Design Science

Setting-driven design: a context-driven approach to behavioural design

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Abstract

This paper introduces Setting-Driven Design (SDD) and supporting tool – the Behaviour Setting Canvas (BSC) – which together address a critical gap in behavioural design by shifting the focus from individual behaviour to the broader context in which behaviour occurs. Rooted in behaviour setting theory, SDD is a powerful approach to behavioural design that offers an end-to-end structure for understanding and intervening in a behavioural design challenge. The process comprises three iterative phases: scoping the behavioural challenge, understanding the setting and intervention development. The process structure revolves around the BSC, a tool for mapping key contextual elements such as roles, motives, norms and routines. While SDD is particularly effective for behaviour change interventions, its utility extends to other design challenges, including introducing new products, shifting social norms and enhancing existing systems where behaviour remains constant. The approach integrates a theory of change to guide intervention development, prototyping and evaluation, ensuring alignment with behavioural objectives and contextual realities. A case study on handwashing in low-income Tanzanian households illustrates the method's utility, culminating in the creation of Tab Soap, a single-use, biodegradable soap designed to improve hygiene behaviours. The study demonstrates how SDD facilitates insight generation and iterative refinement and complements user-centred design. SDD advances behavioural design by combining theoretical rigour with practical application, offering a scalable and adaptable framework for addressing complex design challenges across diverse fields.

Keywords: Design process, Behavioural design, Behaviour change, Design context, Design methods

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1. Introduction

Behavioural design is a systematic approach to addressing design challenges by embedding behavioural insights in design outputs (e.g., products, services, programmes) with the objective to influence behaviour. It is a field built on a wide range of academic disciplines (e.g., psychology, economics, sociology), including practical disciplines (e.g., ergonomics, HCI). This has created rich, but often disconnected, bodies of academic and grey literature that support those working in the space. Prominent examples that build on some foundational understanding of human behaviour (often based on laboratory studies) include behavioural economics, with its advocacy of nudges and choice architecture (Thaler & Sunstein 2008)

and health psychology with its notion of behaviour change techniques (BCTs) (Michie, van Stralen & West 2011; Michie *et al.* 2013). More specific theoretical lenses such as self-determination theory (Deci & Ryan 2012) have been widely used to frame and carry out projects. Finally, a much stronger design focus is found in several approaches including Design with Intent (Lockton, Harrison & Stanton 2010) and persuasive technology (Fogg 2002). However, within this definition of behavioural design, we also view design thinking, human–computer interaction and user-centred design projects to be a form of behavioural design so long as a core objective is to influence behaviour. Indeed, in the literature, it seems that many interventions do not report theoretical foundations, and there is little difference in the resulting outcome of the intervention (Prestwich *et al.* 2014). More details about behavioural design approaches can be found in several substantive reviews (e.g., Niedderer *et al.* 2016; Niedderer, Clune & Ludden 2017; O'Cathain *et al.* 2019; Nielsen, Daalhuizen & Cash 2021; Soman 2024) that offer various surveys and commentaries on behavioural design approaches. What unifies these efforts is some kind of attempt to systematically influence behaviour (typically without coercion).

Common to many approaches in behavioural design is a focus on the individual but often overlooking the broader context in which behaviour occurs (Niedderer *et al.* 2016; Nielsen *et al.* 2021). This narrow focus can limit the effectiveness of interventions, particularly when addressing complex behavioural challenges and the generalisability of learnings and insights to other contexts. For example, engineers designing for the developing world have repeatedly faced pitfalls when contextual knowledge is inadequate, such as assumptions about user needs or insufficient attention to cultural dynamics (Wood & Mattson 2016). Similarly, even within engineering design fields, research has found that contextual factors are often insufficiently integrated into design processes, leading to limited impact and sustainability of solutions (Burleson *et al.* 2023, 2024). Traditional methods such as self-reporting, lab studies, hypothetical scenarios and questionnaire ratings often fail to capture actual behaviour, providing a biased or incomplete view of real-world actions (Nisbett & Wilson 1977; Wilson 2002). As a result, there has been a growing call for research that prioritises the study of behaviour in its natural context, recognising that the environment plays a critical role in shaping behaviour (Baumeister, Vohs & Funder 2007; Banks, Woznyj & Mansfield 2023). While context-driven processes are advocated in theory, the practical demands of many projects – such as the pressure for quick, cost-effective solutions – often lead practitioners to rely on generalised interventions that lack contextual depth, resulting in only small incremental behavioural changes (Andor & Fels 2018; Hansen 2018).

In simpler scenarios, such as optimising website sales or encouraging citizens to sign up for organ donation, a "one-size-fits-all" intervention may often achieve satisfactory outcomes. These scenarios involve relatively straightforward goals and limited contextual variability. However, even in such cases, a more nuanced understanding of the behaviour and its context can enhance the effectiveness of the intervention. For more complex challenges, such as those requiring substantial changes in lifestyle or addressing societal issues, this nuanced understanding becomes critical. These challenges often involve multiple social, physical and environmental factors, which are difficult to manage without a comprehensive design approach (Shelton 2014; Mejía 2021). Such a contextual approach has been

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emphasised by many authors. As Thaler & Sunstein (2008) note in their seminal work on nudging human behaviour, "a good rule of thumb is that 'everything matters.'" By this, they mean that even small factors in the environment may have a significant impact on behaviour – a fact that they acknowledge can be "both paralysing and empowering" (pp. 3–4). More recently, in the concluding chapter of his edited book on applied behavioural science, Soman (2024) emphasises that a potentially costly mistake is to use interventions only tested in the lab since "behavioural results are not typically portable due to changes in situation as well as heterogeneity in how respondents react to our interventions." He then offers several principles to further the field, the first of which is to do a careful and thorough analysis of the situation in which the intervention may be delivered (pp. 337–339).

A number of frameworks from design and related disciplines have been developed to grapple with contextually situating interventions with acknowledgement that design is embedded in, interacting with and interpreted within a specific context (Carbon 2019). Tools such as POEMS (People, Objects, Environments, Messages, Services) (Kumar 2012) and AEIOU (Activities, Environments, Interactions, Objects, Users) (Wasson 2000) offer structure to ethnographic observations and have been used widely in design practice. The ERAF (Elements, Relationships, Activities and Forces) diagram is a similar design tool that is used to map high-level systems views of a context being explored including the entities involved and how they relate (Kumar 2012). Others offer guidelines for specific design contexts such as low- and middle-income countries (LMICs) (Mattson & Wood 2014; Aranda Jan, Jagtap & Moultrie 2016; Wood & Mattson 2016; Jagtap 2021; Jagtap 2024). Beyond design are several disciplines interested in contextual analysis and consideration for intervention. PESTEL (Political, Economic, Social, Technological, Environmental, Legal) analysis is widely used to understand the external macro factors impacting an organisation (Yüksel 2012). Implementation science has several notable tools for contextual understanding such as the Consolidated Framework for Implementation Research (CFIR) (Damschroder *et al.* 2009, 2022) which offers an approach to explaining the determinants of an intervention's effectiveness. Similarly, the Context and Implementation of Complex Interventions (CICI) (Pfadenhauer *et al.* 2017) which seeks to simplify the exploration of the myriad forces that impact intervention success. While these frameworks all help understand various conceptualisations of context, they primarily serve descriptive functions and often lack understanding of the underlying mechanisms that link the environment and behaviour. Indeed, an early-stage framework to consider a behaviour or user experience and one later in the process that helps translate insights into design decisions may be entirely different things (Berni *et al.* 2023). This leaves an opportunity for a structured approach to go beyond contextual understanding and look at how context might be transformed in order to affect behavioural outcomes.

A key insight into improving behavioural design lies in the recognition that behaviour, even in complex environments, is often highly predictable. In fact, the best predictor of a person's behaviour is not their personality or individual characteristics but the environment in which they perform the behaviour (McGann *et al.* 2024). Consider the example of a grocery store checkout, depicted in Figure 1. Behaviour is influenced by a range of factors including the roles of the individuals involved, the presence and effectiveness of technology to support the

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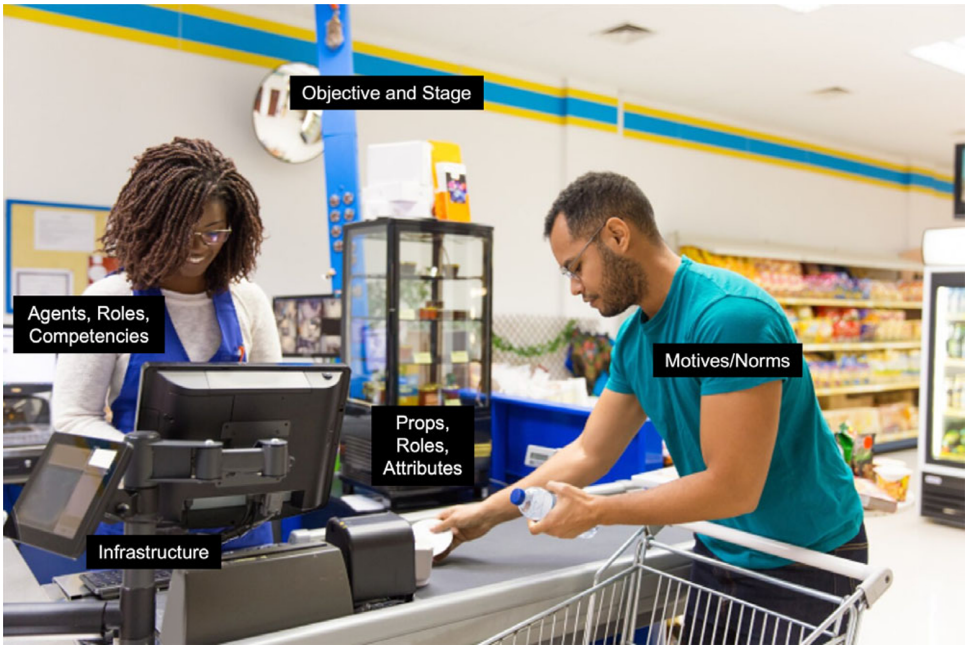

Figure 1. A visual representation of a grocery store checkout as a distinct behaviour setting. The image overlays various factors influencing customer behaviour within the setting, highlighting the interaction of environmental and behavioural elements essential to designing effective interventions.

behaviour, social norms, motives and more. Despite (and indeed because of) these myriad factors, the behaviour of individuals, though varying in minor ways, is largely predictable and conforms to a standardised pattern of behaviour. In cases where individuals or the environment deviate from expectations, corrective pressures usually guide them back to the desired behaviour. This predictability can be seen across numerous settings – whether in a university lecture, a swim meet, a factory assembly line, a doctor's appointment or air travel – and indicates that the broader environment plays a central role in shaping behaviour.

This insight – switching the focus from the individual to the context of behaviour – forms the core innovation of behaviour setting theory, first introduced by Roger Barker in the 1960s (Barker 1968). According to Barker, behaviour settings describe a "standing pattern" or sequence of actions within a specific physical and social environment (Barker 1968). As shown by the examples in the previous paragraph, a noun followed by a standing pattern (e.g., basketball game, back surgery, gift exchange) is a useful way to identify and discuss these settings (Barker 1968, p. 94). By understanding the interplay between the environment and behaviour, it becomes possible to predict behaviour with remarkable accuracy. For instance, when the elements of a setting are properly understood, Barker & Schoggen (1973) demonstrated that behaviour could be predicted with 90% accuracy, without recourse to psychological factors. Enthusiasm for settings remains high, if underexplored, due to this same promise (Curtis *et al.* 2019; Raja & Heras-Escribano 2023; McGann 2014; Aunger 2020b including in settings that comprise digital and virtual elements (Blanchard 2004; Stokols 2018; Aunger *et al.* 2024).

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The potential of this utilisation of behaviour settings lies not only in understanding behaviour but also in using design to influence it within the context.

Over the past several years, the application of behaviour settings in design work has expanded, particularly with the development of Behaviour-Centred Design (BCD), which places behaviour settings at its core (Aunger & Curtis 2016; Aunger 2020a). BCD has been successful in various public health interventions and other design contexts, ranging from communication design through media and interactive demonstrations (Biran *et al.* 2014) to space (or environment) redesign (Gautam *et al.* 2017) and product development (Brial *et al.* 2023). However, despite the progress made, the need for a more dynamic approach to working with behaviour settings has become clear. While understanding the setting is critical for designing interventions, practitioners have often found it challenging to work with this concept in a flexible, practical way. This is because the application of behaviour setting theory often remains conceptually clear but difficult to implement effectively without additional tools and support.

This paper introduces Setting-Driven Design (SDD) – a powerful approach to behavioural design that offers end-to-end structure for understanding and intervening in a behavioural design challenge. SDD offers a theoretically sound and process-rich method for informing when and how to do behavioural design using behaviour settings. This kind of approach that better focuses on integrating design process and behavioural science theory has been called for by other authors (Reid & Schmidt 2018; Schmidt & Reid 2021). It also aligns with the frame and purpose of Design Science to draw on diverse disciplines to better understand how to embed artefacts in the complexity of real-world environments (Papalambros 2015). SDD is an adaptation of BCD which switches the disciplinary foundation of intervention development practice from public health to design per se, with its own approach including process, tools and associated learnings to support the development process all founded on behaviour settings. In SDD, the Behaviour Setting Canvas (BSC) is central to the process, providing a tool for mapping and analysing the elements of a setting. The SDD process, along with the BSC tool and related learnings, represents the unique contribution of the approach to the field of design research.

In the remainder of this paper, we first introduce the SDD process, which includes scoping a behavioural challenge, understanding the challenge context and developing an intervention. We then describe the BSC, its constituent elements and its role in guiding research and intervention development. Finally, we discuss the SDD process and illustrate this through a case study before reflecting on the use of SDD, its limitations and directions for future work.

2. The setting-driven design (SDD) approach

SDD integrates theory and process to guide the development of contextually grounded behavioural interventions. By focusing on the behaviour settings in which actions occur, SDD allows designers to understand and influence behaviour in a more comprehensive way. This approach not only addresses behaviour change through the disruption of existing settings but also supports designers in tackling other challenges, such as integrating technology into established routines or creating entirely new settings.

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The SDD approach was developed over several years in three distinct phases: scoping, development and testing. During the scoping phase, we identified the challenges and opportunities of working with behaviour settings, drawing insights from teaching and the application of BCD with both novice and experienced designers and practitioners. In the development phase, we engaged in an iterative process of prototyping tools (e.g., the BSC) and refining process descriptions, testing these in diverse teaching, research and practice settings. The approach and BSC were applied across a wide range of projects, from low-income nutrition and handwashing initiatives in LMICs to the integration of smart technologies in modern office environments, working with experienced engineering teams. Beyond behaviour change, the SDD approach has been successfully used for tasks like integrating technology into existing routines, redefining norms and designing new products or services. These applications demonstrate the flexibility of SDD in addressing a wide spectrum of design challenges. In total, the method was used by dozens of professional designers and engineers across several countries (the United Kingdom, Canada, Ghana, the Netherlands, Tanzania, Austria, France, Kenya and more), involving a variety of stakeholders and contexts. The final testing phase occurred through implementation in a broad range of contexts as well as teaching the approach and BSC to more than 500 undergraduate and postgraduate students from various fields. This provided valuable insights as students scoped behavioural challenges, developed an understanding of the challenge space and identified intervention opportunities. Additionally, the method was applied in-depth across approximately 30 student projects and 15 professional projects, where the BSC played a central role in diagnosing behavioural challenges and guiding the development of interventions, as highlighted in Brial *et al.* (2023) and contextually reported as a case study later in this paper. Throughout these phases, the approach has proven to be accessible for both practitioners and researchers from diverse backgrounds, offering a rigorous framework for understanding behavioural challenges and driving effective design processes.

2.1. Setting-driven design theory

The theoretical foundation of SDD is rooted in behaviour setting theory (Barker 1968; Schoggen 1989; McGann *et al.* 2024) which is further described and enhanced by a theory of change (ToC) (Aunger & Curtis 2016). The ToC, depicted in Figure 2, shows the causal links between interventions, environmental changes and the resulting behaviour. Specifically, an intervention modifies the environment, which then influences how individuals think and feel, leading to a behavioural response. Over time, these behavioural responses contribute to broader outcomes, such as improved health or production efficiency. A behaviour setting constitutes the context in which the environment–brain–behaviour chain is made. This offers a diagrammatic representation of an earlier point that behaviour settings are self-regulating. This self-regulating system consists of several key aspects. The first is the overarching goal of the setting. That is to say that all behaviour works towards some outcome decided at the level of a setting rather than any individual. An understanding of this outcome dictates what is done and what is seen as success within a setting. The next aspect is the creation of a setting with strong synomorphy or "fit" between the environment and the standing pattern of behaviour. In other words, how well the afforded and constrained environment

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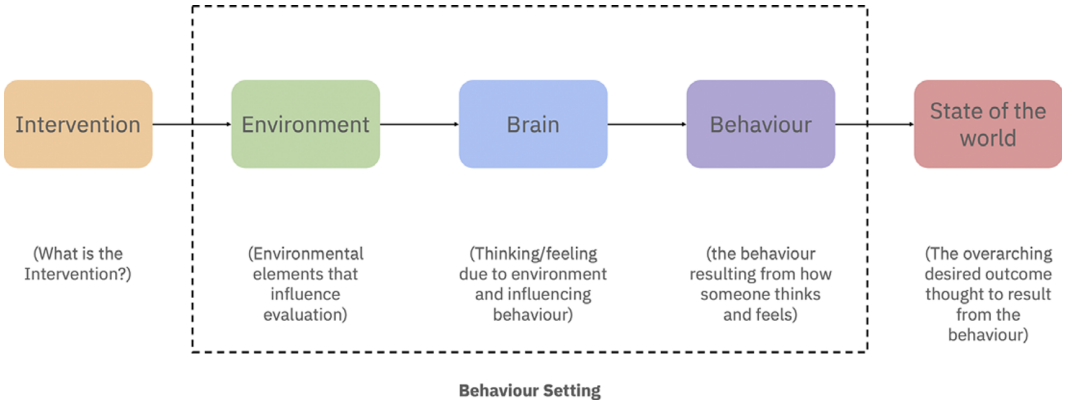

Figure 2. A generic ToC for use with behaviour settings which link interventions to desired outcomes. The behaviour setting comprises the three middle elements of the ToC – environment, brain and behaviour. Adapted from (Aunger & Curtis 2016).

supports the behavioural performance in achieving the setting goal. Indeed, this notion of synomorphy is closely related to the more familiar idea of an "affordance" between objects and people as outlined in several related pieces of work (Gibson 1977; Lockton *et al.* 2010; Lahlou 2024). The final aspect that governs the self-regulation of a setting is the maintenance of the setting to prevent behavioural drift from the desired synomorphic state of the setting. Maintenance can be proactive or reactive. Proactive maintenance includes the prevention of behavioural drift through behaviours such as modelling and affirming desired behaviour and selective admittance into the setting based on suspected compliance. Reactive behaviours may include anything that corrects setting elements (behavioural or otherwise) to keep the standing pattern of behaviour from drift. Examples of this include normative corrections such as shushing someone to encourage quiet during a lecture and maintenance of the wider supporting environment to maintain synomorphy such as repairing a book in a library to keep it in circulation.

The ToC clarifies why certain behaviours (typically the target of behaviour change) occur within a given setting and how interventions can be framed to disrupt existing patterns, leading to lasting change. This framework encourages designers to consider both immediate interventions that address pressing needs and strategies for ensuring long-term sustainability of behaviours. Crucially, successful interventions are not only effective in producing the desired behaviour initially but are also designed to embed and reinforce that behaviour within the setting, fostering a self-sustaining cycle of change over time.

3. The behaviour setting canvas

The BSC (Figure 3) offers a single place for documenting elements of the behaviour setting to be recorded, analysed, discussed and potentially disrupted with the introduction of an intervention. In this sense, it can represent both documentation of a current state of a setting or the desired state based on an intervention. The Canvas can reflect a single, specific setting or summarise an archetypal setting synthesised from insights across multiple observations of similar settings. For instance, an archetypal setting might emerge from examining checkout routines

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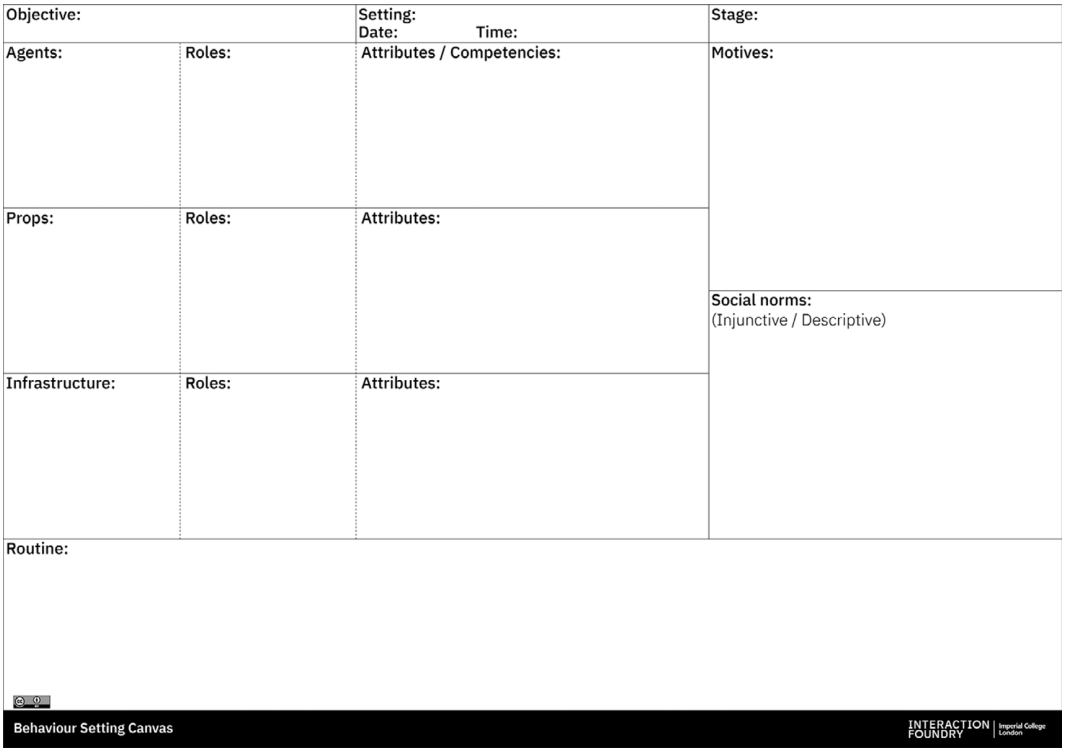

Figure 3. A blank copy of BSC with text enlarged for readability including the routine where the behaviour pattern is captured and elements that influence performance within the setting.

across several grocery stores or particular workout routines in various locations. While individual settings may differ in certain aspects, enough commonality often exists to enable meaningful comparison and synthesis into an archetype. This approach allows the canvas to represent patterns and consistencies across contexts, making it a versatile tool for analysis. Additionally, the Canvas has been designed to be used in either small or large formats, visually capturing the interrelationships of key setting elements.

The canvas consists of boxes representing places where setting elements can be recorded. This starts with the overall setting objective, i.e., the intent of the successful completion of the standing pattern of behaviour. It also captures the people, props and infrastructure along with associated roles and attributes. Further, it captures the social roles and motives along with the routine. A mapping of these elements back to the ToC presented in Figure 2 can be clarified as follows: the environment includes people, props and infrastructure within the setting. The brain engages in the (re)evaluation of motives, norms and roles within the setting. Finally, the behaviour will show up within the routine that is captured at the bottom of the canvas. The ToC is thus more explicit about the relationships between components of the physical environment, psychological mechanisms and behaviour which drive the role-playing by the elements of a setting, manifesting as a routine. Because the canvas is meant to offer an overview of the understanding from the behavioural design team, the items listed may be a shorthand

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annotation that references a wider set of notes elsewhere. This may then mean the setting (and Canvas) elements that are described further below and summarised in Table 1 will take a different form depending on the intended use within the broader design process.

3.1. Objective

The BSC forces teams to be explicit about the objective (which can be different from the motivation they have as a role-player within the setting – see below). The objective is embodied in the setting's end-state. For instance, a grocery store checkout is a behaviour setting with the objective of having customers pay for purchases. There may also be other objectives such as to provide friendly or efficient service to customers. The objective not only focuses the team in terms of things to include in the setting description but also areas of particular interest that may help or hinder achieving the desired outcome.

Table 1. Behaviour Setting Elements along with a description and common methods for developing an understanding of each, adapted from (Curtis *et al.* 2019)

Element	Description	Method
objective	The behaviour you want someone to do and the intended or hoped difference made in the world as a result	Decided or deduced through analysis
Stage	The backdrop that does not change during the behaviour	Direct observation
Agents	People (and others with a degree of agency such as pets) within the setting that play a role in the successful completion of the behaviour	Direct observation, behavioural demo
Props	Those objects manipulated in the setting during the completion of the desired behaviour	Direct observation, behavioural demo
Infrastructure	The physical and/or digital elements of the setting employed to complete a behaviour	Direct observation, behavioural demo
Roles	Functionally distinct tactics or strategies which help the performance of people, props and infrastructure	Observation, demo, interview
Attributes	The features of the props and infrastructure which aid in fulfilling a role The competencies or characteristics of people that aid in fulfilling a role	Observation, demo, interview
Motives	The goal or benefit a person hopes to gain by fulfilling a role	In-depth interviews
Norms	Informal or implicit rules that govern or relate to the accomplishment of a setting	In-depth interviews
Routine	The regular sequence of behaviours from initiation to completion of a setting	Observation, demo

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3.2. Setting, date and time

In the top middle of the Canvas is a place to note the setting being investigated, the date and the time. This is for practical record keeping, as many different settings may be explored. For instance, this may note a "business meeting" setting within a particular hotel lobby at 2 pm if you are making observations of such settings in various hotel lobbies at different times of the day. The setting can also be any other relevant setting, such as a doctor appointment, factory assembly line, public transport journey or family dinner.

3.3. Stage

This box captures the backdrop in which the setting occurs. Behaviours occur within circumscribed locations; offering a short description of this "stage" is an essential way to provide significant information and set the scene in which behaviour is performed. In a single stage, there could be multiple settings delineated by various temporal, social or physical thresholds. An example might be a swimming pool (stage) that could be the backdrop for several settings, such as lap swimming, pool party or swim meet. Another could be a café area of a building (stage) which, at mealtimes, could support the lunch eating setting but outside of this time could serve as a group study setting or a birthday party setting.

3.4. Agents

All those actors in the setting who have agency are recorded in this box. This includes individuals who contribute to the behaviour (or lack of behaviour). Generally, this could feature the "protagonist" (the person who is doing a target behaviour) but may also include other contributors. In his early work, Barker differentiated levels of involvement and responsibility among inhabitants of a setting from the outermost to innermost including onlooker, audience or invited guest, member or customer, active functionary, joint leaders and finally the single leader (Barker 1968). Depending on the setting in question, it can be useful to differentiate people in other ways, including the emotional salience of the experience, familiarity with cultural expectations, expertise or other dimensions. In some cases, you may have other entities that have some autonomy in a setting such as pets or artificial intelligence that exhibit a degree of agency.

3.5. Props

These are objects that are manipulated in the setting during the completion of some aspect of the setting's behavioural performance. In a physical setting, these are typically products, buttons, packaging, coats, pens, handles, masks, doorknobs or other physical things individuals touch and interact with to achieve a behaviour. In a digital setting, a prop could be an aspect of an interface such as buttons, virtual tools or other interactive elements.

3.6. Infrastructure

The infrastructure includes all physical and digital aspects of the setting that may not be moved, but still contribute to the setting behaviour. Examples of physical

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infrastructure could be a sink basin for hand washing, a wall where posters are displayed, a kitchen table for mealtime or a whiteboard within a classroom setting. In a digital context, these are similarly supportive elements, such as a database or webpage. The difference between props and infrastructure is whether people actively manipulate it in the setting though such a distinction is sometimes grey, and this does not tend to be an issue practically if documented in one section or the other.

3.7. Roles

Agents (e.g., people), props and infrastructure each have functionally distinct roles that help in the performance of the setting. For instance, in addition to the obvious role a surgeon has within a surgical theatre (to do the surgical procedure), they may also play the role of delegating tasks, explaining the procedure to the patient, as well as more subtle roles such as conveying trust and more. Another example may be with a teacher who, of course, has a role of conveying information but will often also have a role of correcting misbehaviour and generating class participation. The use of functions (Taylor 1969) or "jobs to be done" (Christensen *et al.* 2016) is common in various areas of design, engineering and business and can be analogous to how roles are used here. For props and infrastructure, list the functions that the object has. Refining the title given to a role will help shape how the element is positioned within the broader setting.

3.8. Attributes (and competencies)

People, props and infrastructure all have specific attributes or competencies required to effectively fulfil a role. In other words, attributes are the embodied features and characteristics that help enable a role to be performed. For a surgeon to effectively explain the procedure to the patient (a role of an explainer or comforter), they may need an attribute or competency around good bedside manner to fulfil that role. Even more descriptive would be to say approachable, articulate and knowledgeable. A prop used in a surgical setting such as a scalpel has the role of making incisions. To effectively fulfil that role, the attributes it requires are being sharp, small and fit in a human hand. People have roles which often require competencies rather than attributes. Clarifying the link between roles and the attributes or competencies to fulfil them is an important part of the analysis and subsequent intervention development.

3.9. Motives

The goal or benefit a person hopes to gain by fulfilling a role is their motive. Action in behaviour settings generally utilises short-term rewards to regulate behaviour. Thus, while the section of the canvas related to motives can be used generally, the motives commonly used in BCD are effective here, given their strong theoretical (Aunger & Curtis 2013) and empirical underpinning (Aunger, Foster & Curtis 2021; Aunger, Gallyamova & Grigoryev 2025).

In addition to identifying which motive(s) best help explain the target behaviour(s) in a given setting, it may be helpful to note if motives are intrinsic (do something for its own sake or personal reward) or extrinsic (doing something

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for external recognition or reward). Other implementation factors, such as costs (financial, temporal, energetic, etc.), which may be seen as an impedance to acting on a motive, can also be useful to note within this box.

3.10. Norms

Norms are the implicit or informal rules that govern behaviour in a behaviour setting. A simple way to conceptualise this is by considering what is expected in a situation (Deutsch & Gerard 1955). Norms are often thought of in relation to other people (as expectations of someone), but they can also relate to props or infrastructure, e.g., with respect to their use in the expected behaviours. For instance, the normal (and expected) performance of a material, whether an interface feature signals a particular action or expectations around how automatic doors operate. Norms fall into two categories (Cialdini, Reno & Kallgren 1990). Injunctive norms are those behaviours seen as approved or disapproved (and hence punishable). Descriptive norms are those behaviours observed to be performed. An example may be seen with public transportation. An injunctive norm may be that people should pay for their fare, but you may see people getting on without paying and thus note a descriptive norm that people travel without paying.

Norms can have strong associations with settings and be strong drivers of behaviour. Indeed, the strength of the norm associated with a setting correlates with adherence to expected normative behaviour. Critically, such behaviour is not driven by mood but expectations of how to act (Aarts & Dijksterhuis 2003). Understanding the manifestation and mechanisms underlying these norms is crucial to drive action at the level of a setting. Particularly useful is to understand how desired normative behaviour is praised and deviations are corrected within a setting – something (Barker 1968, p. 169) calls deviation countering mechanisms of behaviour settings which provide the self-regulation of the setting.

3.11. Routine

The routine maps the sequence of behaviours from the initiation to completion of a behaviour sequence in a setting by the agents. It maps how agents, props and infrastructure interact during the enactment of the setting's objective and shows how each element (agents, props and infrastructure) plays a role over time. Think of it as a script or step-by-step process that guides the actions of everyone involved in the setting rather than a list of isolated actions. By understanding the routine, designers can identify where things might go wrong, where the setting can be improved or how an intervention might be applied. This visualisation focuses on observable behaviours rather than motives, norms, thoughts or feelings. It is similar conceptually to the "user journey" in human-centred design.

4. Setting-driven design (SDD) process

The SDD process follows a phase-based process common to many behavioural design processes (Cash, Hartlev & Durazo 2017) represented here as a variation of the double diamond process (Design Council 2007). Prior to starting the work, the challenge needs to be framed and scoped as a behavioural design challenge before going through the phases of understanding the setting and intervention

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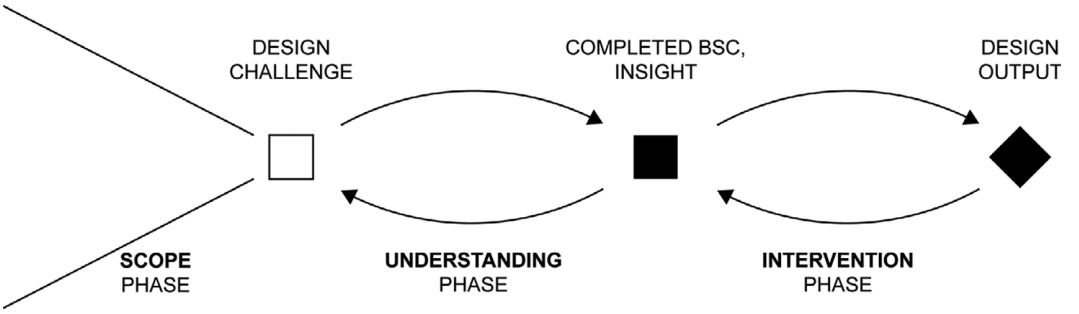

Figure 4. The SDD process, including the scoping, understanding and intervention phases with overlaid outputs of the process at the top of the diagram.

development, as supported by the use of the BSC. These phases, outlined in Figure 4, guide the design team through an iterative process of understanding the behaviour within its setting and designing effective interventions. While these phases generally progress linearly, the process is inherently iterative as indicated by the arrows in each phase of the diagram. Project teams would typically move back and forth between phases as new learnings emerge.

4.1. Scoping behaviour setting challenges

The first phase of the SDD process is to scope a challenge whose objective fits within a behaviour setting framework. The most straightforward challenge is one in which an existing setting is to be influenced or disrupted, as would be the case with behaviour change projects. However, SDD's tools have proven versatile across a range of applications where behaviour may be influenced but the focus is on another challenge, such as introducing novel products, reshaping social norms or refining existing processes (e.g., improving synomorphy within the setting). One common application is a technological intervention in which new technologies augment or automate actions that individuals already perform within a setting. Finally, there may be other relevant challenges, such as creating a new setting altogether, such as when a new policy, technology or other force suggests a fundamentally new way of arranging behaviour and environment to reach an objective. This phase is completed when the team agrees on the challenge, objective and alignment with behaviour settings.

A sample of SDD challenges successfully addressed to date includes the following:

- Encouraging a patient to take medication using a conversational agent.
- Improving how people form connections at a networking event.
- Integrating new sensor and actuator technology to enhance group collaboration in smart offices.
- Increasing handwashing with soap after defecation.
- Improving training and performance of personnel in an industrial setting.
- The limitations and opportunities afforded in extended reality settings.
- Understanding the features of a car used to support different use cases (i.e., settings).

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- Supporting wider participation among older people in physical activity events to encourage fitness.
- Normalising desired behaviour such as the prevalence and effectiveness of a designated driver.

There are also many challenges that might sit outside of this frame. For instance, the use of a different theoretical lens through which the challenge is viewed may give precedence to a different framing. The investigation of interactions with a single object across multiple settings (e.g., exploration of phone usage throughout the day) may not always benefit from SDD since there is so much variability in the settings. Finally, there may be an interest in behaviour that exists outside of the standing patterns more generally.

It is common – and expected – for the understanding of the challenge to evolve as the project progresses. The primary goal is to ensure the challenge is behaviour-setting related, providing a clear focus for subsequent phases of the process.

The boundaries of a setting are crucial to defining and understanding its scope. Settings can be delineated by a combination of physical, temporal and social thresholds. A setting is characterised by a "standing pattern of behaviour," and it is not uncommon to observe multiple settings occurring in sequence, such as shopping in a grocery store followed by checking out at the cashier. Each of these would be considered a distinct setting, even if they are part of a larger behavioural sequence. While scholarly discussions delve deeply into the theoretical and empirical aspects of setting boundaries (Schoggen 1989; Sasmita & Swallow 2022; Lucas 2024), a pragmatic approach is more appropriate for design work. This involves clearly defining the start and end points of the setting under investigation to ensure a focused and actionable understanding.

A well-framed challenge should explicitly define the overall objective within the setting, as this determines how the setting will be viewed and interpreted throughout the project. For instance, in the example of a grocery store checkout, shifting the objective from efficiency to creating a personal experience fundamentally changes how the setting is analysed and the types of interventions considered. Moreover, a single project may encompass multiple objectives, which should also be noted during this phase to provide clarity and guide decision-making as the work progresses.

4.2. Understanding the behaviour setting

Once the challenge is scoped, the second phase focuses on developing insights through fieldwork. Initial understanding of the behaviour setting often begins with observation, allowing the team to gather foundational information about how the setting functions. To delve deeper into specific elements, contextual interviews with people involved in the setting are typically required. Table 1 provides a summary of appropriate methods for interrogating the various elements of a setting.

Learnings from this phase are captured and summarised in the BSC. Work in this phase is considered complete when the setting is fully understood, and the canvas reflects this understanding. Thus, the canvas would, in this phase, represent the current state or "as is" setting condition and only later be considered with a desired change in mind. While the canvas can document findings from a single

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setting, it is often beneficial to study multiple comparable settings (e.g., several grocery store checkout settings) to develop an understanding of an archetypal setting. This helps generalise insights and ensures they are applicable across similar contexts. A sufficient analysis is generally understood to be achieved when rich and nuanced information is gathered and additional conceptual insight is no longer emerging from the data collection process. This is consistent with approaches to qualitative thematic analysis that look at adequate coding as determined by the richness of codes as interpreted from the team rather than a strict view of data saturation (Brooks *et al.* 2015; Braun & Clarke 2021b, 2021a) This will mean that the specific detail and way a team engages with data analysis will and likely should vary according to the specific constraints of the brief, the background of the team and the broader context of the project. Indeed, as shown in the diagram, this process will often be iterative as some aspects of a project often cannot be fully understood beforehand and additional understanding is needed to proceed through the remainder of the work. In practice, the BSC then not only acts as a template for coding and organising findings but also provides a structured basis for discussion to confirm that the meaning behind the data is fully understood.

In some cases, this phase may also include additional activities, such as identifying constraints, feasibility requirements or other relevant considerations that influence the design process but that would be documented beyond the canvas.

While there is no fixed procedure for completing the BSC, the following sequence is recommended based on its logical progression and ease of use:

1. Behaviour, Objective, Operational Notes and Stage: Start by filling in the overarching behaviour, the objective of the setting, any operational notes and the general stage in which the behaviour occurs.
2. Routine: Document the routine step by step, capturing the sequence of actions from the initiation to the completion of the behaviour.
3. People, Props and Infrastructure: Identify the agents involved, the props they interact with and the broader infrastructure that supports the setting.
4. Roles and Attributes: For each agent, prop and infrastructure element, outline their roles and the associated attributes or competencies they require.
5. Norms and Motives: Document the norms governing the setting and the motives driving the behaviour of agents.

Following this sequence ensures dependencies are addressed and complexities are unravelled systematically. Only the elements relevant to the setting should be included in the canvas, as additional or tangential details may serve to distract. It is common for this to occur since there is much in a stage that may have little to do with a particular behaviour setting. However, good design work often requires a broader understanding of the challenge, incorporating considerations such as user adoption, institutional constraints or other contextual factors that influence the success or mere possibility of an intervention. While the canvas serves as a central anchor for synthesising and visualising formative research, it is not a substitute for the broader formative research activities needed to comprehensively understand the challenge space.

The BSC serves as a summary of the target setting, highlighting its key elements and their interrelations. While additional notes or descriptions may be required to detail specific elements, the canvas provides a structured, high-level view of the setting. Its primary purpose is to guide the team in understanding why and how the

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setting functions as it does, enabling informed design decisions. The canvas may also be used for other purposes, such as creating hypothetical scenarios, but its traditional use is to document existing conditions.

In addition to the canvas being completed, the design team should document insights that will guide the next phase of work. We differentiate between two kinds of insights. Descriptive insights give a deeper understanding of why and how behavioural performance occurs in the current situation. Prescriptive insights are information that, when properly contextualised and embodied, can drive the desired behavioural outcomes. Insights should offer a clear understanding of how the setting might be changed to achieve the intended result. The canvas acts as a grounding tool, helping the team evaluate how each element of the setting might be adjusted and what implications these changes may have. Insights should ideally be documented formally to ensure clarity and alignment across the team. This is particularly important when members of the team may change, such as adding additional creative support, moving into the next phase of work, where interventions are developed.

Effective insights share certain qualities:

- Specificity: Insights should be actionable and directly linked to elements of the canvas. They should reflect the particular fieldwork done.
- Grounded in Qualitative Data: Insights should be based on fieldwork, including observations and interviews, to ensure they reflect the realities of the setting.
- Connection to Theory: Insights should draw on the ToC, canvas or other principles of behaviour settings (e.g., deviation countering) to provide a rationale for how changes to the setting will lead to desired outcomes.

Insights may range from observational (e.g., "Gendered roles are critical in how tasks are divided within families") to theoretical (e.g., "If a core motive is embodied in the intervention, it should drive behaviour change"). A deeper level of insight often combines both, creating a path forward for intervention.

An example of insight: In Tanzania, men are typically viewed as providers of a home, which is seen as a status symbol. However, the toilet is not traditionally regarded as part of this status. By extending the role of "provider" to include the toilet facility, an intervention could leverage the status motive to encourage men to improve residential sanitation facilities (Aunger, Mwambuli & Cardosi 2023).

A useful structure for documenting insights is to outline the state of the world, the identified issue and a potential way forward. This approach ensures insights are not only descriptive but also prescriptive, providing a clear path to action.

4.3. Intervention development and integration

The third phase in SDD focuses on developing and integrating contextually grounded interventions that address the challenge identified in earlier phases. These interventions should align with the specific elements of the behaviour setting, ensuring they are embedded in and relevant to the context. Success in this phase is achieved when an intervention based on one or more insights from the earlier phases is embodied and effectively integrated into the relevant behaviour setting(s).

Interventions are embodied (i.e., given form) through one or more of the following:

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1. Agents: Changes involving agents within the setting, such as training, role creation or behaviour adjustment.
2. Props: Modifications to or the addition of objects or tools that agents interact with during the behaviour, such as redesigned products or interfaces.
3. Infrastructure: Adjustments to the broader physical or digital environment, such as layouts, systems or built spaces.
4. Communications: Messaging, prompts or educational materials that influence behaviour indirectly (e.g., through role modification or increased motivation). Note that communication often exists outside the immediate setting and is thus not an element of the setting but is still a common intervention form that is meant to help drive behaviour by changing how people think within the setting.

Selecting the appropriate form(s) of embodiment is crucial to ensure the intervention is aligned with the behaviour setting and maximises its impact. Ideally, the intervention should be as close to the point of action as possible, directly addressing the behaviour at the moment it occurs.

In many cases, a single intervention may not suffice. Instead, multiple interventions are combined to address different aspects of the behaviour setting, forming an overarching intervention strategy. For instance:

- Agents: Linking the role of parents to teaching children to wash their hands.
- Props: Introducing easy-to-use handwashing stations.
- Infrastructure: Ensuring consistent water supply.
- Communications: Developing campaigns to motivate participation and normalise desired behaviours.

These interventions, when implemented together, reinforce each other and create a more robust approach to driving sustained behavioural change.

There are at least six ways the setting elements, as outlined on the canvas (i.e., the boxes) and in Table 1, can be modified to develop interventions in the setting:

1. Adding: Introducing new elements to the setting that support the desired outcome.
2. Removing: Eliminating elements to support the desired outcome.
3. Strengthening: Enhancing existing elements to make them more effective at producing the outcome.
4. Weakening: Reducing the influence of elements that promote undesired outcomes.
5. Transforming: Changing the function or role of an element within the setting.
6. Swapping: Replacing one element with another to achieve better alignment with the setting objective.

This list can act as a set of prompts to support ideation, particularly when focusing on changing an existing setting.

The ToC is a valuable tool for guiding this phase, from ideation through prototyping and evaluation. By mapping out the causal links between the intervention, the behaviour setting and the desired outcomes, the ToC helps ensure the intervention is both intentional and effective. Specifically, it plays several critical roles:

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1. Strengthening the Causal Links: The ToC ensures that the design is grounded in a logical progression, where each element of the intervention contributes meaningfully to the desired behavioural change. This helps during ideation to identify which elements of the setting need to be adjusted and why.
2. Guiding Ideation: During ideation, the ToC provides a structured framework to generate ideas for interventions that align with the desired outcomes. By focusing on specific points in the causal chain, the team can brainstorm targeted ways to introduce change, ensuring that ideas are contextually relevant and likely to produce the desired effects.
3. Identifying and Mitigating Risks: By anticipating where the intervention might fail (e.g., a node in the ToC does not lead to the next as expected), the ToC helps the team proactively address risks and adjust the intervention to improve its effectiveness. For instance, the change in the environment may produce an expected brain response or feeling but that might lead to a behaviour not expected or desired. Thus, the team can ask how they might mitigate the workaround there.
4. Informing Prototyping: During prototyping, the ToC helps the team identify key elements of the setting to test and validate. It highlights potential weak points or risks in the intervention's design, such as causal links that might not function as expected, enabling the team to refine the intervention iteratively.
5. Planning Evaluation: The ToC provides a clear framework for identifying what to measure and why during evaluation. By linking metrics to the causal chain, it ensures the evaluation captures both the process and the outcomes of the intervention. For example:
   - Process Metrics: Monitoring whether the intervention is being implemented as designed.
   - Outcome Metrics: Assessing short- and long-term impacts.
6. Executing Evaluation: The ToC helps track progress along the causal chain during implementation. By identifying breakpoints where the intervention may not be achieving the intended effects, the ToC provides actionable insights for improving the design at the point where the issue occurs rather than discarding all work. It also helps evaluate sustainability, ensuring the intervention produces lasting change in the behaviour setting. This latter point is particularly informed by the self-regulating aspect of behaviour settings – what elements help to correct the behaviour when it varies from expectation or ideal.

Explicitly writing out the ToC for one or more interventions at even a conceptual stage is a useful process for facilitating the discussion, refinement and selection of an intervention.

Prototyping is essential for testing and refining interventions. During this phase, the team performs the following:

- Validates Assumptions: Ensures the intervention aligns with the setting and behaves as intended.
- Identifies Challenges: Observes how the intervention interacts with the setting and addresses unforeseen barriers.
- Refines the Design: Iterates on the intervention to improve its effectiveness and feasibility.

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Even simple prototyping can greatly reduce costly changes later in the intervention process.

The phase concludes when one or more insights have been successfully embodied and integrated into the behaviour setting through interventions that address the specific challenge. These interventions should be actionable, sustainable and deeply aligned with the setting, ensuring that they influence behaviour effectively and persistently. Important to note with the above are factors beyond the setting, such as institutional constraints or ongoing roles and costs associated with the maintenance of interventions. The team should also consider more fringe interactions that might highlight roles or behaviours that may not be adequately cared for in the original setting. In a grocery store checkout, many of the roles were transferred to the shopper and the technology to support self-checkout. However, employees have continued to be needed for some tasks such as verification of age checks, supporting when technological issues arise or removing anti-theft protection.

5. Case study: Tab Soap

This case study illustrates the use of the SDD approach. The challenge was to develop an intervention aimed at improving handwashing practices in low-income contexts via a change in hand-cleansing services. Handwashing with soap has been demonstrated to significantly reduce illness, school absenteeism and associated health issues (Wang *et al.* 2017; Tofail *et al.* 2018; Rutter *et al.* 2021; Wolf *et al.* 2022). The intervention described here and documented in more detail in Brial *et al.* (2023) highlights the use of SDD in product design but underscores the flexibility of the method for other interventions, such as training, infrastructure and communication design.

5.1. Background to the challenge

Despite its simplicity and proven benefits, handwashing with soap remains a persistent challenge to promote sustainably and at scale. Various public health projects have addressed this issue through education, infrastructure development and supply provision, with mixed results. In this project, SDD was applied to address the unique challenges faced by households in unplanned urban settlements in Tanzania, where there was a limited tradition of handwashing with soap, even after defecation. The objective was to design a behaviour setting-specific intervention that could sustainably increase handwashing with soap in these resource-constrained environments.

5.2. Scoping the challenge

The project began with refining a broad behavioural challenge: *increasing post-defecation handwashing with soap among low-income populations in Tanzania earning less than $5 per day*. This behavioural challenge was explicitly linked to a specific behaviour setting – the household post-defecation hygiene setting. The scope was further refined to focus on residential use rather than communal settings (e.g., schools or workplaces) and on developing an intervention directly tied to the soap itself rather than communication campaigns or environmental changes as a

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Figure 5. An example of a toilet setting explored in the Tab Soap case study with internal and external views and a focus on key props (e.g., buckets, soap.).

constraint of the brief due to the interest of the funder and collaborators who primarily have worked on public health campaigns rather than product innovation. Figure 5 provides an example of one of the toilet areas explored in the project.

Initial scoping workshops, involving stakeholders from government, businesses and public health sectors, helped frame the challenge within the behaviour setting context. The workshops identified key barriers, including the lack of soap products clearly positioned for handwashing in low-income households, and established constraints for the project, such as affordability, simplicity and cultural relevance.

By the end of this phase, the challenge was clearly articulated as follows: How can we develop an affordable and contextually appropriate soap product that enables post-defecation handwashing within the household post-defecation hygiene setting? This framing provided the foundation for the subsequent phases of the SDD process.

5.3. Understanding the behaviour setting

The second phase involved fieldwork and analysis to develop a detailed understanding of the behaviour setting and identify actionable insights. The BSC served as the central tool for mapping elements of the setting and structuring the research process. Alongside generating insights, the team also considered constraints (e.g., affordability, production feasibility) and requirements (e.g., cultural appropriateness, ease of use) common to product design and human-centred design work to ensure the intervention would be both practical and impactful.

The research process included the following:

1. Secondary Research: Reviewing existing studies on handwashing behaviour and public health challenges in low-income contexts.

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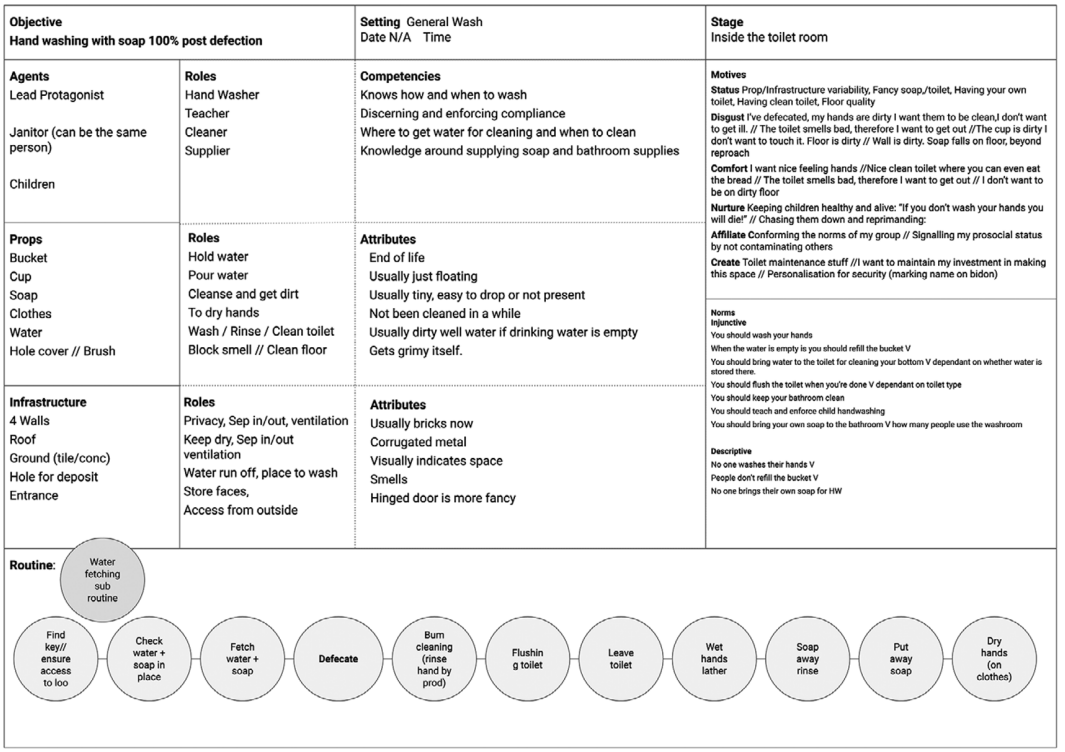

Figure 6. A completed BSC for handwashing with soap in Tanzania. This canvas represents a summary of fieldwork and thus is a pared-back version of the understanding developed. The letter "v" is used to indicate where some variability was seen.

2. Stakeholder Workshop: Engaging government, business and public health stakeholders to consolidate existing knowledge about the behaviour setting. This combined with the secondary research to produce the first draft of the canvas.
3. In-Context Interviews: Conducting interviews with households across several locations in Tanzania to understand soap use, handwashing routines and the social and physical dynamics of the setting. Since observing post-defecation handwashing directly was not possible for ethical and practical reasons, participants demonstrated their routines and described norms, motives and other elements of the behaviour. These activities iteratively developed the canvas further and were refined as data collection continued to understand all parts of the canvas.

Findings from these activities were synthesised into a completed Canvas (see Figure 6) to represent the archetypal setting. The Canvas captured details such as the following:

- Infrastructure: The roof's role in protecting soap from theft and weather while defining the physical boundaries of the toilet area.
- Routine: A clear sequence of actions following defecation, with variations noted across households.
- Norms and Motives: Cultural perceptions of soap and its uses within the household.

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The canvas also critically acted as a boundary object throughout the understanding phase by facilitating directed conversations between the immediate research team and the other relevant stakeholders (i.e., during the stakeholder workshop and later in the ideation part of the next phase of work). Specifically, it helped ensure that the setting was fully understood, grounded conversations about how various setting elements relate and clarified how and what various stakeholders were referring to when communicating about findings as many of these disciplines use the same terms in different ways.

Through this process, several insights were developed, each aligned with different aspects of the Canvas. One particularly critical insight related to a missing role in the props category, multipurpose soap, while commonly available, was not perceived as suitable for handwashing. Participants associated bar soap with tasks like laundry, bathing and dishwashing, while liquid soap was seen as an aspirational product used exclusively for handwashing but priced beyond their reach. This gap highlighted an opportunity to design a soap product specifically for handwashing that would fit within the mental models and price points of low-income households.

This insight, along with others such as a fundamental understanding of human motives that might be embedded in the design, was synthesised into a detailed design brief, providing a clear direction for the intervention phase. The brief emphasised the need for a product that communicates handwashing as its primary function while remaining affordable and easy to use in the household post-defecation hygiene setting, and particularly the stage which is the toilet area itself. This, along with constraints, requirements and other detailed notations from the previous phase, provided a basis for entering the intervention phase.

5.4. Intervention development and integration

The final phase focused on translating insights into actionable, contextually grounded interventions. Using the completed BSC as a guide, the team developed and refined the intervention through a structured process of ideation, prototyping and testing. Ideation relied on a number of insights developed during the previous phase, but also on fundamental truths relating to behaviour settings (see section on Core Tactics for Intervention Development). One intervention that emerged from this process was Tab Soap, a biodegradable swatch of fabric impregnated with soap, designed to promote handwashing in low-income households.

The original concept for the intervention leveraged curiosity as a motive which is understood here as gathering information about whether or not one has won a prize as revealed after the soap is used. This early idea (Figure 7) involved integrating the soap swatch with a reward system: each swatch contained a code that could be revealed when the soap was used, offering users a chance to win a prize, such as a mobile phone. This approach aimed to make handwashing both fun and incentivised. However, while participants expressed interest in the prize-based concept during early interviews and testing, several critical issues emerged:

1. Risk of Misuse: Some participants indicated they might rinse the swatch solely to reveal the code, bypassing its intended use for handwashing.

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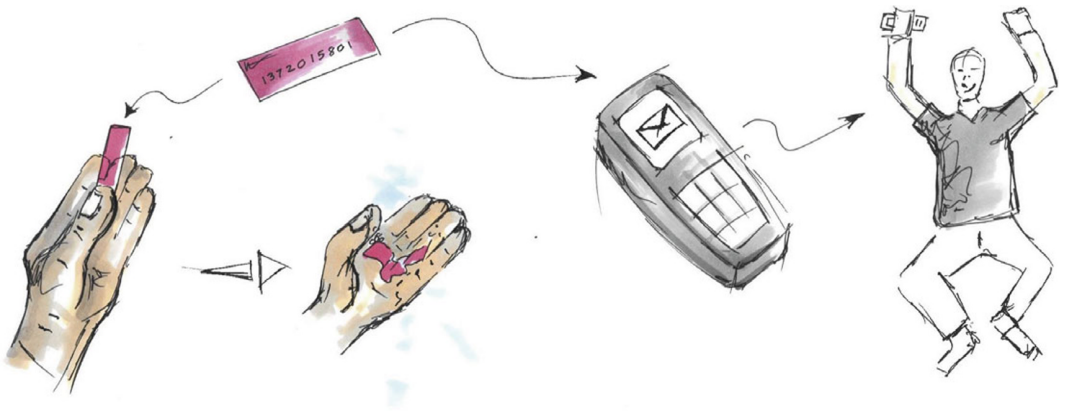

Figure 7. An early sketch of the soap and associated reward system.

2. Operational Complexity: Implementing the prize system posed significant logistical challenges, including distributing prizes and managing a redemption process, which would add considerable cost and complexity to the intervention.
3. Compelling Core Features: Feedback showed that participants were highly interested in the product's core attributes – its portability, single-use design and hygienic appeal – even without the prize mechanism. These factors became stronger motivators than the original curiosity-based approach.

Based on these findings, the team decided to focus on Tab Soap as a standalone product without the prize feature. This shift simplified the intervention and allowed resources to be concentrated on refining the core design to maximise its effectiveness and scalability. Figure 8 shows a user providing feedback on the concept.

The Tab Soap intervention was developed and refined through a series of iterative steps:

1. Ideation and Refinement:

Initial brainstorming sessions produced a range of concepts, including the prize-based soap swatch idea, as shown in Figures 7, 8 and 9a. These concepts were

Figure 8. An image of a user trialling and providing feedback during testing of the Tab Soap concept.

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a b

Figure 9. Prototypes used in fieldwork when getting feedback on concepts including the implementation of the prize concept (a) and understanding how the soap and casing might be placed in a toilet setting (b).

evaluated against the ToC, with refinements made to align them more closely with behavioural objectives and mitigate identified risks. This was done explicitly by writing out a ToC for each potential intervention along with possible risks and then refining the conceptual idea for the concept. For example, the risk of circumventing the need to wash one's hands to see the code that would be revealed on the soap led to new considerations on how this might be displayed to force agitation of the swatch for the reveal. This was also trialled through immediate feedback on the concept with potential users of the system to understand what resonated with them and why. Thus, the conceptual design of the concept was anchored in the ToC and how it would be demonstrated in the BSC such that features can better align with this thinking and provide a basis for evaluating prototypes.

2. Prototyping:

Prototypes of the soap tabs were created and tested with households over both short (1–2 hours) and longer (one week) durations. Feedback was used to refine the product, emphasising simplicity, affordability and effectiveness while amplifying attributes that resonated with users (e.g., portability, cleanliness). Attention was given to each phase of the ToC outlined at the conceptual stage and iteratively developed throughout testing to understand how it might best fit into the setting, for instance (Figure 9b), and how it might contribute to various motives and how the device might cue handwashing and thus reduce the cognitive need to remember to wash hands. Throughout this period, the BSC was used to ground conversations around how the concept was fitting more broadly. For instance, a critical part of this was the role of a new agent – the soap seller – which included replenishing the soap supply but critically was also a reminder about the desired behaviour.

3. Final Testing:

The final version of Tab Soap was tested in 12 households over two months. During this period, the ToC was iteratively updated to reflect user feedback and ensure alignment with the desired behavioural and health outcomes. Refinements focused on simplifying the product and reinforcing its intended use at the point of action.

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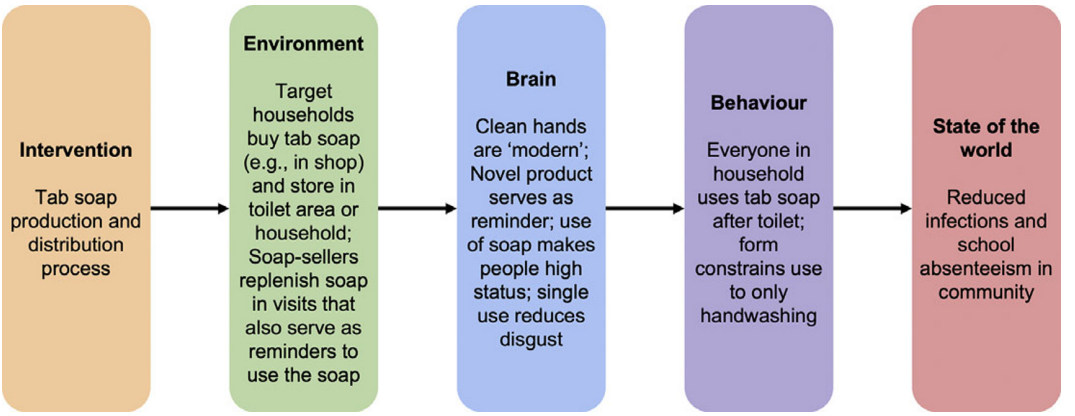

Figure 10. The ToC for Tab Soap's development and evaluation in Tanzania.

The Tab Soap intervention was designed to fit seamlessly within the household toilet setting, addressing barriers to handwashing identified during earlier phases. Its ToC (Figure 10) outlines the links between the intervention's features and subsequent impact. The intervention itself consists of a new prop in the form of a biodegradable, single-use fabric swatch impregnated with soap, specifically designed to discourage alternative uses (e.g., laundry or dishwashing) while remaining portable and easy to place at the point of use. Within the environment, Tab Soap is positioned for immediate accessibility where handwashing typically occurs. Its novel design acts as a visual reminder and reinforces handwashing with soap at the critical moment. It also motivates use by leveraging novelty and aspirational status and alleviates disgust through its single-use format. The environment also involves the periodic presence of the soap seller who replenishes the soap and acts to remind of and reinforce compliance with the intended behaviour of handwashing. Behaviourally, Tab Soap supports hand washing with a dedicated product that simplifies the action and ensures its intended purpose is clear. The ultimate impact is thought to be lower rates of illness and absenteeism based on the rationale gathered from other research.

The ToC also played a critical role in guiding the design, prototyping and testing of Tab Soap. During prototyping, the ToC highlighted specific areas of focus to ensure alignment with the desired behavioural outcomes. For example, it emphasised the importance of testing the placement of Tab Soap within the environment to verify its accessibility and visibility at the point of action. Additionally, the ToC helped prioritise attributes like portability, single-use design and novelty, which were amplified during refinement to maximise their behavioural impact. Risks identified during the earlier stages, such as potential misuse or low adoption, were evaluated during testing. For instance, the team tested whether the portability of Tab Soap allowed it to be conveniently stored and carried without disrupting its functionality, ensuring that its placement in the household aligned with user needs and behaviours.

By structuring prototyping decisions around the ToC and BSC, the team was able to iteratively refine the intervention, ensuring it effectively addressed barriers to handwashing and integrated seamlessly into the behaviour setting.

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5.5. Results and learnings

A small-scale, month-long trial showed strong adoption and consistent use of Tab Soap across all participating households, validating its effectiveness as an intervention in the specific context of the study. Participants highlighted the convenience of the product, its single-use design and its aspirational status as key drivers of adoption. Importantly, the intervention succeeded in addressing the barriers to handwashing identified during earlier phases, with the final design fully aligned with the behaviour setting and user needs.

However, the intervention's limitations must also be acknowledged. The study was a small-scale pilot conducted with a limited number of households, and while the results indicate potential for broader success, the question of repeat purchase remains unresolved. This reinforces the idea that SDD helps to focus on a specific setting but other factors are at play to make a more holistic offering. Specifically, it is unclear whether households would consistently purchase Tab Soap once external support is removed, particularly in resource-constrained contexts where competing priorities for limited funds may reduce demand over time. This is a critical factor for scaling the intervention sustainably and requires further investigation in larger studies.

Despite these limitations, the study provided valuable insights, including a refined ToC and situated intervention within the context of a BSC that offers a structured understanding of why and how the intervention works. This ToC provides a basis for assessing whether Tab Soap – or similar interventions – might succeed in other contexts. While the unique dynamics of a particular behaviour setting always need to be considered, the ToC offers a flexible framework for evaluating the alignment between the intervention's mechanisms and the characteristics of new settings. In particular, it helps understand which specific features of the intervention link to behavioural mechanisms. This includes the product itself (e.g., the way the design constrains performance to the desired agitation of soap rather than bathing or alternative uses, the novelty of the interaction leading to status), how it was situated in the context (e.g., the portability allowing placement, the tabs themselves being carried) and wider aspects of the intervention such as the soap seller's role in reinforcing desired behavioural performance.

In summary, the Tab Soap pilot demonstrated the utility of the SDD approach in designing contextually grounded interventions and highlighted the importance of iterative prototyping and user feedback. The insights gained from this process, particularly the ToC and the canvas, provide a foundation for refining and scaling the intervention while also informing its potential applicability in other settings. This complements a range of other studies looking at design for low-resource settings and contextual consideration more generally that have been referenced in the introduction.

SDD has been applied across a diverse range of contexts with variability in technological focus, team expertise and target output. Depending on the project, the process may focus solely on descriptive analysis or extend through to the development and testing of interventions. In all cases, the BSC serves as a critical tool for summarising findings and guiding decision-making. To support users in understanding the application of the canvas, a number of completed examples are provided in Appendix A. These include settings such as participation in a twitch stream (Figure A2) and engagement in a micro-venue at a conference meant to help people form connections (Figure A3). These additional examples offer

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practical insights into the flexibility and utility of the BSC in varied design challenges. The appendix also includes a blank canvas (Figure A1) that can be downloaded and used in behavioural design work.

6. Discussion

SDD offers several advantages over alternative approaches to behavioural design. First, it provides a structured framework for understanding behaviour within its environmental context, addressing the limitations of approaches that neglect the interplay between behaviour and setting. Without the behaviour setting concept, designers often face a conceptual fog, struggling to disentangle the myriad factors that influence behavioural choices and indeed how specific features of an intervention in the setting may work together to produce an outcome. The BSC, central to SDD, simplifies this complexity by providing a familiar and parsimonious categorisation of the critical elements shaping behaviour. This clarity enhances the intervention design process and ensures greater alignment between intervention strategies and the behavioural objectives. However, while this tool has proven useful, a focus should remain on the broader task of SDD which is to scope setting-type challenges and use the theory to further both understanding and intervention development. It is likely that certain applications will benefit from other behaviour setting tools (e.g., checklists (Aunger & Curtis 2016), setting identification methods (Lucas 2024), agent-based setting model (Aunger 2020b) and indeed future tool and method development. We thus advocate, consistent with other work (Gericke *et al.* 2020), not for a strict adherence to the BSC tool presented here but rather an evolving ecosystem of methods to support SDD's central goal of advancing a systematic approach to applying behaviour setting theory to design tasks. This includes the need to ensure good design practice is followed, such as appropriate engagement of end users through codesign and other participatory methods.

SDD's emphasis on theory-led framing addresses the tendency to prioritise internal validity over engagement with complex contextual factors (Deaton & Cartwright 2018) commonly seen in behaviour change work. Behaviour setting theory guides the framing of objectives, understanding causal relationships and developing interventions, while still accommodating the inherent complexity of time-and-space-dependent behaviours. By balancing theoretical rigour with practical design considerations, SDD enhances the flexibility of the design process, enabling nuanced understandings of contextual factors that influence outcomes. This theoretical foundation also fosters deeper learning about the boundaries of the theory and its practical applications, including how specific features link to desired outcomes.

Nielsen *et al.* (2021)) identified six dimensions of the behavioural problem space, which are often overlooked in existing behavioural design frameworks. These include cognition, ability, motivation, timing, social and physical context. SDD's context-driven nature inherently accounts for all six dimensions to varying degrees, enabling designers to "zoom out" for broader objective framing or "zoom in" to refine specific intervention features. This dual focus strengthens the link between the intervention (output) and its behavioural effect (outcome), a critical aspect of behavioural design (Khadilkar & Cash 2020). In particular, the SDD approach helps to make sense of how complex interventions that draw on multiple elements each contribute to the desired change in a setting.

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This focus on the tension between interactions and the built environment is closely related to affordance theory (Gibson 1977) which has been significantly contextualised within design by many authors (e.g., Maier & Fadel 2003; Norman 2013), including authors who link affordances to various behavioural challenges (Srivastava & Shu 2013; Baxter, Aurisicchio & Childs 2015; Mardon, Denegri-Knott & Molesworth 2023). Indeed, the SDD is thus closely linked to other approaches that include afforded interactions to influence behaviour. Notably, the Design with Intent Method (Lockton *et al.* 2010) and Installation Theory (Lahlou 2024) both explicitly reference Barker's original behaviour setting theory. Common to all of these approaches is a reckoning with the complexity of real-world interventions, particularly when including the use of theory, which can be a fundamentally difficult part of a design process but also the most valuable (Bason & Austin 2019). Thus, we suspect this approach will best be implemented by practitioners of design (or those working with practitioners) rather than those with a more cognitive approach (Rylander Eklund, Navarro Aguiar & Amacker 2022), given the more involved nature of embedding within and navigating the complexities inherent in complex intervention development within settings.

A key strength of the SDD approach lies in its ability to balance behavioural objectives with the practical constraints identified during the scoping phase. This is especially critical in fields like engineering design, where constraints such as infrastructure limitations or resource scarcity must be considered alongside user needs (Burleson *et al.* 2024). The BSC provides a structured method for identifying many of these constraints and aligning them with behavioural insights, enabling interventions that are both contextually appropriate and feasible. This approach ensures that interventions are grounded in the realities of the setting, avoiding the misalignment that often undermines long-term success (Wood & Mattson 2016).

By leveraging analogies between settings, SDD helps to facilitate cross-contextual insights. Recognising common elements across settings enables designers to transfer learnings, insights and interventions from one context to another. This approach supports generalisability, ensuring that similar interventions can be applied to analogous settings with predictable outcomes or indicating where adjustments may be required across settings to account for setting-specific differences.

The BSC serves as an effective boundary object (Star & Griesemer 1989), fostering collaboration among multidisciplinary teams by providing a common framework for discussion. This has been demonstrated in teams with representatives from different backgrounds where the same word is often used quite differently (e.g., mechanism, function, intervention). The canvas helped to anchor conversations, clarify these terms and better voice hypotheses or assumptions underlying the thinking both in the understanding of intervention within the setting. This is helped by visualising the canvas and the specific elements that need exploration. This use of the Canvas then acts as a support in a "what is" analysis in which teams can discuss the setting as it exists and underlying assumptions, as well as a "what-if" analysis in which teams explore potential impacts of design changes on various elements of the setting.

SDD does not replace existing design methodologies but complements them. For example, it integrates well with engineering design practices that prioritise constraints and requirements, institutional considerations typical of public health interventions and the insight generation processes central to human-centred

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design. Teams can augment the BSC with insights and constraints derived from these complementary approaches, creating a more comprehensive design process.

The use of the BSC is influenced by the composition of the design team, including their competencies, perspectives and areas of focus. For instance, teams with a strong engineering background may prioritise infrastructure and constraints, while those with behavioural science expertise may delve deeper into motives and norms. Importantly, it forces any team to consider the wider setting and not just the default they may focus on normally. Therefore, while the multidisciplinary nature of the tool allows it to adapt to the team's strengths, its effectiveness depends on fostering collaboration and cross-disciplinary dialogue. Ensuring all perspectives are represented and integrated is crucial to avoid blind spots in the design process. Such a perspective is consistent with qualitative analysis approaches (e.g., Braun & Clarke, 2021a) that recognise the role of the researcher (or designer) in making sense of data. Teams should acknowledge how their backgrounds both support and constrain their ability to construct meaning of their data throughout the SDD process.

SDD typically focuses on a single behaviour setting, but it is important to recognise that settings often exist within broader chains of behaviour settings. Understanding the settings that precede or follow the one in question can illuminate dependencies, transitions and additional factors that may influence behaviour. For example, the success of a handwashing intervention in a household post-defecation hygiene setting may rely on activities in adjacent settings, such as food preparation areas or childcare routines. Expanding the scope to include these interconnected settings can provide a more holistic understanding of the behavioural ecosystem.

The behaviour setting concept, once underexplored, is experiencing a resurgence across disciplines (McGann *et al.* 2024). This revival reflects its versatility and relevance, particularly in complex, context-dependent design challenges. SDD capitalises on this renewed interest by demonstrating how behaviour setting theory can act as a guiding framework for designing both physical and digital interventions. Critically, it is also a major step in making the theory more accessible for designers. While often focused on behaviour change, SDD's flexibility makes it equally suited to projects like introducing new digital tools, redesigning existing workflows or creating new cultural norms in virtual environments. Recent extensions of the theory to virtual environments (Aunger *et al.* 2024) highlight its applicability in digital settings, enabling robust specifications for products and services that address behavioural and contextual needs. Whether in a physical or digital context, behaviour settings provide a structured lens through which designers can predict and influence behaviour, fostering innovative solutions that are deeply integrated into their environment.

6.1. Limitations and future work

While SDD offers substantial benefits, it is not without limitations. One key challenge is that not all design problems occur within well-defined behaviour settings, and some contexts may lack the clarity or stability needed for effective application of the approach. Additionally, the process of understanding a behaviour setting can require extensive fieldwork and detailed evaluation, which can demand significant time and resources. While we believe such work is critical for understanding any complex intervention and it is highlighted as an important part

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of behavioural design practice (Cash *et al.* 2017, 2022), SDD may be less feasible for projects with tight timelines or limited budgets compared to alternative, less rigorous methods.

Future work could explore ways to refine and expand the tools used within the SDD framework, particularly the BSC. While the BSC has proven effective in many contexts, there may be cases where its structure cannot fully capture the complexity or fluidity of certain environments such as highly dynamic and evolving settings such as an unfolding disaster or protest. Developing alternative or complementary mapping tools – such as methods for digital ethnography, network analysis or tools tailored to dynamic or overlapping settings – could enhance the versatility of the approach. Similarly, research could investigate how to streamline the SDD process to reduce its resource intensity without compromising its effectiveness. The exploration of design principles or guidelines (Fu, Yang & Wood 2016) is one particularly useful exercise towards achieving this outcome. Future work may focus on design principles that focus on one or more of the following: theoretical principles that support ways BST might be actioned, principles to more easily ground contextual exploration to BST and principles that link specific features of embodied aspects of the environment (including interventions) to aspects of BST.

Another promising direction involves examining the scalability and sustainability of SDD interventions. Many projects, particularly in resource-constrained settings, require interventions that can be scaled across diverse contexts while maintaining their effectiveness. The refinement of scalability strategies, along with long-term studies assessing the sustainability of behaviour changes initiated through SDD, would significantly strengthen the method's impact. Additionally, future research should consider how ethical considerations can be systematically integrated into the SDD process, ensuring that interventions respect user agency, avoid manipulation and remain culturally sensitive.

Finally, further exploration is needed into the interplay between individual behaviour settings and broader chains of settings. Recognising and mapping interdependencies between adjacent settings – such as how a household post-defecation hygiene setting interacts with food preparation or childcare routines – can provide a more holistic understanding of the behavioural ecosystem. This perspective would allow designers to account for transitions and reliance between settings, identifying opportunities for more cohesive and impactful interventions.

In summary, while SDD is a robust and flexible framework for behavioural design, continued refinement of its tools, expansion of its theoretical foundations and systematic evaluation of its practical applications will be essential for broadening its utility and impact across diverse challenges and contexts.

7. Conclusions

The behaviour setting concept, on which SDD is founded, represents a robust framework for understanding and influencing behaviour. Rooted in one of the most comprehensive datasets of real-world behavioural observations ever collected – spanning a wide range of settings across two towns over an extended period (Barker 1968) – this concept offers an unparalleled foundation for a behavioural design process. By leveraging this theoretical strength, SDD

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provides a practical and highly predictive approach to mapping and intervening in behaviour.

At the core of SDD is the BSC, a tool designed to identify and map the minimal set of contextual factors driving behaviour. It enables teams to uncover opportunities for behaviour change through a structured, theory-driven process that spans from initial research to intervention testing. SDD supports a broad spectrum of design challenges, from refining and strengthening existing behaviour settings to creating entirely new settings. Its flexibility and depth ensure that it can be applied effectively across diverse contexts and project goals.

One of the key strengths of the BSC is its role as a boundary object, facilitating collaboration across multidisciplinary teams. By visualising collective knowledge, it helps align perspectives, anchor discussions in contextually rich details and generate actionable insights. The tool's structured approach ensures that conversations remain grounded in the "why" behind behaviour, fostering a shared understanding of opportunities for change.

While intentionally approachable for those new to behavioural design, the SDD process is equally valuable for experienced practitioners. It allows for iterative refinement and deep exploration of critical setting elements such as roles, motives, norms and routines. By integrating these elements into a unified framework, the tool balances clarity with nuance, enabling design teams to develop interventions that are both theoretically sound and contextually tailored. The canvas and ToC also allow teams to understand how several elements of an intervention work in concert to produce the desired change in the setting.

Ultimately, SDD represents a significant advancement in the field of behavioural design. It bridges the gap between theory and practice, offering a rigorous yet flexible methodology that is as effective in guiding novice teams as it is in supporting experienced practitioners seeking to explore behaviour in depth. By connecting rich contextual understanding with actionable design outputs, SDD offers a comprehensive pathway for designing interventions that have the potential to achieve meaningful and sustainable behaviour change. Beyond its strength in designing for behaviour change, SDD provides a robust framework for addressing broader design challenges, such as norm-shifting, product introduction or enhancing systems without altering behaviours.

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Competing interest

The authors declare none.

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Appendix A. Behaviour setting canvas resources

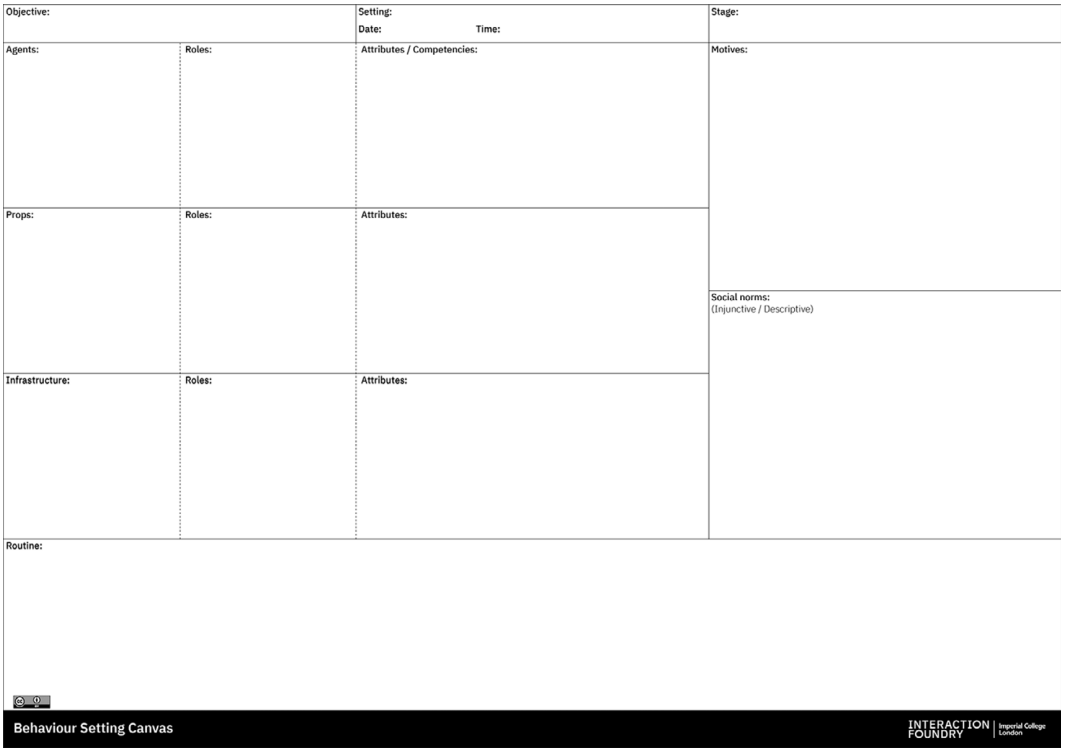

Figure A1. A blank BSC template. This visualises the key elements of a behaviour setting, including roles, norms, motives, props, infrastructure and the routine, providing a structured framework for documenting and analysing settings.

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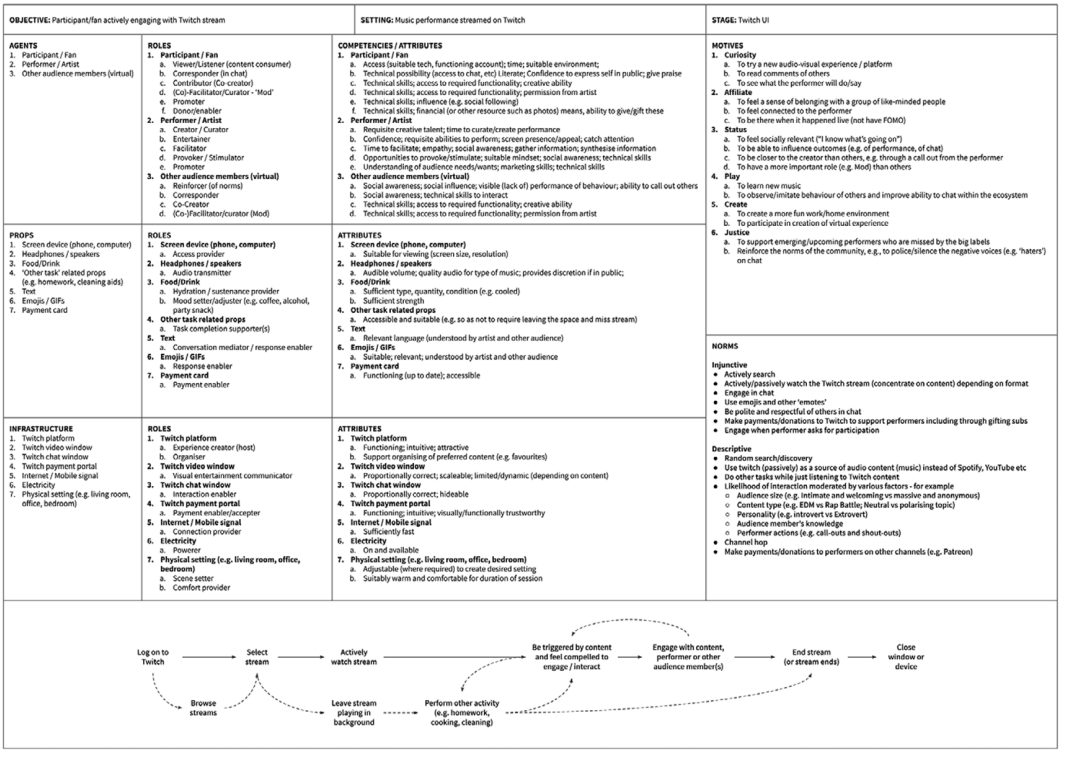

Figure A2. An example of a completed BSC for Twitch streaming engagement. The canvas outlines the critical elements influencing user participation, including norms of interaction in chat, the roles of streamers and moderators and the routines. This example also shows numerical coding between the Agents, Props and Infrastructure with associated roles and attributes.

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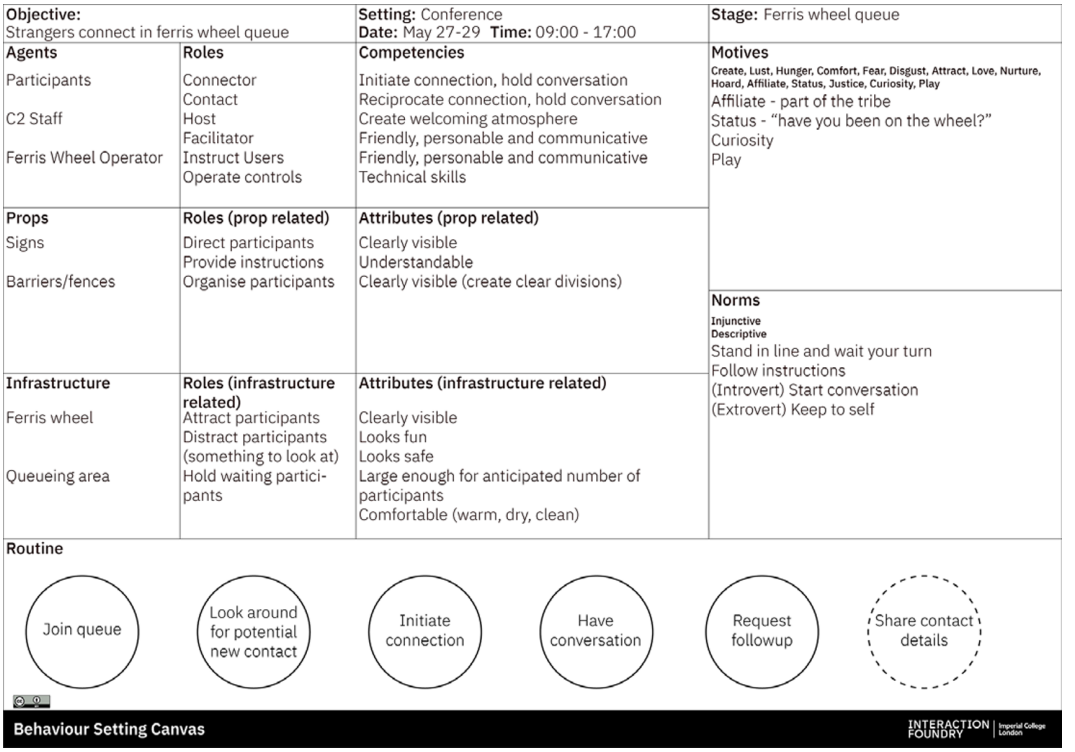

Figure A3. A completed BSC for facilitating connections between strangers at a micro-venue during a conference. This example highlights how roles, routines and environmental cues were designed to encourage interaction and foster meaningful connections within a temporary, event-specific setting.

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