Towards a social simulation interaction tool for policy makers - a new research agenda to enable usage of more complex social simulations

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Abstract. Social simulations can be a powerful tool for policy makers and other decision makers to support them in their decision making process. To be a powerful tool, it is not only important that the agents in the simulation exhibit realistic - human like - behavior, but also that the simulation is empowering the policy maker to use it in a - for them - meaningful way. To tackle this problem, we require interaction tools and visualization capabilities necessary to support non-expert users (such as policy makers). To understand what these non-expert users need, we performed a focus group study to gain insights into the potential requirements of such an interaction tool with respect to norms. This resulted in a list of requirements to support non-expert users in the analysis of norm conflicts after they happened during the simulation. But more importantly we are calling for a new research agenda in the field of social simulations to support non-expert users with the abstract analysis of norms before complex happen in the simulation run, as the results showed that the participants were to able to do that kind of analysis.

Keywords: Social Simulations, Norms, Policy Support, Interaction

1 Introduction

Social simulations can be a powerful tool for policy makers and other decision makers to support them in their decision making process. To be a powerful tool, it is not only important that the agents in the simulation exhibit realistic - human like - behavior [14,15,13], but also that the simulation is empowering the policy maker to use it in a - for them - meaningful way.

Previous work on supporting policy makers only focused on the agent's deliberation process to increase realism in the agent's decision making, see for example [2,5,10,12,22,8,13,15]. While it was acknowledged that the policy maker needs to be empowered to use the simulation [2] no emphasis was put on *how* that interaction actually works.

This is especially important, since *the strong increase in complexity* of the simulations (a direct consequence of increased realism [8,13]) had negative effects

on the usability of the models, as it became harder to understand *why* something is happening, resulting in a less intuitive use for a policy maker.

Before we can develop interaction tools for policy makers however, we need to understand what it is they actually require. To do so, we present the results of a focus group study (Section 3) that aimed at identifying those requirements. Based on the results and discussion of them we are calling for a new research agenda (Section 4) that has the usability [14] and user support as its focus.

2 Towards the Conceptual Interaction Tool

In general, simulations should be easy to adapt and expand, and facilitate communication with stakeholders [20, p.86]. The need for a new interaction tool (especially with a focus on norms) will be explained below and can be seen in Figure 1, showing that there is a disconnect between the world of policy makers and social simulation modelers.

One of the reasons for this disconnect is the plethora of background knowledge that the policy makers lack compared to us modelers (with respect to social simulations) [20] potentially hindering them to get quick insights into the agent's behavior. In particular in our domain, where we design social simulations that allow for agents to deal with (new) norms in different ways, i.e. the agents can comply, violate and work around a norm, we use a lot of concepts, such as norms, goals, actions, planning, that need to be understood.

In contrast to that, policy makers (politicians as well as bureaucrats) are experts in policy making and mostly having no/little expertise in modeling. Modelers on the other hand are experts in modeling and not in policy making. We have some idea on how to transfer policies into norms using conceptualizations of norms but there is no guarantee that this is actually matching the reality.

Consequently, we need to be aware of the difference in background knowledge and the language used. As modelers we may be well versed in using concepts such as goals, actions, planning and norms which is too easy to be taken for granted and unconsciously used every time we analyze or interpret a problem or result [20, p.100]. As a result we need communication tools for policy makers that empower them to use the simulation in a meaningful way for them rather than having to submit to its (the simulations) complexity [20, p.100].

There are different aspects that are at the core of this challenge of understanding social simulations. One is that social simulations can only provide a 'reasonable' abstraction of reality. This abstraction and what is 'reasonable' strongly depends on the purpose that the simulation is made for, for example disease transmission in COVID-19. Consequently, a lot of discussions were centered around what is relevant for the purpose, what must be included, and what can be omitted, see for example [7] for COVID-19.

Having this understanding, that the model is a *reasonably* simplified representation of reality, is crucial, because it helps to understand that for the given *purpose* of the model some parts of the model are fixed (to ensure its functioning) or simplified, while others must be complex. This can vary from model to

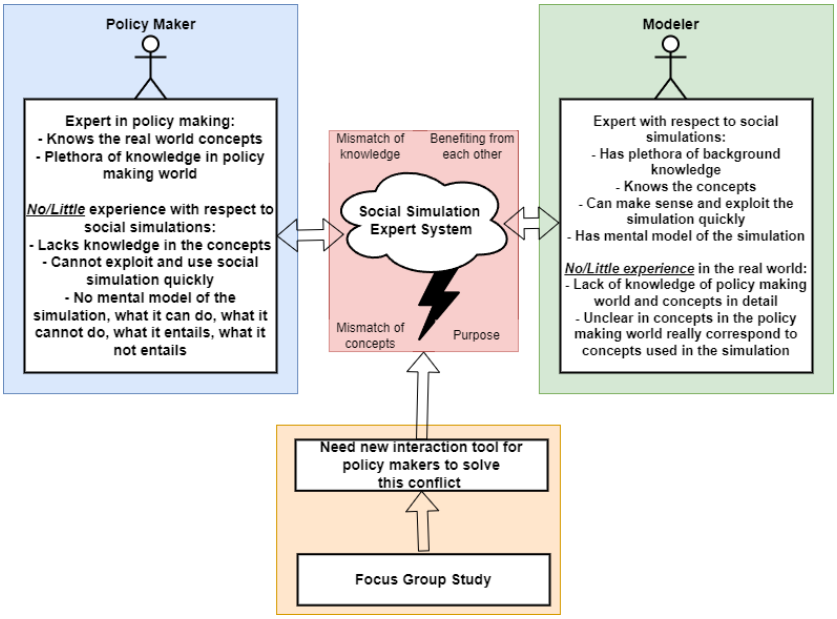

Fig. 1. Motivation for the Focus Group Study with social simulation as an expert system in the middle and potential points of friction in the corners.

model. For example, models, such as [8,13], for policy support require human-like realistic agents and thus a high degree of complexity of the agent's deliberation, whereas other models, such as land use [11], or marketing [17], suffice with agents that have a comparatively simpler decision-making process of the agent.

2.1 Bridging the gap between modelers and policy users

In our norm-centered approach, policy makers can use simulation to explore and evaluate potential policies (norms) before implementing them in the real world. In our simulation the possible reactions of the agents to a norm are:

Obedience Obedience describes the conventionally modeled reaction of agents to a norm. Agents simply obey and as a consequence a norm is a restriction on their behavior without any further deliberation, e.g. being off the streets after 22:00 when there is a curfew. It is important to note here that this obedience might either be an "active" choice or the result of not deliberating about the norm at all and "blindly" obeying it.

Violation Violation means that the agent deliberates about a norm and decides to "actively" violate it. This can happen when the agent sees the act that violates the norm as more beneficial then to obey e.g. staying out with friends while a curfew is imposed.

Circumvention Circumventing a norm can result from an agent being receptive of the motivational component of the norm [4,19]. Here the agents tries

to find alternative behavior to work around and thus, circumvent the norm, meaning they try to do both, obey the norm and also execute the desired action. For example: If a there is a curfew in place, the agent decides to go out before the curfew (and thus still meeting their friends), rather than staying at home and seeing the curfew as a restriction on their behavior.

In the design of an norm-centered interaction tool we have to keep in mind that the simulation is the point of entry for the policy maker, (see Figure 2). Therefore, it has to enable the things that the policy maker needs in terms of the interface and model. This means that the policy makers must be able to translate their inquiries and demands into the world of the model via the interaction tool. To tackle this challenge, we start with discussing what the policy maker wants to see and then translate their potential questions in to the social simulation world. Once we are in this world, we use these questions to discuss what the policy maker can see and thereby moving back out of the social simulation world.

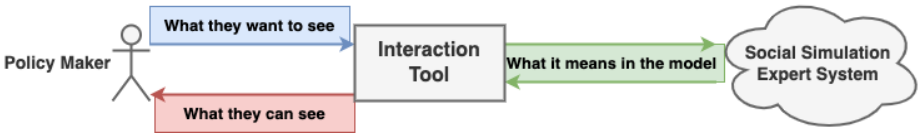

Fig. 2. Interaction and information flow with the interaction tool in the center as the mediator between the policy maker and the simulaion.

2.2 What the policy maker wants to see

This is the point where the policy maker starts to interact with the simulation (blue arrow in Figure 2) through the interaction tool and tries to seek answers to their questions which in our norm focused approach could be:

How does the new/modified norm conflict with existing norms?

Norms do have a fulfillment and a violation condition [13]. If the fulfillment condition is met by the agent they successfully complied to the norm and if the violation condition is met, the agent violated the norm. Two norms are in conflict if the fulfillment condition of one norm can only be met by simultaneously also meeting the violation condition of another norm, given that they are active in the same context. The context is very important, because the conditions of two norms can be in conflict but if they are not active in the same context, it does not matter. For example, being at the office at 8AM while simultaneously having to be at home at 8AM is in conflict, but having to be in office at 8AM and having to be at home at 8PM is not in conflict. Furthermore, it can be possible that the norms in themselves are not conflicting with each other (which can even happen with just one norm), but situations can occur where they conflict. For example,

having to be at office at 8AM and obeying the speed limit are not conflicting, unless the agent is late and must now make a decision between being at the office at 8AM and violating the speed limit or the other way around.

Can the policy maker assess how the behavior (of agents) changes?

A policy maker adds a new norm or modifies an existing one with the intention to influence the agents behavior. Similar to the real world where norms are used to guide and determine the people's behavior. Therefore, the policy maker is interested to see if the norm change has its intended effect on the agent's behavior. To do they need insight to see not only beforehand how the behavior of the agents might change but also after the implementation of the norm.

Can the policy maker asses why the (new) norm is violated?

Similarly to the two previous questions, it is very important for the policy to understand how likely it is that a (new) norm is violated and why that is the case. There is no simple answer to that. Maybe the new norm interferes with existing norms both legal or social that are more important to the agent. Furthermore, it might be possible that the actions forbidden by the new norm are more important to the agent than the norm. Also, it might be possible that the violations occur regularly or are just exceptions and the norm is usually followed. The reasons can be various and the simulation must provide insights.

2.3 What it means in the model

The interaction tool must now map these questions onto the concepts used in the model and then answer back, see green arrows in Figure 2. With respect to norms, this means to use deontic logic: Obligations (must norms), Prohibitions (must not norms), and Permissions (can norms) [6].

to show how to connect these types to the questions from the previous section, we use the second question, assessing the behavior change of the agent, as an example (the other questions work analogues). Given a new or modified norm, it can be possible now that the desired action of an agent became forbidden (is now prohibited) or a different action became obliged. If the originally desired action is more important compared to adhering to the new/modified nothing changes, but if the norm is important, the behavior of the agents changes in a certain way. It is importnant to node here that the if a norm makes an action that the agent does anyway obliged, nothing changes. To show why this is the case, how and in what way a norm has been taken into account in the agent's deliberation process, and how the potential behavior changes looks is the the responsibility of the red arrow (Figure 2), discussed in the next section.

2.4 What the policy maker can see

in the last step, the red arrow of Figure 2, the interaction tool has to translate back the data gathered from the model to the world and terms of the policy maker. Furthermore, based on how the answers match with initial questions, the interaction tool needs to provide ways to interact with the simulation such

that the answers (red arrow) match the questions (blue arrow, Section 2.2). For example, to see the likelihood that a certain norm is violated, we have to identify if the policy maker wants a simple ranking of norms based on their violations or if they want to see the violations over time, or just an abstract analysis showing potential norm conflicts and conflicting situations. Furthermore, we have to identify the support that policy makers need to modify an existing norm or add a new norm. It might be possible that they want to see at every step in the formalization process how and if the current formalization is conflicting with an existing norm or which agents are potentially affected by it. Importantly, it might be possible that the policy maker wants a preview/trial simulations, within the overall simulation, with only a few agents to verify if the current formulation works as intended or to see potential norm conflicts and conflicting situations in the existing sets of norms without having to run the whole simulation, and thereby being able to focus only on a small subset of the simulation. This leads to the following list of very concrete questions that need to be considered: Does the policy maker need: Textual support? Graphical support? Previews? Other ways? To get insights into these questions, we performed a focus group study.

3 The Focus Group Study

3.1 Method & Preparation

To gain insights into the potential requirements of a norm focused interaction tool for policy makers, we choose to do focus groups. Focus groups are "a way of collecting qualitative data, which - essentially - involves engaging a small number of people in an informal group discussion (or discussions), 'focused' around a particular topic or set of issues" [25, p.177]. One major advantage of this informal setting is that it allows the participants to feel safe which can result in them being more open in the interactions (which can provide important data), creating spontaneous responses, and applying experience from personal problems to provide solutions [24,16,3,9,18].

For the focus group study in itself, we used the scenario analysis approach based on Ramanath & Gilbert [21]. To do so, we constructed a scenario that the participants went through in a role playing approach. In the scenario the participants where playing the role of a mayor, i.e., a policy maker, of an average European town. The town is governed by laws as well as people upholding social norms between them. These norms in the scenario were simple norms. For example, *being in time for a meeting* or *socialize with colleagues over a beer on Fridays* would be social norms; whereas *adhering to the speed limit*, or *no drunk driving* are examples of the type of legal norms .

The overall narrative for the participants was that the town had a problem with drunk driving which they, as the mayor, promised to tackle. To do so, they were provided with an imaginary social simulation platform. It is important to note here that the whole study was a *conceptual* one, meaning that it was done on paper with no existing simulation platform. The goal was to already identify requirements before designing such a simulation platform.

Procedure: After setting the stage, the participants were provided with different tasks to discuss in the group. In total, we had six questions that were split up into two main themes which we distributed beforehand between the group. Each theme contained three questions:

Theme 1 Gathering information and adding a new norm: After presenting the hypothetical simulation and the problem of drunk driving, the theme contained questions regarding what information and in which way certain information would be helpful to assess the problem. Additionally, the focus group participants dealt with the way the system can support the user to add a new norm to tackle the problem; but also how to find out why potentially unexpected consequences occurs after the introduction of the new norm.

Theme 2 Identifying and solving norm conflicts: Groups dealing with this theme were presented with a concrete norm conflict. Questions the focus group participants dealt with concerned how this specific conflict should be presented (i.e. to show that there is a conflict in the given situation), how the simulation can support the user in solving conflicts, and how overall norm conflicts (any conflict) and violations should be presented to the user.

We ran six focus groups (17 participants) of which half had theme one and half theme two. Each group consisted of two to four participants. Each focus group took 60 minutes, of which about 15 minutes were reserved for each of the three questions and the remaining time was used for the introduction and debriefing. We designed this focus group study in-line with the recommendations of focus group design: a) to have a focus group session last between one to two hours, and b) to have a small amount of participants per group to make use of the expert knowledge existing within the group [18].

As participants, we invited researchers part of different research disciplines: law, computing science, education, philosophy, psychology, political science, and feminist philosophy, to ensure a variety of backgrounds to get as many and various inputs as possible and not having the risk to have only input from one viewpoint. Since we chose to do this exercise with researchers of diverse disciplines, we thus did not engage with policy makers yet as they often have busy schedules and the exercises may be considered too abstract with no concretely implemented application for their local use.

The analysis method was as follows. We used the notes from the participants together with the recording to identify all the arguments made. For each argument we decided to include or exclude it based on not only the amount of agreement it got but also the momentum behind each argument. This ensured that also the arguments of more silent and seemingly shy people where included.

3.2 Results

Given that we want to provide overall requirements for a norm focused interaction tool, we are giving the general results and are not dividing them by question here. Furthermore, the answers overlap between the individual questions and the

same arguments have been used for the different questions, for example a common argumentation pattern by all participants was "as we said for question [...] we want [...] here as well". The complete list of results can be seen Table 1 below:

Color Coding	Spotlight function	Only show why on demand
Graph maker tool	History of changes	Flow-graph of agent's decision making
Color change in graph	Warnings of potential cascading effects	Sims inspired graphical information
Grouping of norm conflicts	onClick on the agent	ReadMe/manual at the beginning
Narrative based on single agents	"Profiler"	Disclaimers/hover functions
Filters for agents	Warnings about norm intrusion	Information per neighborhood
Behavior space plus	Layering of maps	Recording/Re-Run with special focus
(Aggregated) Log	Heat maps	Dynamic norm graph

Table 1. List of results of the focus group study, in no particular order.

We can see from the list of results that the focus overall was on the exploring the simulation. What we mean by this is that the participants mentioned many aspects, such as color coding or filters for agents or hover functions to see the definitions or what the colors represent. Furthermore, they wanted to see various kinds of maps, such as traffic flow maps or heat maps and potentially layering them. Also, a tool that combines the NetLogo Behavior Space [3] together with the statistical analysis afterwards combined in one tool was discussed.

While many suggestions were made related to graphs, we considered two suggestions particularly relevant: 1) a 'graph maker' tool, where users either can select the data they want to see and then based on the selected data the simulation shows possible graphs that can be created or vice versa and 2)the option to have the color changed in a graph based on the activation status of a norm. The graph maker provides great interactivity with the simulation as well as freedom for the user to see the generated data in many different lights. The main reason mentioned by the participants was that this would create more insights for them and aid them in understanding why things are happening in the simulation. The color change in the norm graph idea mentioned by some of the participants was that in order to contrast agent behavior before and after a certain norm got (de)activated, the color of, for example, a line graph could change. Meaning that if there is for example a graph that shows the amount of people at a specific location over time, the line could be blue, and once a norm targeting that location gets (de)activated, the color of that line changes.

[3] https://ccl.northwestern.edu/netlogo/docs/behaviorspace.html

Another relevant suggestion concerned a 'dynamic norm graph' by some participants. With this the participants meant a graph where the nodes represent the norms and the edges connect norms that share the same object. In such a graph, norms that are connected by edges are more closely grouped together and nodes with no edges between them are further away from each other. Using color codes (in such a graph) one can signal a conflict between two norms. To make this graph interactive, the user can click on a norm (a node) or an edge to get further details and insights. Furthermore, the layout of the graph can be changed in such a way that nodes (norms) that have the same property (for example agents that have to adhere to it) are closer together and others are further away. This dynamic norm graph would (visually) provide deeper and more detailed insights into the connections between the norms.

Lastly, some participants argued for understanding how agents solve norm conflicts and also whether or not to violate a given norm in favor of an action to use a flow-chart or decision-tree-like structure that is shown when clicking on an agent. This was considered to support the user of an interaction tool to get insights into why the agent made their decision in that way and thus provide potential answers to the *real why* of why things are happening the way they do in the simulation. Further information that could be available when clicking on the agent, as mentioned by the participants, could be their current goal, their current needs satisfaction, their next action, and so forth.

3.3 Interpretation of the Results

To interpret the results and to relate them back to the original question proposed in Section 2.2, *what the policy maker wants to see*, we have to make a differentiation between norm conflicts that can happen, based on fulfillment/violation condition conflicts or potentially conflicting situations but **have not happened yet** in the simulation run, and norm conflicts that *have happened* in the simulation. We call the former **ex ante** (before the norm conflicting situation occurred in the simulation run), and the latter *ex post* (after the norm conflicting situation run occurred in the simulation run. Figure 3 shows this divide. Furthermore, the Figure shows a differentiation between norms that conflict based on their fulfillment/violation conditions and norms that do not conflict in themselves but can create conflicting situations.

The results of the focus group study reported in the previous section fall into the *ex post* (after the conflicting situation occurred in the simulation run) category, such as an agent has to decide between speeding or being late for a meeting. When presented with such a situation, people have a very clear idea on what they want to see and how to analyze it. In our example, the drinking and consequently being late for a meeting the next day conflict, it was clear for people to look, at for example different neighborhoods or use filters for agents. All these things were meant to provide them with deeper insight into the conflict and how to find measures against it. Even the dynamic norm graph, and the flow chart of the agent's decision making only help in terms of conflicts that occurred in the simulation, as they can represent what had already happened.

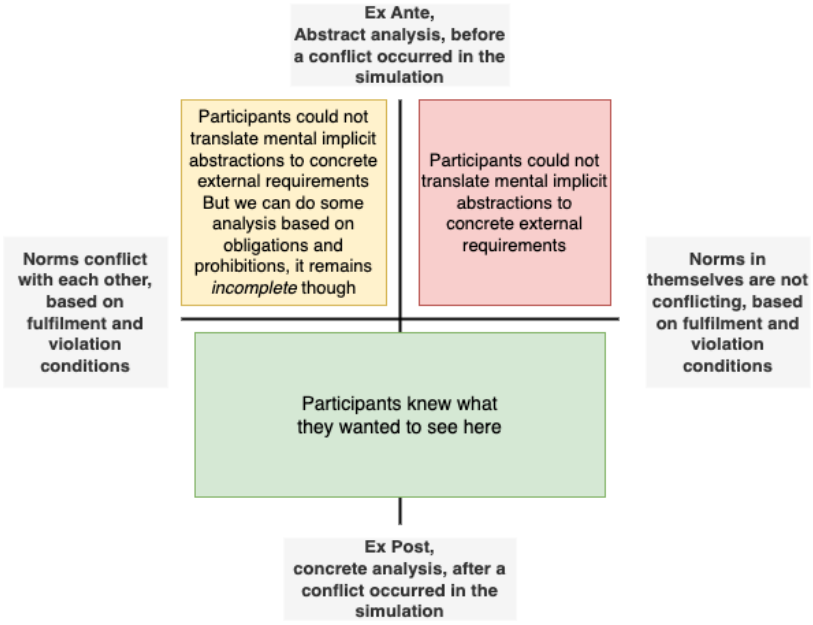

Fig. 3. Two-dimensional analysis space with color coding, from has been addressed (green) to has not been addressed (red) in the focus group study

4 A new Research Agenda

The crucial part we need to discuss and for what we need a new research agenda is the *ex ante* analysis. This means that in theory, just by having the set of norms, conflicts could occur when running the simulation, but importantly the simulation has not run yet. For example, in theory there can be a conflict between speeding and being in time for a meeting. But if the agent is never late, this problem (conflict) never occurs. When we look at these two quadrants in Figure 3, we see that the participants were actually not sure what they want to see there. The main problem here is that the conflicting has not yet happened in the simulation. Consequently, there is no concrete event that the participants could focus on and analyze. While with respect to logically inconsistent sets of norms we can show potential conflicts within and between obligations and prohibitions (via the dynamic norm graph), for example having to be at two different places at the same time, this is not possible for permissions as the state space is to large and too many conflicting situations can occur.

To make this interaction fruitful and as close to the human mind as possible, we call for a new research agenda within the social simulations community: ***Interaction tools to support the abstract analysis of norms***.

The focus group study showed that the participants are not able to do this kind of analysis. Even though we are able to do this kind of analysis in our head when looking at complex problems and scanning for small subsets of potential

solutions, when asked about in concretely how a simulation interaction tool could support them in this process, the participants often either shied away from the answer and tried to switched topic or claimed that it was very hard or impossible.

This means that we need to find further ways to support the users in doing this abstract reasoning. Given that the main overall theme of the results is *interaction*, we envision here a small preview tool that enables the users to experiment with a small set of norms and a minimal viable agent set to see if they can find conflicting situations. For example given the norms that police cars have right of passage and traffic from the right has right of passage, there could be a mini preview simulations within the main simulation that shows an intersection and the user can drag and drop police cars around to identify potential consequences. Such a tool can then also be beneficial when adding new norms and assessing their potential impact. Furthermore, given that traffic is an abstract term, policy makers could select vehicles, just like selecting filters, to decide what counts as traffic. Finally, a drag and drop function could be used, to provide the policy makers to explicitly set priorities between norms.

However, to identify if that is really something that the users want, requires further focus group studies with implemented versions of the simulation, so participants have something concretely to analyze. Gaining this kind of abstract reasoning and insights in the simulation is crucial, especially when it comes to norms. It is not enough to just see if a conflict occurs during the simulation but also beforehand. It might be possible that the conflicting situation never occurs making it easy to jump to the faulty conclusion that there are no conflicts. This is highly problematic, as it is basically like saying *everything is fine as long as it does not break*. However, this is **not** how it works in the real world.

One could now suggest to use participatory modeling approaches to tackle these issues. Such approaches have been used in the community very early on (see e.g. [21] or very recently (see e.g. [1]). However crucially, these approaches do not focus on interaction to make the results of the simulation and the behavior of the agents more accessible, as for example Ahrweiler et al. [1] also pointed out in their work. "[...] new visualization and interactive technologies can help to make simulation results more accessible to stakeholders" [1, p.8].

This is very important as norms come into play in various stages of the agent's deliberation process [13]. The way in which the norms are implemented is not only a technical question on how it ought to be done. Rather, it is a technical *as well as a methodological* challenge. How a norm is implemented in the system greatly affects the outcome. This is to say that we are not opposed to participatory modeling approaches. They can be very fruitful and used for example to discuss how to mode the *ex post* dimension from our focus group study. However, the results of our focus group study showed that the people have to problems in the *ex ante* dimension and thus do not know what they want to focus on and discuss about. To tackle this challenge we find a recently emerging strand of research promoted by Schimpf & Castellani [23] promising, as they argue for more cognitive sensitive approaches and dimension to be considered with smart technologies.

5 Conclusion & The Way Forward

Our focus group study results show that we need novel interaction tools to empower policy makers and other non-expert users to use the simulation in a - for them - meaningful way.

The participants had a clear idea on what support and tools they need to conduct an ex post analysis of norm conflicts, i.e. after they happened in the simulation run. The results clearly list requirements that the participants consider useful to get insights and to analyze why a particular norm conflict occurred.

However, it was not clear for them what they need and how to do an abstract analysis of norms before running the whole simulation. They were not able to translate the implicit abstractions that seem natural to us when doing them in our mind into concrete external requirements. While we proposed some potential solutions, **we are calling for a new research agenda** within the social simulation field which has this abstract reasoning as its focus.

For our immediate future work, we are going to implement the discussed requirements and potential solutions in an interaction tool. This interaction tool will then allow us to conduct further focus group studies to identify the support that policy makers and other non-expert users need to perform an abstract analysis of norms. The implementation step before directly jumping to new focus group studies is important, as the results show that a purely theoretical paper-based focus group study is not sufficient. People need a concrete tool to explore.

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