Ministry of Housing, Communities & Local Government

Domestic Abuse Duty Evaluation: Agent-based modelling (ABM) report

ABM Version 4

July 2025

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List of acronyms and abbreviations

ABM – agent-based model
LA – local authority
MHCLG – Ministry of Housing, Local Government and Communities
QCA – Qualitative Comparative Analysis
UKLHS – UK Longitudinal Household Survey
ToC – Theory of Change

Executive Summary

Introduction

This report has been produced to provide additional information on the agent-based modelling (ABM) strand of the Evaluation of the Domestic Abuse Duty for Support in Safe Accommodation and should be read in association with the main evaluation report. Part 4 of the Domestic Abuse Act 2021, known as the DA Duty and from here referred to as the duty, was introduced in recognition that providing safe accommodation can be crucial for survivors' safety and protection but may be insufficient without appropriate support. The duty requires Tier 1 local authorities (LAs) in England to provide appropriate support within safe accommodation for victims of domestic abuse and their children, as victims in their own right, and requires Tier 2 LAs to cooperate with the Tier 1 LA in achieving this. The core aim of the duty is for victim-survivors of domestic abuse, including their children, to be able to access appropriate support in safe accommodation when they need it.

ABM is a computational method for exploring and understanding how complex systems operate. It involves developing a computational model of the system by simulating its environment and the interactions between autonomous agents within it. In the model, these interactions take the form of messages being passed between agents, to which agents respond from the information in the messages. Applied to human behaviour, the agents in an ABM may be individuals, collectives (e.g. households), organisations (e.g. service providers) or larger entities (e.g. nations). ABM replicates agents' interactions by programming micro-level behaviours of real-life actors into the model and then repeatedly running the simulation to analyse responses of the system. In this way, ABM can explore how processes and structures influence interactions between agents and how underpinning mechanisms may be influencing the results.

In this study, the complex system being explored is the context within which the duty operates, and victim-survivors are intended to experience support in safe accommodation. The agents are diverse, including those considered significant within the system, such as victim-survivors of domestic abuse, statutory agencies involved in identifying and responding to domestic abuse, and statutory or third-sector organisations that provide safe accommodation and/or support for victim-survivors of domestic abuse.

ABM was chosen as an exploratory strand in the evaluation of the duty. By making use of the detailed evidence being gathered across the evaluation, it intended to supplement and refine the analysis of the longitudinal theory-based process and outcomes evaluation data, particularly in the absence of a feasible quasi-experimental design.

The overall goals for the ABM include refining the evaluation Theory of Change, identifying data gaps, providing an additional robustness check on quantitative analyses, conducting processual risk analysis, serving as a diagnostic tool, and aiding cautious generalisation of lessons learnt. Note that the ABM is not intended to quantify impact nor to predict results.

This report focuses on version 4 of the ABM, the final stage in the model's development during the evaluation. This report presents a summative assessment of the ABM's progress, alongside the findings from the analysis of version 4's findings.

Modelling approach

Given the exploratory nature of the ABM component of the evaluation, a staged approach to development was agreed. The process for developing the model were iterative, with input and feedback from MHCLG, the Advisory Group and others to help direct and strengthen the model. Four versions of the model were to be developed alongside the phases of data collection and with differing levels of consultation on each (covered further below).

The following approaches have been used to develop the ABM:

- **An evidence-led approach** –the available evidence was used to set up the model, and to identify and integrate into the model processes and strategies that agents use (i.e. drawing on agents' interactions within real-life domestic abuse service systems). We have used our analysis to prioritise those that are most significant and deprioritise or exclude those that are less important. This has included consultations with key stakeholders from the domestic abuse sector, MHCLG and the advisory group and engagement with the study's Lived Experience Panel (see 'evidence base' below).

- **Cross-validation** – this is where qualitative input (including from scoping interviews and the Lived Experience Panel) is used to inform the micro-level specification of the ABM (in particular, different behaviours that different kinds of agents might use) but where the outcomes are compared against available macro-level quantitative data (such as aggregate LA-level statistics on domestic abuse support services).

- **Use of a synthetic population** – to ensure that victim-survivor agents within the model reflect the heterogeneity of real-life victim-survivor characteristics, we create a synthetic population of such agents to replicate the English population average for comparing cases. This is based on the most detailed data set available – the UK Longitudinal Household Survey (UKLHS). The model currently only utilises some characteristics included within the UKLHS: sex of the adult; children's ages; and level of mental health needs.

Using the UKLHS, we adopt a two-step approach:

1. We use the survey to develop a synthetic population of households that represents the citizens of synthetic local authority based on the England-average.

2. We then tune this England-representative population using the national domestic abuse prevalence statistics to produce a set of unique synthetic victim-survivor agents that seek help within the model.

The evidence base

The following evidence sources have been used:

- **Ten qualitative scoping interviews** – with the aim of (a) identifying the range of strategies that each actor at each level might use and (b) to find out the range of possible issues that might affect the quality of domestic abuse provision.

- **Two sessions with the Lived-experience panel (LEP)** – to help identify additional issues to be considered, especially those that caused the most frustration or impediments to victim-survivors.

- **Aggregate LA-level statistics from MHCLG MI 2022/23** (the latest data available at that stage of model development) – including data on a) the number, types and capacity of safe accommodation; b) number of victim-survivors helped, with which support services; c) how many victim-survivor families were unable to be supported and reasons; d) number and kind of specialist characteristics of victim-survivors helped; and e) distribution of time spent in safe accommodation receiving services.

- **The UK Longitudinal Household Survey (UKLHS)** – to construct the synthetic population for each LA case (as discussed above).

- **A mapping of local providers and their services in two LA case studies** – these cases were chosen from the wider evaluation to build iterations of the model to replicate their local setup to aid testing and exploration of the model.

- **The Domestic Abuse Commissioner's 2021 report "A Patchwork of Provision"** – used to design the different cases included in version 4 by illustrating the different levels of maturity of provision in terms of the available domestic abuse support services and accommodation for victim-survivors and how they are organised.

The model

The four versions of the model are summarised below:

Version 1 was an illustrative proof-of-concept, to give MHCLG and advisors an idea of what a model might be able to do and look like. It introduced the synthetic population generation and an idealised flow of victim-survivors through the system.

In **version 2**, the model introduced the various elements of "friction" into the provision to reflect the interviews with coordinators and managers throughout the system. The synthetic population generation was then upgraded to use more recent data from the UKLHS.

In **version 3**, the ABM modelling (led by MHCLG's direction) focused on investigating the following question: "*How do different coordination structures affect how victim-survivors reach and access safe accommodation support?*".

An exploration of this research direction and associated early findings were presented in the ABM version 3 interim report. However, it highlighted that coordination structures made little difference due to dominating role of the supply of move-on accommodation over all other factors (though this analysis and findings did not consider sanctuary schemes).

In **version 4**, the focus shifted from specific coordination arrangements to exploring:

- The contrast between more and less mature systems of domestic abuse service systems.

- An analysis of the factors that might be most important in improving the provision of domestic abuse support services in both of these cases.

- What other factors might emerge as important in the case where there was a sufficient supply of move-on accommodation.

- A specific focus on provision for households with less common characteristics (males, those with mental health needs etc.) – in particular, the synthetic population was now divided so that the number of households with less common characteristics seeking help could be controlled using parameters.

The basic model structures are as follows:

- **Four kinds of agent are represented within the model:** (a) victim-survivor; (b) representatives that might refer victim-survivors to domestic abuse services; (c) coordinators that may triage and/or allocate victim-survivors to providers; and (d) caseworkers associated with providers who help victim-survivors access the services they need.

- **Some aspects are included to represent parts of the LA's strategy, policies and context**, including: (a) awareness by agencies in the LA on how to access domestic abuse services; (b) the kinds and capacities of service providers; (c) whether access to domestic abuse services is through a centralised process or decentralised ones; (d) the supply of move-on accommodation; and (e) the capacity of coordinators and caseworkers in terms of caseload. This can (indirectly) help replicate LAs' strategic plans for implementing the duty.

- **Kinds of accommodation included in the ABM**: only three distinct kinds of safe accommodation are represented in the model: refuge accommodation, dispersed accommodation and 'move-on' accommodation that households would move into. Sanctuary schemes were initially included in the model, but there was little evidence of how these were working in practice. As they are a very distinct provision, in which the household stays in their own home with it made safe around them, the limited evidence on their use meant it was more accurate to exclude them from the model.

- **Five stages victim-survivor agents pass through in the model (which may or may not happen for all real-life actors in local domestic abuse service systems):**

    1. *Generation* – a stream of agents representing victim-survivor households needing domestic abuse services is generated from the synthetic population for the LA (note that a household can be an individual adult).

    2. *Making contact* – these agents then seek to find domestic abuse services, with varied knowledge of the national domestic abuse helpline and services available locally.

    3. *Coordinator allocation* – once in contact with domestic abuse services a coordinator may look for safe accommodation and/or services for them (if no safe accommodation is available immediately). In some LAs there is a central coordinator who then may refer them on to provider coordinators.

4. *Receiving services* – those waiting for accommodation might still get some support services in some cases but these are typically more restricted. As in the ‘making contact’ stage, knowledge about what support services exist and how to get them might be patchy. Provider caseworkers, coordinators or other victim-survivors at the accommodation might inform them about these.

5. *Moving on* – the victim-survivor agents move on from safe accommodation, ideally to independent settled accommodation, but only if and when this is available, otherwise they stay in safe accommodation.

The model captures several ‘frictions’ that may mean victim-survivor agents do not receive all the services they need and/or doing so may take longer than anticipated. These aspects are deliberately designed into the model to better reflect the complexities, tensions and trade-offs that exist in domestic abuse service allocation and provision. These are: victim-survivor agent variety, patchy service distribution, resource constraints; and imperfect knowledge by agents of what is available and where to look.

Finally, the ABM aims to capture some of what is possible in the real world. It does not indicate what is *likely* to be the case in the situation being modelled or indicate *central* tendencies but is an analysis of what may happen. The particular value of an ABM is it can reveal outcomes some of the non-obvious complexity inherent in such systems. Whether such “emergent” outcomes also sometimes apply in the real-life systems it is modelling, needs careful consideration.

Model findings

Model findings: Introduction

The analysis is designed around analysing different 'cases' based on two key variables:

- **Local domestic abuse service system 'maturity'** – with a more 'mature' and less 'mature' system differing in various respects, including: the extent of survivors' knowledge of how to contact domestic abuse support services, how often triage by coordinators and caseworkers occurs, the range of support services available and how widely these are spread, the range of characteristics that can be accommodated, the capacity of safe accommodation, and the coordination between providers.

- **Move-on accommodation supply** – with version 3 of the ABM showing this factor dominates all other factors within the delivery of domestic abuse support services (as it the most influential factor overall and over individual factors), versions of these two cases where move-on accommodation supply is not a constraint (i.e. supply exceeds demand) are also included.

These key variables helped form the four different cases examined, summarised in Table ES1 below, which also gives the shortened case names of each.

Table ES1. The four cases analysed and shortened case names

	Immature domestic abuse service system	Mature domestic abuse service system
Limited move-on accommodation	"Immature-limited"	"Mature-limited"
Unlimited move-on accommodation	"Immature-unlimited"	"Mature-unlimited"

The analysis focuses on exploring the complex relationship between different factors within the ABM by controlling and adapting factors one-at-a-time within each case to see the impact of each factor on the key measured outcomes. The findings are then compared to better understand what and why the results may be happening.

The outcomes examined and presented within this analysis are:

1. The average number of victim-survivor needs met by providing them with services.

2. The median time spent by victim-survivors in safe accommodation as they were being supported.

Model findings: Summary of differences between Immature and Mature cases

The analysis examining the difference between the immature and mature cases suggests:

- The supply of ***move-on accommodation*** is a limiting factor, thus increasing this so that the supply is greater than the demand greatly increases the number of victim-

survivor needs met and/or the number of victim-survivors supported, and also greatly reduces the time spent in safe accommodation.

- Following that, the ***supply of the more diverse safe accommodation*** (that with fewer restrictions than refuge accommodation in terms of the variety of victim-survivors catered for, e.g. specialist or dispersed accommodation) increases the number of needs met, but also increases the time spent in safe accommodation.

- Changing ***other factors*** one-at-a-time has little significant impact on the outcomes of the immature case, indicating that many aspects need to improve simultaneously to achieve improved outcomes. This implies a more systematic, whole-system approach to change is needed to improve outcomes in the immature-limited case.

- A low level of provider service coverage or total refuge capacity can restrict what might be achieved in the mature case in terms of needs.

Model findings: Summary of the impact of removing the constraint of move-on accommodation in the model

The analysis examining the impact of move-on accommodation supply in the immature and mature cases suggests:

- If starting from an immature domestic abuse service system then some coordination measures (spread of mutual knowledge, number of provider coordinators, a central coordinator) could improve number of needs met if move-on accommodation is not constrained.

- Removing the move-on accommodation constraint has a different impact on a mature domestic abuse service system. Adding more coordination in this case does not increase needs met.

- The impact of factors on time spent in safe accommodation with and without move-on accommodation constraints is less clear, with some factors no longer having impact and others emerging in each case.

Model findings: Summary of provision for those with less common needs

The analysis examining provision for victim-survivors with less common characteristics suggests:

- In the model, reducing the most constrained factors (of move-on accommodation supply, the restrictions on available safe accommodation and its supply) most effectively results in more of the needs of households with less common needs being met.

- If more households with less common needs seek support, then it is important that the domestic abuse service system has the capacity to accommodate them, otherwise dealing with these could frustrate the provision of support services to other victim-survivors.

Model findings: Explanations from the model

Whilst a simplification of a real-life system, the ABM is complex and allows for exploration of how different processes interact. This can aid understanding of real-life domestic abuse service systems. Some possible explanations to interpret what is happening inside the model and may warrant further investigation include:

- Limited move-on accommodation can mean households are in safe accommodation when this is no longer useful for them (e.g. their needs have been met and there are no more available support services to help them). This means other households who need safe accommodation may not get this regardless of how well organised providers and coordination are in other respects. Thus, this is a key limiting factor.

- Many other aspects may also act as limiting factors that frustrate the provision of support services. For example, whether survivors know how to contact domestic abuse support services, whether there is safe accommodation suitable for them, whether they find and can access the support services they need, and the delays in such a search, all can mean fewer needs are met. To substantially increase the number of victim-survivor needs served, all of these aspects need to be improved.

- If there are significant capacity constraints (in terms of what support services are available and what kinds of safe accommodation exist) then a better flow of information as to what is available and where can result in slightly more victim-survivors getting support services for their needs. However, when these constraints are loosened this flow of information is less important. Thus, in the mature cases neither the presence of centralised nor provider coordinators (past a certain number) were notably impactful.

- In the mature-unlimited case, when there was a sufficient number of coordinators, the bottleneck in the system was the total capacity and types of safe accommodation rather than the total capacity of the coordinators, this may mean that households are waiting longer to be placed in safe accommodation but might be less optimally placed (from the point of view of ensuring households with less common characteristics and needs are better placed).

Model findings: Limitations of the analysis

- The model does not significantly deal with the interface between the criminal justice and domestic abuse service systems. Similarly, it does not model sanctuary schemes as there was little available evidence as to how support is provided within them.

- The agents in the model are simplifications of both victim-survivors and those involved in coordinating or providing domestic abuse support services, and does not accurately reflect the knowledge, skills and intelligence of real actors. For example, this means the creativity and flexibility professionals will apply daily to help victim-survivors is not included.

- The two measures chosen (number of victim-survivor needs met and the time spent in safe accommodation) are just two ways of summarising the experience of all the

victim-survivors that pass through the domestic abuse support system. Exploration of other measures may further enrich and deepen the findings presented.

- The model does not explicitly represent the flows of victim-survivors between LAs. These flows will change the number and type of households an LA should help, as well as adding considerable stress and dislocation to those who thus have to move. In particular, the loss of personal support networks, contacts and employment are not modelled.

- There was not much evidence available on several aspects of the domestic abuse services systems as implemented within LAs, including: the range of strategies that coordinators and caseworkers use when faced with a household that they cannot place in safe accommodation, how and when households choose to move on when such accommodation is available, and which households need which support services.

Discussion

Whilst ABM of this kind will not predict the outcome of any change in a narrow sense, it can indicate real-life possibilities concerning the complex interaction of processes that may be occurring. This can be viewed as a kind of processual risk analysis – identifying how the processes involved might go surprisingly wrong (or right)[1]. This then needs comparing to what is known about those processes from elsewhere (in this case what is coming from the wider evaluation of the implementation of the duty.

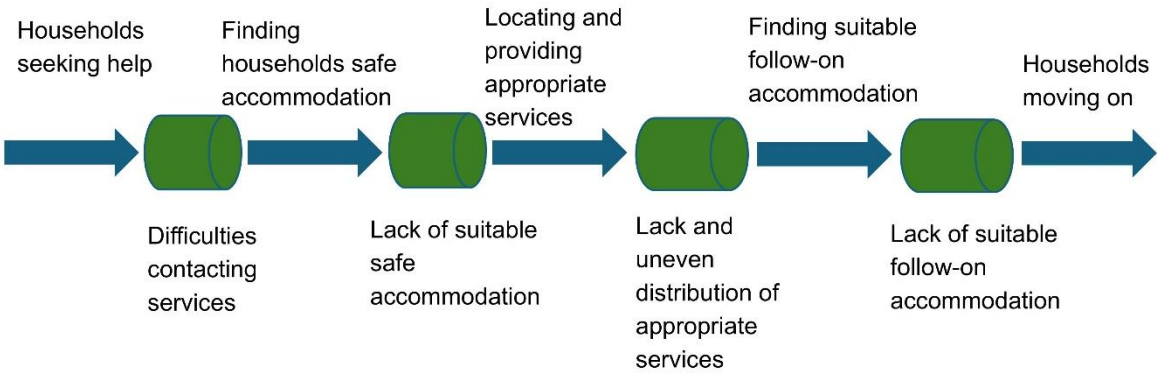
In this light, the ABM highlights the following possibilities:

- The supply of move-on accommodation is a key constraint on how the whole domestic abuse support systems functions – affecting several different aspects. Increasing this reduces average time spent in safe accommodation and allows more victim-survivor needs to be met.
- The capacity and flexibility of safe accommodation is important for the delivery of support services, but to different extents in mature and immature domestic abuse service systems.
- Changing other factors individually might have less impact without a wider whole-system approach to progress a more mature service system.
- Some coordination measures may help in a relatively immature domestic abuse support system but be less impactful in more mature systems.
- Low levels of service coverage by providers and total refuge capacity may constrain the meeting of victim-survivor needs in an otherwise more mature domestic abuse support systems.
- Some factors that increase the number of victim-survivors needs met also have a side-effect in terms of increasing time spent in safe accommodation as these are delivered. This is a consequence of finding, scheduling and delivering more services to victim-survivors within imperfect systems. So, the overall capacity might need to increase as a wider range of victim-survivor needs are catered for.
- The restrictions on and supply of non-refuge safe accommodation is important in helping households with less common characteristics, but this capacity needs to be sufficient to the demand from such households.

A notably simplified visual showing these conclusions and the “bottlenecks” that can limit the provision of the help that victim-survivor households need is shown in Figure ES1.

[1] Edmonds, B. & Adoha, L. (2019) Using agent-based simulation to inform policy – what could possibly go wrong? In Davidson, P. & Verhargen, H. (Eds.) (2019). Multi-Agent-Based Simulation XIX, MABS 2018, Stockholm, July 2018, Lecture Notes in AI, 11463, Springer, pp. 1-16. DOI: 10.1007/978-3-030-22270-3_1

Figure ES1. A simplified illustration of some of the factors emerging from the ABM of the service provision system as "bottlenecks" (arrows are processes the cylinders are the bottlenecks)



Reflections on designing and delivering the ABM

Agent-based models (ABMs) offer endless potential for detail and complexity, but practical constraints like time, evidence, and feedback determine their scope and development. While the ABM discussed achieved many goals (below and section 6.3), there's room for refinement, particularly in scrutinizing and improving model assumptions. Conclusions drawn from the model should be considered alongside other findings and real-world contexts.

Using ABMs in UK policy evaluations is relatively new, offering learning opportunities for analysts and policymakers. Key considerations include defining ABM boundaries and objectives, integration within existing evaluation processes, and optimal use cases. While general computational modelling guidance exists, specific ABM guidelines are lacking. Collaboration with policy and analysis experts is crucial, as this case study highlighted.

Progress against general goals:

Table ES2 below presents progress against the general goals set at the onset of the ABM.

Table ES2. Evaluation against general modelling goals (for details about the goals see section 1.3)

1. **General Goals**	2. **Progress in Version 4**	**3. Key learning**
Refine ToC	The model now contrasts mature and immature cases contributing a bottom-up view to the ToC. In particular identifying potential areas of development to prioritise when considering developing a domestic abuse service system.	A shift from immature to mature service systems made a significant impact on outcomes due to multiple dimensions improving. Supply of move-on accommodation and having more safe accommodation that is suitable for households with a broader range of characteristics helped in all cases.
Identify key gaps in data	Significant gaps in knowledge for the modelling were identified, some of which were later supplied, though not all (e.g., sanctuary schemes).	There are areas where creative problem-solving is done by established providers to get around system limitations that were not known or modellable.
Additional robustness check	There were no regression models developed during the evaluation to check.	The model outcomes were checked against the MI figures in two contrasting LA cases.
Processual risk analysis	Some of the processes that can frustrate (and enable) the effective provision of domestic abuse support services have been identified and the reasons suggested by the ABM.	The impact of improvements in management, coordination and skill by coordinators and providers can be frustrated by other constraints such as availability of move-on accommodation or the diversity of dispersed accommodation available.
Diagnostic tool	The ABM looked at the role of move-on accommodation supply and some of the factors that might have frustrated the supply of support services to households with less common characteristics.	The model suggests that easing constraints (i.e., restrictions on who can access) on the provision of support services for those with less common characteristics may lead to the largest improvement in victim-survivor outcomes.
Aid cautious generalisation	The model has suggested some causal patterns that may be generalisable. The extent to which this will help generalisation can only be evaluated by others in the full knowledge of all the evaluation conclusions.	

Next steps

The next steps for the ABM are **archiving, full documentation and Sensitivity Analysis of the ABM**. The model code, the documentation of the model using the latest version of the ODD standard and a more extensive sensitivity analysis will be made available on the CoMSeS simulation model archive under an open license so anyone (accepting similar conditions) can download, inspect and use it[2].

[2] More about this at https://forum.comses.net/t/why-archive-your-model/7376

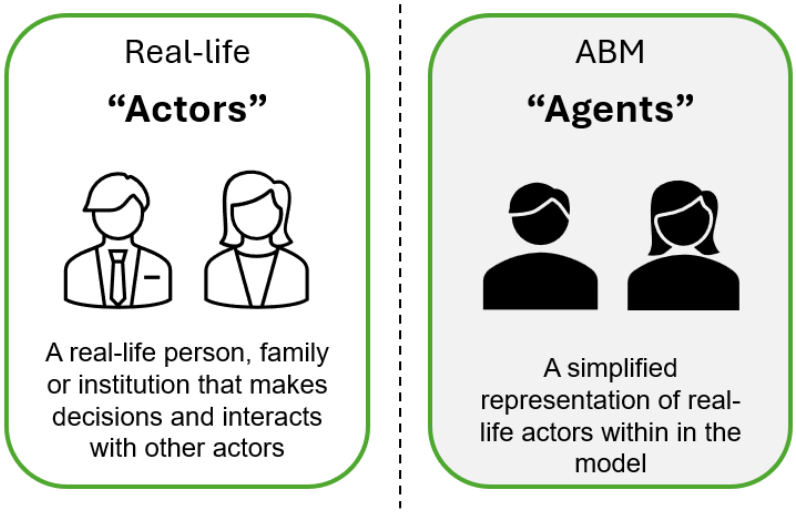
1 Context and Purpose of the Modelling

This report has been produced to provide additional information on the agent-based modelling (ABM) strand of the duty evaluation and should be read in association with the main evaluation report.

1.1 About Agent Based Modelling (ABM)

ABM is a computational method in which a model that simulates a complex system (in this case the system of agencies that support domestic abuse victim-survivors) is developed and each of the significant actors within the system (e.g. victim-survivors, support providers) is separately represented within the model as an 'agent'. The model aims to replicate the interactions between agents (reflected within the model as messages passed between them) on the types of interactions real-life actors make. Note that this terminology is used throughout, so the *actor* is the real-life person, household or institution that makes decisions and interacts with others and the *agent* represents these actors in the model.

Figure 1. Real-life actors and agents within the ABM



The model is developed by programming in the micro-level behaviours for the different agents in the model (e.g. what steps a victim-survivor might take to find support services that meet their needs) and then running the model to see what happens when they interact as the simulation progresses. By repeating the simulation and analysing the results of what happens, the ABM can allow you to explore the processes and structures influencing how actors interact and the underpinning mechanisms that may be determining the results.

In this context, the significant advantages of this approach are as follows.

- It can represent a range of different real-world actors within a local authority's domestic abuse service system and replicate their different roles, behaviours and knowledge, both between and within different sets of actors. In this case: victim-survivors, caseworkers, coordinators, and other actors who might refer people to domestic abuse support services (whether in safe accommodation or elsewhere). It represents their roles and behaviours while similarly reflecting how different victim-survivors might have

different levels of knowledge about the support services available. This is important as it allows us to represent a variety of victim-survivors, approaching the variety seen in real-world cases.

- Due to ABM's flexibility as an approach, it can be based on a wide range of evidence. In this case the range of behaviours of agents was suggested by interviews and panel sessions with a range of stakeholders (including the Lived Experience Panel), and then the model parameters and features adjusted so that its properties match MI data.

- It is a 'bottom-up' approach that can be centred on representations of individual victim-survivors as they seek and receive domestic abuse support services within their local authority. Importantly, it allows us to explore how the different processes and structures involved might affect each other (e.g. one frustrates another in particular circumstances).

Whilst ABM models are a simplification of reality, they can be complex and require intensive analysis after they have been built to extract insight from them. The strategy for using ABM is thus: (a) to develop and adjust a model so that it corresponds with a wide range of known evidence and then (b) to investigate and understand the model to gain understanding about how processes and structures might be working.

The aim of an ABM is not to understand the impact of a policy that has been implemented, as there are too many variations in reality that can interact. Instead, an ABM is used as a diagnostic tool, to explore how complicated systems can work well, or less well. It can then suggest policy or organisational changes.

An accessible introduction to complex simulation is the 2018 Government Office for Science report on computational modelling[3]. Other useful sources on ABM include: a comprehensive guide to agent-based modelling[4], and its uses and limitations for policy purposes[5].

1.2 Agent-based modelling (ABM) within the wider evaluation

The feasibility assessment for a counterfactual impact evaluation (CIE) concluded that, as the necessary primary and secondary data was unavailable, it was not feasible to conduct a reliable quasi-experimental design. This provided an opportunity to use more exploratory methods to understand what has been happening since the introduction of the Domestic Abuse Duty and specifically to explore how different contextual factors influence accessing and using safe accommodation. In discussion with the client, agent-based modelling (ABM) was chosen to explore **how** the duty might be having an impact. It was intended as a complement to other analytical approaches to the evaluation, such as the Qualitative Comparative Analysis (QCA) strand. Although it does not quantify impact, it is

[3] Government Office for Science (2018) *Computational Modelling: Technological Futures*. https://www.gov.uk/government/publications/computational-modelling-blackett-review
[4] Edmonds, B. & Meyer, R. (2017) *Simulating Social Complexity - a handbook*, 2nd edition. Springer.
[5] Edmonds, B. & Adoha, L. (2019) Using agent-based simulation to inform policy – what could possibly go wrong? In Davidson & Verhargen (Eds.) (2019). *Multi-Agent-Based Simulation XIX*, Lecture Notes in AI, 11463, Springer. DOI: 10.1007/978-3-030-22270-3_1

intended to supplement and refine the analysis of evidence that will be gathered over the longitudinal theory-based process and outcomes evaluation.

1.3 General goals for the modelling component

During the setup phase of the ABM, six goals were identified (outlined in Table 1.1). These were of various degrees of difficulty, but only two were considered high risk in terms of their complexity.

Levels of difficulty were classified as follows:

- Low – there are no significant difficulties anticipated and would be confident about achieving the goal.
- Medium – some difficulties are anticipated but that these might well be solvable and if they are not the goal may only be reached to a limited extent.
- High – these are ambitious goals and cannot be guaranteed to be achieved.

Table 1.1 General Modelling Goals

General Goal	Difficulty
***Refine ToC* – The processes of developing the ABM can allow refinement of the possible strands of causation that may be occurring**	Medium
***Identify key gaps in data* – The processes of developing the ABM can identify missing areas of the evidence that seem to be crucial for understanding implementation of the Duty**	Low
***Additional robustness check* – on quantitative analyses, by relaxing assumptions, producing synthetic data and comparing those quantitative analyses to the available data**	High
***Processual risk analysis* – to identify some ways the implementation of the Duty can be facilitated or frustrated**	Low
***Diagnostic tool* – to identify hypotheses as to how duty processes in LA cases are working and so inform subsequent evidence collection**	Medium
***Aid cautious generalisation* of lessons in implementing the duty**	High

2 Modelling Approach

2.1 Iterative development

Given the exploratory nature of the ABM component of the evaluation, a staged approach to development was agreed. The process for developing the model is iterative, with input and feedback from MHCLG, its Advisory Group and other co-production groups to help direct and strengthen the model. Four versions of the model were developed interweaved with the phases of data collection and with different levels of consultation at each stage.

2.2 Evidence-led modelling

Due to the lack of reliable behavioural theories on which to base the simulation, we employ an evidence-led approach. This uses available evidence from the qualitative interviews and Lived Experience Panel (LEP) co-production groups to develop the simulation and then relies on analysis later to simplify/ignore any aspects of the model that turn out not to be significant whilst including any strategies and processes that warrant inclusion[6]. This "evidence-first" approach can help ensure that important aspects are less likely to be left out of the ABM specification because of over-simplification. There is always a tension between encoding increasingly more detailed data into models to better represent agents and processes (as revealed in the evidence) and the need to prioritise the most important details (by removing or not inputting lesser important details, referred to as abstraction) for ease of use, even if this leads to real-life processes and nuances being a simplified within the model.

2.3 Cross-validation

We apply the "cross-validation" method of simulation development and testing here. This is where qualitative input is used to inform the micro-level specification of the ABM (in particular, the different kinds of behaviour that various agents might use) but where the outcomes are compared against available macro-level quantitative data[7] (this data is described in Section 3). The qualitative input ensures that the model includes agent behaviours of the right kinds and reflects the behavioural varieties observed in real-life. These determine what processes and structures are built into the model. Other information from interviews with actors at all levels of implementing the duty are then used to check the model outcomes are sensible, then the MI data is then used to adjust the model to fit particular case study LAs which provide a further sense check and allows us to see the range of possibilities that might emerge in these cases.

[6] Following the approach in Moss, S. and Edmonds, B. (2005) Sociology and Simulation: - Statistical and Qualitative Cross-Validation, American Journal of Sociology, 110(4) 1095-1131.
[7] Moss, S. and Edmonds, B. (2005) Sociology and Simulation: - Statistical and Qualitative Cross-Validation, American Journal of Sociology, 110(4) 1095-1131.

2.4 Use of a synthetic population

One of the central concerns in the provision of domestic abuse support services is with increasing provision for victim-survivors with under-represented characteristics (e.g. LGBTQIA+ victim-survivors). Thus, it is important that the variations of agents representing victim-survivors within the model reflects the real-life heterogeneity of victim-survivor characteristics. For this reason, we create a synthetic population of such agents calibrated to replicate the English population average for comparing the cases in this report, based on the most detailed data set available – the UK Longitudinal Household Survey (UKLHS). In this way, each victim-survivor agent in the model comes with hundreds of characteristics, however the current model only utilises sex, child ages, and level of mental health needs. Starting from a single wave of this survey, we adjust how frequently each of the original households appear in the synthetic population so that it represents the citizens of a synthetic local authority based on the England-average. We then deliver a second stage where this representative population is tuned to national domestic abuse prevalence statistics[8] to produce a set of unique synthetic victim-survivor agents that are included within the ABM. These agents are used to generate the households that seek help within the model. This approach has the added advantage that, if features and processes are added later to the model, these can make use of the vast range of characteristics that are associated with each victim-survivor agent (individual adult victim-survivors and where relevant their children as victim-survivors in their own right).

[8] These statistics were produced using the Crime Survey for England and Wales (2023)

3 The Evidence Base

3.1 Qualitative Scoping Interviews

The evaluation involved hundreds of interviews with professionals involved in overseeing, producing and delivering support in safe accommodation, and the synthesis of that data was utilised in the modelling. It was too large, however, to provide a useful starting point for developing the initial model. Therefore, a separate set of interviews was undertaken to inform the development of the model, allowing those involved in the modelling to ask more focused questions related to the parameters of interest for the agent-based modelling. This was for two purposes: (a) to identify the range of strategies that each actor at each level might use and (b) to find out the range of possible issues that might affect the quality of domestic abuse provision.

Ten interviews were conducted with decision-makers, coordinators and caseworkers at a variety of levels of the domestic abuse ecosystem. These were online and lasted around one hour each. The interviewee sample was broadly representative of the wider set of local professionals involved in overseeing the provision of support in safe accommodation for domestic abuse victim-survivors, to provide a cross-section of technical perspectives.

3.2 Lived-experience panel (LEP) sessions

Two sessions with LEP members were held, approximately one hour long. These were moderated by Ipsos and Dr Kelly Bracewell from the University of Central Lancashire and each involved four victim-survivors. These were not representative of all victim-survivors due to the small numbers involved and the fact that members were self-selected and tend to have sought help before the duty was implemented. However, their feedback identified additional issues to be considered, especially those that caused the most frustration to victim-survivors.

3.3 Aggregate LA-level Statistics

MHCLG MI data for 2022/23 provided:

- Figures on the number of, type and capacity of safe accommodation available.
- The numbers of victim-survivors helped, with which support services.
- How many victim-survivor households (including single adults) were unable to be supported (and the reasons).
- The numbers and kinds of specialist characteristics of victim-survivors supported.
- The distribution of time spent in safe accommodation.

3.4 The UK Longitudinal Household Survey (UKLHS)

The UKLHS follows a sample of 26,000 households over time[9]. It asks each member of the participating household an extensive series of questions covering a range of topics, including, importantly for the ABM, the children within the household. This UKHLS data was used as the basis for constructing the synthetic population of victim-survivor agents in the ABM. We do note that, although this is an extensive data set, it is still a limited approximation of the actual population of people who experience domestic abuse because it includes only people within residential households. It does not include people who are vulnerably housed, on the street or in any institutional setting (including refuges, hospitals or prison). It also slightly under-represents recent immigrant households (those arrived in the last few years). However, this is a mature data set and has evolved its methodology to mitigate any comparative weaknesses. It is considered one of the best such data sets in the world[10]. This is used to generate the stream of households in the ABM.

Please note that the UKLHS is constructed in terms of *households*, and this is used to generate agents representing the victim-survivor *households* that are assisted by LAs. Thus, the synthetic data stage of the modelling is described in terms of "households" as this is the units processed in order to generate a plausible and diverse range of households composed of the victim-survivor adults plus their children, if they have any, in the model.

3.5 A mapping of local providers and their services

For version 3, two LAs taking part in the wider evaluation as case studies were chosen as examples to build iterations of the model that replicated local provider setup and services, to aid further exploration. These iterations were produced using information collected during the evaluation and supplemented with online research. They were selected as contrasting cases in terms of the maturity of the domestic abuse service system based on a system mapping exercise and consultation with their case study area leads. These were used to test the consistency of the ABM with the MHCLG MI data.

For version 4, artificial cases were used rather than real-life LAs (further outlined in Section 5.1). This was to enable greater control of key variables of interest to enhance the analyses. The learning on mapping local providers and service providers helped construct these cases and identify relevant factors to be adjusted to further understanding (Section 5.2).

[9] https://www.understandingsociety.ac.uk/about/about-the-study/

[10] For those interested in current levels of representativeness see: Benzeval, M., Bollinger, C. R., Burton, J., Crossley, T. F., & Lynn, P. (2020). The representativeness of understanding society. *Inst Soc Econ Res*, *8*.

3.6 The Domestic Abuse Commissioner's 2021 report "A Patchwork of Provision"

This report illustrates the different levels of maturity of provision around the country in terms of the available domestic abuse support services and accommodation for victim-survivors and how they are organised. This report was influential to designing the cases within version 4 of the ABM by giving an insight into the ranges in which these systems varied. However, numerical values for the mature and immature cases were inferred by fitting the model to the two LA case studies.

4 The Model

4.1 The direction of modelling

ABM is an iterative approach and so can flex around changes in prioritisation. This section explains how the direction of modelling evolved – from a focus on how local arrangements for coordinating responses to domestic abuse might influence victim-survivors' access to safe accommodation to the final focus on how contextual factors influence overall access. Below, each version of the model is described:

- Version 1 was illustrative, to give MHCLG and advisors an idea of what a model might be able to do and look like. It introduced a proof-of-concept of the synthetic population generation and an idealised flow of victim-survivors through the system.
- In version 2, the model introduced the various elements of "friction" into the provision to reflect the interviews with coordinators and managers throughout the system. The synthetic population generation was then upgraded to use more recent data from the UKHLS.
- In version 3, the ABM modelling (led by MHCLG's direction) focused on investigating the following question: **"*How do different coordination structures affect how victim-survivors reach and access safe accommodation support?*"**.

An exploration of this research direction and associated early findings were presented in the ABM version 3 report. However, it highlighted that coordination structures made little difference due to dominating role of the supply of move-on accommodation over all other factors (though this analysis and findings did not consider sanctuary schemes).

- In version 4, the focus shifted from specific coordination arrangements to exploring:
    - The contrast between more and less mature systems of domestic abuse service systems.
    - An analysis of the factors that might be most important in improving the provision of domestic abuse support services in both of these cases.
    - What other factors might emerge as important in the case where there was a sufficient supply of move-on accommodation.
    - A specific focus on provision for households with less common characteristics (males, those with mental health needs etc.) – in particular, the synthetic population was now divided so that the number of households with less common characteristics seeking help could be controlled using parameters.

4.2 Basic Model Structure

Model entities

Whilst the model aims to represent (artificial but feasible) LA domestic abuse service systems, it is the agents making day-day decisions that, together, determine the outcomes that are achieved. Therefore, whilst the model shows individual agents' actions, it also represents LAs as a whole, and the impacts of its strategies and policies in terms of the structures, actors and support services in place to implement the duty (which can then be compared).

There are four kinds of agent currently explicitly represented within the model:

1. **Victim-survivor agents** (depicted together with any children that accompany them – we do acknowledge that the children are victim-survivors in their own right, but they are described in relation to the adult as a household unit).

2. **Representative agent**s for support services that might refer victim-survivors to domestic abuse support services (including domestic abuse-related helplines).

3. **Coordinators** that may triage and/or allocate victim-survivor agents to providers (or if no safe accommodation is available might try providing some support services until this is available).

4. **Caseworkers** associated with providers who help the victim-survivor agent to get the support services they need, which can be once the victim-survivor is housed in safe accommodation, but sometimes elsewhere.

The following aspects are built into the model to represent some aspects of LAs' strategy, policies and situation:

- The awareness among other statutory and voluntary agencies in the LA (e.g. health care or police) of how to access domestic abuse support services and their willingness to refer people to these.

- The kinds and capacities of service providers within the LA.

- Whether access to domestic abuse support services is through a centralised process or a decentralised one.

- The extent to which proactive triage of individual victim-survivor needs is done by coordinators and/or caseworkers.

- The knowledge of what support services are available and by which provider among coordinators and/or caseworkers.

- The capacity of coordinators and/or caseworkers.

- The supply of housing for victim-survivors to move on to after safe accommodation.

The strategic plans of LAs for implementing the duty can be (indirectly) represented in terms of the above, for example by:

- The capacities in place.
- The mutual knowledge of support services (e.g. as facilitated by co-working).
- The wider awareness of domestic abuse support services that are available so that victim-survivors can be directed to them.

Kinds of accommodation

Given the variety of kinds of accommodation involved in the provision of support services to victim-survivors and the lack of information in the management information data to distinguish these, only three distinct kinds of accommodation are represented in the model: refuge accommodation, dispersed accommodation and permanent accommodation that households might move on to. However, the numbers and diversity of kinds of household that refuge and dispersed accommodation might cope with are parameters of the model which would allow for specialist accommodation to be effectively included. Sanctuary schemes were initially included in the model, but there was little evidence available as to how these were working and how widespread their use was.

Model stages

Victim-survivor agents pass through the following stages in the model (which may or may not happen for each victim-survivor actor in real-world local domestic abuse service systems):

1. *Generation* – a stream of agents representing victim-survivor households needing domestic abuse support services is generated from the synthetic population for the LA and according to national domestic abuse prevalence statistics according to a parameter that was set to represent the numbers in the MI data.

2. *Making contact* – these agents then seek to find domestic abuse support services. They may know of the helpline but may not know the support services available to them locally. Thus, some victim-survivor agents go through a process of contacting other support services who may (or may not) put them into contact with domestic abuse support services.

3. *Coordinator allocation* – once in contact with domestic abuse support services a coordinator may look for safe accommodation and/or support services for them (if no safe accommodation is available immediately). In some LAs there is a central coordinator that then might refer them to provider coordinators.

4. *Receiving services* – once in safe accommodation, the victim-survivor agents find out about and access the support services they need. Those waiting for accommodation might still get some support services in some cases but these are typically more restricted. As in the ‘making contact’ stage, knowledge about what support services exist and how to get them might be patchy. Provider caseworkers, coordinators or other victim-survivors at the accommodation might inform them about these.

5. *Moving on* – after a while, especially if their needs have been met, the victim-survivor agents move on to independent settled accommodation, but only if and when this is available, otherwise they stay in safe accommodation for this. We do recognise that journeys into, through and beyond safe accommodation are not linear and may include return to safe accommodation. However, the model is set up to describe a linear journey as this simplifies exploration of how the provision of support in safe accommodation is influenced by contextual factors; results will nevertheless need to be caveated in this.

'Friction' in the model

There are a number of aspects that can mean that that victim-survivor agents (a) may not get all the support services they need and/or (b) it may take longer than anticipated for this to happen. These aspects are deliberately designed into the model to better reflect the complexities, tensions and trade-offs that exist in domestic abuse service allocation and provision. These are:

- Victim-survivor agent variety.
- Patchy service distribution.
- Resource constraints.
- Imperfect knowledge by agents of various kinds of what is available and where to look.

More specifically these are varied as follows:

- Statistics that condition victim-survivor agents within the model can be varied to fit a specific LA case or could be used to examine counter-factual cases (e.g. what if greater public awareness resulted in more victim-survivors with specialist needs).
- Not all providers provide all possible support services and sometimes provide few services – the "unevenness" of this distribution can be varied from each service being only provided by one provider to all support services are provided by all.
- There are a limited number of coordinators, caseworkers, safe accommodation places etc. These can be varied to compare the impact of these upon the levels of service provision achieved in the model.
- Knowledge about what support services are provided (including their suitability for different kinds of victim-survivor and where) can affect whether victim-survivor agents are referred for and receive support services that meet their need. Factors that affect this can be varied (e.g. the extent of knowledge in referring agents from other support services or the availability of pro-active triage done by providers).

The extent of these aspects can be varied in the model. If the model shows a noticeable effect of a combination of factors, this could be a reason to explore these in the other evaluation data. However, an effect (or lack of) in the model does not necessarily mean this would be replicated in real-life, as the model is an imperfect simulation of real-life so this may be due to how the model has been developed.

Model boundaries

For version 4, the boundaries of safe accommodation included within the model were reduced in scope, so that only those receiving services within safe accommodation are being modelled and not those delivered in the community. This was due to the lack of evidence to support the distinction of safe accommodation and support services from non-safe accommodation/community services robustly within the model. Similarly, sanctuary schemes were not included in the model due to a lack of evidence as to how they operate in practice being identified, with just policy and guidance documentation found.

4.3 Model Purpose, Reliability and Interpretation

It is important to understand the nature and purpose of the ABM in this context, particularly if the reader is more used to statistical or economic modelling.

The ABM aims to capture some of what is possible in the real world, rather than what is probable. It does not indicate what is *likely* to be the case in the situation being modelled or indicate *central* tendencies but is an analysis of what may happen. In particular, it is not aimed at giving numbers for outcomes, but rather is a tool for diagnosing how the various actors and processes might interact. It is for this reason that numbers nor graphs are used to summarise the results, as this might mislead readers. Rather the model findings are described in broader qualitative terms with a particular focus on understanding the processes involved. ABM can be interpreted as a kind of risk analysis – showing how things might go surprisingly wrong (or right) in the whole domestic abuse support services "ecosystem". The particular value of an ABM is it can reveal outcomes that one might not have otherwise envisaged on the basis of common-sense – it precisely reveals some of the non-obvious complexity inherent in such systems. Whether such "emergent" outcomes also apply in real-life systems needs careful consideration. Although ABMs do capture some of the complexity of real-life systems, they are based on simplifications and assumptions, so all outcomes must be assessed against other forms of evidence.

In particular, they include some of the inevitable trade-offs that occur in practice that might contrast with a more normative picture of how things should ideally be. Thus, one should expect that the bottom-up workings of such models, that incorporate a little of the "messiness" of real-life systems and the consequences of such imperfection.

The ABM has not been *independently* validated – that is, checked against data that was not used in its construction. That would take more data and time than available. However, the ABM has been built in an evidence-based way and verified via its ability to roughly replicate the yearly management information figures from two contrasting LAs. Thus, the conclusions from the ABM can be used as indications as to interactions between processes that may be happening in LAs and broad tendencies in the impact of different constraints and levels of maturity. These conclusions should only be relied upon further when combined with other streams of evidence.

5 Model findings

This section presents the findings from the final version (v4) of the ABM. It does this by comparing two cases representing: the situation in a more mature system introduction of the duty, it helps better understand how different components of domestic abuse support provision may help or hinder their ability to support, and the experiences of, victim-survivors within the system. By doing so, this may identify areas in which support services may want to prioritise developing in the future or may have developed as a result of the introduction of the duty and funding, as captured within the Theory of Change, providing a dynamic and bottom-up view of system change.

To do this, we present the findings from analysing victim-survivor agents' journeys through domestic abuse support services within the different cases included the model (explained below). The analysis is focused on two outcome measures: (a) the average number of victim-survivor needs met; and (b) the average length of stay by victim-survivors in safe accommodation.

Please note that there is a summary of the main findings at the end of each subsection.

Cases within the model

The analysis is designed around comparing two cases representing (a) a more "mature" system of local domestic abuse support provision and (b) a less "mature" system. These differ in a number of respects, including: the extent of knowledge of how to contact domestic abuse support services in victim-survivors, how often triage by coordinators and case-workers occurs, the range of support services available and how widely these are spread, the range of characteristics that can be accommodated, the capacity of safe accommodation, and the coordination between providers.

Similarly, building on the findings from version 3 of the ABM that move-on accommodation supply dominates all other factors within the delivery of domestic abuse support services (as it the most influential factor overall and over individual factors), versions of these two cases where move-on accommodation supply is not a constraint (i.e., supply exceeds demand) are also included. The cases with and without supply constraints are then compared. This enables factors that otherwise may be marginalised due to move-on accommodation supply's dominance to be better understood. These findings may then suggest what factors might be important in a future real-life LA where the supply of move-on accommodation has improved.

Thus, overall, there are four different cases examined, summarised in

Table 2 below, which also gives the shortened case names of these.

Table 2. The four cases analysed and shortened case names

	Immature domestic abuse service system	**Mature domestic abuse service system**
Limited move-on accommodation	"Immature-limited"	"Mature-limited"
Unlimited move-on accommodation	"Immature-unlimited"	"Mature-unlimited"

These cases are the *starting point* for the exploration of complex causation within the ABM. Thus, for each case, we vary the various possible factors (corresponding to settings or parameters in the ABM) *one-at-a-time*, to see the impact of each factor on the key measured outcomes, given that case as a starting point. We then compare the causation patterns of the different cases to see what is different (or the same) in each. Thus, for example, we may start from the "mature-unlimited" case but then vary a single factor (e.g. amount of refuge accommodation) to explore the impact of this.

The patterns of outcome coming out from ABMs can be complicated. Here we summarise the outcomes using two key measures:

1. The average number of victim-survivor needs met by providing them with services.

2. The median time spent by victim-survivors in safe accommodation as they were being supported.

The rest of this section looks at the following: (a) the contrast between mature and immature cases, (b) what differences might arise if limitations on the supply of move-on accommodation are removed, (c) how some factors particularly related to the provision of support services to households with less common characteristics. The section ends with a discussion concerning interpretation of the findings and key model limitations.

Even though this is a simplified picture of the ABM outcomes, there is a lot of detail below. For this reason we have collected the most important conclusions about the ABM model in Section 6.

5.1 Mature vs. immature cases

The two strategic objectives of the duty were to improve the number of victim-survivors supported in safe accommodation and reduce the number turned away. This is not only a matter of identifying and commissioning the support services that are needed but also developing a robust and effective domestic abuse service system that coordinates the various elements in order to deliver help that is appropriate to each victim-survivor. The ABM can help analyse some of the system complexities involved. In the model, it is often the case that the various factors are co-dependent – that is, sometimes varying one factor at a time will have little effect, as other factors may be limiting their effect –may identify which factors might have an immediate impact when focused on individually and which require a more systematic approach.

To do this first we compare the two different levels of "maturity" of the local domestic abuse service system: the "immature-limited" and "mature-limited" cases (as further explained above).

The main difference between these cases in terms of outcomes is as follows:

- **Needs met**. Examining the number of victim-survivor needs met11 within each case highlights that mature domestic abuse service systems (mature-limited) consistently meet many more individual victim-survivor needs compared to less mature systems (immature-limited).

- **Time spent in safe accommodation**. Examining the (average) time spent in safe accommodation within each case type shows that victim-survivors in mature domestic abuse service systems (mature-limited) spend more time in safe accommodation compared to immature domestic abuse service systems (immature-limited), this appears to be due to victim-survivors receiving more support services than they would in the immature-limited case and thus taking more time on average.

Next, we summarise some of the model outcomes that result from varying some individual relevant factors. These findings should be interpreted as indicative, as factors are often interlinked and interdependent on one another and cannot be individually altered within real-world systems.

Supply of move-on accommodation

In the model, the supply of move-on accommodation is a key limiting factor. That is, increasing the supply has a big effect on its own, but also that a tight supply means that improvements on some other dimensions has little effect. The reason for this, in the model, is that places in safe accommodation become full, as households cannot move on, and this both restricts the total number of victim-survivor needs that can be met as well as increasing the time spent in safe accommodation.

[11] Victim-survivor needs here refers to the total number of needs across all victim-survivors; individual victim-survivors can have multiple needs – or more needs may now be recognised through more effective engagement – so the total number relates to needs not people.

Increasing the supply improves the proportion of needs met in both mature and immature cases, but even more in the mature case as there are fewer other constraints to service provision. Increasing the supply also dramatically decreases the time spent in safe accommodation. Once the supply of move-on accommodation reaches a level just above the level of demand for safe accommodation, time in safe accommodation no longer decreases.

The supply and restrictiveness of dispersed and specialist safe accommodation

In the model, dispersed accommodation is less restricted as to what kinds of households it can cater for, due to the restrictions imposed by communal living in refuges. Thus, such dispersed accommodation may be able to cater for men, households with older children, disabled, with mental health or drug dependency needs etc. in a way that is not possible in refuge accommodation.

Increasing the supply of such dispersed accommodation increases the number of victim-survivor needs met in both cases (but only from lower levels in the immature-limited case, meaning when there was previously limited supply). It also increases the time spent in safe accommodation (since meeting these needs takes time). Increasing the diversity of this accommodation (i.e. it being less restricted as to the kinds of household they can cater for) also increases the number of needs that are met and, in the mature-limited case how much time is spend in safe accommodation on average.

Other factors

For other factors, the picture is more complicated, with different factors having different impacts in different cases. The above two factors had a consistent impact in both mature-limited and immature-limited cases, having a significant impact, whilst the following factors have much more of a marginal impact. Thus, the following effects should be considered as less robust indications from the model and need corroboration from more direct parts of the overall evaluation and/or further exploration.

In terms of **needs met**, the provider service coverage (extent to which all providers offer all support services) and the total refuge capacity mattered in the mature-limited case. A summary of factors, including the difference between the cases is shown in Table 3.

Table 3. Impact of increasing individual factors on the number of needs met (coloured to highlight difference in immature-limited and mature-limited cases)

	Immature	Mature
Limited Move-on Accommodation	+Supply of move-on accommodation +Dispersed safe accommodation capacity (from low levels only) +Unrestrictiveness of dispersed safe accommodation	+Supply of move-on accommodation +Dispersed safe accommodation capacity +Unrestrictiveness of dispersed safe accommodation +Provider service coverage (from low levels only) +Total refuge capacity (from low levels only)

In terms of the **time spent in safe accommodation** the other factors only had a noticeable impact upon the mature case. There, the lack of restrictions for dispersed safe accommodation, having a centralised coordinator and the total refuge capacity increased the time spent in safe accommodation whilst the number of dispersed providers slightly decreased time spent in safe accommodation. A summary of factors, including the difference between the cases is shown in Table 4.

Table 4. Impact of increasing individual factors on time spent in safe accommodation (coloured to highlight difference between immature and mature cases)

	Immature	Mature
Limited Move-on Accommodation	-Supply of move-on accommodation +Dispersed safe accommodation capacity	-Supply of move-on accommodation +Dispersed safe accommodation capacity +Dispersed Unrestrictiveness +Having a centralised coordinator +Total refuge capacity -Number of dispersed accommodation providers -Provider service coverage

Summary of differences between Immature and Mature cases

The model suggests:

- The supply of ***move-on accommodation*** is a limiting factor, thus increasing this so that the supply is greater than the demand greatly increases the number of victim-survivor needs met and/or the number of victim-survivors supported, and also greatly reduces the time spent in safe accommodation.
- Following that, the ***supply of the more diverse safe accommodation*** (that with fewer restrictions than refuge accommodation in terms of the variety of victim-survivors catered for, e.g. specialist or dispersed accommodation) increases the number of needs met, but also increases the time spent in safe accommodation.
- Changing ***other factors*** one-at-a-time has little significant impact on the outcomes of the immature case, indicating that many aspects need to improve simultaneously to achieve an improvement of outcomes. This implies a more systematic and whole-system approach to change is needed to improve outcomes within the immature-limited case.
- A low level of provider service coverage or total refuge capacity can restrict what might be achieved in the mature case in terms of needs.

5.2 What if move-on accommodation is not limited?

Given that move-on accommodation is a dominating factor in the model (as shown in the version 3 report), we also examined cases where supply was not a constraint, to see what *other* factors might emerge as important if supply is unlimited.

In terms of needs met, some mechanisms of coordination emerged as improving the number of needs met from the immature-unlimited case when compared to the immature-limited case. These were: increasing the number of provider coordinators/caseworkers, having a wider spread of support services among providers and having a central coordinator. However, increasing these did not increase the number of needs met in the mature-unlimited when compared to the mature-limited case, whilst similarly having a centralised coordinator had a marginally negative impact in the mature-unlimited case (due to the slight delays and bottlenecks that this can cause with higher volumes of victim-survivors). Though please note, the version of central coordination replicated within the model is much less advanced and intelligent than may be observed in real life domestic abuse service systems, so this effect may depend on how this function is delivered.

Counter-intuitively, increasing the spread of knowledge as to how to contact domestic abuse support services slightly decreased the average number of needs met (per household) in the immature-unlimited case as this limited demand to a level the system could cope with. The immature-unlimited system is prone to “bottlenecks” with more cases than it can triage and so this can have a limiting impact on needs met. Whether this would be an effect observed in real cases is unclear.

Table 5 summarises the differences if the constraints on the supply of move-on accommodation are removed for the number of **needs met**. Red showing new factors that emerge as having an impact when moving from a -limited to an -unlimited case and green showing factors that disappear when moving from a -limited cases to an -unlimited case.

Table 5. Impact of increasing other individual factors on the number of needs met (coloured to highlight differences between the limited and unlimited cases)

	Immature	Mature
Limited Move-on Accommodation	+Dispersed safe accommodation capacity (for lower levels only) +Unrestrictiveness of dispersed safe accommodation	+Dispersed safe accommodation capacity +Unrestrictiveness of dispersed safe accommodation + Provider service coverage (from low levels only) +Total refuge capacity (for lower levels only)
Unlimited Move-on Accommodation	+Dispersed safe accommodation capacity +Unrestrictiveness of dispersed safe accommodation +Number of dispersed providers (from low levels only) +Number of provider coordinators/caseworkers (from low levels only) +Spread of provider knowledge of support services +Having a centralised coordinator -Contact knowledge by victim survivors (to higher levels only)	+Dispersed safe accommodation capacity (from lower levels only) +Unrestrictiveness of dispersed safe accommodation +Provider service coverage (from low levels only) +Total refuge capacity -Having a centralised coordinator

Removing the limitations on the supply of move-on accommodation has a more direct impact upon the **time spent in safe accommodation** by victim-survivors in the model. In particular, in the *immature case*, increasing the number of dispersed accommodation providers, the number of provider coordinators/caseworkers and the refuge capacity all act to increase the time spent in safe accommodation due to increased provision of services, whilst more active triage decreases this time. The finding about triage indicates that efforts to ensure victim-survivors are in the right setting is key to meeting needs most effectively. The findings about each of the other changes suggest that where a local authority is still developing its provision, there is substantial unmet need which will show up more clearly if changes mean survivors are better able to connect with services for the time they need. It is a speculative set of findings that would warrant further investigation with real-world data.

Table 6 summarises the differences if the constraints on the supply of move-on accommodation are removed, with red showing new factors that emerge as having an impact when moving from a -limited to an -unlimited case and green showing factors that disappear when moving from a -limited cases to an -unlimited case.

Table 6. Impact of increasing other individual factors on time spent in safe accommodation (coloured to highlight differences between the limited and unlimited cases)

	Immature	Mature
Limited Move-on Accommodation	+Dispersed safe accommodation capacity	+Dispersed safe accommodation capacity +Dispersed Unrestrictiveness +Having a centralised coordinator +Total refuge capacity -Number of dispersed accommodation providers - Provider service coverage
Unlimited Move-on Accommodation	+Number of dispersed accommodation providers (from low levels only) +Number of provider coordinators/caseworker - Active triage by providers +Total Refuge capacity	+Dispersed safe accommodation capacity +Dispersed Unrestrictiveness +Total Refuge capacity

Summary of the impact of removing the constraint of move-on accommodation in the model

- If starting from an immature domestic abuse service system then some coordination measures (spread of mutual knowledge, number of provider coordinators, a central coordinator) could improve number of needs met if move-on accommodation is not constrained.

- Removing the move-on accommodation constraint has a different impact on a mature domestic abuse service system. Adding more coordination in this case does not increase needs met.

- The impact of factors on time spent in safe accommodation with and without move-on accommodation constraints is less clear with some factors no longer having impact and others emerging in each case.

5.3 Less Common Household Characteristics

As mentioned, in version 4 of the ABM, the number of victim-survivor households seeking help can be controlled by parameters by means of splitting the synthetic population into types that can then be “mixed” in different ways (e.g. to reflect the real population or a counterfactual where more of different types present). Catering for victim-survivors with less common characteristics (those with older children, males, those with mental health needs or combinations of these) depends upon a number of factors in the model. Due to the communal nature of refuges, these are centred about the dispersed accommodation available which have fewer restrictions upon who they can take. These include:

- Maturity of the domestic abuse service system.
- The supply of move-on accommodation.
- The restrictions on specialist and dispersed safe accommodation.
- The available supply of safe accommodation without restrictions.
- The proportion of presenting victim-survivors with these characteristics.

All of these affect the average number of victim-survivor needs met in the obvious directions in both mature and immature cases but in non-linear ways. These factors can be seen as constraints on the provision of support services to victim-survivors – the most impact can be obtained by easing the most constrained factors rather than further improving relatively unconstrained ones.

In the model, reducing the restrictions on non-refuge safe accommodation as to whom they can accommodate was always beneficial. However, a sufficient number of providers of such accommodation, each offering accommodation suitable for a small range of needs makes it more likely (though not certain) that every household that needs it can be found some safe accommodation. Likewise, when the total capacity in terms of available dispersed and specialist accommodation is low this can constrain delivery.

If more households with less common characteristics present and are accepted into safe accommodation, then more of their needs are served but increasing numbers of these can mean that the total number of needs served is not increased proportionately if the overall capacity limit of the domestic abuse support services system is reached (so more with more common needs cannot be served). At the moment the provision for those with less common needs is far more constrained than provision for those with more common needs.

Summary of provision for those with less common needs

- In the model, reducing the most constrained factors (of move-on accommodation supply, the restrictions on available safe accommodation and its supply) most effectively results in more of the needs of households with less common needs being met.

- If more households with less common needs seek support, then it is important that the domestic abuse service system has the capacity to accommodate them, otherwise dealing with these could frustrate the provision of support services to other victim-survivors.

5.4 Explanations from the model

Whilst being a simplification of real-life systems, the model is complex, in that multiple different processes interact in complicated ways. Explaining the dynamic reasons why some of the above effects occur in the model can suggest possible interactions that may be occurring within actual domestic abuse service systems. For this reason, we suggest some explanations to interpret what may be happening inside the model, which may warrant further investigation in real-life systems:

- A lack of move-on accommodation may mean that households remain in safe accommodation when this is no longer useful for them (e.g. their needs have been met and there are no more available support services to help them). This means other households who need safe accommodation may not get this regardless of how well organised the providers and coordination are in other respects. Thus, this is a key limiting factor.

- Many other aspects may also act as limiting factors that frustrate the provision of support services to victim-survivors. For example, whether victim-survivors know how to contact domestic abuse support services, whether there is safe accommodation suitable for them, whether they find and can access the support services they need, and the delays in such a search. all can mean fewer needs are met. To substantially increase the number of victim-survivor needs served all of these aspects need to be improved.

- If there are significant capacity constraints (in terms of what support services are available and what kinds of safe accommodation exist) then a better flow of information as to what is available and where can result in slightly more victim-survivors getting support services for their needs. However, when these constraints are loosened this flow of information is less important. Thus, in the mature cases neither the presence of centralised nor provider coordinators (past a certain number) were notably impactful.

- In the mature-unlimited case, when there was a sufficient number of coordinators, the bottleneck in the system was the total capacity and types of safe accommodation rather than the total capacity of the coordinators, this may mean that households are waiting longer to be placed in safe accommodation but might be less optimally placed (from the point of view of ensuring households with less common characteristics and needs are better placed).

5.5 Limitations of the analysis

Despite being dynamic and complex, the model is still a simplification of real-life domestic abuse service systems. Some of these limitations suggest future areas of exploration:

- The model does not significantly deal with the interface between the criminal justice and domestic abuse service systems. In particular, it does not model sanctuary schemes as there was little available evidence as to how they are working.
- Agents in the model are simplifications of both victim-survivors and those involved in coordinating or providing domestic abuse support services, and does not accurately reflect real actors' knowledge, skills and intelligence. For example, the model does not adequately represent the long-standing providers who are creative and flexible in creating new support services for and delivering help to victim-survivors or to those victim-survivors that find their own way to meet their needs.
- The two measures chosen (number of victim-survivor needs met and the time spent in safe accommodation) are just two ways of summarising the experience of all the victim-survivors that pass through the domestic abuse service system. Additional measures were implemented within previous iterations of the model that enabled following individual agents through the system, though were not progressed within version 4. Exploration of these measures may further enrich and deepen the findings presented here.
- The model does not explicitly represent the flows of victim-survivors between LAs. These flows will change the number and type of households a LA should help, as well as adding considerable stress and dislocation to those who thus have to move. In particular, the loss of personal support networks, contacts and employment are not modelled.
- There was not much evidence available on several aspects of the domestic abuse support services systems as implemented within LAs, including: the range of strategies that coordinators and case workers use when faced with a household that they cannot place in safe accommodation, how and when households choose to move on when such accommodation is available, and which households need which support services. It is possible that some of the more established providers might have information of the trajectories of victim-survivors as they give them support services that might better inform us about these aspects.

6 Discussion

The development of an ABM is always an iterative and exploratory process, since the interaction of its elements are not predictable beforehand. Here we reflect conclusions of the study, the progress made overall and specifically against the general goals.

6.1 Summary and illustration of ABM Conclusions

Whilst ABM of this kind will not predict the outcome of any change in a narrow sense, it can indicate real-life possibilities concerning the complex interaction of processes that may be occurring. Such modelling can be seen as a kind of processual risk analysis – identifying how the processes involved might go surprisingly wrong (or right)[12]. This then needs comparing to what is known about those processes from other evidence sources.

In this light, the ABM highlights the following possibilities:

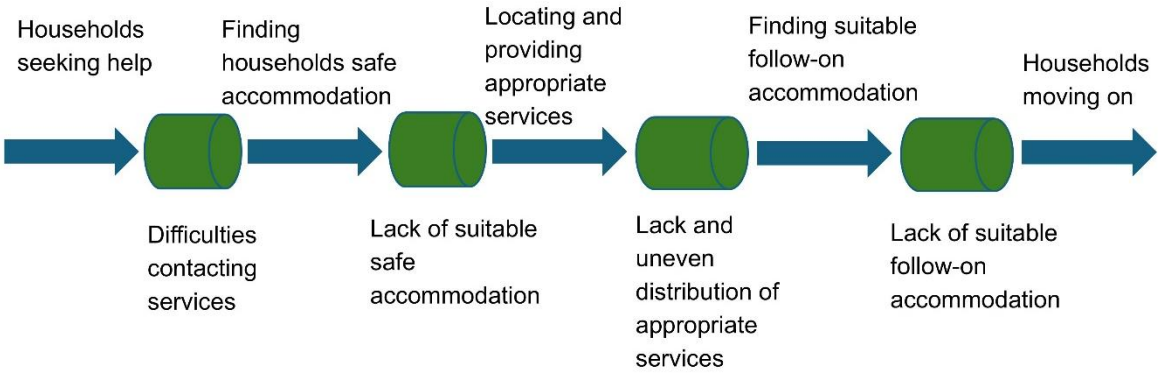
- The supply of move-on accommodation is a key constraint on how whole domestic abuse support services systems function. Increasing this reduces average time spent in safe accommodation and allows for more victim-survivor needs to be met by providing support services to them.
- The capacity and flexibility of safe accommodation is important for the delivery of support services, but to different extents in mature and immature domestic abuse service systems.
- Changing other factors individually might have less impact without a wider whole-system approach to progress a more mature service system.
- Some coordination measures may help in a relatively immature domestic abuse support system but be less impactful in more mature systems.
- Low levels of service coverage by providers and total refuge capacity may constrain the meeting of victim-survivor needs in an otherwise more mature domestic abuse service system.
- Some factors that increase the number of victim-survivors needs met also have a side-effect in terms of increasing time spent in safe accommodation as these are delivered. This is a consequence of finding, scheduling and delivering more services to victim-survivors within imperfect systems. So, the overall capacity might need to increase as a wider range of victim-survivor needs are catered for.
- The restrictions on and supply of non-refuge safe accommodation is important in helping households with less common characteristics, but this capacity needs to be sufficient to the demand from such households.

These conclusions might be understood using a simplified picture – a picture in terms of a series of interacting “bottlenecks” that can limit the provision of the help that victim-survivor households need. This picture reduces the complex ABM to a linear flow of households and what might frustrate them getting the services that are relevant to their needs. It omits many of the processes that complicate this and does not show how agents are creatively solving problems for victim-survivor households. Thus, it eliminates the variation and creativity that is partially captured in the model in particular runs of the model and how the

[12] Edmonds, B. & Adoha, L. (2019) Using agent-based simulation to inform policy – what could possibly go wrong? In Davidson, P. & Verhargen, H. (Eds.) (2019). Multi-Agent-Based Simulation XIX, MABS 2018, Stockholm, July 2018, Lecture Notes in AI, 11463, Springer, pp. 1-16. DOI: 10.1007/978-3-030-22270-3_1

agents representing the various actors involved are variously responding to their situation. It is thus a simplification of reality, and useful only as an aid to understanding the above summary of ABM conclusions (which emerged out of the full complexity of the model).

Figure 2. A simplified illustration of some of the factors emerging from the ABM of the service provision system as “bottlenecks” (arrows are processes **the cylinders are the bottlenecks**)



In different systems (e.g. at different levels of maturity) different bottlenecks might dominate how the system is working overall. The final bottleneck of the supply of long-term accommodation has the power to “back up” the whole system, regardless of how well the other stages are provided. The constraints might be different for households with different characteristics, since suitable accommodation and support services may not be available for those with less common needs. In an immature system, where there is an insufficient suitable safe accommodation and only some support services are available, it may not help overall to address the first bottleneck concerning how to contact support services as the system might be overwhelmed by the demand. To be able to provide all the services needed for more of the households needing help all the bottlenecks will need improving, since any one can frustrate the whole system.

6.2 Reflections on designing and delivering the ABM

There is no limit to the detail, accuracy and complexity of agent-based models, so it is always limitations in terms of time, evidence and feedback that determine when it is finished, which means there is always more that could be done. However, the ABM has achieved many of its goals, as outlined in section 6.3.Model assumptions can always be questioned and improved. The iterative approach has helped in that process, but any conclusions from the modelling need to be considered and substantiated alongside other conclusions from the evaluation (e.g. the QCA analysis) and assessed with respect to the real-life contexts.

The application of agent-based modelling within policy evaluations within the UK is still highly novel, so is it learning process for both analysts and policy actors in terms of determining its boundaries and goals, how it fits within the evaluation cycle and timeframes, and understanding how it might be best utilised. Although there is an

introduction to complex computational modelling and coloured books within government for modelling and evaluation, there are not specific guides for using ABMs there. The presence and collaboration of individuals with expertise in policy and analysis helped in the interactions in this case. Since one role for ABM is the analysis and integration of different kinds of evidence, integrating its development within the processes of evidence gathering (both utilising data as it comes in and informing the collection of further data) will increase its utility. This involves planning for this at the very start of such an evaluation exercise but adds another strand to the complexity of an evaluation.

6.3 Progress against general goals

As summarised in Table 7 the model has achieved some, but not all, of its original goals.

Table 7. Evaluation against general modelling goals

General Goals	Progress in Version 4	Key learning
Refine ToC	The model now contrasts mature and immature cases contributing a bottom-up view to the ToC. In particular identifying potential areas of development to prioritise when considering developing a domestic abuse service system.	Whilst a shift from immature to mature domestic abuse service systems made a significant impact on outcomes; this was due to multiple dimensions improving. The supply of move-on accommodation and having more safe accommodation that is suitable for households with a broader range of characteristics helped in all cases.
Identify key gaps in data	Significant gaps in knowledge for the modelling were identified, some of which were later supplied, though not all (e.g., sanctuary schemes).	There are areas where creative problem-solving is done by established providers to get around system limitations that were not known or modellable.
Additional robustness check	The regression models produced during the evaluation were finalised at the end of version 4's development.	The model outcomes were checked against the MI figures in two contrasting LA cases.
Processual risk analysis	Some of the processes that can frustrate (and enable) the effective provision of domestic abuse support services have been identified and the reasons suggested by the ABM.	The impact of improvements in management, coordination and skill by coordinators and providers can be frustrated by other constraints such as availability of move-on accommodation or the diversity of dispersed accommodation available.
Diagnostic tool	The ABM looked at the role of move-on accommodation supply and some of the factors that might have frustrated the supply of support services to households with less common characteristics.	The model suggests that easing constraints (i.e., restrictions on who can access) on the provision of support services for those with less common characteristics may lead to the largest improvement in victim-survivor outcomes.
Aid cautious general-isation	The model has suggested some causal patterns that may be generalisable. The extent to which this will help generalisation can only be evaluated by others in the full knowledge of all the evaluation conclusions.	

6.4 Documentation

Archiving, full documentation and Sensitivity Analysis of the ABM

The model code, the documentation of the model using the latest version of the ODD standard and a more extensive sensitivity analysis will be made available on the CoMSeS simulation model archive under an open license so anyone (accepting similar conditions) can download, inspect and use it[13].

[13] The model will be available at https://www.comses.net/codebases/e8cdbb3c-9b4a-4b7b-9ba0-77961853d82f/
Details about archiving are available at https://forum.comses.net/t/why-archive-your-model/7376