



Protocol for Using the Mushroom HHSM

**REDUCING PLASTIC PACKAGING AND FOOD WASTE THROUGH
PRODUCT INNOVATION SIMULATION**

The Household Simulation Model (HHSM)

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THE HOUSEHOLD SIMULATION MODEL

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1. Introduction

The HHSM is a simulation tool that models household behaviours and decision-making processes related to food and packaging waste. The model can evaluate the effectiveness of waste reduction interventions and identify trade-offs and factors contributing to household waste generation.

This protocol provides instructions for using the Mushroom HHSM to simulate food and packaging waste in UK households. The protocol includes information on model assumptions, data requirements, model validation, model outputs, and how to use the model to simulate the UK default scenario. Additionally, a user manual is available under request for further details to create a better user experience and provide further support in the simulation of different research scenarios.

The application of the Mushroom HHSM goes beyond its primary application, demonstrating the capacity to simulate waste generation associated with various forms of fresh produce. This is relevant to food items that, like mushrooms, are typically subjected to cooking within households and where the cooked leftovers can be stored by freezing. As such, the Mushroom HHSM is a versatile tool for scholars interested in studying waste generation patterns and examining waste reduction strategies for a wide set of perishable food items.

2. Materials and methods

The simulation of the Mushroom HHSM requires the use of two files:

- The **model file** developed in **Arena Software version 16.2** (Rockwell Automation, 2022) simulates mushroom packs flow from the supermarket stocking shelves to their consumption and disposal in households. The model consists of six modules: (1) Initial data, (2) Market, (3) Shopping, (4) Storing, (5) Consumption and (6) Expiry.
- The **input/output Excel file** links with the model file using VBA syntax. This Excel file sources the model with the required data and

contains the simulation results. The input/output Excel file is organised into three sections:

1. *Input section.* A series of input variables can customise each module to simulate different product characteristics (e.g., visual score), market interventions (e.g., pack size and type placed in the supermarket) and household behaviours (e.g., shopping patterns, leftovers consumption).
2. *Output section.* When a simulation is completed, its results are updated in this section of the Excel file.
3. *Summary in the tab called 'Results A'.* This section summarises and displays the simulation results in graphical form.

2.1 Model Assumptions and Data Requirements

The HHSM assumes that households' behaviour is influenced by a range of factors, such as the characteristics of the packs available on the market and consumer behaviours and attitudes towards food consumption and waste found from empirical data and published research studies (e.g., food storage practices, purchasing habits and packaging information from national surveys, government statistics and published research studies).

The HHSM also allows the simulation of different household archetypes to reflect the food and plastic waste generated in a range of households across the UK population (see Table 1). These household archetypes are based on WRAP's segmentation of the UK population and provide information about the household occupants and their attitudes and behaviours related to waste.

2.2 Model outputs

The HHSM generates weekly average outputs or a range of variables related to household food and plastic waste generation, including the amount of mushroom wasted, plastic waste generated, household consumption and requirement unfulfilled. The outputs also include the wasted/purchased and

unfulfilled/required ratios that provide insight into the effectiveness of waste reduction interventions.

TABLE 1. Household archetypes for the UK population based on segmentation research by WRAP (no reference available)

<i>Household archetype</i>	<i>Weight (%)</i>	<i>Brief description</i>
<i>Aspiration Discoverers (AD) family</i>	11.4%	4-person household, younger children, not willing to take risks with food, confident, good planning, moderately likely to throw away leftovers
<i>Functional Fuellers (FF) single</i>	16.6%	1-person household, less willing to take risks, low confidence in the kitchen, poor planning, likely to throw away leftovers
<i>Functional Fuellers (FF) couple</i>	8%	2-person household, no children, less risk averse, low confidence in the kitchen, poor planning, likely to throw leftovers
<i>Spontaneous Creatives (SC) single</i>	11.4%	1-person household, less risk averse, moderately low confidence in the kitchen, poor planning, leftovers likely to be thrown away
<i>Spontaneous Creatives (SC) couple with one child</i>	16%	3-person household, one child, more risk averse, moderately low confidence in the kitchen, poor planning, leftovers likely to be thrown away
<i>Ideal Advocates (IA) couple</i>	16.8%	2-person household, no children, less risk averse, high confidence in the kitchen, good planning, leftovers will be used
<i>Pressured Providers (PP) family</i>	9.6%	4-person household with (generally older) children, medium confidence in the kitchen, good planning, leftovers will be used
<i>Pressured Providers (PP) single-parent family</i>	10.2%	2-person household, single parent with a teenager, medium confidence in the kitchen, good planning, leftovers will be used

2.3 Model validation

From empirical and bibliographic data, a default scenario with specific input parameters was constructed and validated for UK households. The user

manual for the Mushroom HHSM (available upon request) discusses the input data for this default scenario.

2.4 Simulation of the Grapes HHSM

The following steps outline how to simulate and obtain the results using the HHSM (for a detailed explanation, please refer to Chapter 8 of the user manual):

1. **Inserting input data in the input/output Excel file to create the required scenario.** Open the Excel input/output file and make the required changes in the sheets corresponding to the different modules of the model. Then, save the input/output file on the computer desktop with the name 'Output data' and close Excel.
2. **Simulation of the required scenario in Arena.** First, open the Grapes HHSM developed in Arena. Next, import the input/output Excel file renamed in the last step as 'Output data' into the model. Then, run the simulation by clicking the fast-forward button in the interaction group. Arena will show a window stating 'Maximum Number of Input Sets to be considered = 8. This means the maximum number of HH archetypes the model can simulate per each simulation is 8. Press OK to continue. Then, the simulation's Main Control Panel will appear, and the number of replications, replication length and the number of input sets required for the simulation will be inserted. Finally, click 'Start Running,' and the simulation will start immediately.

Once the simulation is finished, Arena will close and then restart automatically. The user can now check the simulation results, which will be shown in the input/output Excel file used as the input file in the simulation.

3. **Obtaining the output parameters.** Open the 'Output data' file'. Then, click the 'Run this Scenario' button in the file's 'Results A' tab. The results of the default scenario will be shown here and in the five output sheets. In order to extrapolate the results of the different archetypes to the UK

general population, a weighted average can be used using the weights of each household archetype shown in Table 1.

References

- Reynolds, Christian and Fayad, Ramzi (2023). Reducing Plastic Packaging and Food Waste Through Product Innovation Simulation: Household Simulation Model for Grapes, 2021-2023. [Data Collection]. Colchester, Essex: UK Data Service. 10.5255/UKDA-SN-856554
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