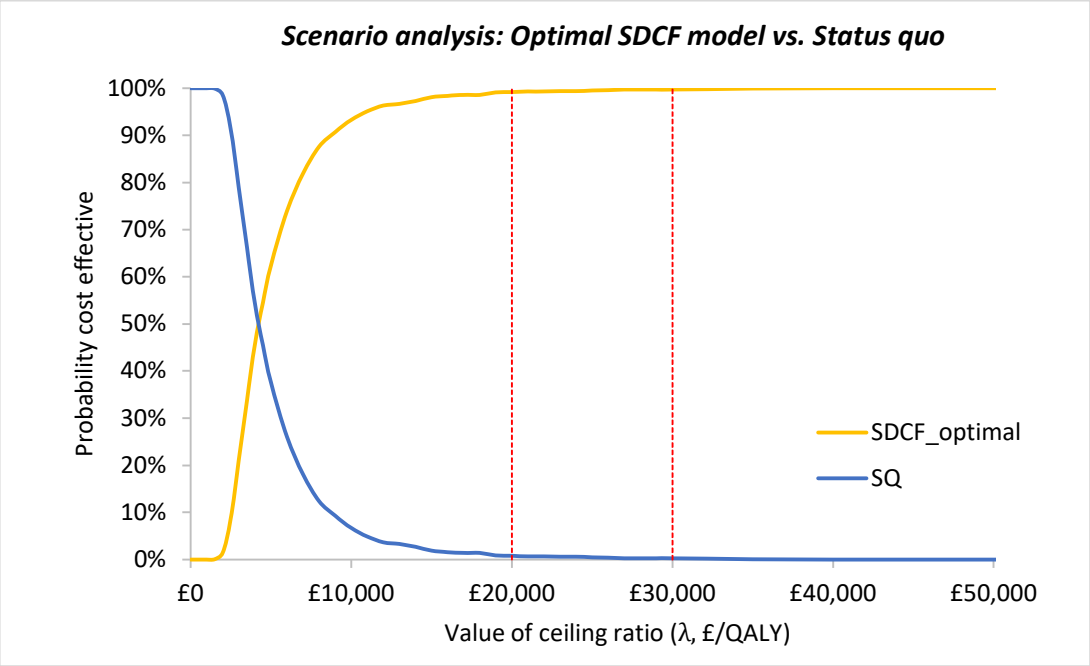


Figure 8. *Cost-effectiveness acceptability curves (CEAC)*

6.4 Discussion

6.4.1 Main findings

The main objective of this study was to estimate the potential cost-effectiveness of implementing a SDCF compared to having no SDCF available in Glasgow, Scotland, using international literature and local epidemiological data to develop decision analytical models in the absence of clinical trials in the Scottish setting. This hypothetical study developed a short-term decision tree to estimate the effectiveness of SDCF in preventing overdoses, followed by a Markov cohort model to forecast the lifetime benefit of referring SDCF service users into long-term recovery in MAT. It was planned and commenced before the Glasgow pilot SDCF and its evaluation was announced and funded (and cost-effectiveness is one of the evaluation components). Thus, this analysis services as a pre-implementation assessment that provides prior information on the projected short- and long-term costs, benefits, and cost-effectiveness of implementing a SDCF in Glasgow. It will provide early insights into the ongoing NIHR-funded natural experiment (evaluation started in April 2025), by identifying key parameters and uncertainties that should be closely considered and monitored. In addition, an alternative facility configuration was further examined by integrating findings of a DCE study that explored potential service users' preferences regarding SDCF service configurations in Scotland (Chapter 5).

The findings of this study are consistent with previous studies, suggesting the implementation of SDCFs is cost-saving or cost-effective in short- and long-term time horizons (as reviewed in Chapter 2). Implementing a SDCF in Glasgow would be cost-effective from a healthcare perspective at willingness-to-pay threshold of £20,000-30,000/QALY. Over a 1-year time horizon, a SDCF would be cost-effective with an estimated ICER at £1,378 per QALY gained (or £517,399 per death avoid) compared to the status quo (i.e. no SDCF available). In the lifetime cost-effectiveness analysis, implementing SDCF remained highly cost-effective while incorporating referral benefits for service users engaging with long-term recovery treatment, with an estimated ICER at £2,640 per QALY gained (or £1,693 per life-year saved).

In addition, the scenario analysis highlighted that a SDCF would further improve service users' life expectancy and quality of life, but also become costly if it offers longer service time and provides drug checking service onsite. With ICERs increasing from £2,640 per QALY gained (or £1,693 per life-year saved) to £3,337 per QALY gained (or £2,140 per life-year saved), the standard SDCF that opens 12 hours without drug checking service would be more cost-effective than the one opens longer time and provides drug checking service at a lifetime horizon. Nevertheless, both service models were predicted to be highly cost effective, which was confirmed in the sensitivity analysis, with the standard SDCF model slightly more likely to be favourable under this perspective.

Despite SDCF providing good value for money per person, the underutilisation of the service would limit its contribution to reducing drug-related deaths across the population. While assuming 8,000 visits annually in the SDCF in Glasgow, a total of 1 drug-related death was predicted to be prevented over one year, corresponding to an annual cost-saving of £335,748 due to avoidance of 183 ambulance call-outs, 118 A&E visits, and 21 inpatient hospitalisations. In comparison to North American settings, the estimated number of prevented deaths by a SDCF ranged from 1 to 15 per year, which included estimations for small to large urban cities with varied savings ranged from US$1,104,454 to $7,800,000 per year [131, 133, 395]. Those facilities tend to save more lives and costs because of their high service uptake among PWUDs. For example, the reported average service usage to SDCFs are 600 visits per day in Canadian '*Insite*', 106 visits per day in Australian '*MSIC*', or 378 visits per day in the German facility [396]. It implies that a higher service utilisation to the SDCF could save more lives, thus a greater saving could be achieved through avoided emergency overdose services. In Scotland, one study estimated that approximately 400-500 people

inject drugs in public areas on a daily basis in Glasgow city centre [285], but the current service uptakes of Glasgow pilot SDCF appear to be much lower (i.e. approximately 24 visits per day), based on data released from Glasgow City Council in the first five months of the service (up to 31st May), compared to other settings [397]. Although the current analysis indicates the potential cost-effectiveness of a SDCF, the underlying epidemiological characteristics of geographic location (i.e. small population size) or low uptake rate may significantly hinder SDCF to achieve its intended impact in Glasgow, Scotland.

6.4.2 Strength and limitations

This is the first study to estimate the potential cost-effectiveness of a SDCF in Glasgow, Scotland. It also simulates a treatment pathway of referring individuals to long-term recovery drug treatment through the SDCF, a potential health benefit promoted by the Scottish Government [230] but not yet considered to date in previous literature. Furthermore, this is the first study to examine an alternative SDCF configuration by incorporating stated preferences in relation to service design among PWUDs in the Scottish setting. It strengths the evidence base by assessing and highlighting additional benefits that were often overlooked in the existing literature and political debate (see Chapter 3), providing a more balanced perspective to inform future discussions.

There are limitations to this study. First, the estimation on the overdose death rate is based on a single observational study on the effectiveness of the SDCF based on Canadian '*Insite*' service model [255]. The study is considered the most robust one amongst others and has consistently been adopted by previous hypothetical cost-effectiveness analyses in settings where SDCF is not yet implemented (as discussed in section 2.3.6.3). Also, the effectiveness of including inhalation booths in the SDCF has not been examined in any trial, but is regarded as necessary service component based on findings from Chapter 5 (as discussed in section 5.4), and the Glasgow pilot facility is seeking approval to provide such spaces as well [398]. Thus, the current model assumptions could change once data becomes available from the ongoing natural experimental study for the Glasgow '*Thistle*' [352].

Second, there is a large degree of uncertainty associated with the values used for the input parameters, regardless of the source from which they were derived to develop this simulation-based analysis (i.e. preview-reviewed literature, Scottish epidemiological data, and Government report). For example, as found in Chapter 3, evidence shows that service users who frequently use SDCF are more likely to be referred to drug treatments. Due to the lack of data, the Scottish survey data on the willingness to use a SDCF is integrated to mimic the potential service usage of the standard SDCF model [243]; and a DCE survey data (from Chapter 5) is used to simulate the service uptake for the optimal SDCF model. However, the high willingness stated in both survey data may not represent individuals' behaviours in reality, thus may overestimate the treatment effects in the model. Performed probabilistic sensitivity analysis suggests a relatively good confidence in the cost-effectiveness of the SDCF, but further investigation is required to understand how SDCF is used by service users and its associated treatment effects in Glasgow, Scotland.

Third, the current study is conducted very conservatively due to the lack of available data in related on to other potential outcomes of SDCF, e.g., change in high-risk behaviours and associated HIV and HCV infections, or impact on drug-related litters in public areas and criminal activities in the local community (as discussed in sec on 3.3.4). The probabilities of having an overdose or not were assumed to be the same across each decision tree branch, representing the fixed risk of events at every me an individual uses drugs, which may not reflect the varying risks among different subgroups of the population who are at high or low risk. Once official figures are published by Public Health Scotland, the model can be updated and re-run using the new data, which will allow the results to be refined and provide accurate and robust evidence for decision making. If the additional data becomes available, taking a societal perspective would enable the inclusion of broader impacts

and costs beyond those captured within the narrative NHS perspective used in this study. Incorporating broader effects, e.g., improvement in community safety and reduction in social care services, may potentially reduce the ICER and make SDCF more cost-effective. Conversely, if unintended negative consequences are found, these effects could alter the ICER and reduce SDCF's cost-effectiveness. This highlights the importance of understanding the consequences of implementing a SDCF within real-world observational studies, which would enable future economic models to adopt a broader perspective, allowing for a comprehensive and robust assessment of the SDCF in Scotland.

Fourth, the current analysis is limited to inherent methodological challenges in decision modelling, for example, the decision tree is unable to capture individuals' movements between frequent use, infrequent use, and no use. The probabilities of having an overdose or not were assumed to be the same across each decision tree branch, representing the fixed risk of events at every time an individual uses drugs, which may not reflect the varying risks among different subgroups of the population who are at high or low risk. Also, the Markov model is not able to reflect the possibility of individuals re-entering recovery treatment after they have moved to continue to use drugs. The Markov assumption indicates that the probability of transitioning to a future state depends only on the current state, thus Markov states are memoryless and cannot account for how long an individual has been in a particular state or how frequently they have transitioned between states [380]. As a result, the Markov model maybe limited to reflect the nature of individuals who repeatedly transition between receiving treatment and continuing drug use throughout their lives. Tackling these issues would require advanced modelling techniques, such as an agent-based model to predict how behavioural changes interact with contextual factors. However, the key obstacle is lacking empirical data. As aforementioned in section 3.3.4, concerns remain about whether the existing empirical research is methodologically rigorous enough to allow for causal inference regarding SDCF's effectiveness. Although new evidence is continuously emerging while writing up this PhD thesis, it does not fully resolve existing debates. For example, a time-series analysis was published in 2024, and did not find significant effects in reducing mortality or morbidity associated with SDCF's implementation at the population level in Ontario, Canada [399]. Similarly, a French cohort study found that SDCF did not impact drug treatment uptake, but slightly prevented injecting equipment sharing behaviours among PWID (1%) compared to those who were not exposed to SDCF (11%) [400]. In addition, public health policy (or intervention) has aspects that are broader than health alone. A cost-consequences analysis (CCA) might be a better method to measure both welfare and quality of life more broadly than the health-related measures (i.e. QALY), especially the aspects that local authorities are likely to find important, including the spillover effects into other areas of local government responsibility [279]. However, as discussed in section 4.3.2, a CCA was not feasible due to data limitations, but the CEA still provides valuable information for decision-makers whether implementing a SDCF is cost-effective versus current practice.

6.4.3 Future research direction

This hypothetical analysis suggests the adoption of the SDCF in Glasgow, Scotland would be cost effective, but more evidence is required to support this recommendation in the future research. It is essential to understand the effects of the SDCF among PWUD and the wider society in the Scottish setting, especially how frequency of use would impact the effectiveness of SDCF in regard to preventing harms and engaging service users in drug treatments. As discussed in section 3.3.4, the reduction of deaths inside the SDCF does not necessarily mean the reduction in mortality in SDCF users, as whether SDCF impacts the consumption behaviours of PWUDs outside the facility is unknown based on existing evidence. Thus, the frequency of use might play an important role in allowing SDCF to deliver its effects at the population level. Furthermore, recent raised concerns by the general public in relation to having the SDCF implemented in Glasgow have indicated the necessity of evaluating the costs and benefits of implementing SDCF from a societal perspective, in

terms of criminal activities [401], disposed litter in the public area [402]. In addition, future research should focus on addressing the uncertainty surrounding long-term outcomes of implementing SDCF (e.g., sustained impact on MAT engagement). While the current analysis provides useful estimates, it remains a risk that benefits may be either over- or under-estimated due to challenges in capturing the long-term impacts of SDCF on other potential health and social outcomes, for example, reduced risks of injecting in outdoors in cold weather.

Chapter 7 Thesis summary and discussion

7.1 Overview

This final chapter draws together the key findings from this PhD work, which aimed to understand and examine the role of health economic methods in contributing to the evidence base that can be drawn on in policymaking in the Scottish context. To achieve this overarching aim, this thesis has presented an interlinked body of work which demonstrated that, while currently underutilised in this policy area, a range of health economic methods can be applied to assess drug policies. The analyses undertaken in this thesis have further demonstrated that economic methods can provide actionable evidence to shift policymaking from politically driven debates towards informed decision grounded in user preferences, costs, benefits, and broader social impact that are central to policy decisions.

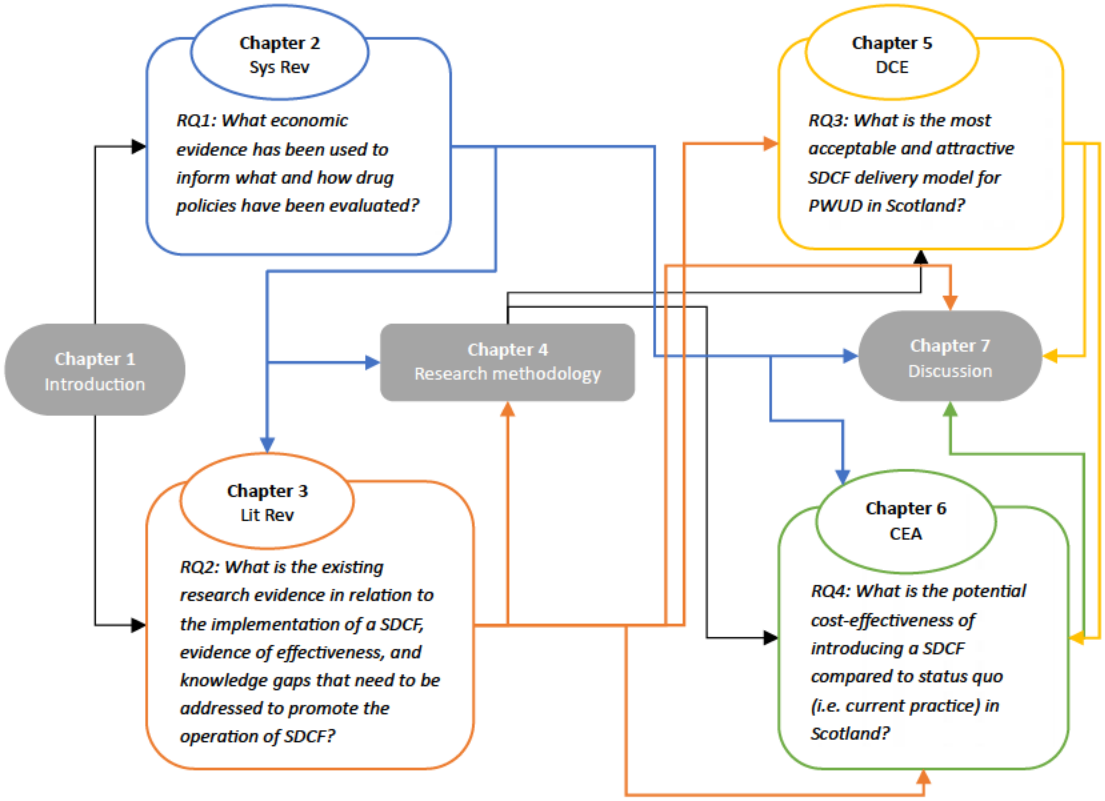
A key strength of this thesis is the focus on SDCF, a novel and politically debated policy option worldwide and within the UK context, providing a timely and policy-relevant opportunity to generate evidence that can inform evidence-based policymaking. The first empirical study used a DCE to bring in the voices of PWUD to guide SDCF's service design in Scotland. This method is particularly valuable in ensuring the service design is tailored to what matters most to those it aims to serve, thereby the findings of DCE can inform policymakers to prioritise features that are likely to maximise user engagement. It is an important consideration in Scotland, where the challenge of low engagement rate in drug treatment services has been persistently faced. Furthermore, locally derived DCE data were further leveraged in a CEA, to estimate what the potential cost-effectiveness of implementing a SDCF in Scotland could be. This increased the relevance of projected impacts and allowed policymakers to account for PWUDs' preferences regarding the delivery model and unique patterns of drug use in the Scottish context. Incorporating local user preferences and conducting a pre-implementation economic evaluation not only provided preliminary information which can support a patient-centred service design in the future, but also can allow policymakers to 'test' whether the SDCF offers better value for money than SDCF being unavailable.

As noted in the state of play, the timing of this PhD meant that the findings did not directly shape the configuration of the Glasgow pilot SDCF, but it remains highly relevant for future iterations or amendments as the facility evolves. Beyond Glasgow site, the evidence generated in this thesis can continue to inform the planning (or evaluation) of potential facilities in other parts of Scotland (e.g., the DCE has fed into the Edinburgh City Council report [322]), the wider UK (e.g., England), and other countries where policy debates on SDCFs remain ongoing. See section 7.3.1 for a detailed discussion on the policy implications.

Furthermore, the systematic review conducted in this thesis has showed that health economic methods can provide multidimensional evidence for assessing drug policies. These methods have been used to estimate the economic burden of illicit drug use and broader societal impact, allowing policymakers to understand the scale of drug problems in monetary terms. They also enabled assessment of the costs of implementing drug policies, and determined the cost-effectiveness to guide efficient resource allocation. Methods such as CV have been used to capture the preferences of the public and PWUD towards drug policies and to elicit values individuals place on specific outcomes. In particular, these methods can evaluate outcomes valued by PWUD that extend beyond health impacts and may not be fully reflected by QALY-based measures, e.g., reduced stigma. MCDA can further integrate other key factors (e.g., social, legal, and community dimensions of drug policies) and incorporate the perspectives of multisectoral stakeholder groups, making it particularly valuable for complex drug policy decisions where trade-offs between competing objectives were unavoidable. Section 7.3.2 outlies the key methodological considerations relevant to this area.

7.2 Summary of the thesis

Prior to the final discussion, the following sections summarise how this thesis has addressed the overarching research questions, depicted in **Figure 9**. Each section begins with restating research question (RQ) for this thesis and provides an overall reflection on how each chapter addressed these questions, highlighting key strengths and limitations.



Note: RQ=research questions; Sys Rev=systematic review; Lit Rev=literature review; DCE=discrete choice experiment; CEA=cost-effectiveness analysis; SDCF=supervised drug consumption facility.

Figure 9. Overview of the thesis

7.2.1 RQ1: What economic evidence has been used to inform what and how drug policies have been evaluated?

To answer this question, in Chapter 2, I conducted a systematic review to critically evaluate the existing economic evidence of drug policy options worldwide and health economic methods have been used to evaluate these policies.

Chapter 2 showed that a wide range of methods have been applied to drug policies. Cost-of-illness (COI) studies highlighted the heavy societal burden of illicit drug use, with criminal justice costs and productivity losses far outweighing healthcare expenditures. While useful for raising awareness on economic burden, COI studies provide limited guidance for choosing between policy options.

A large number of studies evaluated the cost-effectiveness of alternative drug policies. Public health policies were strongly supported by the evidence base, although the majority of evaluations were taken from a narrative healthcare perspective, mainly focusing on the costs and natural clinical outcomes (i.e. HIV or HCV case prevented) related to intravenous drug use. Furthermore, evidence (is limited to seven studies) supported those policies that decriminalise users and diver into healthcare services rather than criminalisation.

Other methods available to evaluate or support decision-making were underutilised. CV and MCDA were employed to capture societal preferences and the multidimensional impacts of drug policies, to reflect the diverse priorities of intersectoral stakeholders. Such methods are highly relevant in a complex real-world context of policymaking, where drug policies have extensive societal impact, and where decisions often involve balancing competing objectives among stakeholders with different perspectives.

The main strength of this review is that a broad range of methodologies were critically reviewed, including full economic evaluation, cost-of-illness, cost analysis, and quantitative preference studies in assisting decision-making. It not only attempts to synthesis the evidence in regard to resources used (cost) and clinical effectiveness of treating the negative health and broader consequences of drug use, and also the broader factors (i.e. spillover effects) of policy actions have been (or not been) considered in the existing health economic research.

There are limitations to this review. First, heterogeneity among reviewed studies has made direct comparison difficult and limited the ability to conclude that what alternative policy action works better than another in what circumstance. Second, in terms of methodological limitation, publication bias may further affect the evidence base. For example, drug policy changes are often introduced in response to political and social pressures, thus research funding or agenda may be diverted more by political priorities than the scientific inquiry that potentially leading to selective evidence. However, I acknowledged that searching grey literature and backwards citations may have yielded some additional results.

7.2.2 RQ2: What is the existing research evidence in regard to implementation of a SDCF, evidence of effectiveness, and acknowledge gaps that need to be addressed to promote the operation of SDCF?

To answer this question, in Chapter 3, I conducted a literature review to generate a profile of existing literature on the topic of the SDCF, and as a foundation for the two empirical studies presented in Chapter 5 and Chapter 6.

A large variation was found in the existing service models across different regions and countries, suggesting that diverse service models were responding to service users' complex needs accordingly. Perceptions related to SDCFs' service design and implementation strategy were also varied across stakeholder groups and research settings. Overall, I concluded that an optimal service model needs to be explored with potential stakeholders in the local context.

Among Scottish studies, the key obstacles to implementing a SDCF were multilayered. First, legislative uncertainty was the biggest barrier – the UK Misuse of Drugs Act 1971. Second, a distinct drug use pattern and population characteristics were reported in Scotland compared to other countries, suggesting the necessity of engaging with potential service users to better understand their needs in the Scottish context. Third, Scottish policymakers have raised their concerns about opportunity costs and initial costs of setting up the SDCF on a wider healthcare budget.

SDCFs' implementation was associated with a wide range of benefits, including improvements in service users' health and wellbeing, as well as positive impacts on the wider community. However, I found uncertainties in the evidence. First, most primary research related to SDCFs was designed as natural experiments (i.e. prospective or retrospective cohort studies). It appears concerns about methodological robustness for causal inference regarding SDCFs. Accordingly, there were some overlaps in the study period, design, and data employed across studies, with later studies using a more rigorous study design and/or longer observational time. Third, evaluations were restrictedly conducted in two settings – Canada and Australia.

7.2.3 RQ3: What is the most acceptable and attractive SDCF delivery model for PWUD in Scotland?

Given the existing evidence reviewed in Chapter 3, I believe there were substantial uncertainties associated with implementing SDCFs in the Scottish context. To help address this, I designed a DCE study to elicit potential service users' preferences towards SDCF delivery model across three major Scottish cities: Edinburgh, Glasgow, and Dundee.

Prior to my first empirical study, in Chapter 4, I provided justification for the use of DCE method versus a CV. The primary research participants (i.e. PWUD) were defined based on the comparisons of multiple stakeholder groups that were identified in Chapter 3. Also, the list of attributes to develop DCE was identified in Chapter 3, with multiple discussions with my supervisory team, PhD advisory group, and informal meetings with living and lived experiences to select the final attributes. In terms of understanding how PWUD make trade-offs between different design features of a SDCF, the willingness to travel (to an improved design feature of a SDCF) was considered the most appropriate alternative method for deriving individuals' willingness to pay. Given the ethical challenges of using direct monetary measures for PWUD, this approach avoids placing financial pressure on a potentially vulnerable population while still capturing the value they place on service configurations.

To analyse the DCE data, I adopted a multinomial logit (MNL) and a mixed logit model (MXL), and found that PWUD preferred a SDCF that involved peer workers, provided drug checking service and inhalation spaces, opened 24 hours a day, in comparison to one without peer workers, did not provide drug checking services, provided injection spaces only, opened during the daytime. The predicted uptake rate of such a facility was approximately 79% compared to SDCF being unavailable.

Peer involvement was considered to be the most relative important attribute compared to other design features. I then used a MXL preference space model and found that the peer involvement in the facility had a great and positive impact on the willingness to travel to the SDCF (MWTT: 55.30 mins, 95%CI: 8.20 to 102.40).

Due to a small sample size of this study, I only found that preferences varied across different geographical locations. In Edinburgh, participants preferred a SDCF that involved peer workers, but were less likely to choose a SDCF that provided inhalation spaces and was open 24 hours a day, compared to Dundee and Glasgow.

This is the first DCE study to measure PWUD's preference towards SDCFs' service design worldwide. Most importantly, I incorporated peer researchers' insights at the questionnaire development stage and obtained their assistance on data collection, which has strengthened the credibility and authenticity of conducting research within PWUD community. Their involvement has enabled the possibility of recruiting PWUDs in my study, through community services or on the streets, supported by their shared lived experience. In addition to this, in-person data collection by peer researchers meant participants were assisted, where necessary, in reading through the questionnaire, supporting completion by those who may not have otherwise participated.

There are limitations. Given the budget and time constraints of my PhD study, qualitative data were not able to be collected to assist the attribute selection process, but a lot of early-stage work was placed on validating my attribute selection with people who have living and lived experiences with drug use. Despite the fact that peer researchers were employed to help me with participant recruitment, I only achieved a small sample size of 77 participants, which did not provide sufficient power for me to capture the preferences for some attributes, or preference heterogeneity, etc. However, it still provided useful information to decision-makers who are considering introducing such a facility in Scotland before the Glasgow pilot facility can be formally assessed and evaluated.

7.2.4 RQ4: What is the potential cost-effectiveness of introducing a SDCF compared to the status quo (i.e. no SDCF) in Scotland?

In Chapter 3, I highlighted the concerns that have been consistently raised by policymakers regarding the financial affordability of implementing a SDCF in Scotland. Based on the economic evaluations reviewed in Chapter 2, I believe the transferability of this evidence to the Scottish context is poor. Especially, in Chapter 1 and 4, I specified that the primary focus of Scottish drug policy is currently the reduction in drug-related deaths and referring more people to recovery treatment [65].

To answer question 4, I developed a decision analytical model, using previously published evidence that was reviewed in Chapter 2 and Chapter 3 and available Scottish data, to estimate the cost-effectiveness of a hypothetical SDCF compared to the status quo (i.e. no SDCF) in Scotland. I also integrated the findings of my DCE study from Chapter 5 to model how cost-effectiveness might vary with changes in service uptake and pattern of use resulting from different facility configurations.

In the base case, short-term model showed that implementing a SDCF would reduce the probability of drug deaths and provided a greater quality of life for service users (0.05 QALY gained) at an incremental cost of £67.02 compared to SDCF being unavailable, predicting an ICER at £517,399 per death avoid (or £1,378 per QALY gained) over one year. In the lifetime model, the referral benefits of frequently attending SDCF were incorporated, assuming service users would be more likely to initiate drug treatments (i.e. MAT), which may have positive effects on drug-related overdose deaths. Results showed that a greater QALY was provided by a SDCF (0.83 QALY gained), and service users' life expectancy was also improved by the SDCF (1.29 life-year saved) compared to the status quo. The ICERs were estimated to be at £2,640 per QALY gained (or £1,693 per life-year saved) over a lifetime horizon, which was considered cost-effectiveness at £20,000-30,000/QALY threshold.

In the scenario analysis, results showed that the lifetime cost of the optimal model was £4,533. A greater QALY was provided by optimal SDCF model (0.86 QALY gained) compared to status quo. Similarly, service users' life expectancy was also improved by optimal SDCF model (1.34 life-year saved) compared to the status quo. The ICERs were estimated to be at £3,337 per QALY gained (or £2,140 per life-year saved) for the optimal SDCF model at a lifetime horizon. Result suggests upgrading to an optimal SDCF model (compared to base case) only gave a small extra health benefit (0.03 QALY or 0.05 LY), but still be acceptable given the WTP threshold at £20,000-30,000/QALY.

This is the first study, to my knowledge, to estimate the potential cost-effectiveness of a SDCF in Glasgow, Scotland. Chapter 6 provided preliminary evidence on the expected health benefits and resource implications of introducing a SDCF in Scotland. Based on the best available evidence, SDCFs are likely to be cost-effective compared to the status quo, this hypothetical analysis supports their consideration as an efficient public health investment, particularly in the context where reducing drug deaths and increasing treatment referrals are the core of policy priorities in Scotland. Furthermore, by testing a user-informed optimal model, the analysis indicated that optimal SDCF would provide a small improvement in QALYs and remain cost-effective.

There are limitations to this study. The current study was conducted conservatively due to the lack of available data in relation to other potential outcomes of the SDCF, e.g., reduce HIV/HCV, drug-related activities in the local community. There was a large degree of uncertainty associated with the values used for the input parameters, but the model can be updated and re-run once official figures are published in Scotland. In addition, the current analysis was also limited to inherent methodological challenges in decision modelling, for example, the decision tree was unable to capture individuals' movements between frequent use, infrequent use, and no use; and the Markov model was not able to reflect the possibility of individuals re-enter recovery treatment after moved to continue use drugs.

7.3 Contribution to knowledge

7.3.1 Informing policy through evidence

This PhD work comprises two novel empirical studies that, for the first time in Scotland, focus on the evaluation of a hypothetical potential SDCF using economic methods. Given the growing interest in evidence-based drug policy, my work offers a unique contribution by applying the discrete choice experiment and cost-effectiveness analysis, to address significant gaps in the existing literature. It demonstrated that health economic methods are practical tools that can strengthen the evidence base for illicit drug policy and ensure decision-making is grounded in the realities of those most affected in both Scottish context and wider context.

7.3.1.1 Scottish context

This section elaborates on how the findings from this PhD work contribute to the policy objectives and priorities of two Scottish Government policy documents [65, 268], highlighting how my research addresses current challenges, supports evidence-based decision making, and provides practical recommendations relevant to Scottish Government's approach to drug policy development and service delivery.

During my PhD between 2021 to 2025, I observed a series of substantial drug policy developments and reforms in Scotland. In January 2021, the Scottish National Mission Plan was published to reduce drug-related deaths and harms supported by a total of £500 million funding per year from the Scottish Government during 2021 and 2026 [65]. This National Mission complements and builds upon the major Scottish alcohol and drug policy strategy that published in 2018 – *'Rights, Respect and Recovery'*, emphasising on reducing drug deaths and improving the lives of those impact by illicit drugs [65, 268]. In both Government documents, SDCF has been greatly promoted as an important harm reduction intervention in responding to drug-related harms in Scotland (although it was not yet implemented back then) [65, 268]. In contributing to this, I conducted a literature review in Chapter 3 that provided a comprehensive understanding on the existing SDCFs' service models and implementation strategies across other jurisdictions, and summarised relevant peer-reviewed articles in the Scottish context, which helped me to develop the following DCE study in Chapter 5 to explore the preferences towards different service configurations of a SDCF by sampling PWUD's perspectives in Scotland.

Chapter 5 quantified the value that PWUD placed on specific design features of a SDCF in Scotland. This is valuable information for policymakers as it provides evidence on which design features matter the most to the population the SDCF is intended to support, allowing decision-makers to prioritise those elements during service planning and resource allocation [403-405]. Importantly, Chapter 5 also revealed some variations in preferences among participants recruited in cities of Edinburgh, Glasgow, and Dundee. These differences suggest that while some design features may be widely valued across Scotland, others are shaped by local context. If SDCFs were to be implemented more widely either in the UK or other countries, as discussed in Chapter 3, the relative importance of these features may vary in settings and a separate study would be warranted to capture local priorities and ensure SDCFs are adopted appropriately.

The findings of Chapter 5 also echoed the challenges identified in Chapter 3 regarding how SDCFs can be designed and implemented sustainably in the face of complex and evolving patters of drug use, reflecting the National Mission's recognition of a *'… changing drugs market'* in the Scottish context [65]. For example, Glasgow '*Thistle*' has illustrated these challenges. It has evolved since its initial launch, with additional features incorporated in response to emerging needs and feedback from service users [398]. While DCE findings provide evidence that additional service components that could strength the current Glasgow '*Thistle*' service model, any further adaptations would need

to balance these user-identified priorities with practical considerations such as legal barriers, funding, and capacity (as discussed in section 5.4.1). Nevertheless, Chapter 5 underscores the central role of continuous engagement with people with lived and living experience and strongly demonstrates that structured methods such as DCE make such engagement both feasible and necessary to refine and improve SDCF service throughout different stages.

Another important contribution of Chapter 5 is its ability to highlight the subgroup differences in preferences. It quantified how priorities vary across different populations, enabling policymakers to forecast emerging needs and craft better policies to target specific groups. For example, section 5.3.5 contributes to new knowledge that participants preferred a SDCF opens 24 hours a day, provides inhalation booths and drug checking services in Scotland, and such preferences were detected to be heterogeneous across geographical locations (*Note:* caution required due to the small sample size).

Furthermore, Chapter 5 contributes to the core component of a human rights-based approach underpinning Scottish drug policy and aligns to the policy priority (i.e. *'4.1 Lived and living experience at the heart'*) from two perspectives [65, 268]. First, through engaging the potential service users (i.e. PWUD) in the research, it makes the voices of living experience central to design the facility that works the best for the targeted population, in turn may lead to more effective policymaking. Second, the involvement of peer researchers with lived experience in developing the DCE questionnaire and collecting data demonstrates the value of embedding lived experience in the research process itself. This approach strengths the knowledge base, helps to identify service gaps and inequalities that may otherwise be unnoticed, and supports continuous quality improvement in healthcare services [403-405].

Building on the evidence of user preference, Chapter 6 extends the contribution of this thesis by modelling the projected short- and long-term cost-effectiveness of introducing a SDCF versus 'no SDCF available' in Glasgow City. This analysis provides decision-makers with an initial framework to weigh the costs and benefits of different facility configurations prior to their implementation. These facility configurations were informed by the preferences of the target population, ensuring that the economic evaluation was grounded in user preference. In the absence of clinical trials in the Scottish setting (although an NIHR founded natural experiment study has since launched in 2025 to evaluate the '*Thistle*' [352]), this hypothetical analysis presented preliminary knowledge and considerations that work by exploring potential impacts of introducing a SDCF in Glasgow that would not otherwise be available at this early stage. Thus, the findings of Chapter 6 should not be seen as definitive evidence of cost-effectiveness (as they were based on a series of necessary assumptions), but rather as an evidence-informed tool that can guide policy discussions, highlight areas of potential value, and help shape the design and evaluation of future studies in evaluating SDCFs [229, 230].

Chapter 6 suggested that a SDCF can provide good value for money per person in Glasgow. And yet, the results also highlighted that the impact of such facility at the population level is highly sensitive to patterns of service uptake. Persistent service underutilisation, where only about half of people who need treatment in Scotland currently receive it [406, 407], would largely reduce service efficiency of the SDCF in reducing drug deaths across the population. In line with findings from section 3.3.4, the decision modelling incorporated different levels of engagement to reflect that service users who frequently use SDCF were more likely to be referred to drug treatments, which highlighted how user engagement is a crucial determinant of SDCF's effectiveness.

In comparison to previous economic evaluations reviewed in Chapter 2, Chapter 6 advanced the evidence base by considering alternative service configuration derived from user preferences and by incorporating the potential long-term benefits of referral for service users. These elements strengthen the relevance of the findings to the Scottish context and policy priorities, where decision-

makers face the dual challenges of addressing acute drug-related harms while also building sustainable pathways into long-term recovery [65, 268].

Chapter 2 found a large amount of the government budget has been allocated to law enforcement, even when the cost-effectiveness of public health policies was strongly supported by the evidence base. For example, in Chapter 2 and Chapter 3, the effectiveness and cost-effectiveness of SDCFs have been consistently suggested by existing evidence. Also, Chapter 3 found that the closure of the first known unsanctioned mobile SDCF in Glasgow city centre was related to the lack of legal support from the Westminster UK and corresponding unsustainable funding and risk to the operator[209]. Legislation plays a major role in drug policy. Chapter 2 confirms that economic evidence in relation to enforcement policies was limited to decriminalisation of cannabis use. To be noted, Chapter 2 did not find any economic evaluations in relation to absolute prohibition policies, but this does not necessarily indicate they are not cost-effective. It highlights an important evidence gap that there is currently insufficient information to determine the cost-effectiveness of enforcement-led policies. In particular, there is little evidence to show whether drug reform proposals in Scotland would lead to reductions in drug-related deaths, greater uptake of recovery treatment, or improvements in employment and wider social outcomes [408]. To address this gap required more evidence not only robust economic evaluations, but also a wider body of interdisciplinary evidence. For example, studies that aim to understand the direct impact of enforcement on drug use patterns, and effects on health, social care, housing, and justice systems; or primary research could help assess how policy changes affect drug-related outcomes over time, especially given the dynamic nature of drug markets [41, 54].

Furthermore, Chapter 2 identified a research gap that a dual approach of combing enforcement policy while being supportive of individuals' wellbeing and holistic recovery as a complementary approach has so far not yet been evaluated. Such complementary strategies may better reflect the complexity of drug use and service needs, yet they have not been systematically assessed. Developing a comprehensive evidence base that integrates epidemiological, economic, and social research would therefore be crucial to inform whether drug policy options can realistically achieve their policy goals.

7.3.1.2 Generalisability in the wider UK and international context

While this thesis has focused on the Scottish context, its findings carry broader relevance across the UK and internationally. As SDCFs remain politically contested in many countries, the analyses presented in this thesis have illustrated the critical role that health economic methods can play in shaping debates about their design, implementation, and value of such facilities.

The DCE study not only captured the voice and preference of PWUDs towards SDCF's configurations in the Scottish context, and also provides a framework that can be adapted to different policy environments. For example, other regions and countries that face challenges with drug problems but have different pattern of drug use could replicate this method to engage potential service users and tailor SDCFs to their local needs. Incorporating user preferences into the design of facilities not only strengthens patient engagement but also provides multiple benefits, such as reducing costs, securing an effective and appropriate resource allocation, ensuring patient-provider satisfaction, and improving healthcare usage and health outcomes [409, 410]. In the context where treatment uptake is persistently low, as in Scotland, such a user-informed approach is essential to ensuring interventions achieve their intended impact.

Furthermore, the CEA can be applied as an evidence-informed tool in other settings that provide a clear picture of value for money and trade-offs involved in the resource allocation, guide policy discussions, and highlight areas of potential value [229, 230]. In some countries (e.g., Canada and Australia), where have already implemented SDCFs, this PhD work strengthens the global case for incorporating economic evidence into drug policy evaluation. It has further reinforced international

evidence in regard to SDCFs' role in reducing overdoses, blood-borne viruses, and associated healthcare costs. The contribution of this thesis lies in highlighting aspects often overlooked in the international literature – particularly the user preferences, the importance of capturing broader health benefits and social impacts, and the need to explicitly address uncertainties inherent in evaluating drug policies and interventions.

7.3.2 Methodological consideration

The methods employed in this PhD work, including discrete choice experiment, cost-effectiveness analysis, and systematic review are well utilised in the healthcare research. Yet, their application in the context of illicit drug policy, particularly in evaluating SDCFs in the Scottish context, represents a novel contribution to the existing literature. Their application in this thesis demonstrates how established health economic methods can be adapted to generate robust, policy-relevant evidence in assisting decision making in drug policy.

Chapter 2 contributes a critical foundation by mapping out what economic methodologies have been used to evaluate drug policy to date, and also provokes discussions on the opportunities and challenges of adopting those different methodologies to assist the drug policy making. For example, an economic evaluation can help decision-makers to weight the costs and benefits of different interventions from healthcare perspective and guide efficient resource allocation in the healthcare system [83]. Chapter 6 necessarily adopted such framing and provided preliminary information regards to SDCF's implementation in the Scottish setting. However, this may risk underrepresenting the full range of costs and benefits associated with SDCFs, many of which extend beyond the health sector (as revealed in Chapter 3). Capturing such cross-sectoral impacts poses methodological challenges. NICE public health guidance suggests to adopt a societal perspective, but no standard method is advised in this guide for dealing with problems that more than one department (or local government) is involved in the delivery of an intervention [279]. In the case of SDCF, such facility intersects several areas of government responsibility, including healthcare departments, social services, and criminal justice. The delivery of SDCFs typically falls under the mix of health departments, local government and charities, but the benefits of such interventions extended beyond the health sector, e.g., reduced disposed needle and injecting in the public area, or fewer drug-related crime. Chapter 2 also points out the challenges in capturing costs and outcomes in a comprehensive manner. For example, intangible costs associated with decreased quality of life due to stigmatization are largely missing in most of the calculations, however, stigma and discrimination can adversely affect the health of people who use illicit drugs and lead to chronic stress as a major barrier to accessing healthcare, sequentially lower treatment effectiveness [411, 412]. In Scotland, disfavoured treatments and service delivery are the major reason that only around half of population in the treatments, especially patients often complain about a stigmatising environment in healthcare services [280].

Additional economic methods can be applied to address these limitations. Chapter 2 identified potential useful methods such as willingness-to-pay to avoid stigma in section 2.3.8, which can help quantify intangible costs. In addition, MCDA offers a structured way to integrate diverse stakeholder perspectives into the policy evaluation. Such method recognises that while evidence of cost-effectiveness is crucial in informing decision making, real-world drug policy implementation is shaped by a much broader set of political, social, and ethical considerations.

Chapter 5 comprises of three key methodological contributions. First, DCE itself that applied in quantifying patients' preferences towards SDCF's design features in the Scottish context represents the major novelty. It is appealing because it provides policy-relevant information and represents a structured method for investigating the relevance of potential policy options [413]. For example, Chapter 5 built on the existing qualitative research (as reviewed in Chapter 3) to gather data from a relatively larger sample and allowing for robust statistical analysis and population-level inference.

This provides decision-makers with information of trade-offs that reflect what potential users value the most, offering a feasible way of testing policy options before implementation. Second, incorporating peer researchers' insights at questionnaire development stage and obtained their assistance on data collection have presented the credibility, authenticity of conducting research within PWUD community. Such involvement also reflects a growing movement towards more inclusive and participatory research in public health and social policy, especially in areas involving marginalised communities. Third, using travel time as a proxy for monetary value in the DCE study is not novel, but it is innovative in such research setting with a vulnerable group. Using walking time to the SDCF as a proxy offered a feasible and acceptable alternative for deriving willingness-to-pay estimates, which enabling the translation of preferences into economic terms.

7.4 Areas for future research

This thesis demonstrates how a multi-methods approach can generate an evidence base that better support the decision making in drug policies, and also raises further questions and highlights several areas where future research is needed to build on these findings.

First, drug policy is shaped not only by the availability of research evidence but also by the political and broader social contexts [414]. If there is the transparency of what decision-making processes are involved in developing drug policies, it then can create more opportunities for economic evidence to contribute or fit in. Future research could explore the policymaking process itself, understanding where and how economic evidence is used to inform policy decisions, and where it could be better aligned with the decision-making process.

Second, while estimating cost-effectiveness restrict to healthcare sector remains a central criterion in economic evaluations, drug policies have far-reaching consequences across multiple sectors of the society. Relying solely on narrow healthcare perspectives risks overlooking these broader impacts. There is therefore a need to expand the current toolkit to capture policy outcomes more comprehensively. For example, as discussed in Chapter 3, reductions in drug-related crime, improvements in neighbourhood safety, or decreased public injecting have substantial social and economic value but are rarely included in the evaluations. A greater emphasis should be placed on evaluating the long-term societal savings of interventions, to inform more equitable and sustainable resource allocation decisions. Previous study has highlighted that unsustainable investment often occurs in public health interventions targeting inclusion health groups that only make up a small proportion of the general population that further exaggerate societal inequalities by neglecting the needs of most marginalised groups [415]. Conducting more research that accounts for both long-term and cross-sectoral impacts would allow for more equitable and sustainable allocation of resources in solving drug-related harms [416].

Third, further research is required in relation to improve the service uptakes in Scotland. Evidence has shown that only about half of people are receiving the treatment they need, for example, people who at risk of a drug death are not in contact with drug treatment services in the six months prior to deaths [407]; or around half of people with problem drug use are receiving opioid substitution treatment [406]. In specific, taking drugs alone is a risk factor for people who die at home in Scotland – 79% of people who had a drug-related death lived in their own home and 58% of them lived alone in 2016 [37]. Future research should therefore prioritise interventions to reaching hard-to-engage populations, and exploring strategies that are effective at encouraging uptake among those at high risk of death.

Fourth, drug-related deaths has now recognised as one of the biggest contributors to Scotland's decreasing life expectancy, especially the people in the most deprived areas were 15 times as likely to have a drug-related death as those in the least deprived areas [278]. Future research should prioritise understanding and addressing the social determinants of drug-related harms that health

economic studies may go beyond average cost-effectiveness to consider the distributional impact of impact interventions across different socioeconomic groups. Distributional cost-effectiveness analysis could be used to explicitly quantify the equity implications of drug policy, offering policymakers tools to balance efficiency with fairness [416, 417]. By integrating considerations of social determinants and health inequalities, future research can help ensure that intervention could narrow the persistent gap between Scotland's most and least deprived populations.

7.5 Conclusion

The overarching research aim to this thesis is to explore how health economic methods can contribute to the evidence base than can be drawn on in policymaking in the Scottish context. My thesis set out to address critical gaps in the evidence base for the design and implementation of the SDCFs. While Scotland faces persistently high levels of drug-related harm, decision makers have lacked evidence on how such facilities should be implemented, and what their likely costs and benefits might be in the Scottish context. By applying a mix-methods approach, this thesis has sought to demonstrate how evidence-informed policymaking can be achieved.

The systematic review established that health economic evidence of drug policy worldwide has employed a wide range of methodological approaches that comprised of full economic evaluations, cost-of-illness, cost analysis, and quantified preference studies (i.e. CV and MCDA) in assisting decision-making. These methods were shown to provide multidimensional evidence of drug policies, including the assessment of the costs of implementing drug policies, cost-effectiveness of polices to guide efficient resource allocation, quantified individual and societal preferences, and integration of broader societal considerations of implementing of drug policies. This review also found that policymaking and policy adoption were highly context-specific, and thereby evaluations have been varied greatly across regions and countries, reflecting variations in the implementation settings and specific aspects of drug problems that were prioritised. This reinforced the need for Scotland-specific evidence to guide policymaking in drug policy.

The literature review mapped out the existing literature on the topic of SDCFs. Diverse service models were found to respond to service users' complex needs accordingly across different regions and countries, as well as diverse perceptions related to SDCFs' service design and implementation strategy across stakeholder groups and research settings. There were acknowledge gaps need to be addressed to implement a SDCF in the Scottish context, including legislative uncertainties under the UK drug law, the distinct drug use pattern and population characteristics compared to other settings, and the economic impact of introducing a SDCF in Scotland.

In the first empirical study, I demonstrated the value of DCE as a stated preference method for engaging potential service users directly in the design of SDCFs in Scotland. By quantifying the relative importance of specific design features, the study provided policymakers with evidence on which elements are most likely to maximise engagement and effectiveness. Findings revealed a strong preference for facilities that are accessible 24 hours a day, provide inhalation spaces and drug checking service, involve peer workers, although some heterogeneities were observed across cities. These results highlighted features that should be considered underpin national service design and also the importance of accommodating local variation. This study provided the first quantitative evidence of user preferences in the Scottish context and offered policymakers useful information to guide service design and development.

In the second empirical study, locally derived DCE data were further leveraged in the cost-effectiveness analysis, to project the short- and long-term cost-effectiveness of implementing a SDCF in Glasgow City, Scotland compared to the status quo (i.e. no SDCF). By embedding user preferences identified in the DCE study, this hypothetical analysis provided policymakers context-specific information on the potential economic impact of a SDCF before its formal assessed. This

pre-implementation economic evaluation not only provided preliminary information to support a patient-centred service design, but also allow policymakers to 'test' whether the SDCF offers better value for money than SDCF being unavailable.

Overall, this thesis demonstrate that health economic methods can strengthen the evidence base for drug policy decision-making in Scotland and the wider context. It contributes new evidence and methodological innovation to the debate on drug policy in the Scottish context, while also offering insights with wider relevance for the UK and other settings. The four studies conducted in this thesis addressed the knowledge gaps, explored and demonstrated the usefulness of health economic methods for designing and evaluating drug policy interventions. These analyses illustrate that applying economic methods in this policy space can produce actionable insights that directly support informed, transparent and evidence-based decision-making. This enables moving illicit drug policy away from being shaped primarily by political or moral debates, and towards being grounded in rigorous evaluation of PWUDs' needs, costs, benefits, and broader social impacts and uncertainties that are central to policy decisions.

Appendices

Appendix 2.1 Search terms

Table A2.1 Systematic review search terms

Economic terms	
1	Economics/
2	exp "costs and cost analysis"/
3	Economics, Behavioral/ or Economics, Hospital/ or Economics, Medical/ or Economics, Pharmaceutical/ or Economics, Nursing/ or Economics, Dental/
4	exp "Fees and Charges"/
5	exp Budgets/
6	Cost-Benefit Analysis/
7	((analyses or analysis) adj1 (cost or benefit or utility or marginal or data or effectiveness or economic or evaluation*)).ab,ti,kf.
8	Cost Allocation/ or Cost Control/ or Cost Savings/ or "Cost of Illness"/
9	(social return on investment or return on investment or social impact assessment or health impact assessment or multi-criteria decision analysis or discrete choice experiment or stated preference).mp.
10	exp models, economic/
11	economic model*.ab,kf.
12	exp Decision Theory/
13	(decision* adj2 (tree* or analy* or model*)).ti,ab,kf.
Intervention terms	
14	exp Harm Reduction/ or Needle-Exchange Programs/ or Naloxone/
15	(''fixing room*'' or ''overdose prevention site*'' or (("supervised consumption" or "supervised injection" or "safe* consumption" or "safe* injection" or "drug consumption room*" or "medical supervised injection") adj (center or centre or site* or facility or facilities or room* or program))).mp.
16	(intervention* or program* or therapy* or treatment or rehabilitation or recovery or cure).ab,kf,ti.
Government level policy terms	
17	exp Government/
18	*Government Regulation/ or *Government Programs/ or *Health Care Reform/ or *Health Policy/
19	(((government* or health*) adj1 policy) or "health care policy" or (health* adj1 policies) or "health care policies" or regulat* or law or laws or legislat* or ''state mandat*'').ab,kf,ti.
Illicit drug terms	
20	Substance-Related Disorders/ or Drug Overdose/ or Substance Abuse, Intravenous/ or Substance Abuse, Oral/ or Illicit Drugs/ or Heroin Dependence/ or Cocaine-Related Disorders/ or Drug Users/
21	("illicit drug*" or heroin or cannabis or "illicit opioids" or cannabis or naloxone or methadone or buprenorphine).ab,kf,ti.

Appendix 2.2 Criteria for Health Economic Quality Evaluation (CHEQUE) tool

Table A2.2 CHEQUE tool: methods quality (final 24-item version)

Domain	Attribute	Rounded importance score	Scoring weight assessment* (yes, somewhat, no, or N/A)	Final score
Decision problem and scope	M1. The analysis answers an important question for decision making.	5		
	M2. The study objective (decision problem) is measurable.	6		
Intervention and comparator(s)	M3. The comparator(s) is/are the best possible option that appropriately measures the opportunity cost of using the new treatment.	4		
Perspective	M4. The analytic perspective(s) is/are appropriate to answer the research question posed.	4		
Population	M5. The scope of the study encompasses all populations affected by the intervention.	1		
Outcome measures	M6. Health outcomes are measured in health metrics that aggregate survival and health-related quality of life or disability (e.g., QALY or DALY).	3		
Time horizon	M7. The analytical tie horizon is sufficiently long enough to reflect all important differences between intervention(s) and comparators.	4		
Discounting	M8. Costs and health effects that occur in the future are discounted to their present value using a recommended discount rate.	2		
Modelling	M9. The chosen model type is appropriate to address study questions.	6		
	M10. The structure of the model reflects the underlying health condition and the impact of the interventions.	8		
	M11. Modelling assumptions are reasonable, given the underlying data.	5		
	M12. The need for extrapolation or integrating multiple data sources is considered.	3		
	M13. Model validation is conducted, including an assessment of the model structure, assumptions, data, and results.	8		
Data inputs and evidence synthesis	M14. A 'best available evidence' approach is used to select data sources for model parameter (e.g., conducted or references systematic review/meta-analyses).	6		
	M15. Data inputs are generated by appropriate statistical and epidemiological techniques.	5		
	M16. The quality of the data, including sources of bias, is assessed appropriately.	6		
Consequences	M17. Major consequences affected by the choice of interventions being compared are identified.	5		
Utilities (preference measures)	M18. Health preferences reflect those of the jurisdiction(s) of interest (as specified in the decision problem).	2		
Costs and resource use	M19. Resource use that is nontrivial in magnitude is included in the reference case analysis.	2		
Analysis	M20. Incremental analyses are conducted (i.e., the additional costs generated by on alternative over another are compared with the additional effects generated).	4		
	M21. ICERs are obtained by comparing each intervention with the next most effective option after eliminating dominated options.	3		
	M22. Probabilistic sensitivity analysis is conducted to account for uncertainty in input parameters simultaneously.	3		
	M23. Alternative modelling choices and assumptions (structural uncertainty) are explored through additional sensitivity analysis (i.e., scenario analysis).	4		
Equity considerations	M24. Relevant equity or distributional considerations are taken into account.	1		
Total		100		

CHEQUE indicates Criteria for Health Economic Quality Evaluation.
DALY, disability-adjusted life-year; ICER, incremental cost-effectiveness ratio; QALY, quality-adjusted life-year; N/A, not applicable.
***Scoring weight: 'yes' = 1.0; 'somewhat' = 0.5; 'no' = 0.0. For 'N/A' you will have the option to give full credit (weight=1.0) or exclude it from the total.**

Appendix 5.1 Experimental design for main survey

Design

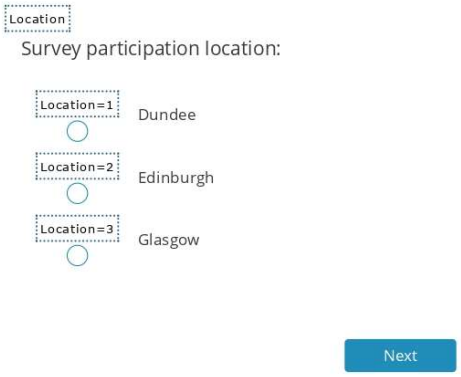
;alts = option1*, option2*, optout
;rows = 36
;block = 4
;eff = (mnl, d, mean)
;alg = mfederov
;bdraws = sobol(200)

;model:
U(option1) = b0[0] + b1.dummy[0|0|0]*Location[1,2,3,4]
+ b2.dummy[0]*staffing[1,2]
+ b3.dummy[(n, -0.09881, 0.066031)]*Space_allocation[1,2]
+ b4.dummy[0]*Drug_checking_service[1,2]
+ b5.dummy[0|0]*Operation_time[1,2,3]
+ b6[0]*travel_time[1,9,19,29] /

U(option2) = b1.dummy*Location[1,2,3,4]
+ b2.dummy*staffing[1,2]
+ b3.dummy*Space_allocation[1,2]
+ b4.dummy*Drug_checking_service[1,2]
+ b5.dummy*Operation_time[1,2,3]
+ b6*travel_time[1,9,19,29]

$

Appendix 5.2 DCE questionnaire



4% 100%

Participationinfosheet

University of Glasgow | College of Medical, Veterinary & Life Sciences

Participation Information Sheet

Research title: Exploring People who Use Drugs (PWUD)'s Preferences Towards Implementing Drug Consumption Rooms (DCRs) in Scotland: A discrete choice experiment

You are being invited to take part in a research study. Before you decide to take part, it is important for you to understand why the research is being done and what it will involve. Please read the following information carefully and discuss it with others if you wish. It is up to you to decide whether or not you wish to take part, and ask peer researchers/key workers if you have any questions or concerns.

What are Drug Consumption Rooms?

'Drug consumption rooms, sometimes known as supervised injecting facilities, are fixed or mobile spaces in which people who inject drugs are provided with sterile injection equipment and can use illicit drugs under the supervision of trained staff[1].'

[1] EMCDDA (2017). Drug consumption rooms: an overview of provision and evidence. Lisbon: European Monitoring Centre for Drugs and Drug Addiction. POD_Drug consumption rooms.pdf (europa.eu) Published 2017. Accessed July 1st, 2022.

What is the research about?

Drug consumption rooms (DCRs) are considered an effective approach to reduce harms, including poor health, and also death from overdose, as well as to support engagement with general healthcare, specialist services, and social support[1]. Opening drug consumption rooms in Scotland is still considered illegal under the UK law, although it has been gaining much support from people who use drugs, their families, and politicians. Yet, even if legal barriers were removed, it is still not clear how the facility would look. As a potential service user, we would like to know what you think are the important things that a DCR should have or do.

Why are we inviting you to participate?

We value your opinions as an individual with living experience of illicit drug use. Your views on the design features of drug consumption rooms can inform what may be offered in Scotland.

Do you have to take part?

Taking part is entirely your choice; you do not have to take part if you don't want to. Yon can ask a peer researcher or key worker any questions about this study. They could read through participant information sheet, consent form, or questionnaire with you if you want. You can stop taking part in this study at any time without giving a reason.

What will it involve and what happens to the information that is collected?

If you are willing to take part, a researcher, peer researcher (someone who has experienced problem substance use), or your key worker will go through a questionnaire with you. This will take approximately 15-20 minutes to complete. The questionnaire will start with 6 different characteristics of drug consumption rooms, e.g., the type of staff who work there, and then you will be shown different versions of drug consumption rooms, and we would like to know which one you prefer. This will allow us to understand your preferences on the service design. Then, we would like to know what you think about opening drug consumption rooms in Scotland, and will ask some information related to your drug use situation, and personal background related to ethnicity, living situation, etc.

What are the possible disadvantages of taking part?

The questionnaire will take some of your time, but beyond that there is no disadvantage or risk to participation.

What are the possible benefits of taking part?

You will receive £5 cash or voucher if you would like to take part and complete the questionnaire.

Will your participation be kept confidential?

Yes. We will not collect personal information from you, e.g. your name or anything else. Your responses to the survey questions will be **anonymous**. You should not state your name or any other information which identifies you in the questionnaire. As such, **your response to the survey will not implicate yourself for any offence**. Anonymous information you provide will be stored safely and used securely. You can withdraw from the study any time during the in-person survey time frame, without any consequence if you decide so; data collected up to this point will be retained and used in the analysis.

What will happen to your data?

This survey will be taken **anonymously** so you cannot be identified from any of your response. The principal researcher at the University of Glasgow is responsible for looking after your information and using it properly. The data we collect from you will form part of the study result that will be used in the PhD thesis and published in journals or shared with other researchers to use (upon request). **No identifiable data will be published**.

Who is organising and funding the research?

This is part of a self-funded PhD study. Internal departmental funds will be used for an honorarium for participants and for towards payment for researchers. This study has also received some funding from Edinburgh City Council, for the data collection within Edinburgh.

Who has reviewed the study?

This research project has been reviewed by the college of Medical, Veterinary & Life Sciences Ethics Committee.

Email: mvls-ethics-admin@glasgow.ac.uk

Contact for further information

Yuejiao Duan, PhD researcher, University of Glasgow,

Email: y.duan.2@research.gla.ac.uk

Thank you for taking part in the study!

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Consent

University of Glasgow | College of Medical, Veterinary & Life Sciences

CONSENT FORM

By completing this survey, I understand that:

1. My participation is voluntary and can be stopped at any time, though data collected up to this point wil be kept.

2. The information I provide within the survey is anonymous, and will be used securely. It will be securely stored for at least 10 years in the University of Glasgow archiving facilities in accordance with relevant Data Protection policy and regulations.

3. Other genuine researchers may have access to my data for further study, but as the data is anonymous, they will not know anything about who provided it.

Consent_1 ☐ Please click the box to confirm consent

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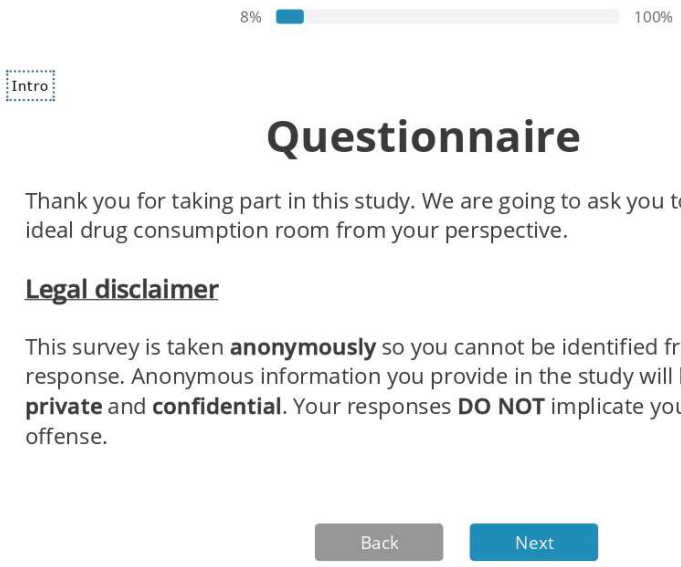
8%
100%
Intro
Questionnaire
Thank you for taking part in this study. We are going to ask you to envision the ideal drug consumption room from your perspective.
Legal disclaimer
This survey is taken **anonymously** so you cannot be identified from any of your response. Anonymous information you provide in the study will be kept strictly **private** and **confidential**. Your responses **DO NOT** implicate yourself for offense.
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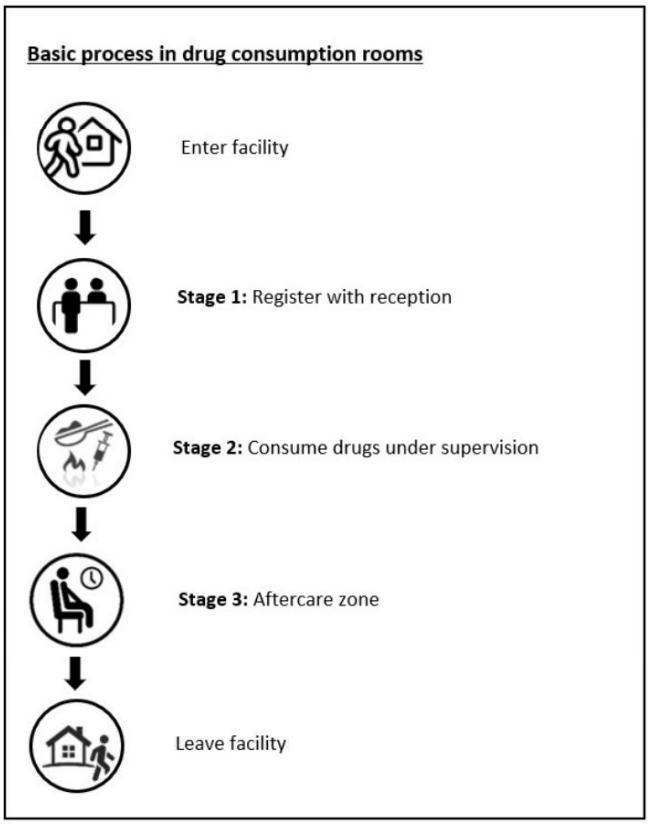
S1IntroAttriuteslevels

Section 1: How do drug consumption rooms(DCRs) work?

Drug consumption rooms are created to offer a safe environment for people to use pre-purchased illicit drugs under supervision. The basic function of the drug consumption rooms can be broken down into three main processes (see flow chart below).



To help find a suitable model for Scotland, we have gathered information on six key design characteristics. These characteristics are location, staffing, operation hours, facility rules, ancillary services, and traveling time. We kindly request that you carefully read and fully understand the definition of each characteristic before moving on to the questions.

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S1Attributeslocation

Defination of Characteristics

1. Location: Drug consumption rooms can be set up in various locations with slightly different purposes. Four options and their descriptions are:

Stand-alone drug consumption rooms

- Suited in close proximity to other drug-related services and near areas known for high levels of illicit drug use.
- The drug consumption room is the only service offered.

Medicalised drug consumption rooms

- Integrated into existing healthcare centres, for instance, hospital.
- You can access health services on top of drug consumption rooms within the same location.

Embedded drug consumption rooms

- Set up in existing charity organisations.
- You can access other non-medical services on top of drug consumption rooms within the same location.

Mobile drug consumption rooms

- Operates in a mobile van.
- It does not have a fixed location.
- The drug consumption room is the only service offered.

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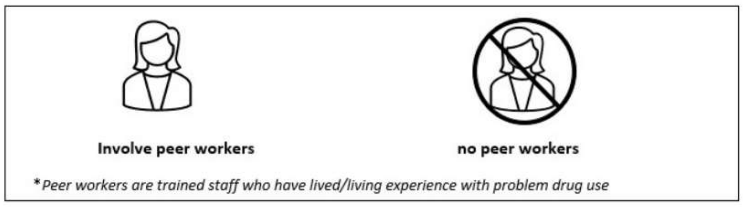
S1AttributesStaffing

2. Staffing: Clinical staff (doctors/nurses) are responsible for supervising the drug consumption process and offering additional support in the drug consumption rooms. To create a more comfortable environment, people with personal experience of using drugs may also be employed in the service (these people are referred to as peer workers). Two options are:



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S1Attribspaceallocation

3. Space allocation: Drug consumption rooms are for people who inject drugs. However, considering the various methods of drug use, these rooms can extend their services to include dedicated space for the inhalation of drugs. Two options are available, either inhalation space is provided alongside injection space, or not:

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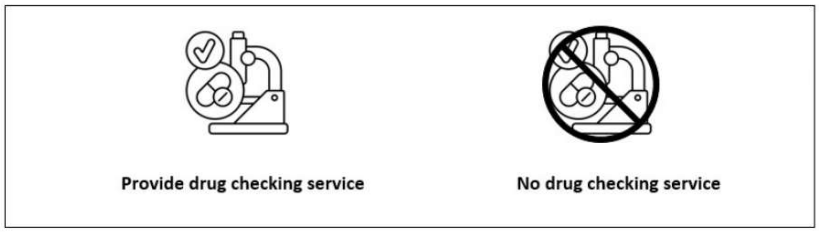
S1AttibutesDCS

4. Drug Checking Service (DCS): To mitigate potential risks such as overdose resulting from the use of unknown drugs, drug consumption rooms can offer a drug checking service. This service allows people to have their drug sample chemically analysed and received a result about the sample. The analysis takes approximately 30 minutes. Two options are available, either a drug checking service is provided or not:



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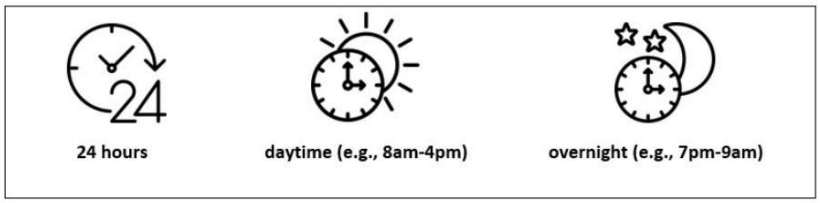
S1Attributeopenhours

5. Opening time: Drug consumption rooms can oprate at different times. Three options are:



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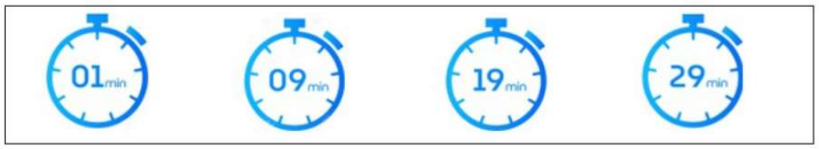
23% 100%

S1AttributeTravTime

6. Travel time: In order to enhance the accessibility and involvement in the service, it is crucial to determine the amount of travel time you are willing to allocate to using drug consumption rooms. For the purpose of this survey, travel time options are:



Back Next

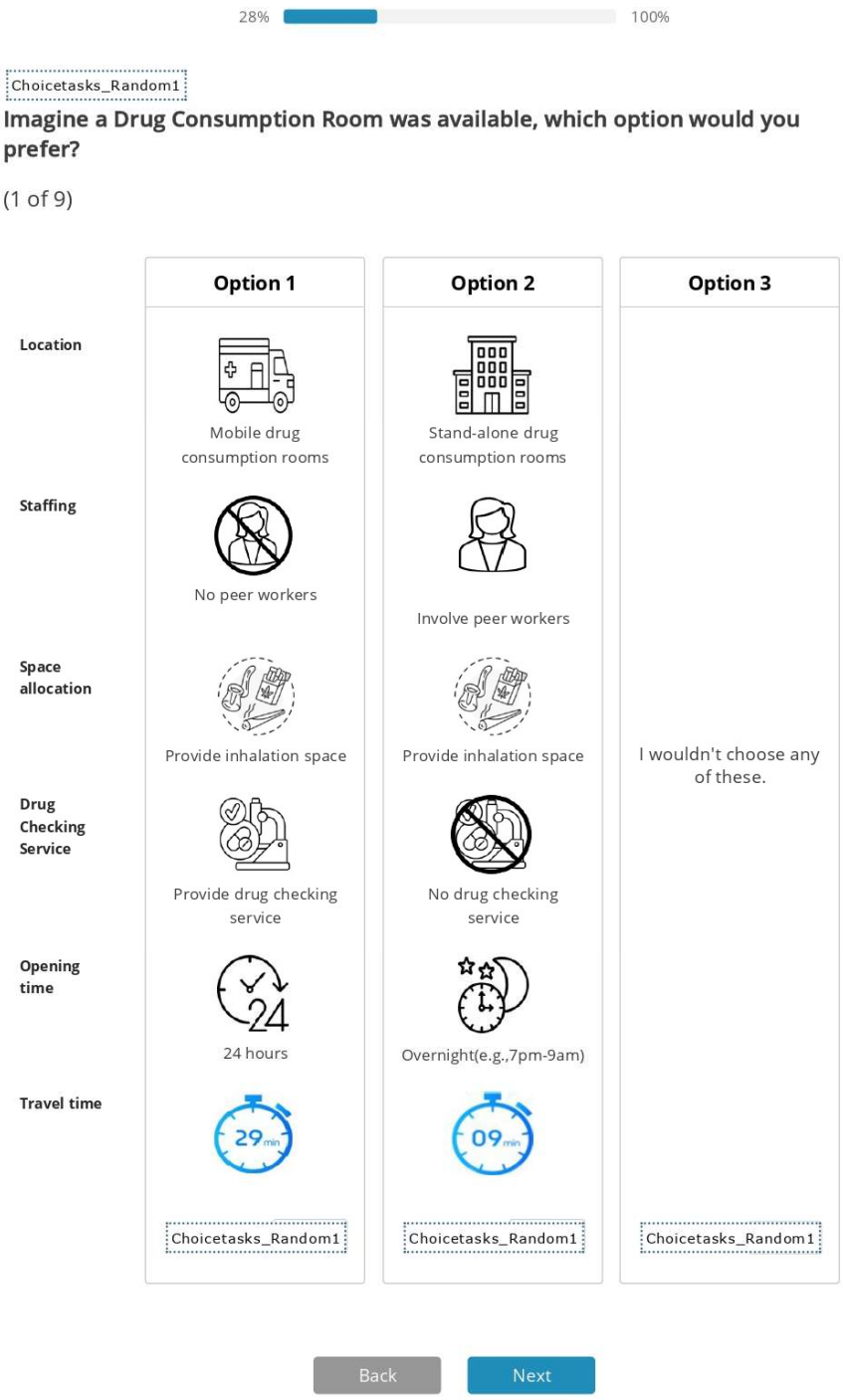
S2IntroChoiceSet

Section 2: Introduction to scenario section

In the questions that appear in this section you will be presented with **9 choice sets**. Each choice set will present with **2 imaginary options** and **an opt-out**. Each option describes drug consumption rooms with different design characteristics.

We would like you to think about each option as though you are making a decision **in the real world**. Remember that you can choose whichever option is best for you (A, B or C). It is legitimate to choose 'Option C', that you prefer not to use the facility. **Please make your choice carefully, as your response will have a potential real-world impact on the policies and practices related to the implementation of drug consumption rooms in Scotland.**

Back Next


28%
100%
Choicetasks_Random1
Imagine a Drug Consumption Room was available, which option would you prefer?
(1 of 9)
Option 1
Option 2
Option 3
Location
Mobile drug consumption rooms
Stand-alone drug consumption rooms
Staffing
No peer workers
Involve peer workers
Space allocation
Provide inhalation space
Provide inhalation space
I wouldn't choose any of these.
Drug Checking Service
Provide drug checking service
No drug checking service
Opening time
24 hours
Overnight(e.g.,7pm-9am)
Travel time
29 min
09 min
Choicetasks_Random1
Choicetasks_Random1
Choicetasks_Random1
Back
Next

30% 100%

Choicetasks_Random2

Imagine a Drug Consumption Room was available, which option would you prefer?

(2 of 9)

	Option 1	Option 2	Option 3
Location	 Embedded drug consumption rooms	 Mobile drug consumption rooms	
Staffing	 No peer workers	 Involve peer workers	
Space allocation	 Provide inhalation space	 Provide inhalation space	I wouldn't choose any of these.
Drug Checking Service	 No drug checking service	 Provide drug checking service	
Opening time	 Daytime(e.g.,8am-4pm)	 24 hours	
Travel time			
	Choicetasks_Random2	Choicetasks_Random2	Choicetasks_Random2

Back Next

32% 100%

Choicetasks_Random3

Imagine a Drug Consumption Room was available, which option would you prefer?

(3 of 9)

	Option 1	Option 2	Option 3
Location	 Stand-alone drug consumption rooms	 Embedded drug consumption rooms	
Staffing	 Involve peer workers	 No peer workers	
Space allocation	 No inhalation space	 No inhalation space	I wouldn't choose any of these.
Drug Checking Service	 No drug checking service	 Provide drug checking service	
Opening time	 Overnight(e.g.,7pm-9am)	 Daytime(e.g.,8am-4pm)	
Travel time			
	Choicetasks_Random3	Choicetasks_Random3	Choicetasks_Random3

Back Next

34% 100%

Choicetasks_Random4

Imagine a Drug Consumption Room was available, which option would you prefer?

(4 of 9)

	Option 1	Option 2	Option 3
Location	 Embedded drug consumption rooms	 Stand-alone drug consumption rooms	
Staffing	 Involve peer workers	 No peer workers	
Space allocation	 Provide inhalation space	 Provide inhalation space	I wouldn't choose any of these.
Drug Checking Service	 Provide drug checking service	 No drug checking service	
Opening time	 Overnight(e.g.,7pm-9am)	 Daytime(e.g.,8am-4pm)	
Travel time			
	Choicetasks_Random4	Choicetasks_Random4	Choicetasks_Random4

Back Next


36%
100%
Choicetasks_Random5
Imagine a Drug Consumption Room was available, which option would you prefer?
(5 of 9)
Option 1
Option 2
Option 3
Location
Medicalised drug consumption rooms
Stand-alone drug consumption rooms
Staffing
No peer workers
Involve peer workers
Space allocation
Provide inhalation space
Provide inhalation space
I wouldn't choose any of these.
Drug Checking Service
Provide drug checking service
No drug checking service
Opening time
Overnight(e.g.,7pm-9am)
24 hours
Travel time
01 min
19 min
Choicetasks_Random5
Choicetasks_Random5
Choicetasks_Random5
Back
Next


39%
100%
Choicetasks_Random6
Imagine a Drug Consumption Room was available, which option would you prefer?
(6 of 9)
Option 1
Option 2
Option 3
Location
Medicalised drug consumption rooms
Stand-alone drug consumption rooms
Staffing
Involve peer workers
No peer workers
Space allocation
No inhalation space
No inhalation space
I wouldn't choose any of these.
Drug Checking Service
Provide drug checking service
Provide drug checking service
Opening time
Overnight(e.g.,7pm-9am)
24 hours
Travel time
29 min
29 min
Choicetasks_Random6
Choicetasks_Random6
Choicetasks_Random6
Back
Next

41% 100%

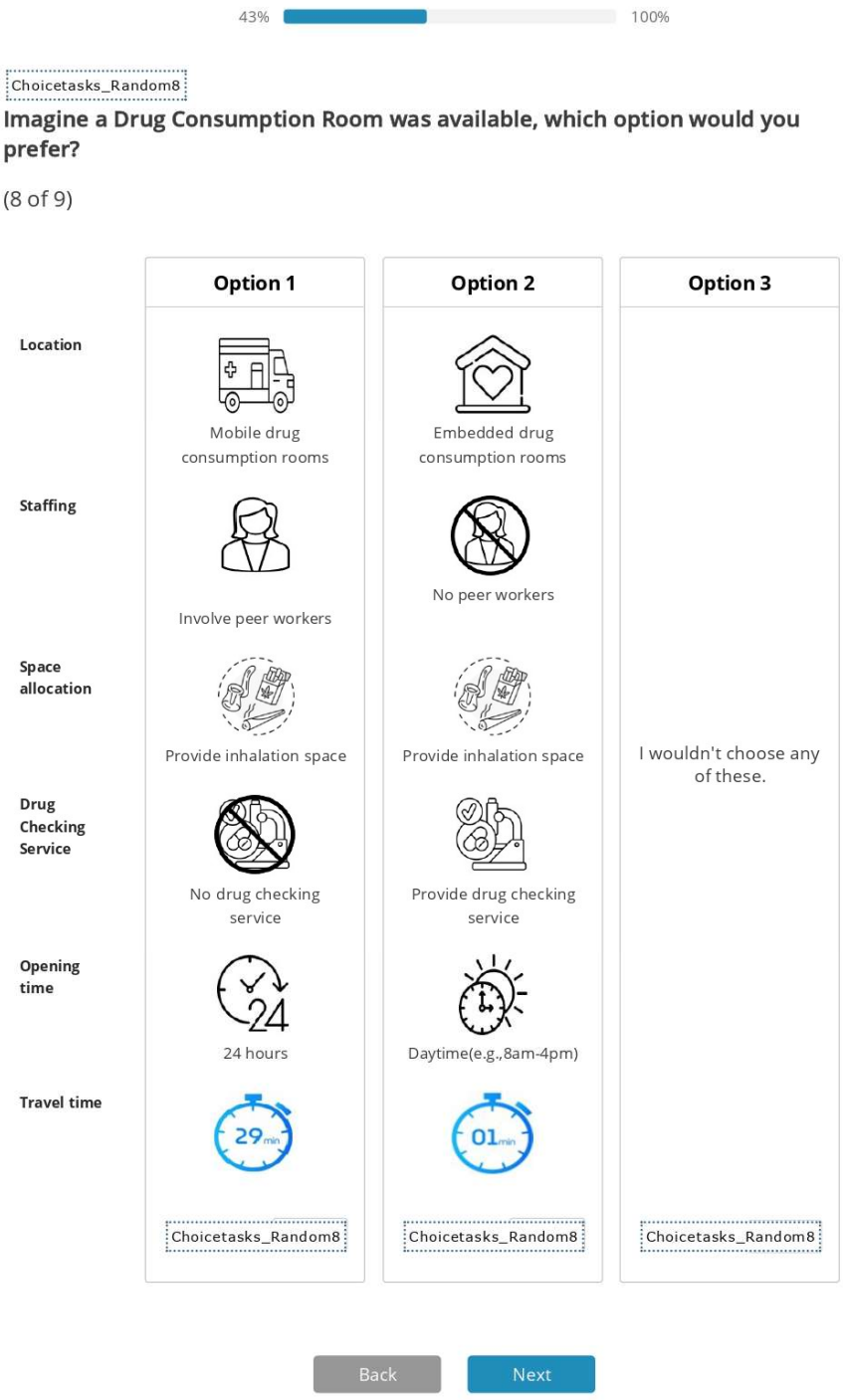
Choicetasks_Random7

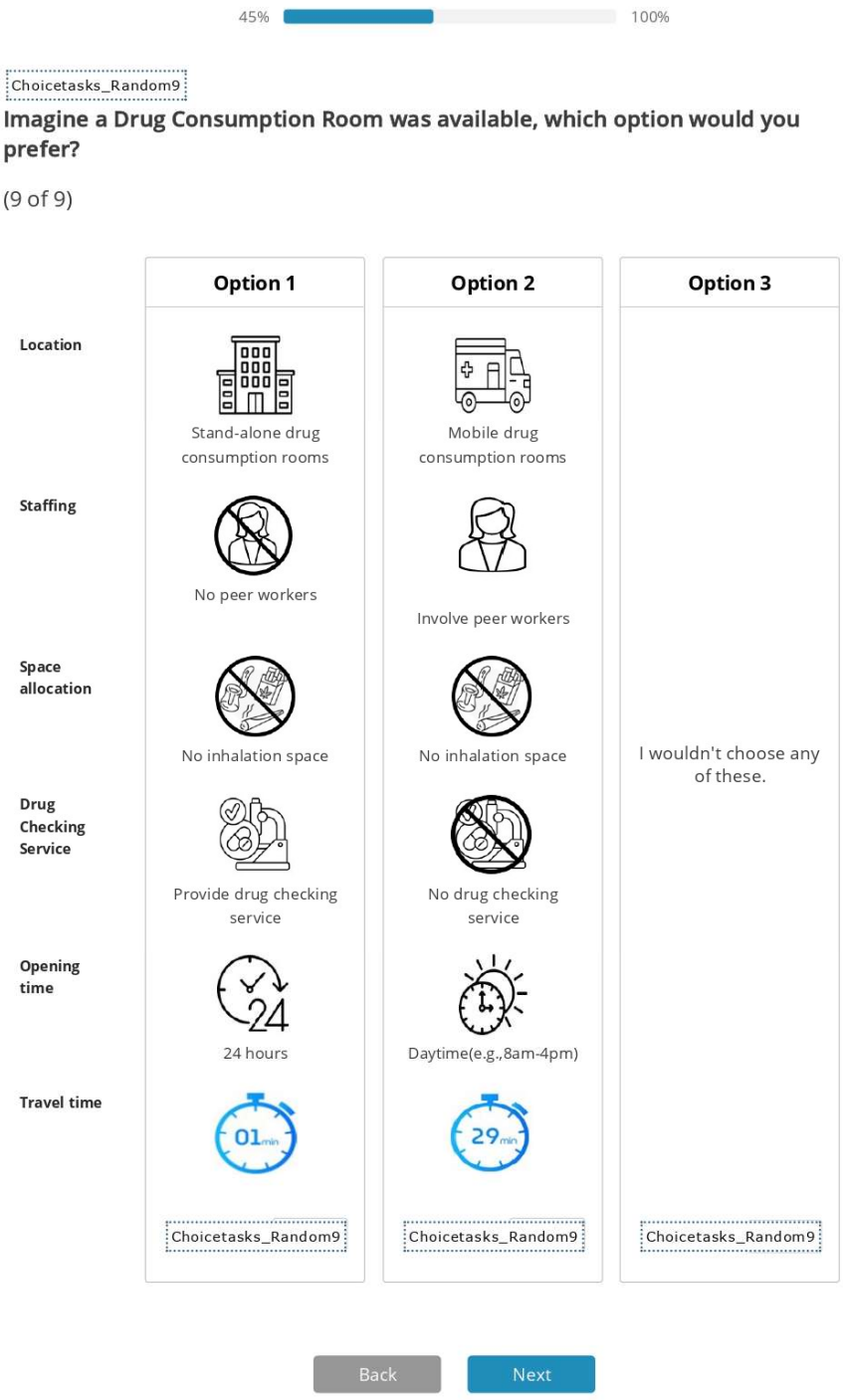
Imagine a Drug Consumption Room was available, which option would you prefer?

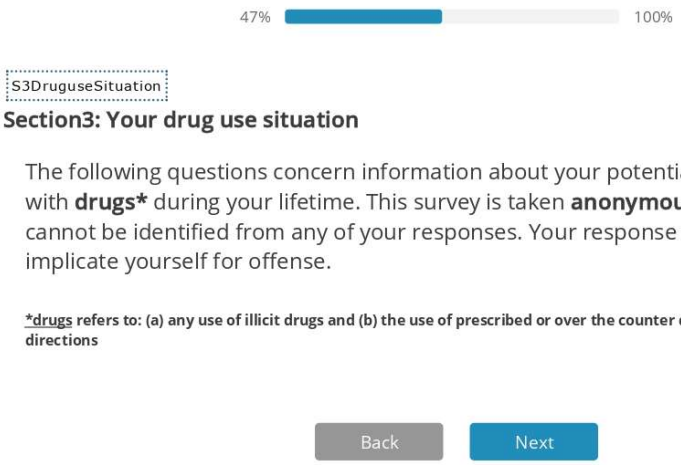
(7 of 9)

	Option 1	Option 2	Option 3
Location	 Mobile drug consumption rooms	 Medicalised drug consumption rooms	
Staffing	 No peer workers	 Involve peer workers	
Space allocation	 Provide inhalation space	 Provide inhalation space	I wouldn't choose any of these.
Drug Checking Service	 Provide drug checking service	 Provide drug checking service	
Opening time	 Daytime(e.g.,8am-4pm)	 Overnight(e.g.,7pm-9am)	
Travel time			
	Choicetasks_Random7	Choicetasks_Random7	Choicetasks_Random7

Back Next


43%
100%
Choicetasks_Random8
Imagine a Drug Consumption Room was available, which option would you prefer?
(8 of 9)
Option 1
Option 2
Option 3
Location
Mobile drug consumption rooms
Embedded drug consumption rooms
Staffing
Involve peer workers
No peer workers
Space allocation
Provide inhalation space
Provide inhalation space
I wouldn't choose any of these.
Drug Checking Service
No drug checking service
Provide drug checking service
Opening time
24 hours
Daytime(e.g.,8am-4pm)
Travel time
29 min
01 min
Choicetasks_Random8
Choicetasks_Random8
Choicetasks_Random8
Back
Next


45%
100%
Choicetasks_Random9
Imagine a Drug Consumption Room was available, which option would you prefer?
(9 of 9)
Option 1
Option 2
Option 3
Location
Stand-alone drug consumption rooms
Mobile drug consumption rooms
Staffing
No peer workers
Involve peer workers
Space allocation
No inhalation space
No inhalation space
Drug Checking Service
Provide drug checking service
No drug checking service
Opening time
24 hours
Daytime(e.g.,8am-4pm)
Travel time
01 min
29 min
I wouldn't choose any of these.
Choicetasks_Random9
Choicetasks_Random9
Choicetasks_Random9
Back
Next


47%
100%
S3DruguseSituation
Section3: Your drug use situation
The following questions concern information about your potential involvement with drugs* during your lifetime. This survey is taken anonymously so you cannot be identified from any of your responses. Your response will NOT implicate yourself for offense.
*drugs refers to: (a) any use of illicit drugs and (b) the use of prescribed or over the counter drugs in excess of the directions
Back
Next

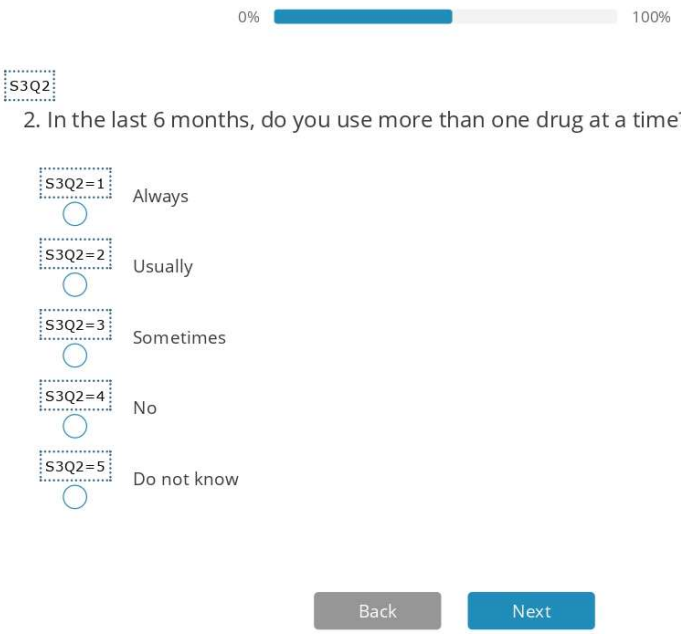
0% 100%

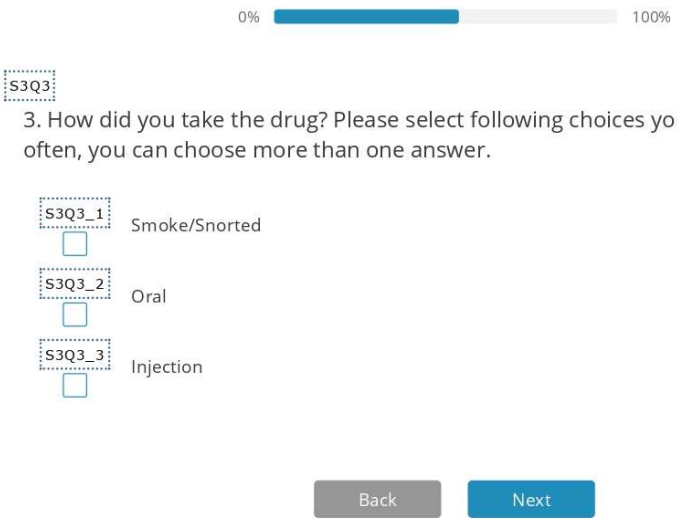
S3Q1

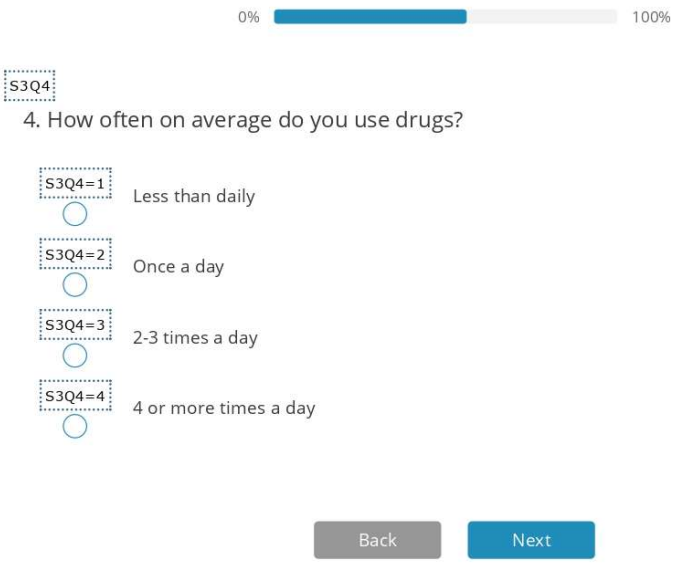
1. In the last 6 months, which of the following drugs have you used? Please select all that are applicable.

- S3Q1_1 ☐ Heroin
- S3Q1_2 ☐ Cocaine
- S3Q1_3 ☐ Crack
- S3Q1_4 ☐ Heroin and cocaine/crack together
- S3Q1_5 ☐ Amphetamines (e.g., Speed)
- S3Q1_6 ☐ Benzos (e.g., Valium, 'blues', etizolam, alprazolam (xanax), diclazepam, etc)
- S3Q1_7 ☐ Bodybuilding drugs (e.g., steroids, HCG)
- S3Q1_8 ☐ New Psychoactive Substances (e.g., burst, mephedrone)
- S3Q1_9 ☐ Cannabis
- S3Q1_10 ☐ S3Q1_10_other Others, please specified here: _____

Back Next


0%
100%
S3Q2
2. In the last 6 months, do you use more than one drug at a time?
S3Q2=1
Always
S3Q2=2
Usually
S3Q2=3
Sometimes
S3Q2=4
No
S3Q2=5
Do not know
Back
Next


0%
100%
S3Q3
3. How did you take the drug? Please select following choices you use most often, you can choose more than one answer.
S3Q3_1
Smoke/Snorted
S3Q3_2
Oral
S3Q3_3
Injection
Back
Next


0%
100%
S3Q4
4. How often on average do you use drugs?
S3Q4=1
Less than daily
S3Q4=2
Once a day
S3Q4=3
2-3 times a day
S3Q4=4
4 or more times a day
Back
Next

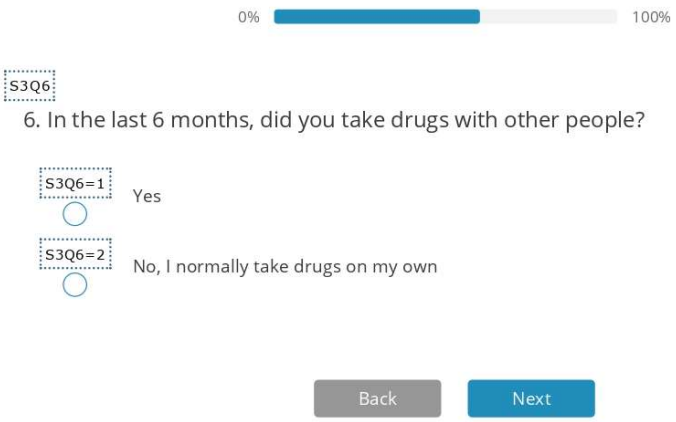
S3Q5

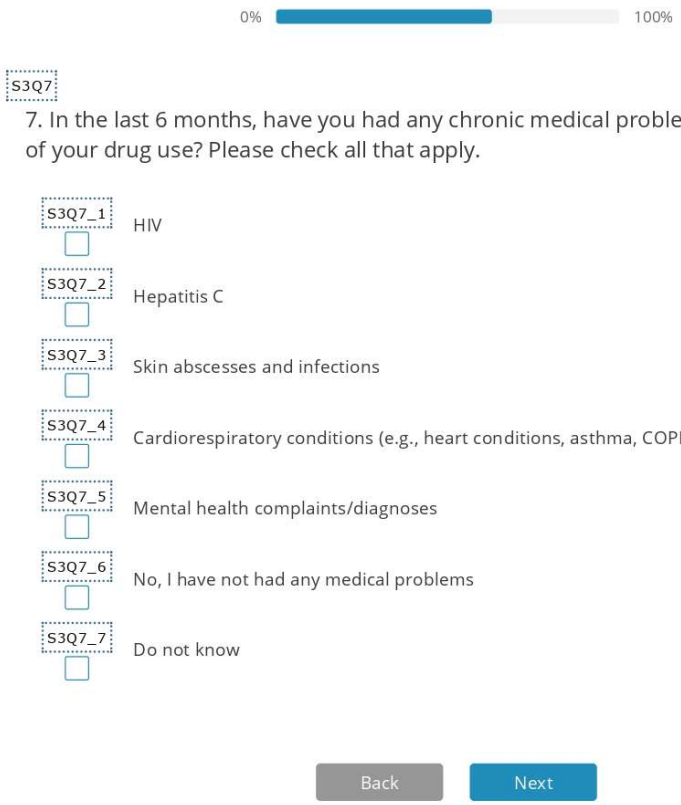
5. In the last 6 months, did you take drugs in public places (e.g., street, park, public toilet, etc)

S3Q5=1 ○ Yes

S3Q5=2 ○ No, I normally take drugs privately (e.g., own home, friends' home, hostel, etc)

Back Next


0%
100%
S3Q6
6. In the last 6 months, did you take drugs with other people?
S3Q6=1
Yes
S3Q6=2
No, I normally take drugs on my own
Back
Next


0%
100%
S3Q7
7. In the last 6 months, have you had any chronic medical problems as a result of your drug use? Please check all that apply.
S3Q7_1
HIV
S3Q7_2
Hepatitis C
S3Q7_3
Skin abscesses and infections
S3Q7_4
Cardiorespiratory conditions (e.g., heart conditions, asthma, COPD)
S3Q7_5
Mental health complaints/diagnoses
S3Q7_6
No, I have not had any medical problems
S3Q7_7
Do not know
Back
Next

S3Q8

8. In the last 6 months, how many times have you overdosed as a result of drug use?

- S3Q8=1 ○ Once
- S3Q8=2 ○ 2-4 times
- S3Q8=3 ○ 5 or more times
- S3Q8=4 ○ No, I have not had an overdose
- S3Q8=5 ○ Do not know

Back Next

S3Q9

9. In the last 6 months, have you obtained equipment (e.g., needle/syringes, filters, foil, etc) from needle and syringes programmes?

S3Q9=1 Yes

S3Q9=2 No

Back Next

S3Q10

10. In the last 6 months, have you been prescribed opioid substitution treatment (OST)?

S3Q10=1 ○ Yes

S3Q10=2 ○ No

Back Next

S3Q11

11. In the last 6 months, have you been carrying take home naloxone (THN) with you while using drugs?

S3Q11=1 ○ Yes

S3Q11=2 ○ No

Back Next

Section4Intro

Section 4: Attitudes towards opening drug consumption rooms in Scotland

The following questions are a measure of your personal beliefs and there is no right or wrong answer for each question, but please carefully consider them before responding. Each question has a scale with numbers (1-5) which reflects the extent to which you agree with the stated questions. Please try to give as honest answer as you can.

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S4Q1

1. Introducing drug consumption rooms as a national harm reduction strategy is the right thing to do in Scotland.

S4Q1=1 1 - Strongly disagree

S4Q1=2 2 - Disagree

S4Q1=3 3 - Indifferent

S4Q1=4 4 - Agree

S4Q1=5 5 - Strongly agree

Back Next

S4Q2

2. People who use drugs would attend these facilities if they are available in Scotland.

S4Q2=1 ○ 1 - Strongly disagree

S4Q2=2 ○ 2 - Disagree

S4Q2=3 ○ 3 - Indifferent

S4Q2=4 ○ 4 - Agree

S4Q2=5 ○ 5 - Strongly agree

Back Next

S4Q3

3. I am concerned about the legal implications of using a drug consumption room.

S4Q3=1 ○ 1 - Strongly disagree

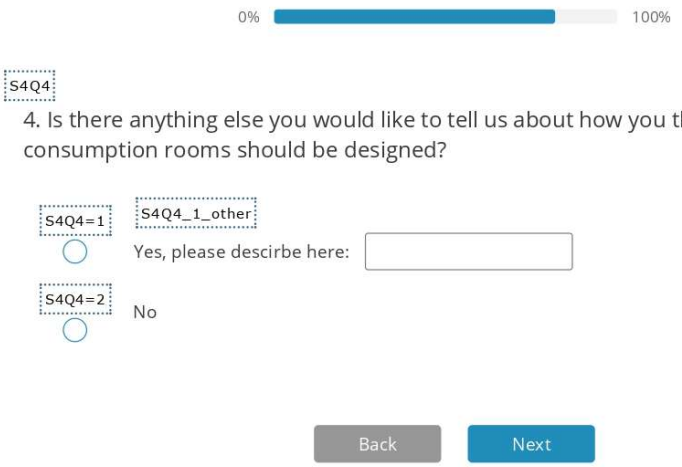
S4Q3=2 ○ 2 - Disagree

S4Q3=3 ○ 3 - Indifferent

S4Q3=4 ○ 4 - Agree

S4Q3=5 ○ 5 - Strongly agree

Back Next


0%
100%
S4Q4
4. Is there anything else you would like to tell us about how you think drug consumption rooms should be designed?
S4Q4=1
S4Q4_1_other
Yes, please descirbe here:
S4Q4=2
No
Back
Next

84% 100%

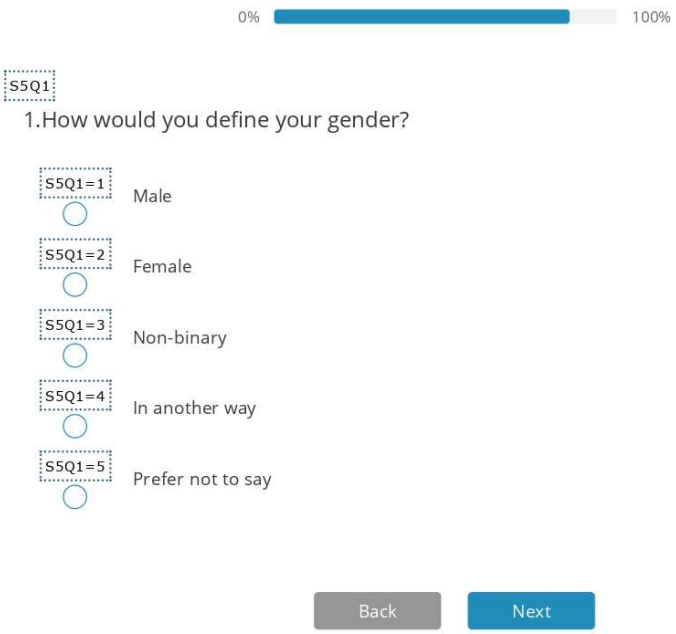
Section5Intro

Section5: Your background information

The following questions ask some final questions about you.

This survey is taken **anonymously** so you cannot be identified from any of your response. Your response will **NOT** implicate yourself for offense.

Back Next


0%
100%
S5Q1
1.How would you define your gender?
S5Q1=1
Male
S5Q1=2
Female
S5Q1=3
Non-binary
S5Q1=4
In another way
S5Q1=5
Prefer not to say
Back
Next

S5Q2

2.How old were you at your last birthday?

S5Q2=1 Age 18-29

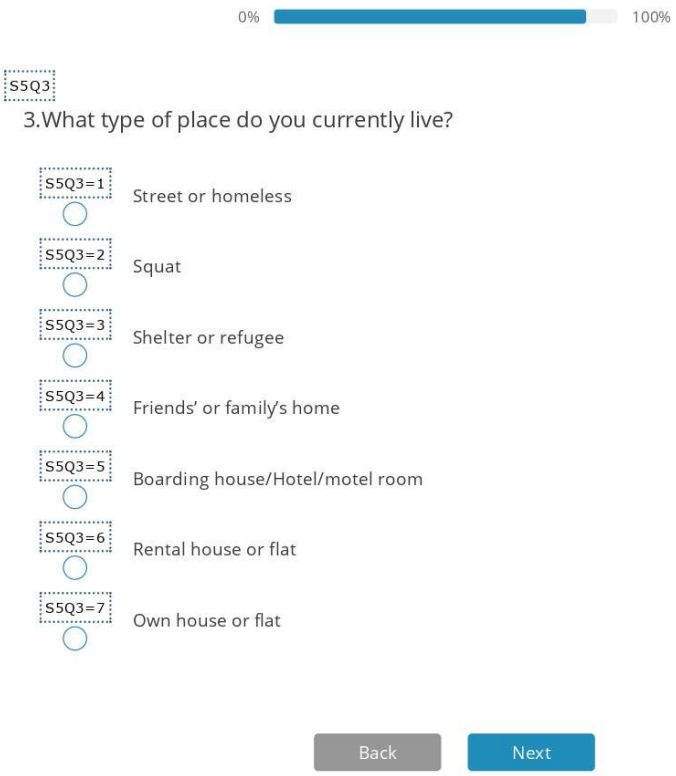
S5Q2=2 Age 30-39

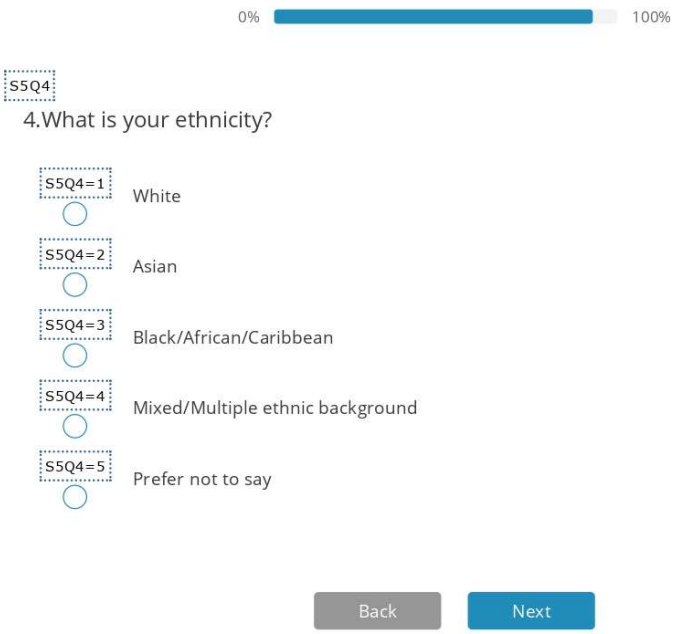
S5Q2=3 Age 40-49

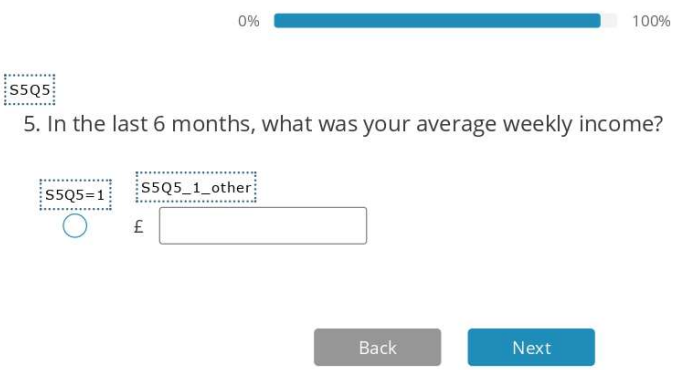
S5Q2=4 Age 50-59

S5Q2=5 Age 60+

Back Next


0%
100%
S5Q3
3.What type of place do you currently live?
S5Q3=1
Street or homeless
S5Q3=2
Squat
S5Q3=3
Shelter or refugee
S5Q3=4
Friends' or family's home
S5Q3=5
Boarding house/Hotel/motel room
S5Q3=6
Rental house or flat
S5Q3=7
Own house or flat
Back
Next


0%
100%
S5Q4
4.What is your ethnicity?
S5Q4=1
White
S5Q4=2
Asian
S5Q4=3
Black/African/Caribbean
S5Q4=4
Mixed/Multiple ethnic background
S5Q4=5
Prefer not to say
Back
Next


0%
100%
S5Q5
5. In the last 6 months, what was your average weekly income?
S5Q5=1
S5Q5_1_other
£
Back
Next

EndofQ

The Survey is now complete!

Thank you for taking the time to complete this survey!

closewindow

Thanks for your time, please close the window!

Appendix 5.3 Ethical approval

University of Glasgow

28th June 2023

MVLS College Ethics Committee

Project Title: Exploring people who use drugs¿(PWUD) preferences towards implementing drug consumption rooms (DCRs) in Scotland: A discrete choice experiment
Project No: 200220329

Dear Dr Kathryn Skivington,

The College Ethics Committee has reviewed your application and has agreed that there is no objection on ethical grounds to the proposed study. It is happy therefore to approve the project.

- Project end date: As stated in application.
- The data should be held securely for a period of ten years after the completion of the research project, or for longer if specified by the research funder or sponsor, in accordance with the University's Code of Good Practice in Research:
- https://www.gla.ac.uk/media/media_490311_en.pdf
- The research should be carried out only on the sites, and/or with the groups defined in the application.
- Any proposed changes in the protocol should be submitted for reassessment, except when it is necessary to change the protocol to eliminate hazard to the subjects or where the change involves only the administrative aspects of the project. The Ethics Committee should be informed of any such changes.
- You should submit a short end of study report to the Ethics Committee within 3 months of completion.
- For projects requiring the use of an online questionnaire, the University has an Online Surveys account for research. To request access, see the University's application procedure at https://www.gla.ac.uk/research/strategy/ourpolicies/useofonlinesurveystoolforresearch/.

Yours sincerely,

[redacted]

Jesse Dawson
MD, BSc (Hons), FRCP, FESO
Professor of Stroke Medicine
Consultant Physician
Clinical Lead Scottish Stroke Research Network / NRS Stroke Research Champion
Chair MVLS Research Ethics Committee

Institute of Cardiovascular and Medical Sciences
College of Medical, Veterinary & Life Sciences
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jesse.dawson@glasgow.ac.uk

Appendix 5.4 Application of different choice models

Table A5.1 Coefficient estimates in MNL, MXL, Latent class and Hierarchical Bayes model

Attributes/levels	Coefficient					
	Model 1 – Multinomial model	Model 2 – Mixed logit model		Model 3 – Latent class†		Model 4 - Hierarchical Bayes
	Mean (SE)	Mean (SE)	SD (SE)	Class 1 (SE)	Class 2 (SE)	Mean (SD)
ASC	-1.010 ***(0.294)	-0.949*(0.467)	2.167***(0.283)	0.949 (0.492)	-3.145 (0.739)	-1.325 (2.322)
Location						
Stand-alone (ref.)						
Medicalised	0.221 (0.157)	0.222 (0.203)	0.359 (0.367)	0.070 (0.186)	0.701 (0.436)	0.222 (0.251)
Embedded	0.177 (0.133)	0.148 (0.162)	0.000 (0.086)	0.026 (0.159)	0.557 (0.408)	0.125 (0.156)
Mobile	-0.111(0.200)	-0.176(0.266)	0.591 (0.480)	-0.062 (0.287)	-0.011 (0.362)	-0.318 (0.299)
Staffing						
No peer workers (ref.)						
Involve peer workers	0.702***(0.122)	0.970***(0.172)	0.341 (0.409)	0.643 (0.154)	0.883 (0.262)	0.977 (0.263)
Space allocation						
No inhalation space (ref.)						
Provide inhalation space	0.268 (0.178)	0.668*(0.314)	1.053***(0.311)	-0.064 (0.283)	1.053 (0.420)	0.700 (0.677)
Ancillary service						
No drug checking service (ref.)						
Provide drug checking service	0.533***(0.153)	0.747***(0.206)	-0.784***(0.193)	0.342 (0.193)	1.034 (0.288)	0.954 (0.769)
Operation time						
Daytime (i.e. 8am-4pm) (ref.)						
Overnight (i.e. 7pm-9am)	0.077 (0.155)	-0.013(0.204)	0.457 (0.440)	0.300 (0.191)	-0.599 (0.391)	-0.185 (0.653)
24 hours	0.385**(0.145)	0.393*(0.193)	0.858***(0.256)	0.542 (0.170)	0.135 (0.409)	0.431 (0.319)
Travel time (per minute)	-0.008*(0.004)	-0.679***(0.698)	0.252 (0.654)	-0.008 (0.006)	-0.009 (0.010)	-0.008 (0.002)
Goodness of fit						
Log likelihood	-715.31	-624.80		-624.00		-609.14
AIC	1450.62	1289.61		1290.00		1348.28
BIC	1496.03	1380.43		1385.37		1643.44

'***', '**', '*' denotes the significant levels at 0.1%, 1% and 5% respectively. †Average membership probability for class 1 is 0.542 and for class 2 is 0.458.

ASC: referred as alternative specific constant, that represented the constant term captured the inherent preference for or against choosing a SDCF in the choice set, which independent of the other explanatory variables in the model; SE: standard error; AIC: Akaike Information Criterion; BIC: Bayesian Information Criterion.

Appendix 5.5 Results of pilot study

Table A5.2 Respondent characteristics (N=21)

	No.	%
Gender		
Male	11	52.4
Female	9	42.8
Non-binary	1	4.8
Age		
18-29	3	14.3
30-39	5	23.8
40-49	8	38.1
50-59	5	23.8
Ethnicity		
White	21	100
Residence		
Street or homeless	11	52.4
Shelter or refugee	8	38.1
Rental house or flat	2	9.5
Weekly income (last 6 months)		
£0 - £100	12	57.2%
£101 - £200	7	33.3%
> £200	2	9.5%
Drug types*		
Heroin	12	
Cocaine	15	
Crack	13	
Heroin and Cocaine/Crack	9	
Amphetamines (e.g., Speed)	1	
Benzos	19	
New Psychoactive Substances	1	
Cannabis	17	
Poly drug use at a time (last 6 months)		
Always	6	28.6
Usually	5	23.8
Sometimes	8	38.1
No	2	9.5
Drug-taking method*		
Smoke/Snorted	19	
Oral	8	
Injection	12	
Drug-taking frequency		
Less than daily	4	19.0
Once a day	5	23.8
2-3 times a day	9	42.9
4 or more times a day	3	14.3
Take drugs publicly (last 6 months)		
Yes	15	71.4
No	6	28.6
Take drugs with others (last 6 months)		
Yes	20	95.2
No	1	4.8
Chronic diseases (last 6 months)*		
Hepatitis C	3	
Skin abscesses and infections	5	
Cardiorespiratory conditions	3	
Mental health complaints/diagnoses	12	
Have not had any medical problems	3	
Overdosed event (last 6 months)		
Once	5	23.8
2-4 times	2	9.5
Not had an overdose	14	66.7

*Survey questions that participants can have multiple choices, thus the percentage was not calculated.

Table A5.2 (Continued.)

	No.	%
Obtain equipment(last 6 months)		
Yes	13	61.9
No	8	38.1
OST (last 6 months)		
Yes	16	76.2
No	5	23.8
Carry THN while using drugs (last 6 months)		
Yes	12	57.1
No	9	42.9
Attitudes towards opening SDCF		
Support roll-out	19	90.5
Willing to attend service	17	81.0
Concerned about legal issue	8	38.1

*Survey questions that participants can have multiple choices, thus the percentage was not calculated.

Table A5.3 PWUD's preferences for SDCF's design features

Attribute	Level	Coefficient	SE	t-value	P value*
ASC**	Status Quo (ref.)				
	SDCF	0.537	0.428	1.254	0.105
Location	Stand-alone SDCF (ref.)	Constrained to be 0			
	Medicalised SDCF	-0.109	0.296	-0.368	0.357
	Embedded SDCF	0.060	0.290	0.209	0.417
	Mobile SDCF	0.301	0.499	0.602	0.274
Staffing	No peer workers (ref.)	Constrained to be 0			
	Involve peer workers	-0.078	0.262	-0.299	0.383
Space allocation	No inhalation space (ref.)	Constrained to be 0			
	Provide inhalation space	-0.412	0.275	-1.496	0.067
Drug checking service	No drug checking service (ref.)	Constrained to be 0			
	Provide drug checking service	-0.299	0.249	-1.199	0.115
Operation time	Daytime (e.g., 8am-4pm) (ref.)	Constrained to be 0			
	Overnight (e.g., 7pm-9am)	0.441	0.359	1.228	0.110
	24 hours	-0.535	0.257	-2.084	0.019
Travel time	Continuous variable (per minute)	-0.011	0.015	-0.745	0.228

**P* value was at 10% significant level, due to a small sample size of this polit study. **ASC: referred as alternative specific constant, that represented the constant term captured the inherent preference for or against choosing a SDCF in the choice set, which independent of the other explanatory variables in the model.

Appendix 5.6 Drug profile

Table A5.4 Drug profile by Scottish cities

	Dundee		Edinburgh		Glasgow		Total sample	
N	*N = 27*		*N = 25*		*N = 25*		*N = 77*	
	n	%	n	%	n	%	n	%
Q1: In the last 6 months, which of the following drugs have you used? *								
Heroin	9	33.3%	14	56.0%	13	52.0%	36	46.8%
Cocaine	11	40.7%	18	72.0%	21	84.0%	50	64.9%
Crack	15	55.6%	16	64.0%	20	80.0%	51	66.2%
Heroin and cocaine/crack together	1	3.7%	10	40.0%	13	52.0%	24	31.2%
Amphetamines (i.e. Speed)	3	11.1%	1	4.0%	4	16.0%	8	10.4%
Benzos (i.e. Valium, 'blues', etizolam, alprazolam (xanax), diclazepam, etc)	14	51.9%	20	80.0%	15	60.0%	49	63.6%
Bodybuilding drugs (i.e. steroids, HCG)	2	7.4%	0	0.0%	1	4.0%	3	3.9%
New Psychoactive Substances (i.e. burst, mephedrone)	0	0.0%	1	4.0%	5	20.0%	6	7.8%
Cannabis	18	66.7%	19	76.0%	17	68.0%	54	70.1%
Others	3	11.1%	4	16.0%	7	28.0%	14	18.2%
Q2: In the last 6 months, do you use more than one drug at a time?								
Always	7	25.9%	7	28.0%	5	20.0%	19	24.7%
Usually	2	7.4%	6	24.0%	7	28.0%	15	19.5%
Sometimes	10	37.0%	10	40.0%	5	20.0%	25	32.5%
No	7	25.9%	2	8.0%	8	32.0%	17	22.1%
Do not know	1	3.7%	0	0.0%	0	0.0%	1	1.3%

Table A5.4 (Continued.)

Q3: How do you take drugs? *								
Smoke/Snorted	24	88.9%	23	92.0%	20	80.0%	67	87.0%
Oral	13	48.1%	8	32.0%	8	32.0%	29	37.7%
Injection	2	7.4%	12	48.0%	18	72.0%	32	41.6%
Q4: How often on average do you use drugs?								
Less than daily	7	25.9%	4	16.0%	7	28.0%	18	23.4%
Once a day	9	33.3%	9	36.0%	2	8.0%	20	26.0%
2-3 times a day	6	22.2%	9	36.0%	9	36.0%	24	31.2%
4 or more times a day	5	18.5%	3	12.0%	7	28.0%	15	19.5%
Q5: In the last 6 months, did you take drugs in public places?								
yes	14	51.9%	15	60.0%	17	68.0%	46	59.7%
no	13	48.1%	10	40.0%	8	32.0%	31	40.3%
Q6: In the last 6 months, did you take drugs with other people?								
yes	21	77.8%	24	96.0%	20	80.0%	65	84.4%
no	6	22.2%	1	4.0%	5	20.0%	12	15.6%
Q7: In the last 6 months, have you had any chronic medical problems as a result of your drug use? *								
HIV	0	0.0%	0	0.0%	3	12.0%	3	3.9%
Hepatitis C	0	0.0%	5	20.0%	9	36.0%	14	18.2%
Cutaneous abscesses and infections	1	3.7%	5	20.0%	6	24.0%	12	15.6%
Cardiorespiratory conditions	3	11.1%	5	20.0%	8	32.0%	16	20.8%
Mental health complaints/diagnoses	9	33.3%	14	56.0%	13	52.0%	36	46.8%
No, I have not had any medical problems	15	55.6%	3	12.0%	4	16.0%	22	28.6%
Do not know	1	3.7%	0	0.0%	2	8.0%	3	3.9%

Table A5.4 (Continued.)

Q8: In the last 6 months, how many time have you overdosed as a result of drug use?								
Once	3	11.1%	6	24.0%	1	4.0%	10	13.0%
2-4 times	2	7.4%	3	12.0%	3	12.0%	8	10.4%
5 or more times	1	3.7%	0	0.0%	2	8.0%	3	3.9%
No, I have not had a overdose	21	77.8%	16	64.0%	17	68.0%	54	70.1%
Do not know	0	0.0%	0	0.0%	2	8.0%	2	2.6%
Q9: In the last 6 months, have you obtained equipment from needle syringes programmes?								
yes	5	18.5%	15	60.0%	19	76.0%	39	50.6%
no	22	81.5%	10	40.0%	6	24.0%	38	49.4%
Q10: In the 6 last months, have you been prescribed OST?								
yes	16	59.3%	20	80.0%	17	68.0%	53	68.8%
no	11	40.7%	5	20.0%	8	32.0%	24	31.2%
Q11: In the last 6 months, have you been carrying THN with you while using drugs?								
yes	14	51.9%	16	64.0%	16	64.0%	46	59.7%
no	13	48.1%	9	36.0%	9	36.0%	31	40.3%

Table A5.5 Drug profile by socioeconomic status

Questions 1: In the last 6 months, which of the following drugs have you used? select all that are applicable.														
	Male	Female	Non-binary	Age 18-29	Age 30-39	Age 40-49	Age 50-59	Age 60+	Street/ homeless	Squat	Shelter/ refugees	Fiends'/family's home	Hotel/motel	Rental flat
Heroin	24	12	0	5	10	14	7	0	11	0	13	1	1	10
Cocaine	31	19	0	5	11	22	11	1	19	0	11	1	1	18
Crack	34	17	0	6	12	19	12	2	15	0	17	2	1	16
Heroin and cocaine/crack	15	8	1	3	7	8	6	0	8	0	8	1	1	6
Amphetamines	6	2	0	0	3	3	1	1	1	0	2	1	1	3
Benzos	32	16	1	5	12	19	13	0	14	0	14	2	2	17
Bodybuilding drugs	3	0	0	0	2	1	0	0	0	0	1	0	0	2
New psychoactive	5	1	0	0	3	2	1	0	1	0	2	1	1	1
Cannabis	36	17	1	8	13	20	12	1	18	0	13	2	2	19
Question 2: In the last 6 months, do you use more than one drug at a time?														
	Male	Female	Non-binary	Age 18-29	Age 30-39	Age 40-49	Age 50-59	Age 60+	Street/ homeless	Squat	Shelter/ refugees	Fiends'/family's home	Hotel/motel	Rental flat
Always	12	7	0	1	5	8	4	1	3	0	5	2	0	9
Usually	13	2	0	3	2	5	5	0	8	0	5	0	0	2
Sometimes	11	13	1	1	6	12	6	0	8	0	5	0	2	10
No	13	4	0	2	6	4	4	1	4	0	4	0	0	9
Do not know	1	0	0	1	0	0	0	0	1	0	0	0	0	0

Table A5.5 (Continued.)

Question 3: how do you take drugs? select all that are applicable:														
	Male	Female	Non-binary	Age 18-29	Age 30-39	Age 40-49	Age 50-59	Age 60+	Street/ homeless	Squat	Shelter/ refugees	Fiends'/family's home	Hotel/motel	Rental flat
Smoke/Snorted	43	23	1	7	17	24	17	2	22	0	16	2	2	25
Oral	24	4	1	2	5	11	10	1	10	0	5	2	1	11
Injection	24	8	0	5	6	16	5	0	12	0	10	1	1	8
Question 4: How often on average do you use drugs?														
	Male	Female	Non-binary	Age 18-29	Age 30-39	Age 40-49	Age 50-59	Age 60+	Street/ homeless	Squat	Shelter/ refugees	Fiends'/family's home	Hotel/motel	Rental flat
Less than daily	15	3	0	2	0	8	7	1	5	0	3	1	1	8
Once a day	10	10	0	3	3	7	7	0	7	0	6	1	0	6
2-3 times a day	15	8	1	0	10	10	3	1	7	0	5	0	0	12
4 or more times a day	10	5	0	3	6	4	2	0	5	0	5	0	1	4
Question 5: In the last 6 months, did you take drugs in public places?														
	Male	Female	Non-binary	Age 18-29	Age 30-39	Age 40-49	Age 50-59	Age 60+	Street/ homeless	Squat	Shelter/ refugees	Fiends'/family's home	Hotel/motel	Rental flat
Yes	33	23	1	6	11	22	6	1	14	0	13	1	2	16
No	17	14	0	2	8	7	13	1	10	0	6	1	0	14
Question 6: In the last 6 months, did you take drugs with other people?														
	Male	Female	Non-binary	Age 18-29	Age 30-39	Age 40-49	Age 50-59	Age 60+	Street/ homeless	Squat	Shelter/ refugees	Fiends'/family's home	Hotel/motel	Rental flat
Yes	42	22	1	6	14	27	17	1	20	0	17	2	2	24
No	8	4	0	2	5	2	2	1	4	0	2	0	0	6

Table A5.5 (Continued.)

Question 7: In the last 6 months, have you had any chronic medical problems as a result of your drug use? select all that are applicable														
	Male	Female	Non-binary	Age 18-29	Age 30-39	Age 40-49	Age 50-59	Age 60+	Street/ homeless	Squat	Shelter/ refugees	Fiends'/family's home	Hotel/motel	Rental flat
HIV	3	0	0	0	1	2	0	0	1	0	2	0	0	0
HCV	11	3	0	2	3	6	3	0	5	0	5	1	1	2
Cutaneous abscesses and infections	7	5	0	3	3	2	4	0	4	0	2	1	0	5
Cardiorespiratory conditions	11	4	1	1	5	5	5	0	5	0	4	1	1	5
Mental health complaints/diagnoses	27	8	1	4	10	10	12	0	10	0	10	1	1	14
No	11	11	0	2	7	8	3	2	6	0	6	1	0	9
Do not know	2	1	0	0	0	2	1	0	1	0	0	0	0	2
Question 8: In the last 6 months, how many times have you overdosed as a result of drug use?														
	Male	Female	Non-binary	Age 18-29	Age 30-39	Age 40-49	Age 50-59	Age 60+	Street/homeless	Squat	Shelter/ refugees	Fiends'/family's home	Hotel/motel	Rental flat
Once	5	4	1	1	3	2	3	1	3	0	5	0	0	2
2-4 times	6	2	0	2	0	6	0	0	3	0	2	0	0	3
5 or more times	3	0	0	0	2	1	0	0	0	0	1	0	1	1
No	34	20	0	5	14	20	14	1	17	0	11	1	1	24
Do not know	2	0	0	0	0	0	2	0	1	0	0	1	0	0

Table A5.5 (Continued.)

Question 9: In the last 6 months, have you obtained equipment from needle and syringes programmes?														
	Male	Female	Non-binary	Age 18-29	Age 30-39	Age 40-49	Age 50-59	Age 60+	Street/homeless	Squat	Shelter/ refugees	Fiends'/family's home	Hotel/motel	Rental flat
Yes	26	12	1	5	11	16	7	0	14	0	12	1	1	11
No	24	14	0	3	8	13	12	2	10	0	7	1	1	19
Question 10: In the last 6 months, have you been prescribed opioid substitution treatment?														
	Male	Female	Non-binary	Age 18-29	Age 30-39	Age 40-49	Age 50-59	Age 60+	Street/homeless	Squat	Shelter/ refugees	Fiends'/family's home	Hotel/motel	Rental flat
Yes	32	21	0	6	12	21	14	0	17	0	15	2	1	18
No	18	5	1	2	7	8	5	2	7	0	4	0	1	12
Question 11: In the last months, have you been carrying take home naloxone with you while using drugs?														
	Male	Female	Non-binary	Age 18-29	Age 30-39	Age 40-49	Age 50-59	Age 60+	Street/homeless	Squat	Shelter/ refugees	Fiends'/family's home	Hotel/motel	Rental flat
Yes	29	16	1	3	11	19	12	1	12	0	12	1	1	20
No	21	10	0	5	8	10	7	1	12	0	7	1	1	10

Appendix 5.7 Attitudes towards opening SDCF in Scotland

Table A5.6 Attitudes towards opening SDCF in Scotland

	Dundee	Edinburgh	Glasgow	Total sample
N	*N=27*	*N=25*	*N=25*	*N=77*
Q1: Introducing SDCF as a national harm reduction strategy is the right thing to do in Scotland.				
1-Strongly disagree	0	1(4.0%)	2(8.0%)	3(3.9%)
2-Disagree	0	1(4.0%)	0	1(1.3%)
3-Indifferent	1(3.7%)	1(4.0%)	1(4.0%)	3(3.9%)
4-Agree	8(29.6%)	8(32.0%)	7(28.0%)	23(29.9%)
5-Strongly agree	18(66.7%)	14(56.0%)	15(60.0%)	47(61.0%)
Q2: People who use drugs would attend these facilities if they were available in Scotland.				
1-Strongly disagree	1(3.7%)	1(4.0%)	0	2(2.6%)
2-Disagree	1(3.7%)	1(4.0%)	0	2(2.6%)
3-Indifferent	2(7.4%)	2(8.0%)	4(16.0%)	8(10.4%)
4-Agree	11(40.7%)	9(36.0%)	10(40.0%)	30(39.0%)
5-Strongly agree	12(44.4%)	12(48.0%)	11(44.0%)	35(45.5%)
Q3: I am concerned about the legal implications of using a drug consumption room.				
1-Strongly disagree	3(11.1%)	3(12.0%)	7(28.0%)	13(16.9%)
2-Disagree	9(33.3%)	8(32.0%)	3(12.0%)	20(26.0%)
3-Indifferent	5(18.5%)	5(20.0%)	3(12.0%)	13(16.9%)
4-Agree	9(33.3%)	6(24.0%)	8(32.0%)	23(29.9%)
5-Strongly agree	1(3.7%)	3(12.0%)	4(16.0%)	8(10.4%)

Appendix 5.8 Preference heterogeneity across cities

Table A5.7 MNL output with interactions

	Dundee			Edinburgh			Glasgow		
	Coeff.	**s.e.**	***P* value**	**Coeff.**	**s.e.**	***P* value**	**Coeff.**	**s.e.**	***P* value**
Standalone (ref.)									
Medicalised	0.294	0.165	0.037	0.356	0.164	0.015	0.297	0.162	0.033
Embedded	0.233	0.132	0.039	0.268	0.129	0.019	0.223	0.132	0.046
Mobile	0.135	0.175	0.221	0.308	0.167	0.033	0.112	0.180	0.268
No peer workers (ref.)									
Involve peer workers	0.382	0.121	0.000	0.876	0.129	0.000	0.649	0.115	0.000
No inhalation space (ref.)									
Provide inhalation space	0.112	0.158	0.239	0.440	0.240	0.033	0.151	0.176	0.195
No drug checking service (ref.)									
Provide drug checking service	0.020	0.169	0.452	0.053	0.168	0.376	0.005	0.172	0.490
Daytime (ref.)									
24h	0.288	0.157	0.335	0.278	0.156	0.038	0.284	0.160	0.038
Overnight	0.137	0.146	0.174	0.069	0.146	0.318	0.154	0.141	0.137
Travel time	-0.012	0.004	0.003	-0.015	0.004	0.000	-0.012	0.004	0.001
ASC	-0.390	0.288	0.087	-0.856	0.306	0.003	-0.801	0.271	0.002
Attributes interact with dummy coded cities									
ASC × city	-1.310	0.451	0.002	0.830	0.399	0.019	*NS*		
Involve peer worker × city	0.883	0.212	0.000	-0.851	0.175	0.000	*NS*		
Provide inhalation space × city	*NS*			-0.681	0.292	0.010	*NS*		
Provide drug checking × city	0.691	0.278	0.006	*NS*			0.696	0.197	0.000
24h × city	0.547	0.196	0.003	-0.482	0.191	0.006	0.720	0.251	0.002
Log Likelihood	*714.65*			*716.19*			*709.87*		
AIC	*1459.29*			*1460.39*			*1443.75*		
BIC	*1520.87*			*1523.96*			*1498.24*		

ASC: Alternative Specific Constant, it captures the mean effect of unobserved factors when choosing alternative of SDCF; AIC: Akaike Information Criterion; BIC: Bayesian Information Criterion; NS: not significant.

Appendix 5.9 Sensitivity analyses for marginal willingness to travel

Table A5.8 Marginal willingness to travel (WTT) estimates (in minutes) using MNL and MXL models, 2023, N=77

	WTT in preference space					*WTT space*		
	Model A	**Model B**		**Model C**		**Model D**		
	Mean(s.e.)	**Mean**	**SD**	**Mean(s.e.)**	**95%CI**	**Mean(s.e.)**	**SD(s.e.)**	**95%CI**
Standalone (ref.)								
Medicalised	29.382(24.344)	14.264	28.372	14.63(14.36)	[-13.52, 42.77]	12.687(13.701)	35.432(25.694)	[-37.67, 63.05]
Embedded	23.516(20.061)	9.635	7.019	9.72(11.65)	[-13.13, 32.56]	7.958(12.776)	17.396(24.452)	[-39.97, 55.88]
Mobile	-14.780(31.011)	-5.519	46.956	-5.8(16.64)	[-38.41, 26.82]	-8.922(23.262)	-40.565(54.053)	[-144.87, 97.02]
No peer workers (ref.)								
Involve peer workers	93.060(60.534)	54.393	42.840	55.30(24.03)	[8.20, 102.40]	60.302*(26.578)	52.022(23.020)	[15.18, 105.42]
No inhalation space (ref.)								
Provide inhalation space	35.566(34.693)	26.721	61.384	29.30(16.80)	[-3.63, 62.24]	30.818(19.652)	-72.326(33.514)	[-34.87, 96.51]
No drug checking service (ref.)								
Provide drug checking service	70.644(49.267)	33.161	51.062	37.74(18.94)	[0.62, 74.85]	38.303(20.059)	57.813(24.873)	[-10.45, 87.05]
Daytime (ref.)								
Overnight	-10.225(20.075)	-0.340	55.580	-6.69(13.52)	[-33.19, 19.80]	-4.213(14.561)	-67.436(31.743)	[-66.43, 58.00]
24 hours	51.100(34.214)	20.712	62.155	15.46(14.56)	[-13.08, 43.99]	17.005(16.822)	-72.810(30.700)	[-43.17, 77.18]
Log likelihood	*-715.31*	*-655.60*		*-662.99*		*-665.19*		
AIC	*1450.62*	*1347.19*		*1359.97*		*1366.37*		
BIC	*1496.03*	*1428.93*		*1437.17*		*1448.11*		

Note: Model A: Multinomial logit model (MNL); Model B: Mixed logit model (MXL), travel time was defined as a lognormally distributed parameter; Model C: MXL, travel time was a fixed parameter that no distribution allowed; Model D: MXL, marginal WTT was directly calculated at estimation stage.

Interpretation:

Sensitivity analyses were conducted by using various model specifications to estimate marginal WTT distributions in terms of testing the robustness. The estimation started with a simple MNL model (Model A), followed by the first MXL model that of travel time was defined as a lognormally distributed parameter (Model B), and the second MXL model with travel time parameter to be fixed (Model C), and third MXL model that calculates marginal WTT directly at estimation stage (Model D, estimation in WTT space). In Model A, B and C, the marginal WTT was calculated as a ratio of two coefficients (estimation in preference space). Overall, difference between marginal WTT estimates in all models were minimal, with fairly similar goodness of fit across the models, indicating the robust WTT estimation in this DCE study.

Appendix 6.1 Definitions of decision tree branches and Markov transition states

Table A6.1 Explanation on model structure

Decision tree branches:	
A	People who use drugs, including injection and non-injection routes
B1	Treatment arm – SDCF available
B2	Control arm – No SDCF
C1	**Weekly attendance** (i.e. ≥ 1 visit per week) was defined as frequent use
C2	**Less than one attendance per week** (i.e. < 1 visit per week) was defined as infrequent use
C3	SDCF was available, but individuals did **not use it**
D1	Service users who **frequently used** SDCF and **did not have overdose (Alive)**
D2	Service users who **frequently used** SDCF and had **non-fatal overdose (Alive)**
D3	Service users who **frequently used** SDCF and had **fatal overdose (Dead)**
D4	Service users who **infrequently used** SDCF and **did not have overdose (Alive)**
D5	Service users who **infrequently used** SDCF and had **non-fatal overdose (Alive)**
D6	Service users who **infrequently used** SDCF and had **fatal overdose (Dead)**
D7	Individuals who did **not use** SDCF and **did not have overdose (Alive)**
D8	Individuals who did **not use** SDCF and had **non-fatal overdose (Alive)**
D9	Individuals who did **not use** SDCF and had **fatal-overdose (Dead)**
D10	Individuals **did not have overdose**, **no SDCF (Alive)**
D11	Individuals had **non-fatal overdose**, **no SDCF (Alive)**
D12	Individuals had **fatal-overdose**, **no SDCF (Dead)**
Markov transition states:	
M1	Individuals who were referred to MAT to **recovery**, and no longer use any illicit drugs
M2	Individuals who **continued to use illicit drugs** in SDCF or elsewhere
M3	Death – Individuals **died** of overdose or old age

SDCF=supervised drug consumption facility; MAT=medicine assisted treatment

Appendix 6.2 Model input parameters with justifications

Table A6.2 Point estimate and range of input parameters

Input parameters	Base case (range)	Justification	Source
Median age of population	36	Age distribution of drug use population in Scotland is not normally distributed. The NESI reported average age of PWID was 43 years old, with the majority of PWID were aged between 35-44 years in 2022/23 [320] In comparison to DAISy dataset in 2022/23, the majority of PWUD (included broader non-injection users) were aged between 30-34 years with a median age of 36 [306]. NESI dataset suggests a right-skewed data as an aging cohort of PWID which tended to be older than PWUD in DAISy dataset. Furthermore, the rate of drug deaths is recorded highest in the age group of 35-54 in 2023 [36]. Thus, in current study, median age is considered more representative to reflect of focused population that includes injection and non-injection users, rather than mean age.	[306]
SDCF capacity	96	Glasgow pilot [230] runs 9am-9pm, has 8 booths, assuming on average each user stays in SDCF for 1h.	Assumption based on Glasgow Gov. documentation [230]
Transition probability			
Proportion of frequent users_standard SDCF	20.75%	Findings from Scotland indicate a high willingness to use SDCFs among 1,469 PWID during 2017-18. In Glasgow city centre, 83% (95%CI 77-87) of PWID reported they would use the SDCF [243]. The calculation on the proportions of frequent and infrequent users was based on previous published observational studies [190, 247, 250] – around 25-29% of individuals frequently used SDCF for all or most of their injections.	Calculated, based on [190, 243, 247, 250]
Proportion of infrequent users_standard SDCF	62.25%		
Proportion of non-users_standard SDCF	17.00%		
Proportion of frequent users_optimal SDCF	26.00%	Individuals (26.0%) who always made the choice to use a SDCF no matter how it was designed were assumed to be the frequent users, and individuals (1.3%) who always chose not to use SDCF were assumed to be non-users, and the remaining were infrequent users (72.7%).	Assumption based on DCE study in Chapter 5
Proportion of infrequent users_optimal SDCF	72.70%		
Proportion of non-users_optimal SDCF	1.30%		
Mortality rate in Glasgow City	44.6 per 100,000 people (42.1-47.0)	Average death rate for a 5-year time period (2019-2023) from the Scottish statistical data on drug misuse deaths [36].	[36]
Proportion of risk reduction in fatal overdose in SDCF neighbourhood beyond 500m	0.35 (0.00-0.58)	Evidence from Canada shows that fatal overdose rate in the 500m radium decreased by 35.0% after the opening of the first supervised injecting facility, from 253.8 to 165.1 deaths per 100,000 person-years (p=0.048) [255]. This study is considered as the most realistic estimation because of its robust research design: a) a long period of time series study between 2001 and 2005; b) control group is an area of city with similar drug profile; c) 500 meters radiation is SDCF's effect size according to the observation of approximately 70% service user lived in such geographical scope. A detailed discussion and comparison to other published studies related to facility effectiveness has provided in section 3.3.4.	[255]

Table A6.2 (Continued.)

Input parameters	Base case (range)	Justification	Source
Transition probability			
Prevalence of non-fatal overdose among PWUD	0.26 (0.23-0.29)	A systematic review and meta-analysis assess a total of 67 international studies, and finding shows a pooled prevalence rate of non-fatal overdose among people who use illicit drugs of 26% (95%CI, 23%-29%) [356].	[356]
Proportion of overdoses require ambulance callout_SDCF available	0.0078 (0.0063-0.0095)	Australian Government reported the proportion of overdoses resulting in ambulance callout in SDCF based on the 5-year clinical trial data on '*MSIC*' [363].	[363]
Proportion of overdoses require A&E visit_SDCF available	0.0078 (0.0063-0.0095)	There is no available data on the proportion of A&E visits. The current study assumed that overdoses in SDCF that required ambulance call outs would require further A&E visit.	[363]
Proportion of overdoses require hospitalisation_SDCF available	0.0050	There is no available data on the proportion of hospitalisation.	Assumption
Proportion of overdoses require ambulance callout_no SDCF	0.096	This is calculated based on a UK study related to naloxone distribution that the proportion of witnessed overdoses of 0.85 (0.32-0.94) multiply the proportion who call an ambulance (no naloxone use) is 0.60 (0.30-0.80) [364]. The calculation is used based on the lowest estimate point 0.32*0.30 to make conservative assumptions.	[364]
Proportion of overdoses require A&E visit_no SDCF	0.065	According to the data from Public Health Scotland, drug-related overdose attendance in A&E is recorded to be 915 cases in Greater Glasgow and Clyde health board in 2022/23 [371], divided by the estimated numbers of PWUD 14,100 live in the area [366].	[366, 371]
Proportion of overdoses require hospitalisation_no SDCF	0.015	According to the data from Public Health Scotland, drug-related hospital statistics records that the total number of drug overdose stays is 123 cases in 2022/23 [372], divided by the estimated numbers of PWUD 8,000 live in the Glasgow City [366].	[372]
Percentage of MAT referral uptake_SDCF available	16.00%	The percentage of successful drug treatment referral uptake in Syndey '*MSIC*' was recorded to be 16% [368].	[368]
Percentage of MAT referral uptake_no SDCF	8.80%	The percentage of referral was unavailable. Assumption was made based on the percentage of referral to smoking cessation services for PWUD in DAISy dataset [306]. In 2023/24, 643 of 7,299 (8.8%) individuals were referred to further service in Glasgow city.	Assumption [306]
Retention rate in MAT	75%	According to the data from Public Health Scotland, 75% of people retained in MAT for six months across Scotland [373].	[373]

Table A6.2 (Continued.)

Input parameters	Base case (range)	Justification	Source
Probability of cessation in MAT (Hazard ratios)			
Year 1	0.73 (0.65-0.81)	Evidence related to drug cessation is largely limited. A cohort study examined the long-term cessation (5 years abstinence) among 794 patients with a history of injecting drug use presenting in primary care in Edinburgh between 1980 and 2007, suggesting a gradually increasing probability of achieving cessation while receiving opiate substation treatment [362]. This finding is consistent with previous literature that cessation is positively associated with longer duration of treatment [381].	[362]
Year 2 to 10	0.89		
Year 11 to 15	0.95		
Year 16 and over	0.91		
Probability of cessation without treatment	0.225	A few studies examined the untreated natural recovery from problematic drug use [357, 382]. The natural recovery probability from substance use (includes alcohol and heroin) is between 22.5% to 25% [357, 382, 383]. It is unknown how well findings from one substance will be generalized to others, especially some drugs are currently under-represented in literature, such as cocaine. Thus, a probability of 22.5% is used in the estimation [357].	[357]
Probability of relapse to use drugs	0.392	The probability of relapse to use drugs was based on a large American cohort study, suggesting cumulative relapse incidence rate of 39.2 per 100 person years during a 12 years follow-up [377].	[377]
Mortality rate due to overdose while receiving MAT	0.24 per 100 person-years (0.20-0.30)	A systematic review and meta-analysis shows that pooled overdose mortality rate is 0.24 per 100 person-years during MAT treatment period based on 16 review papers [365].	[365]
Mortality rate due to overdose while untreated	2.43 per 100 person-years (1.72-3.15)	A systematic review and meta-analysis shows that pooled overdose mortality rate is 2.43 per 100 person-years while untreated based on 16 review papers [365].	[365]
Age-specific mortality rate for general population in the UK	See reference.	It is used to estimate the background mortality, i.e., the probability of drying from causes does not relate to the intervention being evaluated.	[370]
*Utility values**			
Individuals who use drugs	0.730 (0.35-0.84)	PWUD's quality of life was adopted from a large sample size study (n=2,898) in Scotland that median age of participants was 34 years old (IQR: 29-39), with an estimated utility value of 0.73 based on EQ-5D [367]. It was similar to previous published international literature reported utility values that were ranged from 0.67-0.80 [359, 387-389].	[367]
Individuals who received MAT to recovery	0.777	A 6.5% improvement in utility for those who took drug treatments and in recovery [359].	Calculated based on [359]
Individuals who ceased drug use and in abstinence	0.90 (0.85-1.00)	People who achieved drug cessation were assumed to have a utility value equal to general population.	[354]
Individuals who had overdose	0.68 (0.22-0.80)	A retrospective cohort study showed that the quality-of-life score for patients who had overdose was 0.68 compared with no previous overdose at 0.75 [379].	[379]
Individuals who use drugs in public areas due to homelessness	0.613	Evidence is largely limited. The assumption was made based on a cross-section survey conducted in London, suggesting one year of homeless was associated with a loss of 0.117 QALYs [355].	Assumption [355]

*Utility value is a numerical representation of the preference or desirability for a particular health state, on a scale from 0 to 1.

Table A6.2 (Continued.)

Input parameters	Base case (range)	Justification	Source
Costs			
Specialty clinicians	£32 per hour	Staff salary was calculated based on published NHS Scotland staff pay band in April 2025 [375, 376].	[375, 376]
Consultant (specialty in substance use)	£55 per hour		
Nurse	£26 per hour		
Peer workers	£12.60 per hour		
Sterile equipment for drug use	£3.37 per needle	A global systematic review was conducted to summarise and extrapolate the unit cost per syringe for 137 countries, suggesting the unit cost ranged from $0.08 to $20.77 (2020 USD) per syringe distributed [361]. The estimated unit cost in the UK context was $3.71.	Calculated based on [361]
Drug checking service	£394 per sample	A costing analysis was conducted on a pilot drug checking service in USA from Jan 2023 to May 2023, suggesting drug checking service cost $474 per sample [358].	Calculated based on [358]
Naloxone (Prenoxad®) 1mg/ml	£27.72 per kit	Naloxone was provided as injection pre-filled syringes.	[390]
Ambulance run	£254 per call-out		[360]
A&E	£267 per visit	Unit cost of A&E per visit was calculated based on Scottish health service costs summary for financial year 2022/23 [374].	Calculated based on [372, 374]
Hospitalisation	£5,952 per night	Uni cost of hospitalisation was calculated based on Scottish health service costs summary for financial year 2022/23 [374], and the length of stay for general acute hospitalisation because of drug overdoses was 2 days [372].	
Annual cost of MAT	£6,306 per person	Annual cost of MAT per person was $6,552, including medication (e.g., methadone/buprenorphine) and integrated psychosocial and medical support services, and assuming daily visit [378].	Calculated based on [378]
Annual discount rate	3.5%	UK NICE recommendation.	[351]

Appendix 6.3 Calculation breakdown for base case anslysis

Table A6.3 Incremental cost effectiveness per person for decision tree

Input				
	SDCF available		Status quo	
Probability				
Non-fatal overdose	0.26000		0.26000	
Fatal overdose	0.00029		0.00045	
No overdose	0.73971		0.73955	
Frequent use	0.41500		-	
Infrequent use	0.41500		-	
No use	0.17000		-	
Ambulance run	0.00788		0.09600	
A&E	0.00788		0.06489	
Hospitalisation	0.00500		0.01538	
	Unit cost	Resource use	Unit cost	Resource use
Costs				
Psychiatry	£54.9	1.0	-	-
Specialty clinician	£31.6	1.0	-	-
Nurse	£26.3	1.0	-	-
Peer workers	£12.6	1.0	-	-
Sterile equipment	£3.4	1.0	-	-
Cost per visit SDCF	***£126.25***		-	-
Naloxone	£27.7	1.0	£18.0	1.0
Ambulance run	£254.0	0.00788	£254.0	0.09600
A&E	£267.0	0.00788	£267.0	0.06489
Hospitalisation	£11,904	0.00788	£11,904	0.01538
Cost per overdose	***£91.3***		***£227.4***	
Utility				
Use SDCF	0.730		0.613	
Non-fatal overdose	0.680		0.680	
Fatal overdose	0.000		0.000	
No overdose	0.730		0.730	

Output						
	Probability	Cost	Expected cost	Utility	Expected utility	Probability of death
SDCF available						
C1 – D1: Live	0.15349	£116.20	£17.84	0.73	0.22	
C1 – D2: Live	0.05395	£207.54	£11.20	0.71	0.08	
C1 – D3: Die	0.00006	£207.54	£0.01	0.00	0.00	
C2 – D4: Live	0.46047	£116.20	£53.51	0.73	0.22	
C2 – D5: Live	0.16185	£207.54	£33.59	0.71	0.08	
C2 – D6: Die	0.00018	£207.54	£0.04	0.00	0.00	
C3 – D7: Live	0.12572	£0.00	£0.00	0.68	0.08	
C3 – D8: Live	0.04420	£226.47	£10.05	0.66	0.03	
C3 – D9: Die	0.00008	£226.47	£0.02	0.00	0.00	
Total	***1.00***		***£126.25***		***0.71***	***0.00032***
Status quo						
B2 – D10: Live	0.73955	£0.00	£0.00	0.67	0.49	
B2 – D11: Live	0.26000	£227.40	£59.13	0.65	0.17	
B3 – D12: Die	0.00045	£227.40	£0.10	0.00	0.00	
Total	***1.00***		***£59.23***		***0.66***	***0.00045***
Incremental cost-effective ratio, ICER						
						£517,399 per death avoid
						£1,378 per QALY gained

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