Speeding up the transition to a more sustainable food system: New insights into the links in a system of practices

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Speeding up the transition to a more sustainable food system: new insights into the links in a system of practices

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Abstract

More sustainable food choices are part of a complex system that combines practices, which themselves are interconnected in a network of elements made up of competences, meanings and material devices. The present article proposes an innovative method for studying this system through a non-deductive quantitative approach. The research adds to the corpus of the 'theory of practices' by defining the concepts of 'central' practices (i.e., connected to many elements of the system, such as the practice of buying and cooking sustainable products in the sustainable food system) and 'peripheral' practices (i.e., connected in a lesser extent to other elements of the system, such as the practices of anti-waste, growing your own food, and the consumption of plant proteins). It also highlights the 'connector' role between the practices of certain elements. Finally, based on the current structure of the system of sustainable food practices, the article makes several propositions for speeding up change.

Keywords

Sustainable food, Theory of social practices, System of structural equations, Interpretative approach, Food systems

When over one third of greenhouse gas emissions caused by human activities are food-related (Crippa et al., 2021), moving towards a sustainable food system becomes a key transition. However, food is about more than just what we eat: it includes the food we buy, where we buy it, how we prepare and cook it, and even how we store it and manage the waste it produces. A French Senate report about moving towards a sustainable food supply (*Vers une alimentation durable*) (Cartron and Fichet, 2020) considers food, or the 'food system', to be all of the actors and activities that play a part in feeding human beings, from farm to fork. This naturally places food at the heart of sociological, health-related, ecological and economic issues, and helps to guide thinking towards a more sustainable food system.

In response to these challenges, and at the consumer level, guiding people's behaviours towards sustainable food usually involves changing their food system by changing practices that are mostly daily (purchase location, purchase type, meal preparation method, etc.) and interdependent. For example, meal preparation depends on an individual's competences and influences purchase location. The theory of social practices is used in this study to understand the system individuals fit into, and is increasingly used by researchers in sociology and consumer behaviour to analyse the current changes in energy, ecological and societal transitions (e.g. Halkier, 2009; Dubuisson-Quellier and Plessz, 2013; Evans et al., 2017; Roques and Roux, 2018). It provides a theoretical framework for mainly qualitative approaches and therefore allows changes in practices to be described in depth and in detail. The drawback, however, is

that sometimes these studies are not enough to convince decision-makers, in particular public authorities, of the transferable and generalizable nature of the knowledge produced and of its value for decision-making.

In this theoretical framework, the emergence of a new practice is understood *through* a reconfiguration of the roles perceived by the actors based on interactions between elements such as material devices and objects used, attributed meanings (social and personal), and the actors' competences and knowledge (Shove and Pantzar, 2005). Even though these roles can be perceived and understood through a qualitative methodology, a quantitative methodology would make it possible to clarify the importance of the interactions between the practice's elements. However, estimating how influential these elements are in the evolution of the practice remains a challenge and it is still difficult to operationalize the theory to provide answers to the fundamental issues specific to a sustainable marketing approach. This study will address these challenges and consider how consumers can be encouraged to adopt sustainable food practices. More specifically, it will examine the drivers that should be used for encouraging people to engage in more sustainable food practices.

The first objective of this article is theoretical. Understanding a practice means setting out the links between the elements of that practice. Identifying the possibilities of increasing the sustainability of a food practice also means establishing a hierarchy between the elements according to the contribution they make to a sustainable food practice. The contribution of this research is therefore twofold: firstly, it allows us to unpack the system of sustainable food practices, and secondly, it adds to the corpus of practice theory by highlighting 'core' practices in a system and their relationship to 'peripheral' practices. Our results indicate that in the case of the sustainable food system, the central practice consists of actions around buying and cooking sustainable products, and the periphery practices are anti-waste, growing your own food and the consumption of plant protein.

The second objective is methodological. Identifying the contributions of the basic sets in a food ecosystem as it transitions towards greater sustainability involves studying practices from an original methodological angle, thus making it possible to take a more detailed look at potential incentive drivers. Gaining an understanding of an ecosystem is almost always done through a qualitative approach from an interpretative angle (Robert-Demontrond et al., 2020). However, such approaches struggle to measure the links between the system's elements, which then makes it difficult to make recommendations about overall performance. The originality of the present study is that it adopts a quantitative and interpretative approach, by using an inductive quantitative approach adapted to the theory of social practices, to examine several alternative theoretical models in great detail. This positioning is based on studies in the discipline that call for quantitative approaches to be used less often (Brabet, 1988; Galan, 2011). The aim of this research is to build theory and is part of an exploratory approach. Although these approaches are often associated with qualitative methods, according to Hammersley (1992), there are other objective-method combinations that are perfectly reasonable.

The third objective is managerial. It aims to provide concrete solutions to speed up changes in sustainable food practices by distinguishing the drivers to be used to encourage such practices. These incentive drivers are directed at consumers, but are also used by different stakeholders in the food system: industrialists and distributors participating in economic and regional dynamics, and public authorities, *via* incentive and support policies. The results of the study show in particular that competences are a key element in sustainable food practices, thus supporting the idea that enhancing consumers' food sustainability competences is a major driver for speeding up change. Empowering all of these actors to work towards a sustainable food system in a way that has a positive impact on their well-being, on society and on the planet,

thus places this research and its managerial objective in the framework of responsible marketing research, according to Haenlein et al. (2022).

The article proceeds as follows: after presenting a state of the art and current knowledge on the system of sustainable food practices, and the strengths and limitations of using the theory of social practices, the methodology and results are presented in detail. The final section discusses interpretations and implications of the results obtained, and the conclusion addresses how these implications can be exploited to speed up transitions.

Understanding the system of food practices through the theory of social practices

Conceptually, 'food' is a term with multiple interpretations. It can refer to eating behaviours, to emphasise the activity of eating, which also includes purchasing and preparing food (Dyen et al., 2018). More generally, as advocated by Senators Cartron and Fichet in their report (2020), 'food' can be replaced by the term 'food system' and can encompass all actors and activities that contribute to feeding human beings. These conceptions underline that the content of people's plates is strongly linked to specific social and identity frameworks, particular material facilities and purchase environments, and lifestyles. We will therefore use the term 'system of food practices' to take account of the integration of food in an interconnected network of competences, meanings, material and human devices.

Sustainable food

From the consumer's perspective, understanding the subject of sustainable food implies taking into account all food practices that have an impact on ecological transition (Verain et al., 2015; Whittall et al., 2023). In terms of environmental impact assessment, product life cycle analysis is the methodological reference (Institute for Environment and Sustainability, 2010). It addresses the issue from different stages of the food's life, over a person's life span (ADEME, 2016, 2018).

This is why sustainable food encompasses a very broad scope, combining (1) diet, (2) product choices, and (3) domestic practices that emit little (or less) greenhouse gases (GHGs), but are also less resource-intensive and less polluting.

Sustainable diet Today, this mainly concerns the moderation of animal protein-based foods, which are high emitters of GHGs, notably through flexitarianism or the more radical and less frequent vegetarianism or veganism (Biermann and Rau, 2020; Xu et al., 2021; Laisney, 2016; Mathieu and Dorard, 2021). However, introducing products with a high nutritional value into one's diet, and moderating one's diet in general, is also part of the definition of these diets. Finally, and this is connected to the second aspect of sustainable food, sustainable diets also include the notion of seasonal produce and are therefore more often local, less processed and less packaged (Haut conseil de la santé publique, 2017; WWF and Eco2 Initiative, 2017; Fardet, 2017).

Sustainable food products are defined through more sustainable production, processing and distribution. This includes labelled products – such as organic products – which act as product guarantees, or their composite ingredients that are grown without synthetic chemicals, without GMOs and that preserve animal welfare in the case of livestock farming (Sommier et al., 2019; Agence Bio, 2021); or North-South and North-North fair trade products based on fair remuneration for producers and respect for the environment (WFTO, 2017), and sustainable fishing labels. Sustainable food products are also characterised by their minimal processing, a guarantee that nutritional content is preserved (Fardet, 2017), and by low-impact (Guillard et al., 2018), minimal packaging, and packaging-free refillable groceries (Reniou et al., 2021). In the category of sustainable products, local products are included, even if the link between short

local circuits and a better environmental balance can only be proved under certain conditions (ADEME, 2017), although they are a strong marker of sustainability for consumers (Abid et al., 2020).

Finally, *sustainable uses in the home* will be influenced by certain choices made during purchase: mobility, frequency, growing your own food, etc. (Van de Walle, 2013). The sustainability of these uses will also depend on less waste-generating behaviours (Le Borgne et al., 2016), related to product storage (Farr-Wharton et al., 2014), and also ways of cooking (Evans, 2011; Halkier, 2009). Finally, food sustainability also includes waste management through sorting (Monnot et al., 2014).

According to Hennchen (2019), most studies seeking to understand the drivers of food trends and how to exert a greater influence over them so that they move towards greater sustainability come up against a difficulty which arises from adopting the same cognitive assumption: increased knowledge leads to better decisions (for example, by favouring healthier products), through more rational behaviours. Thus, 'traditional' recommendations lead to improving information with the actors, and where appropriate are accompanied by intrinsic incentives (healthy diet). Clearly, according to the results of a study by the French Agency for Food, Environmental and Occupational Health & Safety (ANSES) (INCA3, ANSES, 2017), this cognitive orientation does not appear to be sufficiently effective: it does not automatically follow that information made available will be used, and therefore, consumer guidance needs to be provided at the same time. Nudges have been shown to be effective in several contexts, such as out-of-home catering, to improve food choices (Cadario and Chandon, 2020). However, authors have highlighted their limitations because the effects diminish over time and may not be well accepted by the target audience. Here again, nudges used alone are not enough and education, including more transparency in the objectives of operations, is necessary (Cadario and Chandon, 2019; Girardon et al., 2022). More social approaches can therefore be recommended, and adapted to the understanding of food patterns. The field of study of such approaches is a community of individuals, the phenomenon studied is then the food pattern shared *through* rules of action, norms and values that have been collectively adopted. However, as food habits are rooted in specific conventions and cultures, their evolution seems slow.

Theory of Social Practices (TSP)

The advantage of TSP is that it builds on previous orientations (Robert-Demontrond et al., 2020): it recognises that individuals have knowledge, competences and emotions, and takes into account rules and norms that are collectively applied, and that actors evolve in specific individual material framework (e.g. the home) as well as collective arrangements (e.g. access to waste sorting facilities). Consequently, TSP considers that actions cannot be explained directly by the individual and their cognitive system, or completely by the social rules of the social system in question, as actions also depend on material mechanisms and their use. The main subject of study is therefore no longer the individual or a group of individuals, but the action itself and the practice corresponding to '*a routinized type of behaviour which consists of several elements, interconnected to one other: forms of bodily activities, forms of mental activities, 'things' and their use, a background knowledge in the form of understanding, know-how, states of emotion and motivational knowledge*' (Reckwitz, 2002). Consequently, the main object of study shifts from actors (and in particular their deliberate decisions) to practices and their adoption and evolution. This shift in focus allows us to work with a more contextualised understanding of food-related decisions and behaviours (Hennchen, 2019) and to gain a better understanding of their dynamics.

System of practice elements.

Beyond the ontological positioning of TSP, its originality also lies in its systemic consideration of practices. As such, routines emerge not only from the presence of various elements, but also by their connections made by the actors (Spurling et al., 2013) and the importance they attach to them. More specifically, for Shove et al (2012) (following Røpke, 2009 and Hargreaves, 2011), practices emerge from the interconnection of three types of elements: competences, meanings and the material environment.

Competences cover all the knowledge, skills (physical or cognitive) and know-how to carry out the practice and to function in an appropriate way, in compliance with certain social rules (Reckwitz, 2002; Schatzki, 2002; Warde, 2005). This element brings together the different forms of knowledge identified in environmental and social psychology, recognized for their more or less strong influence in changing individual behaviours: theoretical knowledge, procedural knowledge and evaluative knowledge (Kaiser and Fuhrer, 2003), to which some authors add a social dimension, involving subjective understandings, with social norms and expectations (Redman and Redman, 2014). In this context, theoretical knowledge, which is constructed from the information transmitted, has relatively little influence on behavioural change, unlike procedural and evaluative knowledge (Redman, 2013). The latter correspond to concrete skills or to knowledge that estimates the effectiveness of actions. For example, knowing the best way for storing food (procedural knowledge) is a prerequisite for limiting waste and cooking to current hygiene standards; knowing that a conventional meal emits an average of 1.35 kg/CO_2 eq (carbon dioxide-equivalent) while a steak meal emits 6.3 kg/CO_2 eq, and a vegetarian 0.5 kg/CO_2 eq[1] (evaluative knowledge), provides a 'scale' in the effectiveness of diet choices.

Meanings refer to an individual's mental activities that are associated to a practice. In contrast to competences and material elements, it seems more difficult to reach a consensus on a precise definition of the scope of these mental activities (Shove et al., 2012). According to the various definitions that have been proposed (and in particular those of Reckwitz, 2002; Schatzki, 2002; Shove et al., 2012, which are key studies), they would be translated into motivations, goals, projects, beliefs, or emotions and affective states during practice, to finally aggregate into a posteriori meaning (Innocent, 2017). For example, the motivation to purchase soy-based foods may be derived from a desire to reduce meat intake and lower the risk of cardiovascular disease, and justified by having what is perceived to be a lower environmental impact. The meaning associated with the product is therefore *ultimately* that of a better choice for health and the environment. For the sake of simplification, Shove et al (2012) propose to define meanings as 'representations associated with a practice, which give it meaning'. These authors thus establish a link between meanings and social representations. Lahlou (1995) describes the latter as a structured set of intersubjective cognitive elements that represent the common space of possible representations. Individual mental representations (Gallen, 2005) are considered as subsets of this space.

Materiel environment concerns objects, infrastructures, tools, software and the body itself insofar as it enables action (Shove et al., 2007; Shove et al., 2012). In the case of food practices, this may involve the domestic material environment such as kitchen layout or utensils available, as well as the outdoor material environment such as the different shops to which individuals have access or digital applications enabling them to find specific products, particularly organic, local or packaging-free refillable groceries (Innocent et al., 2021).

[1] Source: Base Carbone© de l'ADEME: https://bilans-ges.ademe.fr/

This interconnection of elements gives properties to the system of practices, including the fact that it can change. This dynamic comes from the evolution of some of these elements and their links. Thus, acquisition of new competences, and changes in material conditions or meanings lead to a change in practice(s). In parallel, through the association and combinations of a variety of these elements, and through their repetition, practices evolve over time (Shove et al., 2007; Shove et al., 2015; Warde, 2005). Practices are therefore to be conceived in a dynamic way, in their evolution and/or potential for evolution (Shove et al., 2012). Consequently, studying the elements of a system of practices and their interactions helps to understand the implemented practices and their actual or potential dynamics. Figure 1 shows the three elements and their interconnections to represent a sustainable food practice.

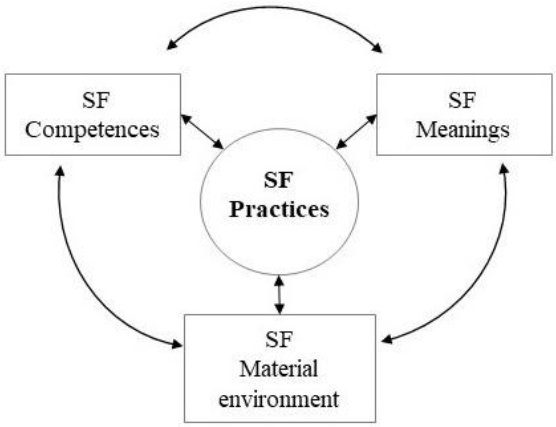

Figure 1: The sustainable food (SF) system

Related practices

Carrying out practices also requires the implementation of chains of action that can encompass several aspects of social life (Schatzki, 2011). Several daily practices can therefore be linked. This is the case for food consumption, since the purchasing/preparation/storage/eating activities are practices in themselves and combine with one another (Warde, 2016; Webb, Mohr and Harris, 2008). In this sense, what has been called the system of food practices amounts to a set of practices related to the notion of food. Shove et al (2012) highlight the importance of focusing on these linked practices, which often have one or more defining elements in common. For example, although buying local and having a vegetable garden to be self-sufficient and grow your own food are two different practices, it seems plausible that both practices are associated with certain common representations in the minds of individuals. Therefore, to understand how several related practices evolve, the network of elements that they share needs to be defined. Furthermore, the idea that meanings, which can be related to representations, could be shared by several related practices, prompts questions about whether a hierarchy exists in related practices. Indeed, it can be hypothesised that a system of several related practices can contain both central and peripheral practices, just as it can central and peripheral representations (Abric, 2014).

Applying TSP to the system of food practices: obstacles to overcome

The literature points to two main obstacles in the general application of the TSP, and its application to the food sector in particular.

The first is scoping the field of practices to be studied. The notion of a system of food practices means that activities never occur in isolation; practices are therefore always embedded in the

interconnections of activities, which must be identified to understand the observed phenomenon (Aricia et al., 2021). However, this identification remains difficult and is generally more conceptual than empirical (Nicolini, 2012). (2021), the practice of eating has not been fully understood: eating is a highly personal and social act that is intrinsically linked to many other central processes of daily life (Paddock, 2015; Warde, 1997).

This systemic and integrative consideration of practices often clashes with the positivist orientation of most research approaches, in which causes and effects can be isolated and controlled, and the (often incremental) changes tracked and counted. However, for Watsona et al (2020), practice theory may give rise to difficulties in attributing impact, while diffusion of responsibility ideas that emerge from research on social practice study make it more difficult to hold particular organisations to account (Evans et al, 2017).

This difficulty relates to the second obstacle in the application of TSP, which is a methodological one. The study of practices requires an understanding of the competences and roles of individuals and how they use the material devices at their disposal (Dubuisson-Quellier and Plessz, 2013). Narrative and ethnographic methods are therefore often adopted, but these methods, based on interviews or observations, generally involve a limited number of participants which makes it difficult to generalise the results obtained. Furthermore, questions can be raised about whether it is appropriate to study a practice through discourse (Robert-Desmontrond et al., 2020), whereas practice theory places the practice at the heart of the system, as the individual is only the bearer. Multi-approach studies are still rare, like those of Plessz et al. (2016) or Dubuisson-Quellier et al. (2019) who combine quantitative data with qualitative study to examine the impact of government directives or market requirements on individuals, rather than simply studying how the recommendations are integrated into food practices.

The limited amount of work and the aforementioned methodological tensions lead to the additional difficulty of obtaining, in a quantitative approach, reliable measures of the different practice elements. For example, in this study we had to make a choice about the measurement of meanings. This was done through consumption values as the link between values and representations is supported by several authors, both in marketing and in sociology (Marion, 2013; Heinich, 2019). Indeed, for Marion, the notion of values is the observable trace of evaluation processes, and thus reflects the rational, but also emotional, aspects of the subject-object interaction. As the proposal has recently been extended from objects to practices (Innocent and François-Lecompte, 2020), the concept seemed to us to be adaptable.

In summary, the TSP is an appropriate conceptual framework for food research: it reveals the complexity of food practices by focusing not only on three types of elements (competences, meanings and material devices), but above all on their interactions and on the links between the various practices. In a systemic approach, a system can renew itself by modifying its connections. By borrowing from the systemic approach the ability of a system to renew itself by modifying its connections, TSP makes it possible to study the dynamics of food practices and the ‘mechanisms’ that favour the emergence of specific practices. However, while the elements of a practice and certain roles are regularly identified in studies, the links between these elements and between the related practices are more difficult to analyse. This major limitation is linked to the methodological choices made, particularly the corpus selected and the collection tool used. By using a quantitative approach, the research presented therefore makes it possible to offer a representation of the system of sustainable food practices, as experienced by consumers, while identifying the drivers of an effective sustainable food practice and precisely determining the influence of each factor that leads to the adoption of this practice.

Methodology

A quantitative study was conducted to ascertain the most effective drivers for sustainable food, and to measure the relationships between the elements of a practice.

Data collection and respondents

The data was collected online at the beginning of 2020[2] from a sample of respondents selected by an access panel company; 501 usable questionnaires were retained[3]. The representative nature of the sample, with regard to the French metropolitan population, was ensured by the quota method on five socio-demographic criteria: age, gender, social class, level of education and place of residence (region). There is a slight difference in the representation of certain age groups and education levels compared to the metropolitan population (Appendix 1).

Presentation of measuring instruments

The study focused on four types of variables, with reference to the system presented in Figure 1: actual practices, competences, meanings and the material environment of sustainable food. These were assessed using reliable measurement scales that had been validated by previous studies.

Actual practices were measured by a 28-item practice scale representing 5 dimensions (Divard et al, 2020a).

- First (16 items) dimension: called 'buying and cooking products with sustainable attributes', is characterised by a set of practices with increasing degrees of difficulty in terms of buying local, seasonal products, packaging-free and refillable groceries or items from the deli counter, labelled products (organic, fair trade, sustainable fishing), and certain everyday practices such as home cooking. This dimension is measured using a score from Item Response Theory (IRT) model, and its reliability is ensured using the SepRep separation coefficient[4]. A polytomous IRT model[5] was used because it can determine the latent trait common to actions that the classical measurement theory approach would have separated into distinct factors (such as purchasing modes and choice of labelled products), while taking into account the probability of respondents carrying out these acts.
- Second dimension: anti-waste food preservation practices (5 items).
- Third dimension: anti-waste practices in the kitchen (3 items),
- Fourth dimension: growing your own food (2 items),
- Fifth dimension: consumption of plant proteins (2 items).

These last four dimensions are based on classical measurement theory. It should be noted that the frequency of meat consumption was tested during the creation of this measurement tool. It was unsuccessful since this variable does not seem to be part of any of the latent practice variables identified.

Competences, which are self-assessed, are measured by 15 items representing 4 dimensions: (1) cooking skills, (2) knowledge of local offer, (3) knowledge of labels, and (4) slightly more technical knowledge about packaging, waste sorting, and seasonal products (Divard et al.,

[2] Also, before the first COVID-19 lockdown in France.

[3] These questionnaires corresponded to the quality conditions we had set, i.e. a response time equal to or greater than 8 minutes (time considered necessary for answering correctly), and no repetitive responses to the item scales.

[4] SepRel (separation reliability) is comparable to Cronbach's alpha (Petrillo et al., 2015).

[5] In the present study, we used a model with 5 response modalities on the frequency of carrying out the proposed actions (from never/rarely/often to always/all the time). For some questions, we proposed a 'not concerned' modality to limit the social desirability bias. These responses were recoded in the 'never' modality.

2020b). The measurement tool was previously tested on a convenience sample (n=571) and was refined on this occasion. The items mainly concern procedural knowledge (cooking skills and local offer) and evaluative knowledge (knowledge of the guarantees offered by different labels). A few items concern more theoretical knowledge, such as knowledge about seasonal fruit and vegetables.

Measurement of meanings is carried out through the concept of consumption values, and takes into account benefits and costs or sacrifices associated with sustainable food practice. Several steps were involved in the construction of the measurement tool. First, we adapted a scale from another responsible practice (Innocent and François-Lecompte, 2020). To ensure that the scale covers all of the meanings associated with sustainable consumption, the tool was initially tested on a sample of 528 respondents. This allowed the initial 23 items to be refined; at this stage, the tool was composed of 21 items divided into seven components, one of which dealt with the social dimension of sustainable food. However, this component had low reliability, so it was deleted and some items were reworded following further qualitative pre-testing of the scale. An 18-item tool, divided into six theoretical components, was thus administered. Confirmatory factor analyses (CFA) with partial least squares path modelling (PLS-PM) were conducted on these six components. The results led to a simplification of the measurement tool into three factors: two for the valuation of sustainable food and one for its devaluation (i.e. 'costs'). Ultimately, the valuation consists of two components: one relating to the collective objectives of sustainable food – environmental and civic actions – and the other to well-being and health-related benefits that more directly affect the individual. Therefore, grouping these items together makes sense from a statistical and theoretical point of view. As the construct is reflexive and the reliability indicators (Cronbach's α and Dillon-Goldstein's Rho) are of very good quality, the total number of items was reduced to 11 for the sake of parsimony.

Material environment was measured using the four spheres of material enablers identified by Innocent et al. (2021): 'Housing and personal equipment', 'Environment in close proximity', 'Purchase area' and 'Digital environment'. Two to three items were created for each sphere, with a total of 11 items. A system of binary yes/no response modalities was used, as this was not an appreciation-based dimension but a matter of access or possession. The tool was then pre-tested with around twenty people. To study how the material environment of sustainable food is structured, from a statistical perspective, we carried out a multiple correspondence analysis (MCA[6]) between the various items proposed in the questionnaire. This method makes it possible to study the association between different qualitative variables. The results show a two-factor structure that differentiates between the domestic material environment, mainly associated with housing and individual equipment, and the outdoor environment, which includes purchasing arrangements in particular. The full set of measures is presented in Appendices 2 to 5. The reliability and validity indicators of the different measures are specified in Table 1.

[6] Multiple Correspondence Analysis (MCA) is to qualitative variables what Principal Component Analysis (PCA) is to quantitative variables. It is mainly used to produce visual representation maps of the similarities between the categories of qualitative variables and observations (Jolibert and Jourdan, 2011).

Table 1. Reliability indicators of the measurement tools

			Indicators	
Name of measure	Accuracy of meaning of the measurement	No. of items	Reliability SepRel ρ D.G.	Validity ρ_{vc}
Measuring sustainable food practices				
Practice: Buying and cooking sustainable products	Buying and cooking products with sustainable attributes: home cooking, sustainable cooking methods, buying different types of organic, local, seasonal, products from deli counters, etc.	16	0.90[2]	-
Practice: Anti-waste storage	Anti-waste food storage and conservation measures: putting products with a short shelf life at the front, checking cupboards, etc.	5	0.81	0.37
Practice: Growing your own food	Supply by growing your own food: consumption of products from your own or your entourage's garden.	2	0.89	0.59
Practice: Plant proteins	Consumption of plant proteins: legumes and drinks, plant-based desserts or cakes, etc.	2	0.79	0.34
Practice: Anti-waste cooking	Anti-waste cooking: using leftovers, preparing improvised meals and keeping surplus food for a long time.	3	0.78	0.41
Measuring competences associated with sustainable food				
Competence: Culinary	Culinary skills: knowing how to cook raw products, legumes, knowing how to use leftovers, etc.	5	0.88	0.49
Competence: Local offer	Knowledge of the local offer: knowing the sales outlets for sustainable products, their location, and opening hours.	4	0.89	0.59
Competence: Labels	Knowledge about sustainable labels: organic, fair trade and sustainable fishing.	3	0.94	0.75
Competence: Technical	Competence: Technical: sorting, seasonality, packaging.	3	0.77	0.28
Measuring benefits and costs associated with sustainable food practices				
Collective benefits	Environmental and civic benefits of sustainable food practices.	3	0.88	0.57
Individual benefits	Individual health and well-being benefits associated with sustainable food practices.	4	0.91	0.62
Costs	Costs of changing habits, organisation, purchase locations, time and information associated with sustainable food practices.	4	0.89	0.55
Measuring sustainable food practices using the material environment score				
Material environment: Domestic	Material environment: Domestic: owning a garden, waste separation equipment, etc.	5	*NC (not concerned)*	
Material environment: Outdoor	Material environment: Outdoor: accessible sales outlets and digital localization platforms, containers for the purchasing of packaging-free refillable groceries.	6		

A quantitative interpretative approach

The objective of the research is to explore the links between the main elements of sustainable food practices, without any initial preconceptions about the causal links between these different elements. In this sense, our scientific project is close to the interpretativist hypothesis, according to which human activities are not erratic but present certain regularities (patterns) that are temporarily stable (Yanow and Schwartz-Shea, 2006; Avenier and Gavard-Perret, 2012). This exploration between the elements of a practice is based on the general framework of theory of social practices (TSP) proposed by Shove et al (2012). TSP thus makes it possible to start from the general hypothesis that there are links between these different elements in the sustainable food practice system, and that these links reflect an 'intersubjective objective reality TSP' through shared meanings (Sandberg, 2005).

Therefore, the only starting position on which our model is based is that the degree of practice depends on the strength of the links between the different practice elements.

To test this model, we used Structural Equation Modelling (SEM). Our approach differs from the classical use of SEMs, which are mainly used in a hypothetico-deductive approach. However, some studies draw attention to the use of quantitative methods in an interpretativist epistemological framework and, more specifically, underline the relevance of quantitative modelling using SEM in this context (Brabet, 1988, Galan, 2011; Massa, 2014). This is a common practice in the ecological sciences, where the discovery of significant statistical relationships in a corpus of data (i.e. 'signatures') often leads to the advancement of theoretical models to the extent that researchers are able to isolate the variables likely to explain a phenomenon (Marquet et al., 2014; Servedio et al., 2014; Houlahan et al., 2017). These questions are increasingly arising and being debated in the human sciences, where big data and algorithmic processing make it possible to identify statistical patterns in large amounts of various data (behavioural, biological, physiological, etc.), and to make relatively precise predictions (Huneman, 2023).

The approach consists in the creation of structural sub-models testing certain relationships. These sub-models are analysed and interpreted to feed into the creation of one or more global structural models that correspond to a representation of the phenomenon studied (Massa, 2014). The aim here is to rigorously explore the various sub-models (Figure 2, M1 to M6) based on the theory of social practices (Shove et al., 2012), with the use of competitive orientation in the statistical links between the latent variables.

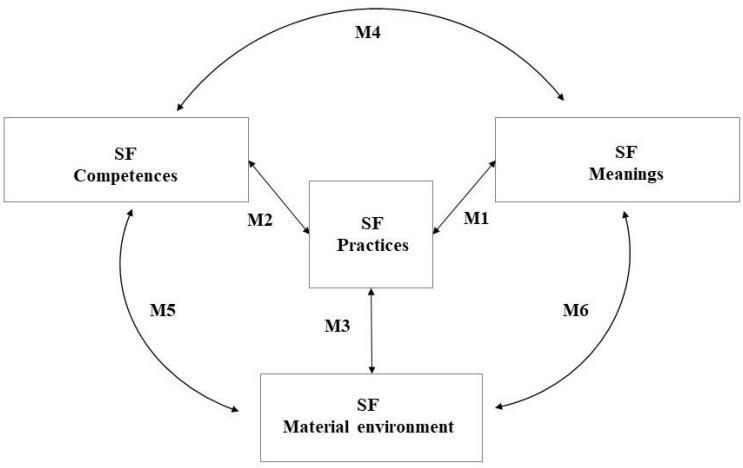

Figure 2 - The six sub-models of the sustainable food (SF) practice system

To test these sub-models, we used EQS (covariance-based SEM) (M1, M3, M5 and M6), and XLSTAT (consistent PLS)[7] (M2 and M4) depending on the number of variables involved[8].

The results from each model were then taken into account to create the overall model, which offers a more synthetic representation of the main links in the sustainable food practice system. For this second step, we chose the PLS-PM approach[9] (variance-based SEM, XLSTAT software and SmartPLS). This choice is justified by the exploratory purpose of the overall model, and the large number of measured and latent variables of which it is composed (Hair et al, 2012; Ringle et al, 2012). The construction of this model and its testing is presented in the Results section.

Results

Emergence of a general model of the system of sustainable food (SF) practices

In order to create a general model of the SF practice system, the first step was to study the covariance matrix between all the latent variables (5 practices, 4 competences, 3 meanings and 2 material environments – Appendix 6), and then the results of the tests of the 6 sub-models of the relationships between each type of variable taken in pairs (Appendix 7).

In more concrete terms, all models were tested one after the other. Table 2 presents the main findings of these tests and reads as follows: the sub-model tested (first column), main statistical results from testing these models[10] (second column), and interpretations and main theoretical lessons derived from them (third column). This is how a general model of the relationships between all elements of the sustainable food practice system gradually emerged (Figure 3).

[7] The consistent PLS (or PLSc) method is an alternative solution for testing models that involves reflexive latent variables and for which the covariance-based SEM approach cannot be applied (Cheah et al., 2018).

[8] We used covariance-based SEM (EQS) software to test these sub-models as every model involves only a moderate number of latent variables. However, some models involving sustainable food competences did not converge (M2 and M4). This is probably due to the large number of measured variables (15). In these two cases, the sub-models were tested with XLSTAT in consistent PLS.

[9] Partial Least Squares (PLS) Path Modelling.

[10] All of the covariances, fit indices and significant relationships for each model can be found in Annexes 6 and 7.

Table 2. Main findings of the sub-model test

Model concerned	**Main statistical results**	**Interpretations and main theoretical lessons**
Covariance matrix	All latent variables are related, except for 5 relationships that are not significant. This mainly concerns the link between certain practices (e.g., 'anti-waste storage', and 'grow your own food'), but also the link between the material environment and certain practices.	The structure of the matrix confirms the notion of a system in which not all practices are linked.
Covariance matrix	There is strong covariance between the practices of 'buying and cooking sustainable products', and 'plant proteins'.	The hypothesis made here is that the practice of 'buying and cooking sustainable products' influences the amount of plant proteins introduced into the diet ('plant proteins' practice). This seems logical insofar as composition of the diet is dependent on product choice and purchase.
M1 Links between practices and meanings	The individual benefits explain 'buying and cooking sustainable products', 'growing your own food', 'plant-based proteins' and 'anti-waste cooking' practices, and are in turn explained by the 'buying and cooking sustainable products' and 'growing your own food' practices. Costs influence 'buying and cooking sustainable products' and 'growing your own food' practices and are influenced by 'buying and cooking sustainable products' and 'anti-waste storage' practices.	There appears to be an interactive meaning-practice relationship for the components of 'individual benefits' and 'cost', particularly for the practice of 'buying and cooking sustainable products': the perceived individual benefits positively influence the practice, which in turn will increase the extent of individual benefits experienced. Perceived costs reduce the practice, but for 'buying and cooking sustainable products', the costs are reduced. In the final model, however, we place: → Individual benefits as antecedents to the practices, as they are the 'engine' that can trigger the process (Meinherz and Fritz, 2021) and, → Cost undercutting as a consequence of practice (Innocent and François-Lecompte, 2020).
M1 Links between practices and meanings	Collective benefits do not influence practices, but they are explained by 'buying and cooking sustainable products' and 'anti-waste storage' practices.	Collective benefits are only a consequence (and not an antecedent) of certain practices. This is in line with the findings of other studies in the transport field (e.g. Meinherz and Fritz, 2021). A possible explanation is that the collective benefits associated with the environment are distant from individuals and would only become concrete once the practice is established (Van Lange and Huckelba, 2021).

M2 Links between competences and practices	All SF practices are explained by the competences, although 'buying and cooking sustainable products' is the practice that is best explained (R2 = 54%). All four competences are in turn explained by the practices, in a significant and homogeneous way (between 26 and 43%).	The different sustainable food-related competences behave as antecedents and consequences of practices. As the aim is to develop the drivers of sustainable food practices, they are placed as antecedents in the general model (Carstensen and Ebert, 2013; Eskenazi, 2022).
M2 Links between competences and practices	The model reveals the existence of specific competence-practice 'pairs' according to the following pattern: → Local offer knowledge with 'growing your own food' practice → Technical competence with 'anti-waste storage' practice → Culinary competence with 'anti-waste cooking' practice 'Buying and cooking sustainable products' is the only practice that influences all competences and is, in turn, influenced by all of them (except the technical competence).	Most competences are practice-specific. However, all of the competences, except the technical ones, influence the 'buying and cooking sustainable products' practice, thus placing it in a specific situation since it is linked to at least two other practices ('growing your own food' and 'anti-waste cooking') through the competences they require. The 'buying and cooking sustainable products' practice is thus representative of a related practice described by Shove et al. (2012). This result gives the 'buying and cooking sustainable products' practice a special and central position in the model.
M3 Links between material environment and practices	The domestic material environment influences several practices (buying and cooking sustainable products, growing your own food, anti-waste cooking) and is in turn influenced by some practices (buying and cooking sustainable products, growing your own food). The outdoor material environment also influences several practices (buying and cooking sustainable products, anti-waste storage, growing your own food, plant proteins) and is influenced by the practices of buying and cooking sustainable products, growing your own food, and plant proteins.	The relationship between the material environment and practices is interactive. A priming effect is made possible by an enabling material environment (e.g. El Alami and Cova, 2018). Therefore, 'environment' is placed as an antecedent in the general model.
M4 Links between competences and meanings	There are several significant links that work both ways (competences to meanings, and meanings to competences). However, the effects are relatively small.	No dominant causal relationship seems to emerge from this sub-model.

M5 Links between material environment and competences	Material environment, in its two components, influences, to varying degrees, the four competence components, while only the purchasing- and product choice-related components (local offer, and label competences) influence the outdoor material environment, whose items are strongly linked to these two activities of purchasing and product choice.	An enabling material environment is a prerequisite for the development of competences. Secondly, specific competences can lead individuals to seek out material solutions in their own environment for sustainable food practices. Arsel and Bean (2013) have furthermore shown that competences act as mediators between the material environment and development of practices. In the general model we will therefore place competences as dependent on the material environment.
M6 Links between meanings and material environment	There are some links between certain meanings and the material environment. However, the explained variability of the latent variables is relatively low.	No dominant causal relationship seems to emerge from this sub-model.

At the end of the analysis of the intermediate models, it emerges that material environment can be placed as a model antecedent. Competences are dependent on this environment and therefore occupy a potentially mediating position between the material environment and practices. We take into account the pairs of competences and practices and the particularity of the 'technical competence' factor to establish the links to be tested. Individual benefits are considered as antecedents of practices, while collective costs and benefits depend on them. Finally, the very strong correlation between 'buying and cooking sustainable products' and the 'consumption of plant proteins' is taken into account by hypothesizing that this first practice influences the second. Finally, Figure 3 represents the general 'testable' model, in a linear version, of the sustainable food practices system, which groups all the links that appeared when testing the previous sub-models.

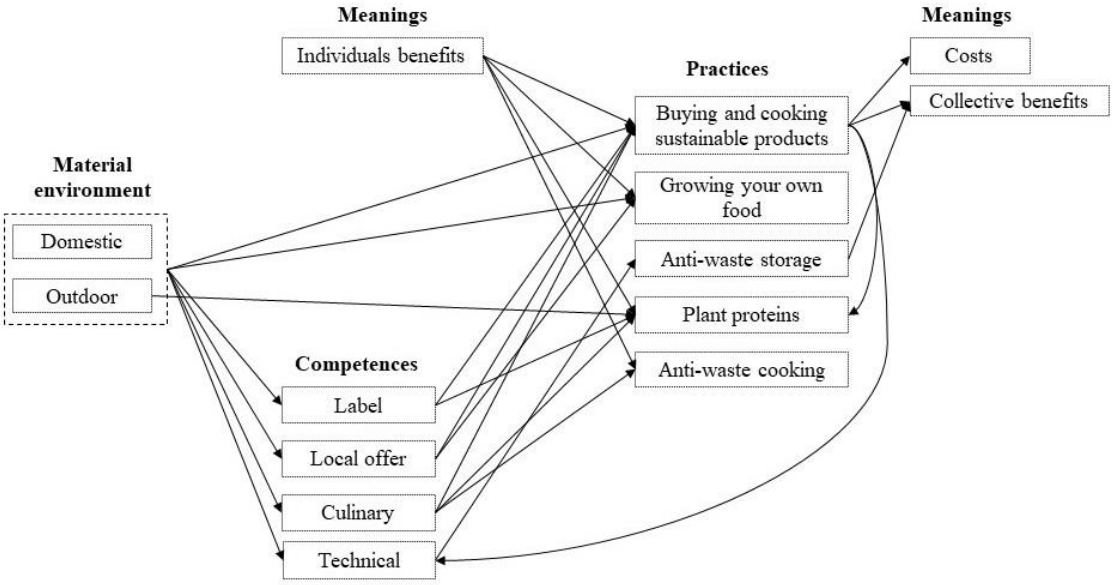

Figure 3 - General model of the sustainable food practice system

Testing the general model of SF practice

This section focuses on testing the general model of the emerging practice system.

The qualities of the measurement and the structural models are satisfactory. The reliability of the PLS-PM measurements is verified on the basis of a 500 bootstrap procedure (Tenenhaus et al., 2005). The results are presented in Table 3. Only significant links with an effect size (f_2)[11] greater than 0.05 – which corresponds to a 'weak superior' effect (Innocent, 2017) – were retained.

[11] The f_2 corresponds to the relative influence of the variable through its participation in the R^2. Values of 0.35, 0.15 and 0.02 of the f_2 correspond respectively to strong, moderate or weak effects (Hair et al., 2012).

Table 3 - Results of the general model

Model Adjustment	Dependent variables		Significant links		
	Var	R^2	Var	Factor score	f_2
Measurement model: ● Parameters all significant: zero absent from the confidence interval ● One-dimensional latent variables ρ D.G ⩾ 0.8 ● Convergent and discriminant validity - AVE ⩾ 0.5 and AVE > squared correlations ● HTMT ratios < 0.85 (Henseler et al., 2015) ● Average of communalities: 0.64 **Structural model:** ● Relative GoF: 0.96 ● Predictive quality: Q2 > 0 except for the 'Culinary' competence, and the practices of anti-waste storage, growing your own food, and anti-waste cooking; Q2 EC1 = 0.57	Competence: Local offer	0.20	Material environment: Domestic > Competence: Local offer Material environment: Outdoor > Competence: Local offer	0.25 (t=6.079) 0.34 (t=8.289)	0.07 0.14
	Competence: Label	0.15	Material environment: Outdoor > Competence: Label	0.31 (t=7.255)	0.11
	Competence: Technical	0.23	Practice: Buying and cooking sustainable products > Competence: Technical	0.36 (t=7.916)	0.13
	Practice: Buying and cooking sustainable products	0.62	Competence: Local offer > Practice: Buying and cooking sustainable products Competence: Label > Practice: Buying and cooking sustainable products Individual benefits > Practice: Buying and cooking sustainable products	0.30 (t=8.414) 0.24 (t=6.992) 0.26 (t=7.444)	0.14 0.10 0.11
	Practice: Anti-waste storage	0.11	Competence: Technical > Practice: Anti-waste storage	0.33 (t=7.678)	0.12
	Practice: Growing your own food	0.23	Material environment: Domestic > Practice: Growing your own food	0.45 (t=10.815)	0.24
	Practice: Plant proteins	0.21	Practice: Buying and cooking sustainable products > Practice: Plant proteins	0.32 (t=5.428)	0.06
	Practice: Anti-waste cooking	0.20	Competence: Culinary > Practice: Anti-waste cooking	0.42 (t=9.376)	0.18
	Collective benefits	0.30	Practice: Buying and cooking sustainable products > Collective benefits	0.50 (t=12.920)	0.34
	Costs	0.18	Practice: Buying and cooking sustainable products > Costs	-0.43 (t=-10.51)	0.22

Discussion

Three main contributions emerge from this research. The first is a proposed categorisation of practices in a system of practices. The second concerns the role of its different elements. The present discussion details these theoretical contributions and then highlights the methodological contributions and questions. The third relates to the implications of these results on food transition, which are addressed in the final concluding section.

The system of sustainable food practices: central and peripheral practices

The results show that the sustainable food system is complex and not homogeneous. Indeed, some sustainable food practices share common elements. However, not all practices and elements are interconnected, and some practices differ from others by how much they interconnect with elements in the system.

The interpretation of these results leads to a categorisation of practices within the system. One of the ways in which this study contributes to the theory of social practices is by proposing a distinct definition of 'core' and 'peripheral' practices in a system, with, in the latter, those which emerge and those which evolve in parallel.

Figure 4 proposes a theoretical translation of the results obtained in diagram format so as to give a clearer view of the sustainable food practice system. It follows the codifications used in the theory of social practices (notably the use of double arrows to link elements, see Shove et al. (2012)).

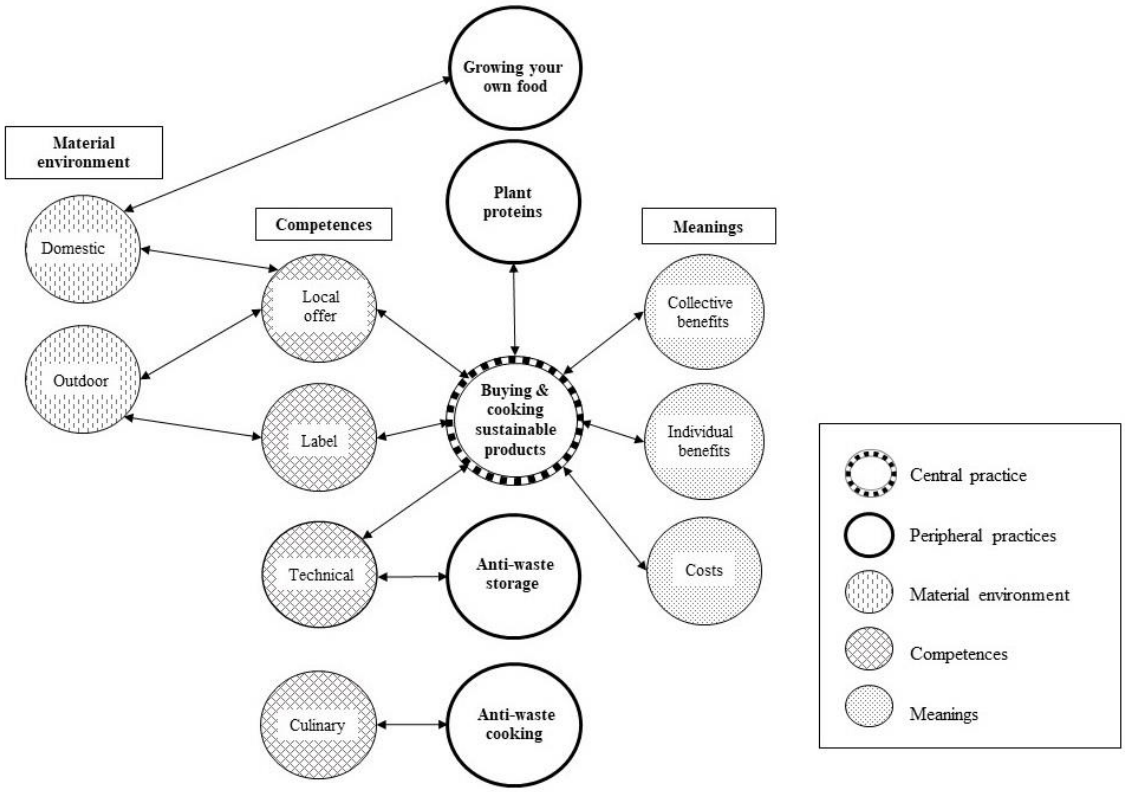

Figure 4 - The system of sustainable food practices – connections and shared elements

Central practices: numerous connections to the elements in the system

'Core practices' can be defined as practices that share and are connected, within the system, with many competences, meanings and material elements. Referring to the 'central core' or 'structuring core' concept of a social representation (Abric, 2014), the central practice could have an organising function of the sustainable food system and also would appear to have a positive influence on other practices. In the system of sustainable food practices, 'buying and cooking sustainable products' is a practice that holds this central position since it has a direct

influence on the consumption of plant proteins, and an indirect one through increasing technical competences, and storage and anti-waste conservation measures. The virtuous circle of sustainable food practices would therefore be based on this foundation composed of a central practice that would allow the emergence or reinforcement of complementary peripheral practices. The composition of this foundation would reflect the consumers' main representations of a more sustainable diet and make it possible to highlight both the drivers and gaps in collective representations and realities with respect to transition (Coley et al., 2011).

The large number of items involved in the latent variable of 'buying and cooking sustainable products' may nevertheless raise questions about a statistical focal effect that would lead to it being artificially assigned the position of central practice. However, the number of items involved in this variable remains consistent with the scientific practice observed in this field (Thogersen et al. in 2010 used a score from an array of 17 items in the field of energy practices). Conversely, the question may arise as to whether there are sufficient items in the other practices to describe them in all their diversity. The tool to measure practices was constructed in such a manner that items reflecting actions that did not fit with any others, such as the frequency of consumption of meat products – a choice that is based on the very definition of practices, which are constellations of actions (Schatzki, 1996).

Peripheral practices: emerging or evolving in parallel

We define peripheral practices as those which share few links with the constituent elements of the system. In our model, the practices of supply by growing your own food and anti-waste storage are considered to be peripheral as they only share the following with the system: domestic material environment for the former, and technical competences for the latter. Anti-waste cooking seems to be isolated within the system as culinary skills do not seem to be linked to any other practice.

Peripheral practices are sometimes emerging – such as the consumption of plant-based proteins – or evolving in parallel (i.e. not closely associated with other sustainable practices) – such as anti-waste practices or growing your own food. Being able to distinguish between peripheral practices and central practices and identify the missing links should lead to a better targeting of the actions to be taken. In our case study, the emerging practice of consuming plant proteins is strongly correlated with the practice of buying and cooking sustainable products. What these two practices have in common is that they are influenced by the same (individual) benefits, the same culinary competences, and knowledge about the label.

In the context of practices that are already established but evolve in parallel, links need to be created via the practice elements. Our results show that, at this stage and in the case of sustainable food, competences play a central mediating role. This is not always the case; other elements can play this mediating role such as meanings (see Shove et al. (2012) and the example of the car).

To try and answer the initial research questions of this study, the entry point via the central practice of sustainable food, that is the practice of buying and cooking sustainable products, seems to be the central driver. However, it can be seen that the system is strongly determined by its elements, which play several roles.

Elements of practice: a connecting and a strengthening role

The first insight revealed by the research on practice elements is the fundamental role played by material elements and competences. It is a role that applies to both the stabilisation and evolution of practices – already reflected by theory and proven by numerous research studies

– and the mediating character of these to ‘connect’ practices to each other, which is predicted by the theory but less frequently proven. Although the importance of a facilitating material environment has already been shown (Innocent et al., 2021) in the field of sustainable food, the driver of competences, procedural knowledge in particular, is probably still underactivated.

A second insight revealed is that different meanings do not play the same role in the practice: individual benefits mainly appear as practice antecedents, while collective benefits and cost minimisation appear as practice consequences. The valorization of individual benefits can therefore be an entry point for encouraging sustainable food practices. Once the latter have been proven, arguments highlighting the practice’s collective benefits and lower costs can lead to the reinforcement of behaviours. These individual and collective benefits are very close to the egocentric and altruistic benefits set out by Achabou and Dekhili (2021) about sustainable consumption and its specificities in the luxury sector. Collective benefits, however, include altruistic benefits that are oriented towards the common, human good, and biospheric benefits (Séré de Lanauze, 2015).

The private/public nature of the practice could also explain the difference in the role given to elements of meaning about the practice. There is a difference between domestic ecological behaviours carried out in the home, and visible behaviours that generate social interactions and can be seen by others (e.g. buying products directly from the producer) (Schmitt et al., 2018). Visible behaviours would bring more life satisfaction through the dual mechanism of social validation and decreased eco-anxiety (Masson and Fritsche, 2021; Schwartz et al., 2022). Thus, the increase in collective benefits and the decrease in costs observed mainly through implementing the ‘buying and cooking sustainable products’ practice, would partly come from the fact that a part of these actions take place in the public space.

Measuring the practice system: methodological contributions and issues

Beyond the limitations inherent in any quantitative study, (such as a slight representativeness bias), this approach raises some questions and difficulties. Some are theoretical and relate to the ‘meanings’ and ‘material environment’ elements of the practice, whereas others are related to the implementation and concern the measurement of competences and practices.

Contributions and questions on the ‘meanings’ and ‘material environment’ constructs

To reliably measure the meanings of practices, several options are available: we can turn to the different concepts from the field of sociology, such as social representations (Abric, 2014; Croizean and Robert-Demontrond, 2021; Lahlou, 1995), or from marketing sciences, such as value (Innocent and Lecompte-François, 2020). Our research offers an example of such implementation. However, the definition of the concept of meanings in the theory of practices remains and is itself a point for reflection for future research.

The material environment element raises further questions. While theoretically based on objective and factual elements, it seems more likely that this factor is partly fixed and partly perceived. For example, there may be digital tools (website, apps, etc.), or accessible sales outlets available, however, if individuals do not go looking for them they could easily imagine that they do not exist. The material reality for a consumer would then be composed of two factors: the material environment available and the material environment perceived to be available. This aspect adds an element of complexity, whose impact on the results of the present study is difficult to assess.

Contributions and challenges of measuring competences and practices

At the same time, it is more complicated to reliably measure the competences and practices carried out. In the case of practices and with a view to proposing a stable and reliable tool, it was necessary to use two measurement theories: item response theory and classical measurement theory. Indeed, practices are either a homogeneous whole that can be described in terms of a limited number of items (frequency of consumption of certain food groups for the consumption of plant proteins, for example), or a combination of uncoordinated actions that contribute to the same objective. Thus, home cooking, buying local, seasonal and labelled products are all different actions that pursue a common objective: a better diet for the environment and for health. These structural differences have consequences on the measurement theories that can be applied to them. As for competences, the difficulties involved in measuring them partially overlap with those of practices because there can be various levels of knowledge homogeneity in a given domain. Furthermore, competences, as we have measured them, are self-evaluated; however, just because a person thinks they have mastered anti-waste cooking techniques, does not necessarily mean that they have done so.

This work shows the importance of improving techniques and furthering the work already carried out on measuring the descriptive constructs of consumer's actual practices and their competences.

Conclusion and implications for speeding up transition

There are three levels of recommendations that can be made on the basis of this work. We need to promote the formation of links within the practice system by building on the core practice, more specific actions should also address emerging practices, and, finally, our results strongly support the idea that it is necessary, as soon as possible, to move from so-called awareness-raising actions to actions that increase competence in order to support responsible transformations.

Building on central practice

The central practice 'buying and cooking sustainable products', seems to be the main driver for strengthening the entire system and thus for speeding up the spread of sustainable food practices.

However, within this very practice, some of the actions are questionable with regard to the objective of food transition, which is to reduce the environmental footprint of our food. In this way, consumers directly associate buying local with sustainable food, whereas for several years ADEME (2017) has been showing that buying local has a limited impact on the reduction of greenhouse gas emissions. At the same time, while the majority of prospective studies on low-carbon diets highlight the importance of introducing more plant-based foods into the diet (Solagro, 2016; LiveWell3, 2017), this behaviour does not yet seem to be integrated by consumers as a central element of a sustainable food practice.

Future support programmes should therefore focus on creating virtuous circles to reinforce the entire system of the practice and also engage in a process aimed at qualifying certain representations. We could thus envisage campaigns built around an idea of sustainable eating which means choosing products with a low environmental impact, reducing packaging at source, avoiding waste by preserving and cooking intelligently, eating plant-based and alternative proteins and, whenever possible, growing your own vegetables.

Supporting the emergence of peripheral practices

Putting in place specific support to encourage emerging practices is the second driver for speeding up change.

Applied to the substitution of animal proteins with plant or alternative proteins (entomophagy for example), it is probably easier to start consuming new products based on these new proteins (peripheral practice in the system), than to reduce meat consumption (isolated action, not integrated in the system).

This is in line with the findings of Verplanken and Faes (1999); for these authors it is easier to introduce a new habit (via specific intentions to implement new actions) than to discontinue an old one. In other words, this is a matter of working towards cultural change through novelty rather than restriction.

However, further work on flexitarian practices seems necessary to gain a better understanding of this aspect of sustainable food practices.

Exploiting the connection function of competences: moving from awareness-raising to competence development

The study results show that competences are a key element of the system of sustainable food practices as they play a mediating role between different practices. Consequently, the third driver towards more sustainable food is to increase consumer competence in food sustainability issues. This involves moving away from an awareness-raising message to actions that enable consumers to acquire new knowledge which can then be used to measure the impact of their actions (evaluative knowledge) and new know-how to increase their power to act (procedural knowledge). *Boosts* illustrate this possibility, but are different from *nudges* in that these programmes play a part in competences and not in behaviour directly, and their effect is considered to be more sustainable over time (Hertwig and Grüne-Yanoff, 2017). Their potential as tools for behavioural change, and thus for speeding up transitions, may be due to their capacity for connecting competences.

Programmes such as cooking workshops for developing competences in home-cooking and raw ingredients can thus promote the practice of 'buying and cooking sustainable products'. These programmes, however, should emphasise plant-based and alternative protein cooking competences as well as food waste reduction in order to activate the entire system of practices.

More indirect competences also need to be developed, based on aspirations for greater naturalness and transparency (Allès et al., 2017). Behind this lies the consumer's need for security, but also the desire to reconnect with nature, which requires a more sensitive and embodied understanding of the natural food production cycle (Sachse, 2020). This reconnection with nature (Otto et al., 2021) contributes to developing the eater's competence through improved understanding of how food is produced and its production constraints.

Extending the research

This study examined the system of sustainable food practices of French consumers. The quantitative and interpretative approach used here could be applied to other systems of practices, such as soft mobilities or the Three Rs (reuse, repair, recycle). It could also be applied to other cultural food contexts. Firstly, this would increase the external validity of the approach proposed here, and secondly it would highlight any differences in the relative influence of the different elements of the system of practices and whether they are central or peripheral.

Finally, a study with a longitudinal approach could be conducted to highlight the real evolution of the system of practices. The continuation of this research would make it possible to evaluate the impact of each element of the system as the development of sustainable food practices progresses and as each of its elements evolve. It could also highlight the diverse pathways of engagement in sustainable food practices.

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Appendices

Appendix 1: Representativeness of the sample in relation to the French population

	As a % of	Sample	France (Metropolitan)
Gender	Male	46	48
	Female	54	52
Age group	15 to 29 years old	19	22
	30 to 44 years old	26	24
	45 to 59 years old	26	24
	60 to 74 years	29*	19
	75 years or older	1*	11
Level of education	Higher education qualification	28	28
	Baccalauréat	25*	17
	Vocational qualification (CAP, BEP)	24	24
	No qualification or highest qualification BEPC, *brevet des collèges* or DNB	22*	31
Socio-professional categories	Self-employed person (Agri., trader, company manager...)	3	4
	Senior manager, liberal professions	8	9
	Middle-level occupations	10*	14
	Employee or Worker	31	29
	Retiree	25	27
	Other: inactive persons	23*	16
Region UDA9	Paris Region	16	19
	North	10*	6
	East	7	8
	Paris Basin East	8	8
	Paris Basin West	8	9
	West	14	14
	South West	12	11
	Central East	12	12
	Mediterranean	12	13

** Difference in proportion is significant at the 0.05% threshold.*

Appendix 2: Measuring sustainable food practices

Wording, parameters and thresholds of the items for the practice of 'buying and cooking sustainable products'

Items	Location	T1	T2	T3	T4
You can prepare 'home-cooked' meals using minimally- or non-processed ingredients (vegetables, cereals, legumes, meat, fish, etc.).	-0.89	-2.31	-1.46	-0.90	1.12
You prefer locally produced fruit and vegetables.	-0.15	-1.05	-1.30	-0.26	2.02
You reuse food packaging if suitable to do so (glass jars, bottles, plastic packaging) rather than throwing it away.	-0.09	-0.78	-1.03	0.43	1.01
You choose food products with limited packaging.	0.10	-1.59	-0.84	0.74	2.10
You buy food products (meat, cheese, etc.) from the deli counter.	0.19	-0.97	-0.80	0.32	2.21
You prefer healthy and energy-efficient cooking methods (braising, pressure cooker).	0.20	-1.48	-0.68	0.56	2.41
You adapt your purchases according to what is offered by local producers.	0.51	-0.29	-0.42	0.63	2.13
You ensure that the seafood you buy is sustainably sourced.	0.52	-0.14	-0.07	0.53	1.76
You buy organic or similar fruit and vegetables.	0.55	-0.68	-0.24	0.88	2.22
You buy fresh produce from local producers (collective farmers' shop, farmers' market, open-air market, farm shop, etc.) .	0.75	-0.43	-0.27	1.07	2.62
You buy certain categories of products (coffee, tea, chocolate, etc.) with a fair trade label.	0.83	-0.27	-0.06	1.15	2.48
You buy packaging-free refillable groceries (excluding fruit and vegetables) .	0.87	-0.26	-0.11	1.14	2.71
You buy store cupboard essentials (flour, pasta, spices, etc.) that are organic or similar.	0.93	-0.21	-0.08	1.27	2.72
You buy longer life or non-perishable products (frozen meat, tinned food, preserves, etc.) from local producers or food artisans.	1.12	-0.06	0.27	1.28	2.97
You buy meat that is organic or similar.	1.14	0.18	0.35	1.44	2.58
You buy organic products from local producers.	1.37	0.08	0.33	1.65	3.41

T = threshold.

Wording and parameters of items for the practice of Anti-waste storage

Items	Correlations	Standard error	Critical ratio
You look at the expiry dates of perishable products at the time of purchase.	0.43	0.09	4.88
You look at the expiry dates of products already in the fridge.	0.76	0.05	16.23
You put products with the shortest expiry date at the front of the shelf in the fridge to use them first.	0.68	0.06	11.93
You check that products stored in the cupboards are still edible.	0.69	0.06	11.91
You make sure you use the recommended storage method for the different types of perishable products (e.g. keeping vegetables that spoil rapidly at the correct temperature) .	0.78	0.05	16.95

Response modalities: Never; Rarely; Occasionally; Often; Always/Systematically; Not concerned or impossible

Wording and parameters of items for the practice of growing your own food

Items	Correlations	Standard error	Critical ratio
You use the produce from your own or a shared garden.	0.89	0.03	35.66
You can use garden-grown food, from your own garden or that of neighbours, family, friends, etc.	0.90	0.02	39.24

Response Modalities: Never; Rarely; Sometimes; Often; Mostly; Not concerned or impossible

Wording and parameters of items for the practice of Plant proteins

Items	Correlations	Standard error	Critical ratio
How often do you consume a portion of plant-based protein products (e.g., soya-based/almond-based etc. drinks, desserts or cakes).	0.75	0.05	13.90
How often do you consume a portion of dried vegetables (dried beans, lentils, peas, soya beans, etc.) .	0.86	0.03	25.65

Response Modalities: Never; Once a week or less; Twice a week; 3 to 5 times a week; Once a day (6 to 7 times a week); Twice a day

Wording and parameters of items for the practice of Anti-waste cooking

Items	Correlations	Standard error	Critical ratio
When you prepare food in large quantities, you store (freeze, refrigerate) the surplus for days when you don't have the time to cook or don't feel like cooking.	0.66	0.07	10.17
You sometimes prepare 'improvised' meals according to what you find in your fridge and cupboards.	0.69	0.06	11.10
You cook the leftovers.	0.86	0.03	34.24

Response Modalities: Never; Rarely; Occasionally; Often; Always/Systematically; Not concerned or impossible

Annex 3: Measuring competences associated with sustainable food

Items	Correlations	Standard error	Critical ratio
Competence: Culinary			
You know how to prepare 'home cooked' meals from raw products.	0.775	0.030	25.725
You know recipes that can be made from fresh, seasonal vegetables.	0.836	0.017	49.076
You know how to cook legumes (lentils, dried beans, chickpeas, etc.).	0.756	0.027	28.059
You know how to cook an 'improvised' meal from ingredients you have at home.	0.751	0.031	24.384
You know how to use leftovers.	0.716	0.030	23.494
Competence: Local offer			
You know where to find local producers in your area.	0.887	0.010	87.982
You know which products are available from local producers in your area.	0.867	0.014	62.907
You know the opening days/times of the different sales outlets for local products in your area (collective farmers' shop, farmers' market, open-air market, farm shop, etc.).	0.838	0.017	50.594
You know where to find local products in your usual shops.	0.693	0.035	19.834
Competence: Labels			
You know the guarantees offered by the organic labels.	0.889	0.016	57.015
You know the guarantees offered by fair trade labels.	0.933	0.009	103.303
You know the guarantees offered by sustainable fishing labels.	0.909	0.010	91.927
Competence: Technical			
You can identify seasonal fruit and vegetables.	0.780	0.025	31.739
You can recognise products that have recyclable packaging.	0.705	0.038	18.644
You know what types of recycling are accepted by your local council (e.g. type of plastic, yoghurt pots, etc.).	0.667	0.038	17.728

Response Modalities: Strongly disagree; Somewhat disagree; Neither agree nor disagree; Somewhat agree; Strongly agree

Appendix 4: Measuring the meanings associated with sustainable food

Wording and parameters of items for measuring the benefits and costs associated with sustainable food practices

Item	Correlations	Standard error	Critical ratio
Collective benefits			
I follow a sustainable diet to preserve the planet and natural resources (e.g., water, energy, climate, biodiversity) .	0.86	0.01	60.23
I follow a sustainable diet to support responsible and/or local agricultural production.	0.84	0.02	42.70
I eat sustainably to reduce food waste.	0.83	0.02	39.67
Individual benefits			
I like knowing more and finding out about sustainable food and the food products I consume.	0.84	0.02	45.27
I like to share my experience of sustainable food with my family, friends and relatives.	0.84	0.02	44.08
Eating more sustainably puts my mind more at rest.	0.85	0.02	52.82
Having sustainable food at home is good for my health and that of my family.	0.86	0.02	56.40
Costs			
It's difficult for me to change my habits and move towards sustainable food.	0.86	0.01	60.84
I find that a sustainable diet is restrictive (in terms of time, organisation, travel or other reasons).	0.82	0.02	33.64
It's difficult for me to get sustainable food products.	0.82	0.02	36.11
It's difficult for me to get the information I need to eat sustainably.	0.75	0.03	24.21

Response Modalities: Strongly disagree; Somewhat disagree; Neither agree nor disagree; Somewhat agree; Strongly agree

Appendix 5: Measuring the material environment associated with sustainable food

Material domestic environment score
Min: 0 - Max: 5 | Mean: 2.87 | Variance (n-1): 1.74 | Standard deviation (n-1): 1.32
I have a garden.
I have the equipment to carry out selective sorting in my home.
I have a device that allows me to make compost.
My local council organises household recycling collections (yellow bins) .
My local council organises household organic-waste collections (compostable organic waste) .
Outdoor material environment score
Min: 0 - Max: 6 | Mean: 3.61 | Variance (n-1): 2.49 | Standard deviation (n-1): 1.58
I have reusable containers for carrying food (bottles, boxes, jars, etc.) .
There are community, shared or allotment gardens near where I live.
I can use my bike or go on foot to do my main food shop.
I can do my main food shop by stopping off during a regular journey (work, school, etc.).
There are places selling local/organic/packaging-free refillable groceries near where I live.
I have access to websites or apps showing places selling food (producers, packaging-free refillable grocery shops, etc.) near where I live.

Appendix 6: Analysis of covariances between latent variables

	Collective benefits	Individual benefits	Costs	Comp: Local offer	Comp: Label	Comp: Technical	Comp: Culinary	Practice: Sustainable products	Practice: Anti-waste storage	Practice: Growing your own food	Practice: Plant proteins	Practice: Anti-waste cooking	Material Env. Domestic	Material Env. Outdoor
Collective benefits	1													
Individual benefits	0.84	1												
Costs	-0.48	-0.44	1											
Comp: Local offer	0.49	0.46	-0.37	1										
Comp: Label	0.44	0.48	-0.35	0.57	1									
Comp: Technical	0.69	0.60	-0.50	0.68	0.66	1								
Comp: Culinary	0.48	0.53	-0.46	0.38	0.37	0.72	1							
Practice: Sustainable products	0.60	0.63	-0.47	0.67	0.63	0.63	0.49	1						
Practice: Anti-waste storage	0.31	0.32	-0.15	0.20	0.22	0.40	0.23	0.25	1					
Practice: Growing your own food	0.17	0.24	-0.21	0.35	0.20	0.29	0.20	0.31	0.08	1				
Practice: Plant proteins	0.37	0.42	-0.19	0.35	0.43	0.46	0.46	0.62	0.17	0.23	1			
Practice: Anti-waste cooking	0.26	0.29	-0.21	0.12	0.13	0.34	0.52	0.28	0.27	0.24	0.30	1		
Material Env: Domestic	0.29	0.30	-0.25	0.33	0.25	0.40	0.18	0.35	0.05	0.26	0.20	0.14	1	
Material Env: Outdoor	0.34	0.30	-0.26	0.40	0.35	0.35	0.24	0.42	0.15	0.02	0.39	0.06	0.18	1

Non-significant relationships are indicated by shaded boxes.

Appendix 7: Fit indices and significant relationships of sub-models

M1 Model between Meanings and Practices

Model	Dependent variables		Significant links	
	Variables	R^2	Variables	Factor score
M1a Meanings > Practices Adjustment indices: Chi² (DoF): 444.39 (235) CFI: 0.94 RMSEA: 0.042 (0.036-0.048)	Practice: Sustainable products	0.47	Individual benefits > Practice: Sustainable products	0.56
	Practice: Anti-waste storage	0.11	Costs > Practice: Sustainable products	-0.22
	Practice: Growing your own food	0.12	Individual benefits > Practice: Sustainable products	0.48
	Practice: Plant proteins	0.25	Costs > Practice: Growing your own food	-0.17
	Practice: Anti-waste cooking	0.09	Individual benefits > Practice: Plant protein	0.61
			Individual benefits > Practice: Anti-waste cooking	0.33
M1b Practices > Meanings Chi² (DoF): 546.41 (237) CFI: 0.90 RMSEA: 0.051 (0.045-0.057)	Collective benefits	0.41	Practice: Sustainable products > Collective benefits	0.55
	Individual benefits	0.44	Practice: Anti-waste storage > Collective benefits	0.22
	Costs	0.22	Practice: Sustainable products > Individual benefits	0.58
			Practice: Anti-waste storage > Individual benefits	0.21
			Practice: Sustainable products	-0.45

Indices of fit and significant links - M2 Model between Competences and Practices

Model	Dependent variables		Significant links	
	Variables	R^2	Variables	Factor score
M2a Competences > Practices Adjustment indices	Practice: Sustainable products	0.54	Comp: Local offer > Practice: Sustainable products	0.46

Relative GoF: 0.90 (Esposito et al., 2013) SRMR saturated model: 0.06 (Cheah et al, 2018)	Practice: Anti-waste storage	0.14	Comp: Culinary > Practice: Sustainable products	0.25
	Practice: Growing your own food	0.10	Comp: Label > Practice: Sustainable products	0.33
	Practice: Plant proteins	0.13	Comp: Technical > Practice: Anti-waste storage	0.68
	Practice: Anti-waste cooking	0.20	Comp: Local offer > Practice: Growing your own food	0.32
			Comp: Culinary > Practice: Plant proteins	0.37
			Comp: Label > Practice: Plant proteins	0.27
			Comp: Culinary > Practice: Anti-waste cooking	0.69
M2b Practices > Competences Relative GoF: 0.96 SRMR saturated model: 0.07	Comp: Local offer	0.43	Practice: Sustainable product > Comp: Local offer	0.68
	Comp: Label	0.37	Practice: Growing your own food > Comp: Local offer	0.20
	Comp. Technical	0.26	Practice: Sustainable product > Comp: Label	0.57
	Comp: Culinary	0.33	Practice: Sustainable products > Comp: Technical	0.41
			Practice: Anti-waste storage > Comp: Technical	0.31
			Practice: Sustainable products > Comp: Culinary	0.24
			Practice: Anti-waste cooking > Comp: Culinary	0.48

** Significant, value of coefficients in PLS consistent*

Model M3 between Material Environment and Practices

Model	Dependent variables		Significant links	
	Variables	R^2	Variables	Factor score
M3a Material Environment > Practices Adjustment indices: Chi² (DoF): 271.24 (82) CFI: 0.85 RMSEA: 0.068 (0.059-0.077)	Practice: Sustainable products	0.25	Material Env: Domestic > Practice: Sustainable products	0.28
	Practice: Anti-waste storage	0.02	Material Env: Outdoor > Practice: Sustainable products	0.37
	Practice: Growing your own food	0.26	Material Env: Outdoor > Practice: Anti-waste storage	0.14
	Practice: Plant proteins	0.17	practice Material Env: Domestic > Practice: Growing your own food	0.52
	Practice: Anti-waste cooking	0.01	Material Env: Outdoor > Practice: Growing your own food	-0.09
			Material Env: Outdoor > Practice: Plant proteins	0.38
			Material Env: Domestic > Practice: Anti-waste cooking	0.12
M3b Practices > Material environment Chi² (DoF): 145.51 (73) CFI: 0.94 RMSEA: 0.045 (0.034-0.055)	Material Env: Domestic	0.31	Practice: Sustainable products >Material Env: Domestic	0.23
	Material Env: Outdoor	0.22	Practice: Growing your own food >Material Env: Domestic	0.46
			Practice: Sustainable products >Material Env: Outdoor	0.31
			Practice: Growing your own food >Material Env: Outdoor	-0.10
			Practice: Plant proteins >Material Env: Outdoor	0.23

M4 Model between Competences and Meanings

Model	Dependent variables		Significant links	
	Variables	R^2	Variables	Factor score
M4a Meanings > Competences Adjustment indices Relative GoF: 0.94 MRS: 0.06	Comp: Local offer	0.23	Collective benefits > Comp: Local offer	0.36
	Comp: Label	0.22	Individual benefits > Comp: Local offer	0.11
	Comp: Technical	0.24	Costs > Comp: Local offer	-0.17
	Comp: Culinary.	0.26	Individual benefits > Comp: Label	0.33
			Costs > Comp: Label	-0.16
			Collective benefits > Comp: Technical	0.52
			Individual benefits > Comp: Technical	0.08
			Costs > Comp: Technical	-0.20
			Individual benefits > Comp: Culinary	0.37
			Costs > Comp: Culinary	-0.25
M4b Competences > Meanings Relative GoF: 0.96 MRS: 0.06	Collective benefits	0.31	Comp: Local offer > Collective benefits	0.21
	Individual benefits	0.33	Comp: Label > Collective benefits	0.12
	Costs	0.20	Comp: Technical > Collective benefits	0.20
			Comp: Culinary > Collective benefits	0.20
			Comp: Local offer > Individual benefits	0.15
			Comp: Label > Individual benefits	0.21
			Comp: Technical > Individual benefits	0.11
			Comp: Culinary > Individual benefits	0.28
			Comp: Local offer > Costs	-0.14
			Comp: Label > Costs	-0.12
			Comp: Culinary > Costs	-0.25

** Significant, value of coefficients in PLS consistent*

Model M5 between Material Environment and Competences

Model	Dependent variables		Significant links	
	Variables	R^2	Variables	Factor score
M5a Material Environment > Competences Adjustment indices: Chi² (DoF): 400.48 (112) CFI: 0.89 RMSEA: 0.072 (0.064-0.079)	Comp: Local offer	0.23	Material Env: Domestic > Comp: Local offer	0.26
	Comp: Label	0.15	Material Env: Outdoor > Comp: Local offer	0.35
	Comp: Technical	0.24	Material Env: Domestic > Comp: Label	0.19
	Comp: Culinary	0.08	Material Env: Outdoor > Comp: Label	0.31
			Material Env: Domestic > Comp: Technical	0.34
			Material Env: Outdoor > Comp: Technical	0.30
			Material Env: Domestic > Comp: Culinary	0.14
			Material Env: Outdoor > Comp: Culinary	0.21
M5b Competences > Material environment Chi² (DoF): 161.03 (107) CFI: 0.96 RMSEA: 0.032 (0.021-0.041)	Material Env: Domestic	0.19	Comp: Local offer > Material Env: Outdoor	0.26
	Material Env: Outdoor	0.19	Comp: Label Material Env: Outdoor	0.15

Model M6 between Meanings and Material Environment

Model	Dependent variables		Significant links	
	Variables	R^2	Variables	Factor score
M6a Meaning > Material environment Adjustment indices: Chi² (DoF): 114.96 (58) / CFI: 0.97 RMSEA: 0.044 (0.032-0.056)	Material Env: Domestic	0.11	Costs > Material Env: Outdoor	-0.13
	Material Env: Outdoor	0.13	Costs > Material Env: Outdoor	-0.12
			Collective benefits Material Env: Outdoor	0.25
M6b	Collective benefits	0.17	Material Env: Domestic > Collective benefits	0.24

Material Environment > Meanings Chi² (DoF): 391.68 (60) CFI: 0.82 RMSEA: 0.105 (0.095-0.115)	Individual benefits	0.15	Material Env: Domestic > Individual benefits	0.25
	Costs	0.11	Material Env: Domestic > Costs	-0.21
			Material Env: Outdoor > Collective benefits	0.30
			Material Env: Outdoor > Individual benefits	0.26
			Material Env: Outdoor > Costs	-0.22