Using Ethnographic Information to Conceptualize Agent-based Models

The case of Greenhouse Innovation
Extended Abstract

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Abstract. Combining the body-of-knowledge of anthropology with agent-based modelling of social systems can bring mutual benefits and novel insights. To investigate this idea, we explore what information and what data from ethnographic analysis could be useful and how it can be used for simulation models. We use a study on innovation practices in the Dutch horticulture sector to explore and put our ideas to the test. To map the obtained knowledge and allow its incorporation in or translation into a model, we used the study results as input to MAIA, a framework for agent-based model development. We developed a conceptual agent-based model of the grower society and horticulture ecosystem development. The model and the conceptualization process thereof provide insights on the ways growers innovate, how they make decisions, how they deal with institutions (rules, norms and shared strategies) and how they decide on investments.

1 Introduction

Fieldwork and ethnography are well known in the field of Anthropology. The information acquired via ethnographic studies provides a rich set of data, which has to be ordered and studied to be useful for social analysis, arriving at hypotheses and explanations on social phenomena. Agent-based modelling and simulation (ABMS) is another area of research for exploring and analysing social systems. Agent-based models are built from bottom-up allowing individual decision making entities to interact which results in patterns and structures to emerge from the simulation. ABMS and ethnography are both used to study behaviour at individual and aggregate level. While ethnography can provide insights about internal system behaviour and explain the underlying causes of social phenomenon, with ABMS we can explore how certain behaviours and interactions lead to emergent patterns and outcomes even if they do not exist in the current system.

It appears that a combination of ABMS and ethnography has mutual benefits for both of these research approaches. On the one hand, ABMS can be used to test the findings of ethnography in an artificial system to discover whether similar patterns and behaviour would emerge as analysed, and introduce new areas for further investigation [2]. On the other hand, since ethnography provides a rich set of data about the system and its entities, it can be used to make richer agent-based models using qualitative data.

The problem with connecting these two areas however lies in the difference between the levels of abstraction and the language used. Ethnographic analysis is presented in textual format in a high level informal language, while agent-based models are presented in low level programming languages. Therefore, formulating and capturing ethnographic descriptions in agent-based models is difficult.

MAIA [4] is a formal agent-based modelling language that describes a model in a high level language in order to make ABMS accessible to inexperienced modellers. Transformation protocols and guidelines support the transition between a MAIA model described in high level language to computer simulation. Since an agent-based model conceptualized in MAIA (i.e., a MAIA model) is described in high level social concepts, it can also be used decompose and structure ethnographic information in agent-based models.

In this paper, we explore the process of using ethnographic data to make MAIA models. We use a case study to explore this process and present the general procedure for making a connection between these two areas of research.

2 Methodology

In this research we combine ethnography with MAIA modelling to gain insights into a social system.

Ethnography In ethnography, information is gathered through observation or experience.

In this research both unstructured and semi-structured interviewing are used. Unstructured means the conversations can take place anywhere and anytime. Semi-structured interviewing implies that the ending is open, but the interview is guided by a list of topics [1]. The second method which we used is participant observation which involves making observation and recording data about peoples daily lives and activities [1]. The data produced are notes, memos, interviews, recordings, and photos etc., which need to be structured and analysed at a later stage.

The MAIA Modelling Platform MAIA (*M*odelling *A*gent systems based on *I*nstitutional *A*nalysis) [4] is an ABMS framework that provides a set of concepts that structure and decompose social systems. In order to support systematic design of agent-based simulations for complex social systems, the MAIA framework extends and formalizes IAD. MAIA builds on the assumption that while understanding and explaining individual behaviour is extremely complex, social rules or institutions are more elicitable [7] and hence a more appropriate unit of analysis or building block that can also more readily be identified and captured by modellers. For using MAIA, the first step is to conceptualize a system.

Figure 1 explains the process of using ethnography to build agent-based models. First, when building semi-structured interviews, the structures and concepts in MAIA (e.g. roles, dependencies) are taken into account. The interviews are then analysed with a set of theories (Bath tub model, IAD, Social mechanism) [8]. The result of the analysis and the ethnographic information are finally used to make the MAIA model which can be used to build running simulations.

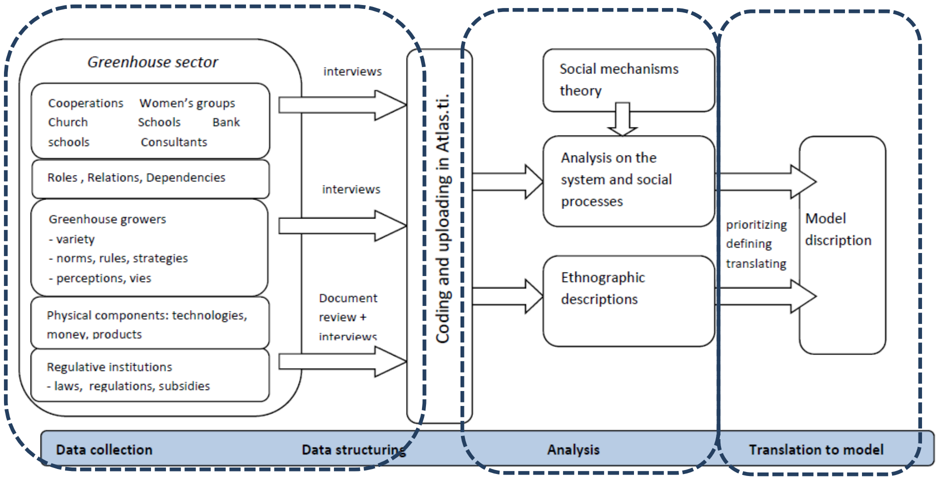

Fig. 1: The process of building agent-based (MAIA) models using ethnographic data and theoretical analysis.

3 Case Study: Innovation in the Greenhouse Sector

The horticulture sector in the Netherlands is facing economic difficulties, which have become more severe since the crisis of 2008 [8]. The dominant presence of some innovation strategies, mainly cost-reducing and volume-increasing strategies, bring down the cost price of products, but fail to bring their organizations sustained benefits, causing serious problems in the sector.

This research explores the innovation practices in the Westland horticulture sector to obtain an understanding on how the observed patterns in innovation emerge and how innovative, entrepreneurial behaviour is shaped and maintained. Insights are provided on the ways growers innovate, how they make decisions, deal with institutions (rules, norms and shared strategies) and come to an investment.

4 Fieldwork and Theoretical Analysis

In conducting ethnographic fieldwork we interviewed various stakeholders in the Westland horticulture sector. The respondents are described below:

1. Experts: Discussions with experts, or key-informants, helped to direct the research and get better overall insights on the sector, and identify main themes. Also, assumptions were verified with the experts.
2. Growers: Around 15 growers were visited at their organizations, the subsequent discussions ranged from 2 to 5 hours and provided insights in the grower's lives.
3. Bank: The bank plays an important role in the sector, and is a key actor since it provides financial capital to companies.
4. Educational institutes: These institutes provided insights on whether the education conflicts with the current greenhouse practices.
5. European committe: The provider of various subsidies including the GMO.
6. Municipality: The municipality has the role to carry out policies, regulations and subsidies in the region. It assumes the role of a regional development authority responsible for the region's prosperity.
7. LTO Glaskracht: LTO North Glass plays an effective lobby that is directly linked to market developments. The organization advocates the horticulture sectors, which means that the organization may play an important role in the creation of institutions.
8. Service providers, wholesalers, supermarkets: These are important actors in the supply chain, but they were not included in the in-depth interviews, due to the scope of the case study research.

4.1 Theoretical Analysis

The study did not only include the decision making strategies of individuals, but also social institutions.

The theoretical analysis showed that actions of individual growers are rational from their perspective, but altogether give rise to system patterns that are undesirable for all. The five categories of social errors (Immediate interest, Errors and self-defeating prophecy, Basic values and Ignorance) provided explanations on the occurrence of unintended outcomes of rational actors aiming for success [8]. As an example, short-term benefits may override long-term benefits, as short-term requirements seem more urgent and are easier to understand and calculate, creating the error of immediate interest.

5 Agent-based Model of the Greenhouse Sector

To conceptualize an agent-based model with MAIA, the system is organized into five structures: collective structure, constitutional structure, physical structure, operational structure and evaluative structure [4]. While structuring the interviews, we took this general model architecture into account as illustrated on the left side of Figure 1.

Collective Structure The 'collective structure' captures the agents in the system and their decision making process. The defined agents are growers and public agents. The growers have properties such as familyID, education, size and age. The public agents are defined to cover the more general/external roles in the system which will be explained in the next section.

The decision making of agents is based on a multi criteria decision approach based on several factors such as: the properties of the growers, their personal preferences, the beliefs or 'information growers have which were classified as a result of the interviews.

Constitutional Structure The constitutional structure explains the roles in the system and the institutions (i.e. rules) that the agents taking those roles must comply with. The grower agent takes roles, including 'owner of greenhouse', investor, seller, bank client and GMO user. The public agent takes the roles of bank, European union, municipality, LTO glaskracht and merchandiser. When agents take a role, they must also comply with the associated institutional rules and norms. For example, an agent in the role of a GMO user must join one of the 6 sales cooperations in order to get GMO subsidy for his greenhouse. Defining rules and norms in MAIA follows a structure called ADICO [4].

Physical Structure Besides the social context, the agents are also embedded in a physical context. In this model we define greenhouse, capital, crop, energy, water and innovation technology as physical components. The five types of innovations are classified as cost-reducing, volume-increasing, activity extending, price-increasing and law-complying component. The important issue was to categorize various components into meaningful categories, considering their economic implications and linking them to the decision criteria of the agents.

Operational Structure In the operational structure agents perform various actions. There are seven different action situations taking place in the time loop of the simulation: daily life activities, cooperation, GMO, loan, innovation, cultivation and selling. In each of these action situations, agents perform various actions. For example, in the innovation situation, agents make decisions about which innovation strategy to take. This decision is affected by many factors including the group of growers the agent is interacting with or his background.

Evaluative Structure The evaluative structure of MAIA defines variables that explain the outcome of the system. Since we wanted to find out how ethnographic data and theoretical analysis can be used to build simulations, we also paid attention to this part of the model and defined variables according to the results of the analysis. For example, with the simulation we want to explore homogenization in the sector because the analysis showed that copying behaviour highly influences the type of innovation growers choose. Furthermore, the analysis showed that product values are decreasing in the sector. Therefore, we also defined variables that would show product value in the simulation and keep track of the trends. Another issue that is worth exploring in the simulation is the sustainability of the sector in terms of planet, profit and people. The planet pillar, studying the ecological impact, can be analysed through the material use by the growers since innovation type can decrease the costs by saving on water, energy and nutrients. The profit of the sector can be studied by (1) the ratio between companies doing well and companies going bankrupt, (2) the total money spend in the sector on innovations and (3) third, the total amount of profit being made in the sector. Finally, we define three ways to study social sustainability. As the greenhouse organizations are closely tied to family income, organizations that are in trouble or go bankrupt put a high pressure on families, and can be said to be socially undesirable.

6 Conclusion

In this research, we used ethnographic data to conceptualize an agent-based model. We used field work and social analysis to build an agent-based model and defined variables to measure simulation outcomes according to this analysis.

Combining ethnography with agent-based modelling benefits ethnographic analysis by verifying the outcomes with simulation and acquiring more insights into the system. This combination also provides more empirical data to build richer agent-based model.

By using the MAIA modelling language, we were able to combine these two approaches. First, we took MAIA concepts and structures into account while building semi-structure interviews which we were then able to analyse using various social theories. Second, we structured and decomposed the data obtained from empirical field work and the result of the social analysis into a MAIA model. Building simulations from MAIA models is straight forward with the available tools and methods. The next step in this research is to build the simulation from the MAIA model to find out whether the simulations results confirm the findings from the analytical study.

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