Developing public transport messaging to provide crowding information during COVID-19: Application of the COM-B model and behaviour change wheel

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A B S T R A C T

The COVID-19 outbreak meant that using public transport was potentially unsafe for risk of catching and transmitting the virus. UK anxiety is high with lockdowns preventing a normal way of life for over a year. A lack of ability to travel freely causes numerous declines in quality of life including social isolation and poor physical and mental health. People need crowding information to choose safer travel options and subdue coronavirus. To provide effective guidance, it is essential to empirically formulate messaging to create clarity and trust which can be acted upon in confidence. Behaviour Change Techniques incorporating the Behaviour Change Wheel and COM-B model have been utilised in vast areas of public health intervention development and messaging. There is consensus that public transport information needs to be clearer and more accessible but BCTs have not been utilised in the development of public transport advice. This paper outlines the development of crowding messaging for public transport on a platform available to UK travellers. Barriers and facilitators were explored; related behaviours, intervention functions and behaviour change techniques were mapped. Specific message phrasing was developed utilising the mapped functions and advice from the literature. With the COVID-19 outbreak, having accessible and effective messaging for safely using public transport is a continuation of the work recently conducted examining the best ways to present public health information. It is important to be transparent when developing messaging and interventions accessible to the public and this work forms a basis for continued exploration and development in this area.

Introduction

Crowding is an major barrier to public transport usage, increasing discomfort and anxiety (Cox et al., 2006; Shrestha et al., 2017; Jenelius, 2019; Hu et al., 2020; Jenelius, 2020). Heightened anxiety over using public transport can lead to many abstaining (Mollenkopf et al., 2017), increasing social isolation and decreasing quality of life (Rosenkvist et al., 2009, The Mental Health Foundation, 2020). Research shows that travellers will amend their behaviour if they are given information about crowding, for instance they will use more of the platform to board or choose a quieter train (Preston et al., 2017; Pritchard 2017; Pritchard and Preston, 2017). The creation of accessible and persuasive messaging to inform travellers about crowding to support less crowded travel and alleviate anxiety is therefore paramount.

The COVID-19 outbreak caused an increase in anxiety and risk in using public transport (Flaherty and Nasir, 2020; Department for Transport, 2021) primarily because crowding in enclosed spaces leads to greater infection rates (Schraer, 2020; Musselwhite et al., 2021). As the pandemic began to take hold in the UK, anxiety and restrictions led to a large reduction in UK public transport usage (rail travel reduced to 4% during the second quarter of 2020) (Department for Transport, 2020). The inability to use public transport (and, for some, to travel at all) during the pandemic caused numerous individual and economic issues, including an increase in private car usage meaning a detriment to the environment (Bas and Sivaprasad, 2020; Department for Transport, 2021), an increase in mental health problems and social isolation (The Mental Health Foundation, 2020a; The Mental Health Foundation, 2020b; The Mental Health Foundation, 2020c) and job loss with a

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decline in the economy (Fros,t 2020).

Rail use has increased but has only reached approximately 50% of the numbers seen pre-pandemic, highlighting the continued reluctance to use rail services (Department for Transport, 2020; Department for Transport, 2021; Office of Rail and Road, 2021). A number of trains are running without meeting physical distancing guidelines and media reports of crowded vehicles have contributed to increased travel anxiety (Flaherty and Nasir, 2020; Stern, 2020). Reluctance to travel because of crowding seems likely to remain for some time with 65% ($n = 5299$) stating they would be very or fairly likely to avoid public transport if it was crowded after restrictions have eased (Department for Transport, 2021). While the literature is pervasive pertaining to the need of clear and accessible messaging to alleviate anxiety more generally, the need for trusted and reliable crowding information during and after the COVID-19 pandemic is considerable (Darsena et al., 2020). With rail usage increasing, the potential for crowded vehicles increases, meaning users of public transport need to be reassured and informed and given the tools to use safer alternatives, especially if COVID-19 case numbers rise once more.

Successful adherence to COVID-19 safety behaviours requires making plans and changes as easy as possible and overcoming barriers to behaving within safety guidelines (Michie et al., 2020a; Michie et al., 2020b). Recent work outlining expert advice for public health campaigns to maintain physical distancing summarised several key principles for message formulation: clear and specific guidance, promotion of collective identity (to act in the collective interest), social influence, social norms and moral behaviour (to act in a socially accepted way, as others do); acceptable, clear, calm messaging from a trusted source; information to help people to anticipate barriers and facilitators for planning to adhere to safety behaviours; the inclusion of reward, incentives and enablement (Bonell et al., 2020; Lunn et al., 2020; Ghio et al., 2021). Clear and persuasive guidance about crowding on services with options provided for alternative, quieter and safer routes, in good time, is vital (Darsena et al., 2020).

The Behaviour Change Wheel (BCW) and Behaviour Change Techniques (BCTs) incorporating the COM-B model (Michie et al., 2011; Michie et al., 2014; Hagger et al., 2020) have been used in numerous health and well-being programmes to amend specific patterns of behaviour in different populations. These include analogue and digital interventions for smoking cessation, post-cancer well-being, weight loss, increasing physical activity and decreasing unnecessary antibiotic usage (Fulton et al., 2016; Samdal et al., 2017; Krusche et al., 2019; Santillo et al., 2019). BCTs have been used to understand and amend travel behaviours, for instance, reducing car usage and increasing more active and eco-friendly modes of travel (Ogilvie et al., 2004; Arnott et al., 2014). BCTs are central to the creation of useful and accessible public health messaging (Epton et al., 2020; Ghio et al., 2021) but to our knowledge, have not been utilised for supporting safe and comfortable public transport usage. With the prominent use of BCTs to effect healthy behaviours in other areas, the use of BCTs to formulate messaging around crowding on public transport amidst the COVID-19 pandemic is appropriate.

This paper outlines the development of credible rail crowding messages using the Behaviour Change Wheel to provide information pertaining to crowding on trains and to influence safer and more comfortable UK transport behaviours. Intervention development processes were utilised to formulate public transport messaging for crowding and alternative routes. We used BCTs to inform the development of messages on the Zipabout platform (described below) to ensure acceptability to UK rail travellers. In line with best practice for intervention development, the Behaviour Change Wheel (Michie et al., 2011) was used to compile and analyse the messages.

Methods

Intervention development processes were used to evaluate the

messaging and in line with best practice, a logic model was developed to encapsulate user perspectives, see Fig. 2. The results of this development research are structured according to the step-wise approach of the Behaviour Change Wheel recommended for intervention development (Michie et al., 2011; Michie et al., 2014; Hagger et al., 2020). Three researchers (AK, LW and CM) coded the messages and Intervention Functions (IFs) to explore BCTs using the definitions in the BCT Taxonomy (BCTTv1 (Michie et al., 2014).

Zipabout Limited (www.zipabout.com) is a journey planner, information and communications provider to the UK rail and bus industry. The Zipabout platform sends alerts and messages with real-time crowding and disruption information through existing services such as Messenger and WhatsApp and existing transport operator apps and websites (e.g., National Rail Enquiries, ScotRail, LNER Assistant). Once a journey plan has been selected, Messenger or WhatsApp alerts the traveller that the journey plan has been saved and thereafter informs about any changes or disruption.

One method to increase the safety of passengers on public transport is to capture and provide data pertaining to the busyness of transport (i. e., by collating and providing reliable crowding data and by requesting crowding information after journey completion for validation, see (Krusche et al., in prep) such that travellers can act on compiled information in good time (Darsena et al., 2020; Krusche et al., in prep). Zipabout uses existing journey plans taken from several operators to extrapolate how busy different journeys will be. Part of the created messaging was utilised to contribute to the validation of this crowding data and asks if people are planning on taking their saved journeys closer to departure time, and thereafter, how crowded the train was on a scale of 1–4 with one option for people who did not take the train ("Pretty empty", "Fair", "Busy", "Very busy", "Didn't take the train"). During the pandemic, the messaging also functions as a form of public health messaging because it can provide crowding data allowing travellers to act on information and advice, providing options to reroute travellers to safer, quieter vehicles where possible.

The COM-B model and Behaviour Change Wheel step-by-step process, including exploration of the Theoretical Domains Framework (Yardley and Murray, 2004; Michie et al., 2011; Michie et al., 2014; Gee, 2017; Hagger et al., 2020) was applied to develop phrasing of travel and crowding information sent in messages. The intentions were to 1) phrase the messages to maximise data collection to validate existing crowding data and 2) to persuade people to adapt behaviour for safety and take less busy routes, where available. The Behaviour Change Wheel (Michie et al., 2011; Michie et al., 2014; Fulton et al., 2016; Ojo et al., 2019) uses a systematic approach to characterise parts of an intervention and link them to an analysis of targeted behaviour. It encompasses a 'behaviour system' with three conditions: capability, opportunity, and motivation (Michie et al., 2011; Cane et al., 2012; Michie et al., 2014) The COM-B system, see Fig. 1). The broad approach of the intervention in this case is to inform and incentivise (reciprocal exchange of knowledge to benefit others and the self and staying safe during the COVID-19 pandemic) and takes into account the nature of behaviour in travellers.

The COM-B conditions are defined thus (Michie et al., 2011; Michie et al., 2014):
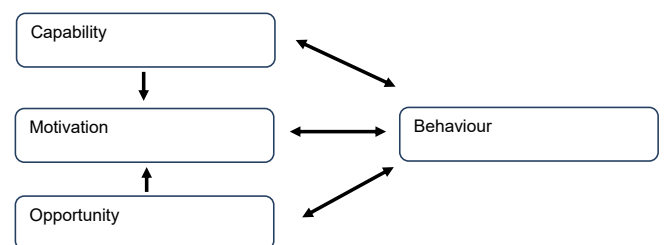

Fig. 1. The COM-B Model of Behaviour (Michie et al., 2014; Michie et al., 2011).

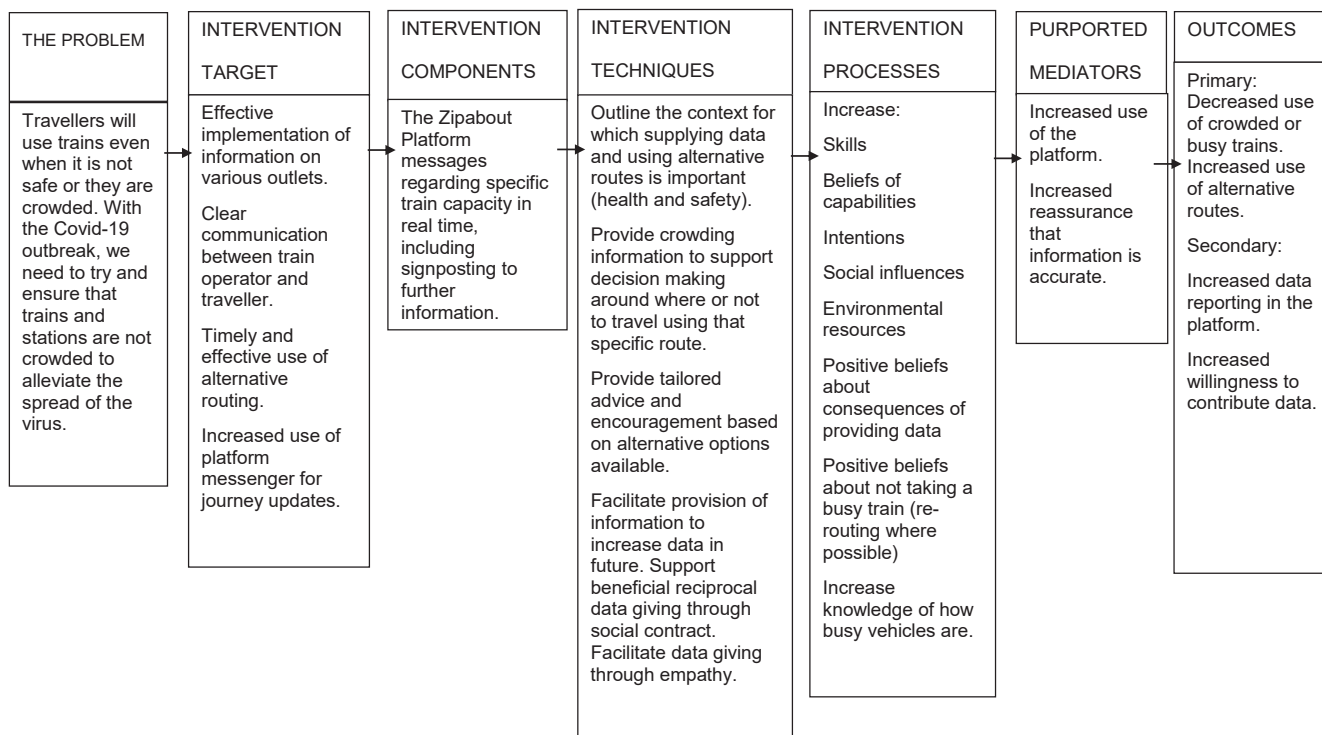| THE PROBLEM	INTERVENTION TARGET	INTERVENTION COMPONENTS	INTERVENTION TECHNIQUES	INTERVENTION PROCESSES	PURPORTED MEDIATORS	OUTCOMES
Travellers will use trains even when it is not safe or they are crowded. With the Covid-19 outbreak, we need to try and ensure that trains and stations are not crowded to alleviate the spread of the virus.	Effective implementation of information on various outlets. Clear communication between train operator and traveller. Timely and effective use of alternative routing. Increased use of platform messenger for journey updates.	The Zipabout Platform messages regarding specific train capacity in real time, including signposting to further information.	Outline the context for which supplying data and using alternative routes is important (health and safety). Provide crowding information to support decision making around where or not to travel using that specific route. Provide tailored advice and encouragement based on alternative options available. Facilitate provision of information to increase data in future. Support beneficial reciprocal data giving through social contract. Facilitate data giving through empathy.	Increase: Skills Beliefs of capabilities Intentions Social influences Environmental resources Positive beliefs about consequences of providing data Positive beliefs about not taking a busy train (re-routing where possible) Increase knowledge of how busy vehicles are.	Increased use of the platform. Increased reassurance that information is accurate.	Primary: Decreased use of crowded or busy trains. Increased use of alternative routes. Secondary: Increased data reporting in the platform. Increased willingness to contribute data.

Fig. 2. The Crowding Messages Logic Model.

- Capability is defined as the individual's psychological and physical capacity to engage in the activity concerned. It includes having the necessary knowledge and skills.
- Motivation is defined as all those brain processes that energize and direct behaviour. It includes habitual processes, emotional responding and analytical decision-making.
- Opportunity is defined as all the factors that lie outside the individual that make the behaviour possible or prompt it.

Results

Development steps are outlined below.

Step 1: Define the problem in behavioural terms

To prevent the spread of infection, train travel (and public transport travel more generally) needs to be conducted using physical distancing as much as possible. The problem under investigation is that people are potentially travelling on trains in the UK to their detriment when trains are busy, because of a lack of crowding information. COVID-19 can be spread easily in close proximity. For people to take quieter modes of transportation they need to be informed so that they can plan and make healthy choices. More generally, crowding is a major barrier to people taking public transport, causing much discomfort and anxiety. Information and support to alleviate this issue would be hugely beneficial to travellers, even after COVID-19 case numbers are no longer a concern.

Step 2: Select the target behaviour

People travel for various reasons: for social gatherings, to visit family and friends and to work, but do not have necessary knowledge regarding crowding on travel modes to make informed choices about which journey may be quieter to take. Even if this knowledge were available, the desire to travel on crowded transportation may still be present because travellers are a) unaware/ignorant of the danger, b) do not consider risk or discomfort when planning, c) decide that their reason

for travel outweighs the risk or d) feel that there is no choice.

Step 3: Specify the target behaviour

The target behaviours were 1) to increase engagement with the platform (provide data about their intentions to take a particular train and then whether or not they took that train) and 2) to take quieter routes where available, see Table 1.

Step 4: Identify what needs to change

While it is usually advisable to conduct qualitative analysis to explore the behaviours necessary to change, in this case, due to the rapid response needed for COVID-19, it was not feasible to conduct qualitative interviews, although a review was conducted. Additionally, the behaviour which needs to change is already understood (people need to keep away from others to prevent the spread of COVID-19 and need accessible crowding information to feel willing and better-able to travel), the intervention is limited, and the current social behaviours allying to the outbreak are novel, inconsistent and rapidly changing. Therefore, observable behaviour was evaluated by a team of transport experts (AK, DC, CM and AF) and three experienced behaviour change researchers (AK, LW and DG), see Table 2.

Table 1
An outline of target behaviour specification.

Target behaviour	1. Engage with the platform 2. Take quieter public transportation
Who needs to perform the behaviour?	All rail users (who use the Zipabout Platform)
What do they need to do differently to achieve the desired change?	Know which transportation is less crowded and be willing or persuaded to take it
When do they need to do it?	Before and during travel
Where do they need to do it?	Whenever they travel; when journey planning
How often do they need to do it?	Before each journey; during each journey
With whom do they need to do it?	Alone or with other travellers

Table 2
Behavioural Change Analysis.

Target Behaviour: Travellers to respond to demand messages and re-route where possible		
COM-B components	What needs to happen for the target behaviour to occur?	Is there a need for change?
Physical capability	Have the physical skills to read and respond to messages and act on travel information	**No change needed**. Users already able to use Messenger and travel if they use the platform
	Have the physical capability to change trains and physical distance	**Change needed** as if passengers are less physically able to take a different mode or maintain distance then need to find alternative route/s earlier to allow time for change
Psychological capability	Know how to respond to messages	**No change needed** as users are already able to use the Zipabout Platform/Messenger
	Knowledge of the correct crowding and re-routing information	**Change needed** as crowding/re-routing data is not currently available to inform and re-route travellers
Physical opportunity	Have the Zipabout Platform with routing and planning details available	**No change needed** as the Zipabout Platform would already be in use and provides information
Social opportunity	Know others and/or believe that there is no need to distance from others	**Change needed** as the spread of COVID-19 is directly linked to human-to-human contact
Reflective motivation	Believe taking a quieter vehicle will result in less COVID-19 risk but lacks information	**Change needed** as there is a lack of information regarding demand, crowding and alternative routes
	Hold beliefs that there are no alternative routes or that risk is minimal regardless	**Change needed** as alternative routes are not always known and risk may be increased if physical distancing is not adhered to
Automatic motivation	Have established travel routes and plans they are comfortable with	**Change needed** to increase confidence in alternative routes and acting on crowding information

Behavioural diagnosis of the relevant COM-B components: Psychological capability, social opportunity, reflective motivation and automatic motivation need to change for the target behaviour.

The review provided a number of potential functions required to effect safe behaviour change during COVID-19 (e.g., (Bonell et al., 2020; Epton et al., 2020; Ghio et al., 2020; Ghio et al., 2021). The behaviours which need to be changed through the messaging are generally habitual (i.e., travel patterns) in an unfamiliar, crisis situation. Reflection must be given to cost-benefit consideration by travellers because travel may be essential and the associated cost of spreading or contracting an illness may be processed as absent, minimal, or justifiable to complete the travel for the benefit (e.g., must go to work or buy food). The messages need to convey a sense of value: the data we are supplying and requesting (i.e., did you travel today?) is helpful for everyone to remain healthy and should convey a sense of communal identity. The importance of re-routing where possible to change habitual and familiar travel patterns will be provided.

Steps 5 and 6: Identify intervention functions and policy categories

Identification of intervention functions were explored by mapping behaviours to the Theoretical Domains Framework (TDF; Cane et al., 2012) to identify barriers and facilitators to acting on the messages received. Supplementary Table 1 outlines barriers and facilitators established as potentially important by three researchers (AK, LW and CM) to re-route travellers safely and to encourage them to reply to messages, categorised using the COM-B. Barriers and facilitators have

been mapped to TDFs and then examined for potential BCTs and intervention functions to suppress barriers and enhance facilitators. Intervention functions (IFs) were considered using the APEASE criteria (affordability, practicability, effectiveness/cost-effectiveness, acceptability, side-effects/safety, equity) to identify which are most appropriate within the context of public transport messaging and therefore most likely to be implemented and have an impact (see Table 3). It is important to note that Supplementary Table 1 includes all potential barriers and facilitators established and so not all BCTs and IFs have been utilised in message formulation as not all were necessary. The most relevant intervention functions for this development work were deemed to be: Enablement, Education, Persuasion and Environmental Restructuring. The TDF domains were used to expand on the COM-B components identified in the behavioural analysis in Table 2. Intervention functions have also been mapped onto a logic model (see Fig. 2).

Policy categories were considered using the APEASE criteria to support the delivery of the intervention functions identified (see Table 4). Four policy categories were identified as relevant to this intervention; Communication/marketing, Guidelines, Environmental/social planning, and Service provision.

Step 7: Identify behaviour change techniques

Supplementary Table 1 shows the BCTs identified as potentially important for messages to effect behaviour change, taking barriers and facilitators into account: to amend a journey plan if a less crowded mode is available and to respond to message check-ins and check-outs to help with data validation. In total, 48 potentially relevant BCTs were identified for public transport messaging. The most promising (the most coded) BCTs and their behaviour change associations in context are described below.

Goal setting (1.1 behaviour, 1.3 outcome), Problem solving (1.2) and Action planning (1.4). The platform is primarily used to plan journeys and find information about journeys (facilities, busyness, weather, etc.). They are inherently used for goal setting, problem solving and action planning. Prompts and alerts also increase knowledge and help with planning, for instance, showing alternative journeys when the

Table 3
Intervention functions meeting the APEASE criteria.

Intervention Function	Definitions	Does the intervention function meet the APEASE criteria?
Education	Increasing knowledge or understanding	Yes
Persuasion	Using communication to induce positive or negative feelings or stimulate action	Yes
Incentivisation	Creating expectation of reward	Yes
Coercion	Creating expectation of punishment or cost	Yes
Training	Imparting skills	Yes
Restriction	Using rules to reduce the opportunity to engage in the target behaviour (or to increase the target behaviour by reducing the opportunity to engage in competing behaviours)	Yes
Environ. Restructuring	Changing the physical or social context	Yes
Modelling	Providing an example for people to aspire to or imitate	Yes
Enablement	Increasing means/reducing barriers to increase capability (beyond education and training) or opportunity (beyond environmental restructuring)	Yes

APEASE: Affordability, Practicability, Effectiveness/cost-effectiveness, Acceptability, Side-effects/safety, Equity.

Table 4
Behaviour Change Wheel policy categories.

Policy Category	Definitions	Does the policy category meet the APEASE criteria?
Communication/ marketing	Using print, electronic, telephonic or broadcast media	Yes
Guidelines	Creating documents that recommend or mandate practice. This includes all changes to service provision	Yes, currently there are no guidelines on messages for public transport
Fiscal measures	Using the tax system to reduce or increase the financial cost	No, not practicable in this context
Regulation	Establishing rules or principles of behaviour or practice	Yes
Legislation	Making or changing laws	No, not practicable in this context
Environmental/ social planning	Designing and/or controlling the physical or social environment	Yes, will enable travelers to plan journeys effectively and safely
Service provision	Delivering a service	Yes

APEASE: Affordability, Practicability, Effectiveness/cost-effectiveness, Acceptability, Side-effects/safety, Equity.

planned journey is crowded. Should a traveller wish to take a less busy journey, the platform and messaging shows how to do this; should a traveller not consider crowding, the platform messages prompt thoughts about safer alternatives. Messages to travellers can be used to encourage goal setting of positive safety behaviours or prompt to identify barriers, for example, reminders about taking a face covering.

Information about health consequences (5.1). Messages can present information about crowding without being prompted, wording such as 'keep safe' and 'less busy' should elicit thinking around COVID-19 risk and safety, thus supporting the thinking and planning necessary to amend plans to take a quieter mode of transportation, e.g., there may not be a physically distanced seat or standing room.

Information about social and environmental consequences (5.3). Messages can provide information about what behaviour should be taken to 'help everyone'. By supporting the thinking around social context and social contracts, behaviour to keep distanced and therefore keep infection rates lower should help people to action changes in plans where needed.

Prompts/cues (7.1). Messages are opted into so that travellers can receive journey and disruption information. To support travellers in making safer choices, messages are sent to prompt/remind passengers to wear a face covering at opportune times and to inform about the busyness of a planned journey. The messages can be sent at opportune times to effect safer behaviours, for instance when making journey plans or two hours before departure to allow for time to make necessary adjustments. Prompts are also utilised to ask for check-in data (i.e., whether or not the travellers is still intending to take the planned journey nearer the time of departure) and check-out data (i.e., whether or not the travellers then took the journey and how crowded it was).

Conserving mental resources (11.3) Crowding information is presented without being requested should a journey look likely to be busy. The option to find alternatives is presented alongside this information. The traveller does not need to find this information if they are concerned and it also acts as a reminder for those who had forgotten that it is important to take quieter modes where available.

When designing the messages, general rules reviewed from the literature around public health messaging and successful behaviour change methodology was addressed in parallel with the BCTs and IFs identified with barriers and facilitators to successfully effect changes in behaviour.

Step 8: Mode of delivery

The mode of delivery chosen for messages is Facebook Messenger as

this has been successful in previous populations and is already in use for the platform. WhatsApp and SMS messaging have started to be developed to provide more options for information access. Messages delivered through Messenger were considered to meet the APEASE criteria; other modes of delivery are not relevant (e.g., face-to-face), affordable, practicable (e.g., phone, print media) or effective (e.g., outdoor media, broadcast media). Messages are sent from credible sources (i.e., National Rail, LNER, ScotRail) and include reiterated guidance from the Department for Transport (and Government) supporting that they are being sent from credible sources, something repeatedly deemed as important for successful behaviour change.

Message development using BCT framework

A review of current literature, exploration of barriers, facilitators, intervention functions and potential behaviour change techniques to impact the response rates to messages and the use of public transport were conducted. Messages were developed with these findings, see Figs. 3 and 4. Consideration was given to the phrasing and information included in each of the messages to elicit responses to check-in and check-out messages and to provide information and guidance for travellers to take quieter modes of transportation, see Fig. 3 for example messages developed.

Informal, accessible language is used to allow for easier and quicker understanding, particularly important if rushing while travelling. The lexicon matches that found at stations and on trains so is familiar within context, making it more easily processed. For an explanation of each message phrasing development including the relevant intervention function, see Table 5. Certain words and phrases were removed through development. 'Reduce crowding' was removed from the messages as it implied there may be an issue with public transport being crowded, thus allowing for the potential to increase anxiety, possibly resulting in undesired behaviour change – to cancel the journey. Initially, messages began with 'we think your journey may be crowded'; this was removed as it alluded to some form of data collection which is not being done and may provoke anxiety using the service. No personal or identifiable data is gathered. The messages were amended to include 'please tell us whether or not you are still taking this journey so that we can help keep travel less busy and safer for everyone'. 'Please tell us' was included to reinforce the reciprocal exchange of information to imply that the information supplied is used to help all travellers, to elicit a greater number of responses to check-in and check-out messages, see Figs. 3 & 4.

Discussion

This paper outlines the use of the behaviour change wheel and related techniques to inform public transport messaging for behaviour change for two actions: 1) to prompt travellers to respond to check-in and check-out messages to validate crowding information and 2) to prompt safer behaviour and decrease anxiety and discomfort by persuading travellers to re-route to less crowded modes of transportation where available.

Crowding is a main barrier to many taking public transport (Jenelius, 2019; Jenelius, 2020) resulting in isolation and lower quality of life (The Mental Health Foundation, 2020), however, travellers are willing to change behaviour when given accessible information (Preston et al., 2017; Pritchard, 2017; Pritchard and Preston, 2017). Change can be implemented by ensuring motivation when an individual has the capability and opportunity to do so (Michie et al., 2014) and sharing information allows for increasing both the individual's capability and the opportunity. Sharing crowding information through real-time update messages is beneficial to individuals and society as a whole. It allows for better-informed travel plans, reducing crowding and transmission of coronavirus and keeping travellers more comfortable even after COVID-19 has abated. The need for accessible and clear guidance for public transport messaging has been highlighted in the literature discussing the
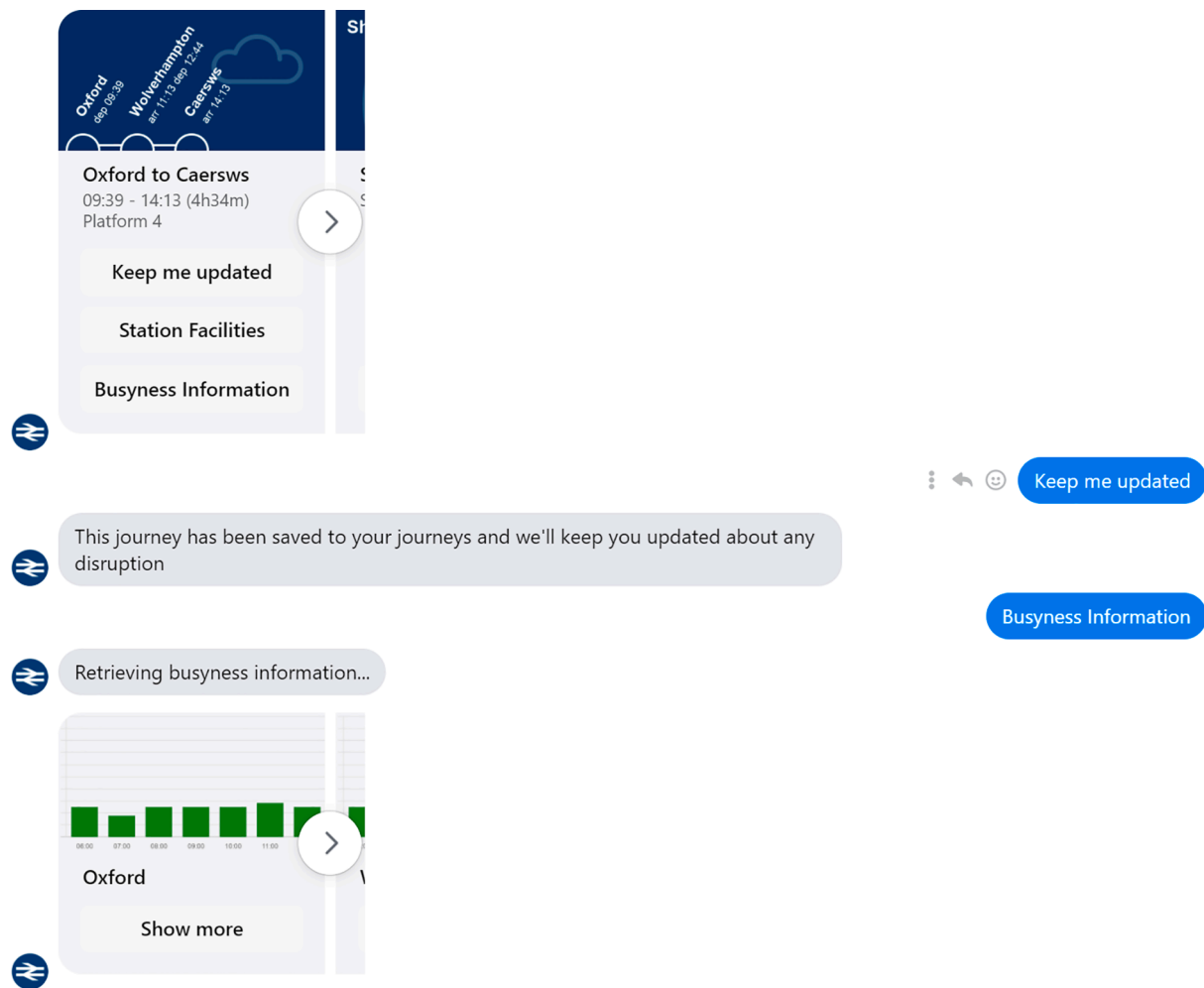
Fig. 3. Message flow output after development showing crowding information.

reasons why people are averse to travel (Cheng, 2010; Oliveira et al., 2019; The Williams Rail Review, 2019; The Williams Rail Review, 2019). It is clear that without effective guidance travellers may continue to use crowded transportation, making public transport ever more rebarbative (Rosenkvist et al., 2009; Mollenkopf et al., 2017).

Behaviour Change Techniques have, thus far, not been implemented in the development of public transport messaging, to our knowledge. Previous literature is clear that messages need to be clear, simple and accessible to allow people to travel, particularly those who were more anxious for various reasons (Suen et al., 1998; Brons and Rietveld, 2009; Grimaldi et al., 2016; Department for Transport, 2017; Department for Transport (DfT), 2018). The fact that public transport can now be a potential location for the spread of COVID-19 (Flaherty and Nasir, 2020) means that it is prudent to use expert guidance regarding public health messaging and techniques which take the traveller into account, including barrier and facilitators to safer behaviour. Essentially, public transport messaging around crowding and prompts for what to do can act as public health messages because of the risks of using public transport as well as acting as a support for travel more generally.

Behaviour Change Techniques and the associated development techniques are central to the creation of clear, accessible and effective messages and recent work has outlined the need for their use during a public health crisis (Epton et al., 2020; Michie et al., 2020; Michie et al., 2020b; Ghio et al., 2021). Leading experts have reviewed and collated data for use during and after the COVID-19 outbreak to keep people behaving in safe ways. The main advice for messaging is that phrases need to be clear and specific (Muller et al., 2017) and those which are,

are more likely to elicit a response (Arguello et al., 2006), to include the promotion of collective identity (and the social benefits/contract), be clear, calm and from a trusted, credible source and to include information to navigate anticipated behaviours to safe behaviour (Lunn et al., 2020; Michie et al., 2020; Michie et al., 2020b). Our message formulation has taken this advice into account and developed messaging using behaviour change methodology: of particular importance is the need to create a sense of a collective for mutual and reciprocal benefit, something which has been done by including this clearly in the messages through the inclusion of 'help us to help everyone' style wording.

The need for accessible information has perhaps not been so important as it appears to be now with the outbreak of COVID-19. Anxiety over the risk of infection on public transport is rife (Schraer, 2020; Department for Transport, 2021) with many proposing that it is likely to last for some time after lockdown and restrictions are lifted (Department for Transport, 2021). There are numerous benefits to informing travellers about crowding on their journeys: should crowding be present when restrictions are lifted, travellers will need data to make informed choices and those anxious about travelling will have the necessary tools and guidance to do so with those who are not cognisant of the potential health risks of crowding informed and prompted to act safely.

Strengths and limitations

The development of public transport messaging to provide crowding information during COVID-19 has utilised the structured approach of
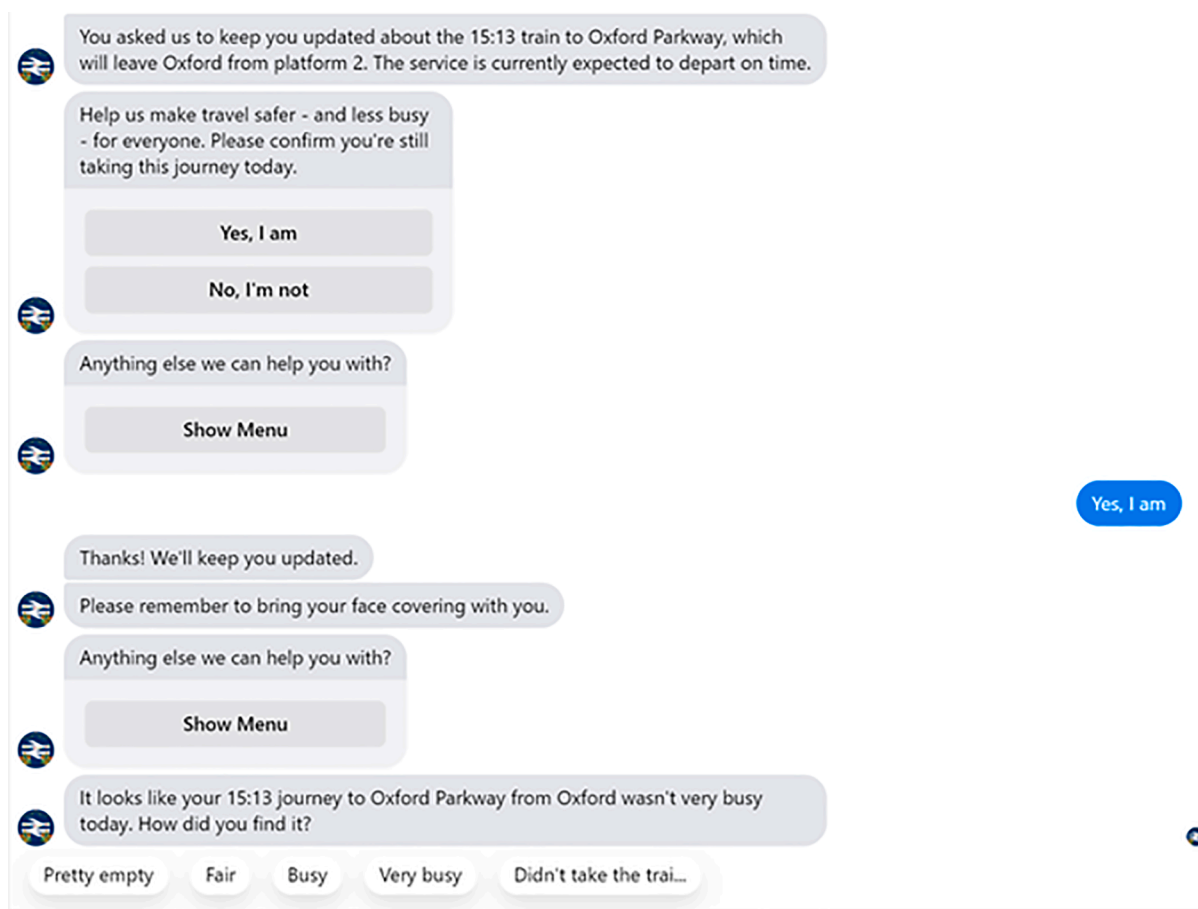
Fig. 4. Message example requesting information after journey.

the COM-B model and Behaviour Change Wheel. The COM-B model provides a systematic, thorough framework for addressing behaviour change including the review of potential intervention functions and policy categories. However, due to the rapid nature of the message development and lack of qualitative research (due to time constraints) to inform barriers and facilitators, some may have been omitted. Nevertheless, using the comprehensive COM-B framework and BCT taxonomy reduces the risk that vital and important behaviours have not been addressed.

Evidence-based development of messages for public transport use is an innovative approach. The development work outlined here may establish the approach for future message providers. Further research is needed on the impact, acceptance, and effectiveness of the messages on behaviour change.

Though COVID-19 restrictions on travel, physical distancing and mask-wearing have eased, there may be other viruses in the future where this knowledge and public health messaging will again be useful to influence behaviour change more quickly. There may also be other situations where we need to 'control' crowding, such as for concerts or sporting events, where there will be a greater number of travellers at a particular time.

This messaging can be used to inform and persuade travellers more generally to take less busy modes and to prevent crowding at stations and on trains, resulting in smoother operations and less dwell time (Pritchard and Preston, 2017). Acting upon these messages can help to make journeys more comfortable, particularly those who are less able or elderly, by allowing them to be able to find a seat or travel more comfortably (Mackett, 2017; Musselwhite et al., 2021).

Finally, there is potential for the messages to be adapted for use in other modes of public transport, such as buses, ferries, and air travel.

Conclusion

The Behaviour Change Wheel was developed within behavioural psychology and this is the first time it has been applied to public transportation and crowding. Utilising behavioural science should be more frequent in the field of public transport messaging and this research acts as a precursor for future development in transportation guidance to improve transparency and availability of information. Providing effective guidance supports travellers to make informed decisions and adhere to government policy and safety guidelines, which will support leisure travel and commuting. It is important to be transparent when developing messages which have a potentially profound effect on public health and dissemination of this work should form the basis for future providers to utilise a similar approach and to take the views of users into account. Given that crowding dissuades so many from using public transport, providing clear, accessible and persuasive messaging with crowding information should be advantageous to travellers who are anxious of using crowded modes. Operators who build upon this work may realistically see greater uptake if they provide travellers the tools to make better informed travel plans. There is potential for these messages to be adapted for other modes of public transport to inform travellers of delays, crowding and disruption. Further research is needed on the impact, acceptance, and effectiveness of the messages on behaviour change.

Financial disclosure

Table 5
Specific messaging phrase development.

Message text	Explanation	Intervention functions
"Help us make travel safer and less busy for everyone"	Outlines the need and incentivises the exchange of information, i.e., it will help everyone including the individualMakes it clear why we are sending the message: enforces social contract by using the same phrasing	Incentivisation, Enablement, Environmental restructuring, Persuasion.
"Help us"	Phrasing is clear that we are requesting something and incurs empathy (help us to help you/everyone)	Incentivisation, Enablement, Persuasion.
"Make travel safer"	"Make travel safer" acts as an alert. The use of the word "safer": safety is something which everyone can relate to and feels is important, thereby more likely to elicit a response based on emotion constructs (positive, understood effect of staying safe vs negative effect of not)	Incentivisation, Enablement, Persuasion.
"Less busy"	Include 'less busy' because people who do not care about physical distancing will likely not want to be crowded anyway. Busyness is an important issue for travellers and is a main factor in travel anxiety so lowering this is also important to most people	Enablement, Environmental restructuring, Persuasion.
"Everyone"	Inclusion of "everyone" implies it is mutually beneficial and begins a social exchange contract. The individual will feel responsible for the community ("help us", "everyone") and want to change their behaviour. Incites Social Influence of aiding the community by changing behaviour	Incentivisation, Enablement, Persuasion.
"It looks like your journey today may be a bit busier than normal"	"May" suggests the crowding level of the train selected could change.	Enablement
"This journey has been saved and we'll let you know if anything changes"	Finishes and supports social contract, exchange of information. Emphasises what we are doing: keeping people updated. Saves having to come back each time to re-plan a regular journey	Enablement
"If we don't hear from you, we'll stop your regular alerts"	Acts as a reminder to reply to journey updates. Makes it clear that a response is necessary to continue to receive updates.	Environmental restructuring

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CRediT authorship contribution statement

Adele Krusche: Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Project administration, Resources, Software, Supervision, Validation, Visualization, Writing – original draft, Writing – review & editing. **Laura Wilde:** Data curation, Formal analysis, Investigation, Methodology, Writing – original draft, Writing – review & editing. **Daniela Ghio:** Formal analysis, Writing – review & editing. **Cora Morrissey:** Data curation, Formal analysis, Project administration, Writing – review & editing. **Alex Froom:** Conceptualization, Resources, Software, Writing – review & editing. **Daniel Chick:** Conceptualization, Data curation, Project administration, Resources, Software, Supervision, Validation, Visualization, Writing – review & editing.

Declaration of Competing Interest

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests: Adele Krusche and Laura Wilde are employees of Zipabout Limited; Daniel Chick is a co-director. Other co-authors declare no conflicts of interest. Zipabout authors were supported wholly by Zipabout Limited wages.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.trip.2022.100564.

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