

Designing solutions to challenging the status quo – a multi-stakeholder approach

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131

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Abstract

Purpose – This paper aims to offer a detailed explanation of the five-step creating collective solutions (CCS) process and a contrast from the collective intelligence (CI) methodology. The CCS process described in this paper is set within the very wicked problem of improving water quality flowing into the World Heritage Listed Great Barrier Reef.

Design/methodology/approach – Leveraging the strengths of CI and co-design methodologies, CCS offers a streamlined five-step process that can be implemented in a short time period (16 weeks).

Findings – A total of 220 barriers were identified by stakeholders selected in the project working group meeting. Stakeholders participating in the CCS workshop identified 12 key barriers, and they generated an action map and solutions that could be applied to improve water quality. The CCS process was delivered in a shorter time frame when compared to the CI method that it drew upon.

Research limitations/implications – This study aimed to extend beyond CI by adding the seven-step co-design process to a shortened CI process. Method details are provided to permit researchers interested in extending CI methodologies beyond problem definition and understanding towards solution generation. Future research is needed to more directly compare and/or contrast the two models of research within the same context. Ideally, this research should be conducted using a field trial to permit a direct evaluation of the two approaches to be undertaken.

Practical implications – Application of the CCS process identified 12 key barriers and solutions that could be implemented to improve water quality. Stakeholders agreed that the installation of stormwater management structures was one approach that could be applied to prevent chemicals from flowing into waterways. Other

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issues included the need for improved communication and confidence to monitor and evaluate progress. CCS delivers clear guidance on approaches that need to be implemented in the short, mid and long term to address very wicked problems.

Originality/value – CCS delivers a guided process that can be implemented in a short time frame to identify solutions that can be implemented to address very wicked problems.

Keywords Systems thinking, Stakeholders, Participatory approach, Creating collective solutions, Environmental change

Paper type Research paper

Introduction

Tackling very wicked problems such as environmental, health and social issues, requires shared responsibility and a portfolio of holistic and co-ordinated actions (Dobbs *et al.*, 2014; Seidell and Halberstadt, 2015) delivered by a variety of organisations (actors within a system). Very wicked problems are inherently difficult and unstructured, with multiple causes and perpetuating factors (Rittel and Webber, 1973).

At present, processes to engage with very wicked problems are lengthy, resulting in a lack of action. People, animals and our planet continue to suffer (e.g. poor health, sexual violence and abuse and poor water quality) while lengthy processes perpetuate. For example, governments undertake enquiries resulting in a series of recommendations, which are then converted into strategies. A recent Australian Government announcement is a perfect example. On 6 September 2024, the Australian Government announced an additional \$3.9bn from the Commonwealth will be provided for frontline legal assistance services for families escaping violence, which will begin flowing from 1 July 2025 (The Guardian, 2024). In the 40 weeks it will take for funding to commence, approximately 25 women, and 3 men will die as a result of violence from an intimate partner (Australian Institute of Health and Welfare, 2024). While funding may start to flow from 1st July 2025, it will still take agencies time to act, and each week lost to deploying funds on the front line leads to more deaths. More is needed to challenge our current prevailing institutional structures. Situated within an environmental context, this paper explains the creating collective solutions (CCS) methodology which was first deployed in the context of water quality within work aimed at protecting the World Heritage Listed Great Barrier Reef (GBR). Water quality is a long-standing very wicked problem where insufficient progress has occurred despite substantial investment more than five billion Australian dollars from 2014-2030 (Australian Government, 2024). Agricultural farming practices, including chemical run off into waterways, have been attributed as a main cause of poor water quality impacting the health of the reef (Pickering *et al.*, 2017).

Attempting to tackle very wicked problems, one must understand the problem (Rittel and Webber, 1973). Further, consensus is needed if holistic and synergistic action across a stakeholder array is to be realised. Multi-faceted, co-ordinated programmes of action featuring public policy, extension support, education, social marketing and other behavioural science approaches can be applied to achieve intended outcomes such as improvements in water quality (Shawky *et al.*, 2023). Gaining consensus from multiple stakeholders on the ideas and actions that need to be implemented can be overly complicated, causing delays and incurring financial burden. Approaches that can be readily and confidently applied in a timely, cost-effective fashion are needed to move research and implementation focus beyond understanding why progress is not being achieved to reaching a consensus on ideas, actions or tested solutions that need to be implemented to achieve the intended outcomes.

Examination of approaches aiming to combat very wicked problems, such as water quality, identifies a raft of problem-focused siloed efforts (Royle and Di Bella, 2017; Sewell *et al.*, 2017). Most interventions are individual focused (David *et al.*, 2022). For instance, Shawky and colleagues (2023) examined barriers and enablers for practice change in the sugarcane industry, assessing a range of projects focused on farming practice change. Rolfe and Harvey (2017) examined heterogeneity in practice adoption, and Small *et al.* (2016) investigated the adoption of good management practices. Examples such as these abound, highlighting the need for alternate research and engagement approaches that can be applied to avoid reactance from one stakeholder group unnecessarily targeted for change owing to prevailing power structures (e.g. farmers) (Brennan *et al.*, 2016).

The need for wider inclusion of stakeholders to overcome complex challenges is noted (Rundle-Thiele *et al.*, 2023; Truong *et al.*, 2018) and is a necessary precondition to achieving shared responsibility. However, current methodologies (e.g. targeted interventions created from research and expert-led approaches such as interviews or focus groups that do not authentically create solutions from the bottom up) do little to overcome prevailing power structures, and they rarely lead to the delivery of effective lasting solutions. Diverse viewpoints are needed that acknowledge the pressures placed on individuals who are targeted for change. As noted by McHugh *et al.* (2018), stakeholder participation in social marketing systems is rare but essential for effective buy-in and implementation of effective solutions. Such approaches to identify solutions to very wicked problems can be achieved using systems thinking drawing on participatory design methodologies.

Systems thinking and participatory design methodologies challenge biases and assumptions, disrupt causal pathways, uncover hidden dynamics, expose power relations and structures, and uncover many other social and systemic issues that are impeding progress (Domegan *et al.*, 2016). The integration of systems thinking and participatory design methodologies can deliver solutions that stakeholders agree will address very wicked problems (Rundle-Thiele *et al.*, 2023; Clayton *et al.*, 2022). Implementation of approaches that encourage people to consider wider societal, cultural and economic structures (Brennan *et al.*, 2016, p. 221) enhance understanding and assist actors to develop an appreciation for the dynamic settings they operate within.

Systems methodologies, such as collective intelligence (CI), offer facilitation and problem-solving approaches. For example, Fauville *et al.* (2018) identify 657 barriers aiming to provide policymakers with a roadmap of actions that can be taken, such as provision of free marine education learning resources. Action maps generated in CI identify hierarchies among identified barriers and an understanding of the structure of the interaction between identified barriers. While significant progress has been made in the development of systems methods, further enhancements drawing on the strengths of participatory design methods, such as co-design, are indicated to provide solutions that can be implemented in the short, medium and long term to more rapidly implement solutions in response to very wicked problems.

Therefore, the aim of this paper, which is set within the very wicked problem of improving water quality flowing into the World Heritage Listed GBR, is to explain how CCS extends to CI. The following research questions guide this study:

RQ1. How does CCS differ from collective intelligence?

RQ2. How can CCS identify actionable solutions for improving water quality?

The contributions of this paper are the first detailed methodological description of CCS – a five-step process that can be applied to identify consensus solutions through deliberative

recruitment of diverse stakeholders. CCS identifies hierarchies among identified barriers and the structure of their interaction and applies participatory design capable of overcoming resistance (Rundle-Thiele *et al.*, 2023; Clayton *et al.*, 2022). CCS offers a streamlined process featuring the addition of the seven-step co-design (Trischler *et al.*, 2019). Within the final stage of CCS, the action map is used by CCS workshop participants to generate ideas and actions. Finally, this paper which is set within the very wicked problem of improving water quality flowing into the world heritage listed GBR, details how the CCS process identified stakeholders to participate in the process. The paper reports barriers stakeholders felt impeded practice change, an action map and co-designed, consensus solutions.

Literature review

Systems thinking

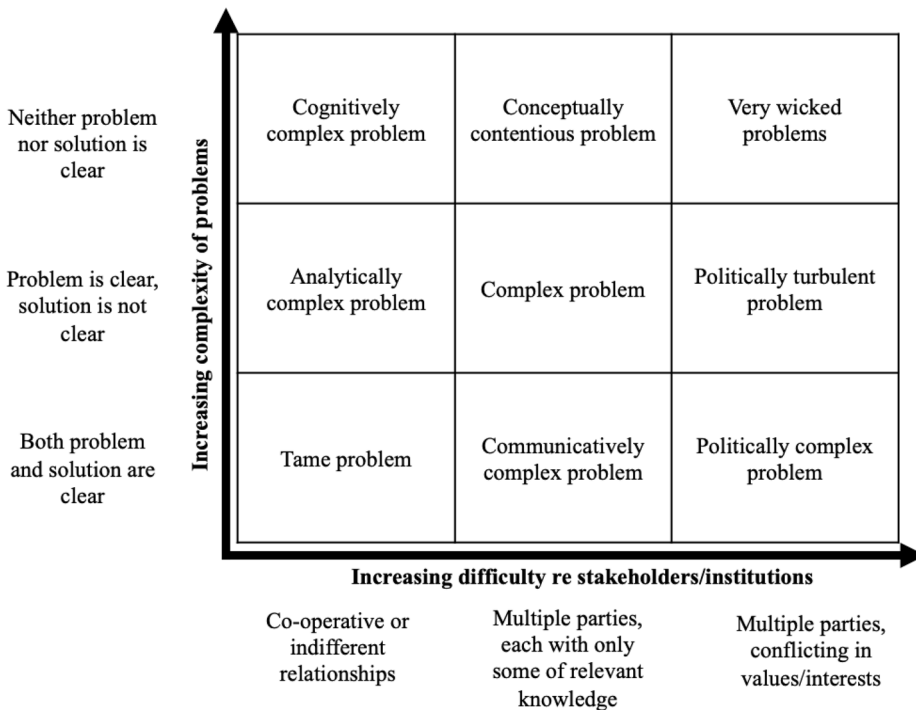
Systems thinking is increasing in popularity within social marketing (Truong *et al.*, 2018) in response to the need for holistic, long-term strategic and co-ordinated approaches (Rundle-Thiele *et al.*, 2023). Systems methods can be applied to tackle complex and wicked problems to achieve system-wide change (Flaherty *et al.*, 2020; Clayton *et al.*, 2022; Rundle-Thiele *et al.*, 2023). Recent reviews reflect an increased uptake of systems social marketing and macro-social marketing (Flaherty *et al.*, 2020; Truong *et al.*, 2018). Systems social marketing encompasses the use of a variety of theories that acknowledge the interconnected nature of wicked problems and point to the necessity for multi-level, multi-stakeholder involvement in trying to identify solutions. Behavioural ecology, institutional theory and MAS theory (mechanism, action, structure – Domegan and Layton, 2015), among others, have all been applied to the area, though systems theory is the most consistently applied (Domegan and Layton, 2015).

Evidence reviews suggest that systems social marketing focuses on evolutionary dynamics and a “whole system in the room” approach pursuing top-down, bottom-up iterative processes informed by experts and system stakeholders, while macro-social marketing approaches simultaneously pursue institutional dynamics and “inside the system” top-down processes led by experts (Truong *et al.*, 2018). It is important to note that governments rarely choose to adopt systemic approaches to behaviour change. Instead, funding is often offered to non-government organisations and behaviour change experts, such as social marketers, to undertake the work in a piecemeal fashion, which can limit success due to the prevailing dominant downstream approach (Seewak *et al.*, 2021). Community groups may also attempt systemic change (Hamby *et al.*, 2017; Huff *et al.*, 2017), and in these instances, groups are left having to identify how they can best use different strategies to understand the very wicked problem that they champion and how best to intervene with available capabilities and resources.

Water quality as a very wicked problem

The matrix proposed by Alford and Head (2017) outlines a starting point for identifying the nature of a problem. The two dimensions reflect the nature of the problem and its complexity (vertical), while the horizontal dimension is concerned with key stakeholders and their institutions who inherently impact the problem. See Figure 1 for an overview of different complex problems.

Improving water quality of the GBR is multifaceted and inherently complex in nature with multiple interdependencies including but not limited to run off from various sources, including agriculture, forestry, new developments and mining activities, which, in turn, also can cause erosion, litter, chemical runoff which all impact water quality. Focusing on farming practices, the stakeholders involved are many with conflicting. Fractured knowledge



Source: Ford and head (2017)

Figure 1. Alternative types of complex problems

and interest with reluctance to share knowledge and achieve understanding between actors are evident (Roemer *et al.*, 2021). Key systems stakeholders include international peak bodies, e.g. UNESCO, Federal, State and local governments with officials from different departments, industry such as chemical resellers, contractors, agronomists, extension provisions, conservation groups, research institutions, industry peak bodies and sugarcane representatives are examples of individuals and stakeholder groups with a vested interest. Owing to the complexities of very wicked problems and the array of stakeholders, the attainment of water quality is positioned as a *Very Wicked Problem* where the key problem itself may not be the focus or known and neither are the potential solutions (Alford and Head, 2017). Water quality cannot be attributed to farming practices alone, leaving the problem unclear, which contrasts with a “Complex problem” where the problem is clear, but the solution is not, and stakeholders are holding some relevant knowledge.

Systems approaches and methods

Systems approaches can include focusing on external facilitators of a very wicked problem; Kemper and Ballantine (2017) identify availability, physical structures, social structures and cultural and media messages as the informal and formal environmental facilitators. They explain that such facilitators can be replaced, eliminated or at least reduced by social marketing interventions at the down, mid and upstream levels. Roger Layton’s MAS theory

(Domegan and Layton, 2015) has also been applied to help understand very wicked problems. Kennedy (2016) posits that social marketing interventions take place within strategic action fields and can use social mechanisms to bring about change in very wicked problems facilitating institutional norms. While this literature has grown the theoretical understanding of systems and potential general points of intervention, practical methods that can be applied are not clearly elucidated. Solution-focused approaches capable of delivering solutions that multiple stakeholders agree can be confidently implemented are needed for a shared-path forward.

Kennedy (2017) suggests a methodology which first creates an understanding of the situation, then models the system, debating the model before acting. Action requires interventions at the downstream (individual), midstream (community/organisational) and upstream (regulatory/government) levels in tandem (Kennedy and Parsons, 2012). To do this, a bottom-up participatory approach involving key stakeholders at each level to define the problems and identify leverage points for change has previously been recommended (Domegan *et al.*, 2013). Collaboration through solution co-design is essential for both understanding and collecting information about the system, its drivers and its points for change but also for legitimating the suggested change when implementation occurs (Domegan *et al.*, 2017; Rundle-Thiele, 2022). Specifically, value co-discovery, co-design and co-delivery processes can deliver this; however, by themselves, they do not take into account systemic perpetuating factors (Domegan *et al.*, 2013). Such collaborative approaches need to be paired with methods to engage stakeholders and uncover the system structures and causes that drive a very wicked problem. Such causal mapping methods include fuzzy cognitive mapping, CI and systems dynamics modelling (Domegan *et al.*, 2017).

Domegan and colleagues (2017) compared fuzzy cognitive mapping, CI and systems dynamics modelling. They found that such methods were most appropriate for complex, dynamic, wicked problems as they assumed non-linear causality. The systems methodology CI was indicated as one approach that allowed multiple participants' thoughts to be captured to begin to provide insights into the dynamics and understanding of the leverage points for change and overcoming individual biases. To drive change, it becomes valuable as consensus agreement is needed.

Efforts to reduce the time-commitment for CI participants are evident (Danaher *et al.*, 2017; Hogan *et al.*, 2015). CI is time-consuming compared to other traditional modes of data collection, such as focus groups or interviews (McCauley *et al.*, 2019). The process of stakeholder identification can take months to complete, and the data collection period can take days, increasing administrative costs (Domegan *et al.*, 2016; Duane *et al.*, 2016). Recognising potential cost and time burdens associated with systems approaches and the need for widespread stakeholder inclusion and structured co-design methodology, this paper contrasts CCS with CI. The CCS methodology developed adheres to the strengths of CI (Domegan *et al.*, 2016; McCauley *et al.*, 2019), permitting a holistic understanding of the issues at hand to emerge from diverse stakeholder perspectives while mitigating its weaknesses. See Table 1 for a comparison of the CCS and CI processes.

Method and creating collective solutions results

This section outlines the CCS process, which was set within the very complex problem of improving water quality flowing into the World Heritage Listed GBR.

The CCS workshop's outcome was the design of implementation strategies to reduce agricultural run off to improve water quality featuring consensus from diverse stakeholders. Consistent with the CI process, CCS commenced with the initial formation of a project

Table 1. Comparison of the CCS and CI process

Process	Tasks	Outcome	Creating collective solutions	Stakeholders	Example	Phase 1	Process	Tasks
Step 1	Trigger question Identify trigger question with key project working group Review/refine/endorse trigger question	Endorsed trigger question to disseminate Identification of the full range of stakeholders to approach to seek response to the trigger question Stakeholder groups identified included: Natural resource management ($n = 8$) Agronomy organisations ($n = 5$) Extension service providers ($n = 4$) Peak sugarcane industry bodies ($n = 8$) Sugarcane growers (multiple segments) ($n = 3$) Chemical providers and resellers ($n = 5$) Contractors ($n = 3$) Research and development ($n = 6$) Various government departments, including agriculture and fisheries, Great Barrier Reef, National Environment Science Program, Bio-security and compliance ($n = 13$) Industry bodies ($n = 16$) Other growers within the catchment (multiple segments) ($n = 1$) Other growers outside catchment ($n = 1$) NGOs ($n = 7$) Media ($n = 3$)	Diverse representation of stakeholders Six key stakeholders: a policy maker, an environmental scientist, a sugarcane farmer, an agronomist, extension support and a behavioural change scientist	“What is preventing farmers from permanently reducing runoff from entering the catchment?”	Online idea generation	Developed in consultation with the working group		
Step 2	Stakeholder engagement Identify stakeholders using design thinking principles [brainwriting (van der Lugt, 2005)] Classify stakeholders using the power/interest matrix (Byson, 2004; Eden and Ackermann, 1996)	Selection of workshop stakeholders Stakeholder participation in the CCS process Barriers from all CCS workshop participants	Stakeholder participation in the CCS process Barriers from all CCS workshop participants		Idea categorisation	Phase 2	- Internal working group ($n = 5$) identified stakeholders - Classified as incumbents, challengers or regulating agencies	

(continued)

Table 1. Continued

Process	Tasks	Outcome	Stakeholders	Example	Process	Tasks
	Project team and working group members invite selected stakeholders to participate in the CCS workshop					
	Trigger question sent to all CCS workshop members					
	Other identified stakeholders are contacted to provide a response to the trigger question					
Step 3	The trigger question was distributed through a survey and hard copy to collect barrier responses from stakeholders	Additional barriers identified by other interested stakeholders	The trigger question was also distributed through an on-ground extension meeting with extension officers, agronomists and scientists present	A total of thirty-five stakeholders identified a total of 220 barriers in response to the trigger question	Barrier categorisation	- Email exchange
Step 4	Analysis of barriers	Barriers were analysed and categorised according to identified themes	Project team	A total of 219 barriers were analysed into nine themes. See Figure 3		- Internal working group. - Paired comparison, e.g. 15 categories
Step 5	CCS workshop	Stakeholders review barriers	The range of stakeholders included policymakers, agronomy services, extension service providers, chemical resellers, farmers, contractors, agricultural and bio-security practitioners	A total of 20 stakeholders participated in the half-day workshop	Structuring barriers	- Check barrier categories and classifications - Consensus voting (min 60%) to identify key barriers - Generation of structural action map - Call to action solutions in response to assigned categories (two)
	Voting round one and two using sticky dots	Stakeholders cast their votes to		The top 12 priority barriers were voted by the stakeholders. See Figure 5 for an example of votes		- Voting for solutions in terms of feasibility and impact
	Voting round three using software	Stakeholders vote through the interpretive structural modelling software		An action map is generated via consensus vote, which asked $n = 45$ relational questions. A total of 11 barriers feature in the map with one dropping off		
	Minimum 70% of consensus			Stakeholders were split into four smaller groups		
	Sevens-step co-design (Tischler <i>et al.</i> 2019) process applied to co-design solutions in response to the action map	Actionable solutions		A total of five actionable solutions were identified that aimed to reduce agricultural run off to improve water quality	Generating calls to action	

Source: Authors' own work

working group and the application of stakeholder identification approaches as outlined in McHugh *et al.* (2018). In line with CI a structuring process was used for key barriers identified during the CCS process. The CCS process follows (see Figure 2).

In this method, a stakeholder is defined as “any group or individual who can affect or is affected by the achievement of the organisation’s objectives” (Freeman, 1984, p. 46). CCS adopts CI’s action mapping technique and commences by identifying stakeholders.

Step 1: Trigger question

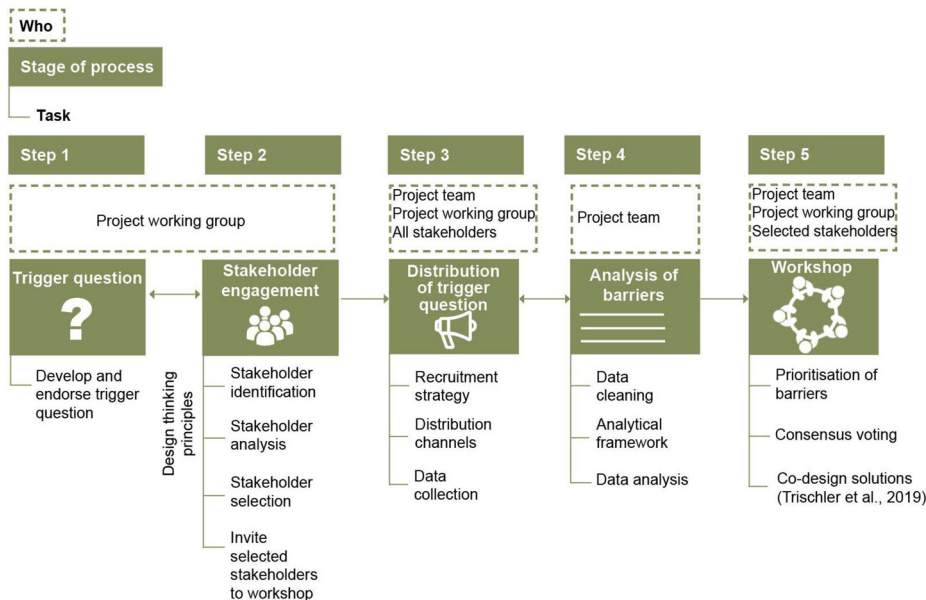
Starting with the intended outcome in mind, the CCS process ensures that the trigger question guiding the full process is focused on the intended outcome. The trigger question aims to capture diverse viewpoints, generate discussion and reflexivity among the diverse stakeholders responding to it.

The project working group (*discussed in Step 2*) identified and endorsed the trigger question for the study. The trigger question was:

Q1. What is preventing farmers from permanently reducing run off from entering the catchment?

Step 2: Stakeholder engagement

A project working group was formed with six key stakeholders representing different areas of the agricultural industry, including a policymaker, an environmental scientist, a sugarcane farmer, an agronomist, an extension support officer and a behavioural change scientist. To



Source: Authors’ own work

Figure 2. CCS process

enhance feasibility, design thinking principles (van der Lugt, 2005) were used to identify stakeholders for inclusion in the CCS process. The working group was tasked with three main agenda items. Firstly, the working group was asked to identify diverse stakeholders who were impacting or were impacted by run off and water quality. Brainwrite, from the design thinking school (van der Lugt, 2005), was used to generate stakeholders. Each project working group participant was asked to identify ten stakeholders, ensuring each stakeholder was individually named on a single post-it note. Next, the post-it notes were passed clockwise, and participants were invited to read the list provided to them. They were then asked to identify as many additional stakeholders as they could. Three rounds of Brainwrite were undertaken. Stakeholder individuals and organisations identified ranged from government officials from various government departments, chemical resellers, agronomists, extension provisions, conservation groups, contractors, research institutions, industry peak bodies, sugarcane representatives and more. More than 80 stakeholders were identified. Project working group participants undertook stakeholder analysis using the two-by-two power versus interest matrix (Bryson, 2004; Eden and Ackermann, 1998). Drawing on the matrix, the project working group then selected CCS workshop participants. Their decision ensured all stakeholder levels and types were represented evenly. Brainstorming techniques were used to identify any last stakeholders. Utilisation of design thinking principles within the project working group ensured that stakeholders could be rapidly identified, greatly reducing stakeholder identification processes previously described in the more time consumer stakeholder identification processes detailed in CI methodology.

Step 3: Distribution of trigger question

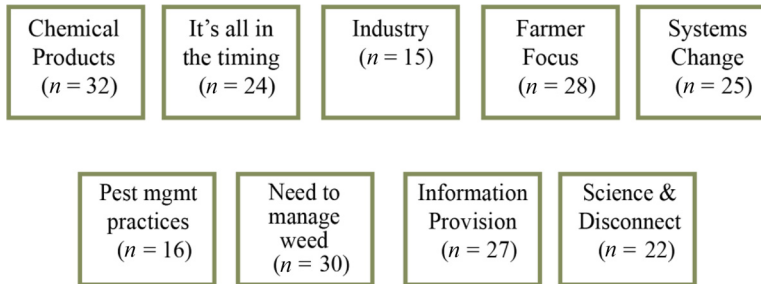
Following testing, the trigger question was distributed via email through a developed survey or in-person via hard copies. On-ground extension meetings with extension officers, agronomists and scientists present were also used to distribute the trigger question. All identified stakeholders were invited to respond to the trigger question, and they were asked to identify up to five barriers in response to the trigger question. A total of 35 stakeholders responded to the trigger question, identifying a total of 220 barriers.

Step 4: Analysis of barriers

Data was transcribed, combined and cleaned in MS Excel with an emphasis on spell-checking and sense-making. Barriers were removed if exact duplicates were present ($n = 1$), "Unwillingness to change, (B8)". Also, if a barrier had two ideas (double-barrelled), these were split into two unique barriers. For example, the barrier "Lack of confidence in efficacy of alternative products and practices that reduce quantities applied" became "Lack of confidence in efficacy of alternative products (B130)" and "Lack of confidence in practices that reduce quantities applied (B203)". Thematic analysis (Clarke *et al.*, 2015) was undertaken internally. Three project team members analysed the 220 barriers inductively into nine themes. See Figure 3 for an overview of the nine themes that emerged from the data, along with the number of barriers placed into the category.

Step 5: Workshop

According to the CI process, between 12 and 21 workshop participants are preferred (McHugh *et al.*, 2015) for the workshop. Twenty-seven stakeholders identified by the working group were invited to participate with some invitees designated as observers only if limits were exceeded. A total of 20 people participated in the half-day workshop held at a convenient and local location. Stakeholder groups included dissenting voices. The range of stakeholders included policymakers, agronomy services, extension service providers,



Source: Authors' own work

Figure 3. Themes with total number of barriers

chemical resellers, farmers, contractors, agricultural and bio-security practitioners. Media were present on the day, encouraging transparent reporting of the process.

Prioritisation of barriers

The workshop commenced with two voting rounds to determine, via a consensus process, the barriers to be structured within the action mapping process.

The first voting process involved identifying the four most important barriers within each theme for each CCS participant. Each participant was provided with a total of 36 yellow votes. Participants were asked to distribute up to four votes (yellow sticky dots) in each of the nine categories placing them on barriers considered most important to them (see [Figure 4](#)).

A second round of voting commenced, providing participants with nine blue votes and four red bonus votes. One blue vote was to be placed on the most important barrier in each category. CCS participants were given the freedom to place their red votes on any barrier they deemed to be the most important providing an opportunity to give further voice to a key issue in any category. The red votes could be placed on one barrier; they could be distributed across barriers or participants could decide not to use them (see [Figure 5](#), for example, of one category with votes distributed within the systems change theme).

Through a multi-stage voting process, stakeholders collectively reached consensus on the most important barriers within each theme.

Consensus voting

The 12 most voted for barriers were entered into the interpretive structural modelling (ISM) software ([McHugh et al., 2018](#); [Warfield and Cárdenas, 2002](#)). ISM software allows for the relational questions to be asked, specifically, *Does Barrier A significantly worsens Barrier B?* (see [Figure 6](#) for an example). The ISM software generates questions from the barriers until a structural map can be produced (see [[Warfield and Cárdenas, 2002](#); [Warfield, 1974](#)] for more info about the ISM software). A consensus of 70% among CCS participants had to be reached before the next voting round could commence.

Following completion of the 45 relational questions a structural map was produced illustrating aggravation paths. Out of the total 12 barriers entered, one barrier was not included in the map arising from the consensus voting "Inability to utilise stormwater management structures on farm to control losses from unpredictable rainfall - may take up land, layout of farm, costs to construct/maintain, cost of irrigation to re-use water (B169)". This indicates this barrier does not aggravate other barriers nor is it aggravated by any other



Source: Authors' own work

Figure 4. First voting process

barrier. Figure 7 illustrates the action map which summarises the relationships between the 11 remaining barriers that do aggravate each other.

Two rounds of consensus voting identified the 12 barriers perceived to be most important by the CCS workshop group. Within the final action map, all barriers are equal. Therefore, within the final action map, no single barrier can be perceived as more or less important than another of the 12 key barriers. For the 11 barriers that aggravate each other, the map is read from left to right, with barriers on the left having the most aggravation. In practice, this means that if the barriers on the left are addressed first, the ones to their right are easier to tackle. Barriers also emerged in clusters, which means they are heavily interrelated with one another, and barriers within a cluster aggravate each other significantly.

Co-designing solutions

Following the generation of the action map, CCS participants entered the seven-step co-design process (Trischler *et al.*, 2019). Sensitisation had occurred through the response to the trigger question, consensus voting and action mapping processes. CCS workshop participants were initially asked to identify two solutions that could be implemented in response to the action map. Each idea was written on one sticky note. Workshop participants were then invited to walk around the room to steal the best ideas from other participants. Next, groups of three to four people were formed with group membership pre-assigned, ensuring that small group diversity was maximised (e.g. one policymaker, one farmer and



Systems Change

Stakeholders with different agendas prevent actual change to occur (B210)	4 7 1	Hostility toward the farming sector from radicals making out that we are environmental vandals (B164)	2
Failure to get other people to understand as farmers we don't want pesticide losses from our farms (B162)	8 4 1	Hostility towards change of any form, especially spray laws (B191)	2
Lack of motivation in industry ... future outlook (B219)	7 2	Unwillingness from state authorities to change their business-as-usual approach (B214)	2
Hostility toward government regulation when other industries are not looked at being a problem to the Great Barrier Reef (B36)	7 1	Hostility towards regulations (B44)	1
Lack of trust that all involved have farmers' interests as a priority (B209)	10 4	Resistance to get the right message across we as farmers do care (B166)	1
Hostility towards proponents of the measure (e.g. governments) (B73)	4 1	Conflict of interests between stakeholders prevents initiatives from taking off (B216)	1
Inability to get across to the public that the farmers only use pesticides where a problem occurs and that we are regulated in a controlled environment (B165)	4 1	Holistic approach to water quality across all water courses (B14)	
Feelings of low morale across industry (B55)	5	Lack of government institutions to act as change ambassadors (B218)	
Red tape around maintaining farming business (B11)	3	Understand the water quality issue is a problem for you office bound types (B54)	
Reputation as good farmers (B97)	3	Inability to combine community effects (B120)	
An unwillingness for a systemic change from key stakeholders (B211)	3	Move work on all parties working together on water quality projects (B111)	
A top down approach hinders solutions to be carried out (B215)	3		
Hostility towards other people (who don't know how difficult it is to make money from cane) telling me what I should do (B79)	2		
Interference from green groups (B122)	2		

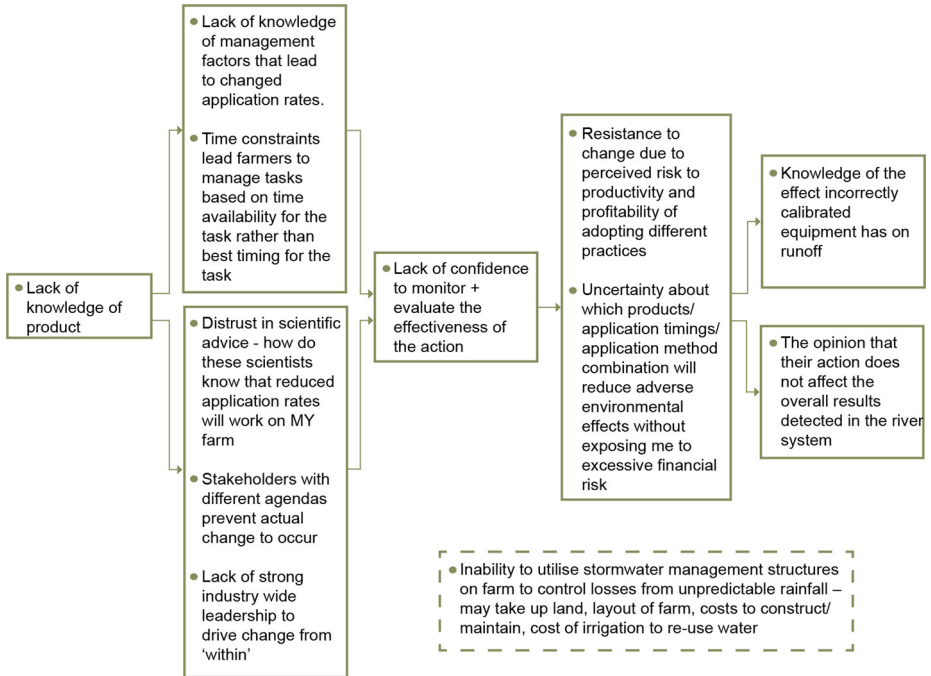
Source: Authors' own work

Figure 5. Distribution of votes "systems change" category



Source: Authors' own work

Figure 6. Example structural question



Source: Authors' own work

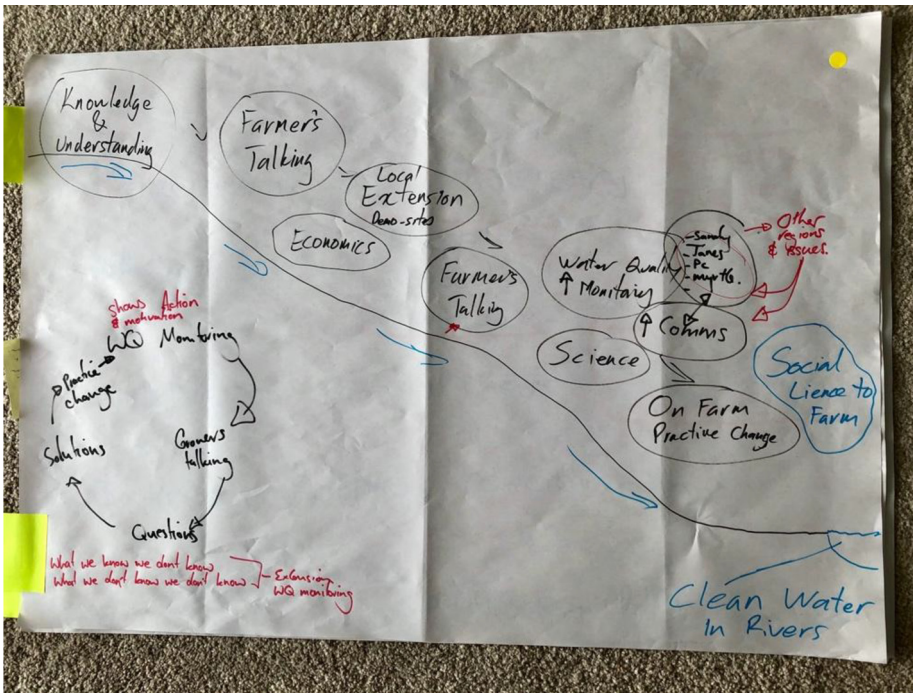
Figure 7. Structural action map

one agronomist), allowing for a diverse and robust debate. Participants were asked to generate short and long-term solutions in response to the action map.

Thematic analysis (Clarke *et al.*, 2015) of co-design data led to the identification of four actionable strategies that aimed to reduce agricultural run off to improve water quality, see Figure 8 for one design delivered within the co-design process. Participants pitched their actions to the remaining groups with the opportunity to further ask questions and provide feedback.

Co-design results

Farmer-led initiatives with industry support. Farmer-led initiatives were a key action emphasising collaboration across the system to facilitate joint ownership among the co-designed



Source: Authors' own work

Figure 8. Example of one group's co-design actions

solutions. Involving farmers in the early phases of programme planning, inception and governance was acknowledged as a mechanism to drive change. In addition, a participatory approach that builds trust in a landscape where stakeholders have failed to adequately consider the needs of other groups was highlighted. Programme pitfalls and improvements can be identified early on and actioned accordingly with end-user involvement. Solution designs emphasised industry-driven initiatives rather than government-driven initiatives.

Extend the evidence base and local knowledge. Another action identified was the need for a robust knowledge base built on localised evidence to inform farm management decisions. Designed solutions sought to combine expert knowledge with tailored support meeting the various stages of change facilitated by increased access to specialised support and information services. There was an appetite for knowledge advancement on chemicals, including new alternatives and improved understanding of chemical life span to assist decision-making. While recognition of peer-reviewed literature was noted, converting scientific rigour to digestible snapshots to increase learnings was a solution sought by CCS stakeholders.

Expert support services. Expert support services were another prevalent action dominating the solutions designed by CCS stakeholders. This action referred to the need for qualified and tailored support to assist farmers. Customised specialist support and

information services that address the requirements of the farmers in the various stages of change and innovation were advocated for. Competence and reliability were key features required for the advisors to provide consistent advice guiding farming practices and optimising change outcomes.

Enhanced communication effectiveness. Communication was also identified as an action receiving consensus across the co-design groups. Positive narratives supporting practice change outcomes were called for. The need for industry and broader stakeholder groups to exchange information aiming to improve industry morale and inform the public was a solution supported by all CCS stakeholders. Localised messaging and practical case studies were highlighted as means to increase confidence among farmers, supporting the notion that change can deliver desired outcomes without compromising profitability.

CCS created exceptional buy-in from the vast agricultural industry, and diverse stakeholders and dissenting voices demonstrated a willingness to be involved. Participants were armed with a unique opportunity to interact and engage with stakeholders from other organisations and levels. Most participants seized this opportunity and entered into very hard conversations that got to the heart of the issue. Very high emotional responses and key learnings from participants were observed and/or reported to the project team. The structural map can serve as a guide for policymakers to action on the challenges highlighted to improve water quality.

Discussion

The contributions of this paper are twofold. Firstly, this paper's contribution is a detailed description of the CCS method, which combines CI and co-design processes delivering a more cost-effective process. Extending on the CI system method, the CCS process was developed to bring diverse stakeholders together to agree on and support paths forward, starting with the intended outcome in mind. The CCS process is guided by an outcome-focused trigger question, ensuring all efforts are directed towards developing consensus. This study focused on understanding the barriers that have prevented improvements in water quality.

A solution-focused approach

In CCS, a consensus process is used to examine all barriers presented by stakeholders. Through a guided process, CCS stakeholders participating in workshops agree on key barriers, they generate an action map and they co-design solutions that could be implemented, delivering an agreed path forward. CCS extends upon Domegan *et al.*'s (2016) CI process [Table 1](#), overlaying the seven-step co-design process (Trischler *et al.*, 2019) to focus stakeholders on generating short, medium and long-term solutions that can be actioned in response to very wicked problems. During the CCS process, key design thinking tools were used within workshops, providing a process to overcome power imbalances. The process ensures that every voice is heard. Harnessing the collective ensures stakeholder mapping processes can be undertaken rapidly and are not expert or research led. Secondly, this paper identified factors that prevent water quality targets from being realised and actionable solutions with diverse stakeholders to improve water quality.

Achieving desired outcomes, such as improved water quality, is challenging and stakeholder interests often conflict with programme goals (Buyucek *et al.*, 2016), resulting in inevitable tension. The adoption of a "systems' mindset delivers a relational approach where conflicts and tensions are facilitated in a carefully managed process to improve the situation for all involved" (Domegan *et al.*, 2019, p. 137). This was evident in this project. The need for stormwater management structures which can capture and prevent water run off was

evident (the barrier that did not aggravate any other barriers), yet appetite to fund structural changes that would prevent run off was not high among stakeholders whose livelihoods depend on providing advice to farmers or setting policies on behalf of the GBR. Behavioural influences are constantly evolving and actors within a system can facilitate or impede changes. Delivering outcomes such as farming practice changes capable of improving water quality requires the involvement of all stakeholders to determine what is (or is not) working, when where and why. When a systems method is applied holistically, and balanced views of what really need to happen can emerge, power structures can be publicly challenged. The implementation of CCS in a context where outcomes were not being realised despite substantial investments enabled participating stakeholders to understand that all stakeholders need to change (e.g. individuals, organisations and funding bodies) to ensure outcomes can be achieved (Luca *et al.*, 2016).

This paper contributes a detailed description of the five-step CCS method, which offers a participatory methodology that removes power structures. Deliberate selection of diverse stakeholders, such as the industry selling chemicals, the farmers applying chemicals, the many advisors and funders tasked with changing growing practices, ensures clear and robust conversations are had. CCS identifies hierarchies among identified barriers and the structure of their interaction and applies co-design to identify the solutions that stakeholders agree can achieve intended outcomes (Rundle-Thiele *et al.*, 2023; Clayton *et al.*, 2022). CCS offers a streamlined process featuring the utilisation of participatory design tools such as the Trischler *et al.* (2019) seven-step co-design process and the Brainwrite process from the design thinking school to ensure all voices are heard and no one party can dominate discussions.

Gaining a collective understanding

Considerable investments have been directed towards very wicked problems. In many cases, health and social inequity gaps are not closing. New methodological approaches are needed to challenge current prevailing practices. Consultative stakeholder approaches should be prioritised when policies are developed, modified or changed (Hogan *et al.*, 2015). To ensure change, stakeholder consultation needs to move beyond listening to the same few voices. Approaches that actively seek people who are not normally involved in prevention efforts (e.g. chemical sellers and manufacturers) and others whose livelihoods are not dependent on maintaining the status quo can help to challenge conventions and thinking. More responsive policies can be developed when a diverse range of stakeholders are consulted and open and frank conversations are encouraged (Jozaei *et al.*, 2020), acknowledging the heterogeneity in populations and problems (Hummel *et al.*, 2013).

Bringing stakeholders physically together in a room to agree on actions can identify solutions in response to very wicked problems (Clayton *et al.*, 2022; Rundle-Thiele *et al.*, 2023). The five-step CCS process outlined in this study facilitated stakeholder buy-in, including from stakeholders who do not engage with water quality or farming on a day-to-day basis. By engaging stakeholders in open and transparent processes a collective understanding of the issues that were preventing improvements in water quality emerged.

Creating collective solutions methodology

Domegan *et al.* (2016) CI process features four steps, namely, barrier generation, barrier categorisation, structuring barriers (map) and generating options in response to assigned barriers. The strength of CI is the diversity of perspectives taken that can counteract individual biases. Key weaknesses of CI centres on time, costs to administer, resources and structured co-design solutions. CCS leverages from CI's strengths, which introduced

systems thinking, systems perspectives and ensures diverse system stakeholders come into a room together. CCS can be implemented in a half-day CCS workshop and two half days for project working group participants. Streamlined involvement of stakeholders in the CCS process lessens the participation burden to 25% of the time commitment described for CI, resulting in substantial cost savings, which is important from a practical standpoint.

CCS delivers an iterative process that can be implemented to address very wicked problems. In a guided process, stakeholders consider multi-layered influences, see the perspectives of other stakeholders and through a guided consensus process they build an appreciation of the need for actions from all actors across all levels. The CCS process is capable of effectively engaging a wide range of stakeholders, many of whom may not have previously thought about the wicked problem. The diversity of perspectives assists in overcoming biases and assumptions that are perpetuated in any expert or researcher-led process. CCS brings stakeholders together to acknowledge they are part of the problem. Organisations that operate within siloed structures create divides between stakeholders, and a lack of transparency fosters a system of distrust (O'Hara and Stagl, 2001). Processes, such as CCS, that bring together diverse stakeholders can span boundaries and assist in delivering the consensus needed for action to occur (Rundle-Thiele *et al.*, 2023).

Implications for research and practice

There is a lack of progress in response to very wicked problems such as violence and abuse, health inequalities for Indigenous people, biodiversity decline, climate change, water quality and more. While billions of dollars have been invested, we are yet to see gaps close. Alternative approaches are needed to challenge conventions. CCS is offered as one process that can be used to challenge stakeholders and disrupt the status quo. CCS can be implemented in as little as 16 weeks and can be used as a governance tool. Stakeholders involved can agree on key priorities for action and solution designs that can be implemented, monitored and evaluated.

Application of the CCS process identified 12 key barriers and solutions that could be implemented to improve water quality. Stakeholders agreed that the installation of stormwater management structures was one approach that could be applied to ensure chemicals could not flow into waterways. Other issues included the need for improved communication and confidence to monitor and evaluate progress. CCS delivers clear guidance on approaches that need to be implemented in the short, mid and long term to address very wicked problems. Profitability loss was identified as a key factor that could be used in education, extension and social advertising efforts to motivate farmers to prevent chemical run off.

Further research and limitations

The current study lays a solid foundation for future research to extend and build upon the CCS process and determine the capacity of this systems methodology to facilitate change. The broad directions for future research outlined below also reflect limitations identified in this inaugural application of CCS. This study aimed to extend beyond CI by adding the seven-step co-design process to a shortened CI process. Method details are provided to permit researchers interested in extending CI methodologies beyond problem definition and understanding towards solution generation. Future research is needed to more directly compare and/or contrast the two models of research within the same context. Ideally, this research should be conducted using a field trial to permit a direct evaluation of the two approaches to be undertaken.

In the present study, stakeholders were identified by the project working group under a facilitated discussion featuring key design thinking principles. This study and the issues identified are limited to views expressed by the stakeholders who participated in the outlined CCS process, and they reflect the stakeholder identification process applied in this study. Future research should assess alternative stakeholder identification processes that can be implemented by assessing the number and diversity of stakeholders identified along with a concurrent cost-benefit analysis to determine optimal stakeholder identification processes. The approach used in the present study may be criticised by some systems scholars for taking a reductionist standpoint, which may violate non-linear assumptions underpinning social marketing systems methods. Future research is needed to compare and contrast the application of CI and CCS to identify any undesired consequences of reductions made to the process.

[Domegan et al.'s \(2016\)](#) procedure in relation to identified barriers was adhered to in full in the current study, and additional means to minimise the CCS workshop participant burden can be tested in future CCS processes. The [Domegan et al. \(2016\)](#) process stated that barriers which were duplicated word for word were the only barriers to be removed prior to the workshop. In this study, the one barrier that was duplicated was “Unwillingness to change”. Barriers identified in varying word forms could be considered to have the same meaning. For example, two barriers identified stated:

- (1) “The opinion that their action does not effect the overall result of chemical detection in river system (B154)”.
- (2) “Failure to accept that their individual minor contribution to the losses matter (B145)”.

Consideration of duplicate handling is an important area for future research. Future research that implements processes to identify duplicates is recommended to reduce the number of barriers that would be put forward for CCS workshops as a further means to reduce participant burden. In the current study, a total of 219 barriers were identified by 35 stakeholders surveyed anonymously online and in person, and other than word-perfect duplicates, no barriers were removed for CCS working group consideration. Consideration of any potential impact for reducing the number of barriers put forward for CCS workshop participants is recommended to understand potential impacts on structural maps and the solutions generated. Finally, barriers representing two ideas in one were separated into two unique barriers. For example, “Lack of confidence in efficacy of alternative products and practices that reduce quantities applied” became “Lack of confidence in efficacy of alternative products (B130)” and “Lack of confidence in practices that reduce quantities applied (B203)” in the current study. Future research is needed to consider the impact of double-barrelled issues in structural mapping and solution generation.

Barrier themes were placed on the wall for consensus voting, and voting took place with the use of sticky dots, creating a potential for bias. While votes were distributed broadly, and in-person processes were chosen for transparency reasons, future research is recommended to understand if the order of barriers impacts voting and if an option to vote anonymously changes preferences. The CCS process implemented in the current study culminated at the completion of the workshop. To ascertain the capacity of CCS to deliver measurable change, stakeholder practices and processes identified within the CCS solutions need to be monitored and evaluated.

A final limitation in the present study may relate to the thematic analysis procedures applied, which required that barriers identified be placed into a maximum of ten themes. In contrast to [Domegan et al. \(2016\)](#), who undertook thematic analysis with the project working

group, thematic analysis was undertaken by the research team, who at the time had four years of experience working on farming practice change in agriculture to minimise project working group time commitments. Themes identified by the research team may not reflect themes that would be generated by a project working group, and this can be tested in future research. Future research can examine the impact of different theme limits or test whether any analysis is needed to organise barriers prior to implementing the CCS workshop.

While the fundamentals of the CCS workshop are based on consensus and rely on diverse stakeholders to identify their viewpoints, the relationship between stakeholders participating may limit in-person discussions occurring in the room. Online approaches that continue to permit anonymity may support more robust and open viewpoints to emerge.

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