

A TUTORIAL ON PARTICIPATIVE DISCRETE EVENT SIMULATION IN THE VIRTUAL WORKSHOP ENVIRONMENT

Antuela A. Tako

School of Business and Economics
Loughborough University
Ashby Road, Loughborough
Leicestershire, LE11 3TU, UK

Kathy Kotiadis

Kent Business School
University of Kent
Canterbury
Kent, CT2 7PE, UK

ABSTRACT

Facilitated discrete event simulation offers an alternative mode of engagement with stakeholders (clients) in simulation projects. Pre-covid19 this was undertaken in face-to-face workshops but the new reality has meant that this is no longer possible for many of us around the globe. This tutorial explores PartiSim, short for Participative Simulation, as adapted to fit the new reality of holding virtual workshops with stakeholders. PartiSim is a participative and facilitated modelling approach developed to support simulation projects through a framework, stakeholder-oriented tools and manuals in facilitated workshops. We describe a typical PartiSim study consisting of six stages, four of which involve facilitated workshops and how it can be undertaken in a virtual workshop environment. We have developed games to provide those attending the tutorial with the experience of virtual facilitation.

1 INTRODUCTION

This tutorial aims to provide an introduction to participative simulation in the synchronous virtual workshop environment. The virtual environment and video conferencing has become the norm in many organisations, including board meetings during the Covid19 pandemic (Wiley 2020). We have now become accustomed to a new way of working, since the Covid19 pandemic rendered all face to face workshops and meetings a health hazard aside from the need for remote working. At the same time, the need for simulation has never been greater than now with governments and organizations dependent on the savings made and lives saved by modelling (Currie et al 2020). The new reality has forced us also, to move our facilitation practice to online platforms. In this tutorial we share our new experience of running online facilitated workshops. This tutorial would be useful to those simulation modellers interested in transitioning to a virtual facilitated practice and more particularly to incorporating virtual group-based participative stakeholder workshops in simulation modelling studies.

The PartiSim approach was developed as a result of a project funded by the UK's EPSRC back in 2007. PartiSim consists of a framework (Tako and Kotiadis 2015), tools and manuals (Kotiadis et al 2014, Kotiadis and Tako 2018) that support the analyst in carrying out modelling activities involving stakeholders throughout the project. Its framework, tools and manuals were developed and tested in two UK healthcare settings in the UK. Subsequently a toolkit was developed including a user guide, tools and manuals in 2010 (Kotiadis and Tako 2010), and later updated in 2018. These are available for modellers to download for free from the PartiSim website (www.partisim.org).

The aim of this tutorial is to provide an update of facilitative simulation in light of our change in practice and contributes towards the emerging conversation and research about moving communication with stakeholders online (Currie et al 2020). Our previous research and tutorials at the Winter Simulation Conference 2018 and Simulation Workshop 2021 has provided insights on how to conduct face to face PartiSim workshops (Kotiadis et al 2014, Tako and Kotiadis 2015, Kotiadis and Tako 2018, Tako and

Kotiadis 2018, Kotiadis and Tako 2021). The PartiSim approach, short for Participative Simulation, was developed to support analysts in involving stakeholders in the modelling process in a non-technical way (Kotiadis et al 2014, Tako and Kotiadis 2015). Stakeholders are engaged primarily in facilitated workshops to identify options and consider solutions through the use of simulation models. We are now able to contribute our emerging findings from conducting facilitated workshops online, that we have more recently adopted due to the pandemic and remote working practices. We have identified the need for online games and activities to engage the stakeholders in group activities. In this tutorial we describe a warm-up game (the three bearded men game) which we used to introduce stakeholders to the online facilitation platform and facilitation practice. We also contribute a game (the safari modelling exercise) that we have used to engage modellers in virtual facilitation. These games can be used as they are or adapted by modellers to support their practice. These can also be used in teaching.

This tutorial introduces the simulation analyst to virtual facilitation workshops to support the development of a simulation model. In doing that we first introduce the PartiSim framework and tools and explain how to run participative simulation studies. Thus, section 2 provides an overview of the pre-virtual PartiSim approach, with face-to-face workshops. Section 3 we offer our reflections on the aspects that require adaptation in organizing virtual workshops as well as the PartiSim approach more generally, based on our more recent experience. Next, section 4 presents the games we have used to support the move to a virtual facilitation practice. Section 5 concludes this tutorial with some practical tips for using the PartiSim approach and its tools in a virtual environment that could be useful for potential adopters.

2 OVERVIEW OF THE PARTISIM FRAMEWORK & TOOLS

The PartiSim approach is designed to support the modellers' interaction with a group of stakeholders throughout the DES study lifecycle. A framework and tools support the modeller in undertaking the different modelling activities during a simulation study. Undertaking the simulation study in a participative way can help save time in building the model on the computer, mainly because the workshops help to achieve a common understanding between the modeller and the stakeholder team. This can help to decide collaboratively the model scope and model specification, and at the same time to gain quick access to the data needed to develop the model and commitment to the study and its findings.

Using the PartiSim approach offers benefits to both the modelling team and the clients/ stakeholder team involved in a simulation study. More specifically, the modelling team can benefit from using the PartiSim approach (Kotiadis and Tako 2010), because it prescribes a set of group activities which allow the modelling team to engage concurrently with all the stakeholders leading to common views and consensus being built in a transparent way in a meeting/workshop. The dedicated tools supporting each workshop allows for a more structured and leaner modelling process throughout the study, compared to studies where the modeller is developing the model on his own and checks or validates the model with individual stakeholders on a one to one basis. The structured process helps the modelling team to understand the complexities involved in their settings. The tools and manuals included in the toolset offer the facilitator suggestions of relevant topics to discuss with the stakeholder group that ensure better communication and more effective discussions.

From the stakeholder team point of view PartiSim allows the participants to share their opinions about the problem and their system in a collaborative way. It furthermore allows for the stakeholders to be part of the process and the solutions identified, while at the same time non-technical language is used to extract their views. They feel engaged in and part of the process and feel empowered that the views are being taken into consideration.

The authors have trained students and modellers on using PartiSim, mainly in the UK through their teaching programmes at their respective universities (Loughborough and Kent) and also the UK OR society training programme. To the best of our knowledge it has been also embedded on at least two occasions in the curriculum of an undergraduate business and a postgraduate engineering module at two UK institutions. Further applications have followed. Reports of its use exist in the academic literature. For example, Proudlove et al (2017) report using a similar approach to PartiSim to undertake facilitated modelling in

three health care projects. Philips and Nikolopoulos (2019) used PartiSim to explore uncertainty and production smoothing in a complex pharmaceutical manufacturing environment. Tako et al (2019) report on adapting the PartiSim facilitated approach to model health and social care services in the Leicestershire area in the UK. PartiSim was also applied in a healthcare ambulance setting as part of a masters dissertation project (Puntambekar, 2016) under the supervision of one of the co-authors (Tako). The success of these studies varies, however, they all identify the benefits of engaging the stakeholders in conversations to co-develop options and solutions for their own problems (Tako and Kotiadis 2018).

The PartiSim approach consists of six stages and five sub-stage, as depicted in Figure 1. The stages are: 1. Initiate simulation study; 2. Define Problem; 3. Define conceptual model; 4. Model Coding; 5. Experiment with model; 6. Implement Findings (Tako and Kotiadis 2015, Kotiadis and Tako 2010). There are also five sub-stages that support the main stages, either to prepare for the workshop-based stages or to translate the outputs developed in workshops and confirm these with the stakeholders. Model coding, a middle stage in PartiSim, is not undertaken in a facilitated mode and that is acceptable practice in facilitated DES (Robinson et al 2014).



Figure 1: The main PartiSim stages

More details of the PartiSim framework are provided in Table 1 below. Column 1 shows six key stages and sub-stages. Each stage/sub-stage includes a number of prescribed activities (column 2), tools (column 3) and corresponding stakeholder-oriented deliverables (outputs) (column 4), which enable participative DES modelling to take place. Each stage (and sub-stage) prescribes a number of dedicated activities (Table 1, column 2). These are distinguished in two types: modelling and workshop activities. The modelling activities are aimed at supporting the modelling process while workshop activities support the facilitation of the group of stakeholders. The activities for the sub-stages are mainly undertaken by the modelling team, who report back to the stakeholders the outputs agreed in the workshops or seek further reflections and clarifications. Most of the workshop activities borrow concepts based on Soft Systems Methodology (Checkland 1999) or from traditional DES modelling activities, adapted to be carried out in a facilitated environment, giving stakeholders the space to express their preferences and discuss alternatives. An example is the “Debate desirable and feasible solution space” activity (stage 5), where the results of relevant scenarios are presented and debated with the stakeholders.

Each stage is supported by tools and the associated manuals which support the modelling team and stakeholders to reach to the prescribed dedicated outputs for each stage (column 3, Table 1). Scripts are

also available for some of the stages, useful particularly for the facilitator. These are different from the tools or manuals in that they include advice to support the facilitation process. The tools and manuals are paper based and freely available on the PartiSim website (www.partisim.org). For more details about the framework and tools readers are directed to our previous research (Kotiadis et al 2014, Tako and Kotiadis 2015, Kotiadis and Tako 2018).

Most of the activities support the development of the intermediate deliverables or outputs (Table 1, column 4). They are called intermediate because they can be revised or converted into a different output in the next stage. Some, for example “A bounded system within which the problem to be addressed exists” (sub-stage 2.a), are developed in a sub-stage with the view to using and leading the discussion during the workshop in stage 3. While others such as the conceptual model (stages 2 and 3), are developed during the workshop, but refined during a sub-stage (3.a) and converted into a different output (a simulation model) in stage 4.

Table 1: The PartiSim Framework, including stages, activities, tools and outputs

Stage & purpose	Activities ¹	Tools	Outputs
1. Initiate Study <u>Purpose:</u> Identify stakeholder team Identify key problem situation(s)	The modelling team undertake: - informal meetings and/or - on-site observations and/or - one-to-one interviews - with project champion and key stakeholder(s), to address preliminary information needs	- Feasibility of simulation modelling and its use Script - Situation of Interest Tool with manual - Recording Observations Tool with manual - Bank of questions Script - Stakeholder details Tool with manual - List of reading materials Tool with manual	List of stakeholder team roles. Preliminary understanding of the problem situation Study proposal, incl. initial study aims and timescales
1.a Pre-workshop (Sub-stage) <u>Purpose:</u> Preparations for workshop 1	- Identify modelling team and stakeholder team roles. - Modelling team prepare preliminary materials to be used in workshop 1 - Decide workshop venue and time slots. - Stakeholders are invited to workshops		
2: Define the Problem (workshop 1) <u>Purpose:</u> Agree on the problem situation and the wider system, within which it exists.	<i>Agree problem statement</i> <i>Define the system</i> <i>Draw a system model</i>	- Define the system Tool with manual - Draw the System Model Tool with manual	Overall study objectives/aims System map
2.a Post workshop 1/Pre-workshop 2 stage	Modelling team re-draw tools & disseminate workshop outputs to stakeholders		

<p><u>Purpose:</u> Disseminate workshop 1 outputs and prepare for workshop 2</p>	<p>Prepare preliminary materials for use in workshop 2</p>		
<p>3. Define conceptual model (workshop 2)</p> <p><u>Purpose:</u> Define specific elements of the conceptual model</p>	<p>Participating stakeholders take part in a facilitated workshop process to:</p> <ul style="list-style-type: none"> - <i>Brainstorm study objectives</i> - <i>Draw the Performance Measurement Model (PMM)</i> - <i>Define simulation study objectives</i> - <i>Draw communicative model</i> - <i>Discuss data collection</i> 	<ul style="list-style-type: none"> - Performance Measurement Model (PMM) with manual - Study objectives Tool with manual - Communicative Model Tool with manual 2018 	<p>Model inputs, outputs and contents</p> <p>Simulation objectives</p> <p>Process flow diagram</p> <p>A list of data requirements</p>
<p>3.a Post workshop 2 (sub-stage)</p> <p><u>Purpose:</u> Disseminate workshop 2 outputs and refine conceptual model</p>	<p>Modelling team:</p> <ul style="list-style-type: none"> - Prepare report detailing Refined workshop outputs and Data requirements - Liaise with the stakeholder team over correctness of workshop 2 outputs. 		
<p>4. Model coding</p> <p><u>Purpose:</u> Conceptual model is converted into a computer model</p>	<ul style="list-style-type: none"> - Data collection (modeller and stakeholders) - Build simulation model on the computer (modeller) 		<p>Model results</p> <p>Model validation and verification</p> <p>Preliminary future scenarios</p>
<p>4.a Pre-workshop 3 sub-stage</p> <p><u>Purpose:</u> Preparations for Workshop 3</p>	<ul style="list-style-type: none"> - Prepare preliminary materials for use in workshop 3 (stage 5): • Liaise with the project champion over correctness of model & its results (modeller and project champion) • Review preliminary scenarios with project champion • Prepare preliminary materials for use in the next workshop 		
<p>5. Experimentation stage (workshop 3)</p> <p><u>Purpose:</u> Define alternative scenarios to experiment with model</p>	<p>Stakeholders are invited to:</p> <ul style="list-style-type: none"> - <i>Validate the simulation model & its results</i> - <i>Rate performance measures (linked to model results)</i> - <i>Debate desirable and feasible scenarios</i> 	<ul style="list-style-type: none"> - Model validation tool - Rating the Performance Measures tool with manual - Debating the Alternative 	<p>Model validation and verification</p> <p>Alternative future scenarios</p>

		Scenarios tool with manual	
5.a Post-workshop 3/ Pre-workshop 4 sub-stage <u>Purpose:</u> Refine alternative scenarios & prepare for workshop 4	Modelling team: - Tweak or correct simulation model - Implement additional scenarios suggested (based on stakeholder feedback from workshop 3.) - Liaise with the stakeholder team over correctness of model results - Prepare preliminary materials for use in workshop 4		New alternative future scenarios Revised simulation model Revised model results
6. Implementation stage (workshop 4) <u>Purpose:</u> Define an implementation plan	Stakeholders are invited to: - <i>Review learning & changes implemented</i> - <i>Risk analysis and feasibility of change</i> - <i>Agree action trail</i>	- Script for Identifying changes in the system - Feasibility and Risks Scale tool with manual - Barriers to Change tool with manual - Action and Communication Plan tool with manual	Agreeable and feasible scenario(s) to be taken forward Action plan with deliverables (including due date and person responsible)

¹ Activities in italics are workshop activities

3 ADAPTING PARTISIM FOR THE VIRTUAL WORKSHOP ENVIRONMENT

In 2020 most of the world moved day to day business online because of the pandemic. Due to our ongoing collaborations, this meant that facilitated workshops had to be done online. The concept of holding virtual workshops is new and to our knowledge so far there have not been any studies reporting on most the use of most recent technologies and processes in such workshops, besides a recent book by Andersen et al (2021). This book provides general advice and tips about how to hold virtual events (meetings, workshops, trainings), however not specifically geared towards facilitated simulation modelling.

There were two key challenges we became aware of in creating a communication forum and adapting the process to fit the new reality. One of the initial communication challenges was to consider the practicalities such as what software could replace the typical virtual workshop environment. Typical workshops environments have space for people to collaborate such as flipchart paper with pens or use of sticky notes to enable ideas and diagrams to be created and shared. Typically in these environments you also have an overhead projector so you can concurrently do a number of things such as display information; initiate a conversation and invite participants to discuss. Our experience of virtual environments for meetings was Skype initially but these were certainly meetings and not workshops. We had almost always organised a coffee break prior to every workshop which would not be possible virtually. The humble coffee break beforehand enabled those attending to build a rapport, create an atmosphere of trust and support good communication. Interestingly we don't even mention that as a crucial part of PartiSim and only recognised it as such during this process of reflection. We were concerned that workshop participants that had not met prior to the workshops would be disadvantaged to those that had met or/and feel uncomfortable discussing

sensitive issues. It was therefore important to have an activity that replaced informal introductions and relationship building.

Another communication challenge of the transition to virtual facilitation was the software and deciding what could recreate the environment and enable a facilitation experience. Our practice was very much influenced by our online teaching which started in March 2020 with initial workshops scheduled in June 2020. We recognised that there were a variety of platforms to provide synchronous voice and image capture such as Zoom, Microsoft (MS) Teams, Skype and Google meet. During our practice however we settled on using MS Teams because that was the platform of choice for the majority of the stakeholders we interacted with in the UK. We recognise that this could change over time depending on the improved functionality of other platforms and ease of use. These platforms enable concurrent chat, projection of slides or models or websites and discussions to take place. Some platforms initially were more sensitive to multiple participants than others but this seems to have abated in our experience with all platforms improving over time to enable groups of around 12 participants comfortably taking part in our workshops.

Our next challenge was to find a replacement for flipchart paper/pen that we were so reliant on for brainstorming. We considered google docs which is Google's browser-based collaborative word processor, which offers shared online document editing (Siebers 2018). We had used Google Docs to collaborate on writing an article virtually during the early stage of the pandemic with authors on multiple locations (Currie et al 2020). Even though this platform is a great collaborative tool that enhances productivity allowing people to concurrently work on the same document, it did not fulfil the aim of the group activities as it did not support creativity and imagination, which are very important elements for our participative workshops. Google Docs allows the concurrent adding and sharing of ideas to support brainstorming. However, in our facilitation practice we needed a tool that besides brainstorming it can efficiently support idea generation by managing and tracking the progression of ideas concurrently during the workshop.

In our pursuit looking for online brainstorming tools we discovered Padlets.com. We have since then come across other similar platforms, which the readers might also be familiar with, such as Mural, MindMup, Miro. However we found Padlets more suitable for our purposes, due to its easy to use functionality. Padlet is essentially a noticeboard that enables people to create posts, comment on each other's post, vote or rate posts and attach other pictures or documents. The benefit of sharing all the information on a virtual noticeboard is that it is accessible by all the participants and offers the opportunity for them to add or comment on the ideas shared and even to augment them. This in turn, supports idea generation and creativity in a more transparent way. It furthermore, supports flexible asynchronous communication so that workshop participants can continue working even outside the workshop and continue adding posts. This was an advantage over face to face workshops that are time sensitive and do not enable further interactions in a transparent way unless it is via email.

We developed our practice so that we could combine Padlets with MS Teams audio (and video) to enable communication. Workshop participants were able to use MS Teams for voice and Padlets to concurrently brainstorm and vote. The processes and activities as described in section 3 above, are similar in nature, however the tools and outputs remain the same. Some deviation is expected with the activities as these are now virtual. We are currently reviewing them as we update our practice. In the next section, we give the reader a flavour of the new activities by describing a game that is aimed at replacing the coffee break experience in face to face workshops by helping workshop participants to get to know each other through a fun activity. This game is called the three bearded men game.

4 THE PARTISIM TUTORIAL GAMES

In this section we briefly introduce the games we will deploy at the tutorial: The three bearded men game and the Safari Park modelling game. The first game aims to introduce stakeholders to the workshop environment (The three bearded men game) and the second game aims to help modellers to transition to the virtual facilitation environment (safari park modelling exercise).

4.1 The three bearded men game

This game pre-existed the pandemic and was originally a face to face game we used to explain the benefits of working in groups. The original game had to be modified a bit so readers that may have taken part in one of our previous PartiSim tutorials should keep this in mind. The game can take around 20-30 minutes which is about the same amount of time for the meet and greet coffee breaks for PartiSim face to face workshops. We have experience of running a similar tutorial for the Simulation Workshop of the UK OR society in 2021 (SW21) so we will reflect on that experience when describing the game.

The workshop participants are given the link to the Padlet page (Figure 2) and asked to go into breakout rooms of around 4-6 people for about 10 minutes with one person acting as the observer to the group. The observer is just asked to record the process followed and any interesting observations around the process. The other members of the group are asked to initially introduce themselves to each other and then consider the activity question which is what characteristics do these individuals share? The group members are asked to not search for any information. The individuals displayed are well known individuals and participants use the padlet group comment space to add their findings. The reason that the game is called the three bearded men game is that most groups make that their first observation.

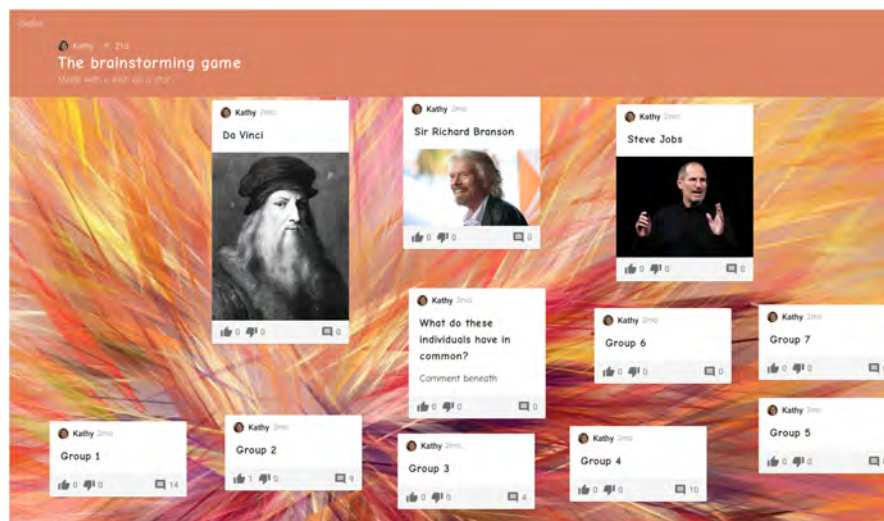


Figure 2: Padlet screenshot of the Three bearded men

Following the breakout room the groups are reunited on the virtual platform (e.g. Zoom) and the facilitator asks each observer to briefly describe the process followed by the group. For example did every person contribute to the conversation or write in Padlet. Did they brainstorm and record and then discuss? Groups do not behave uniformly and come up with a different number of shared characteristics. Groups assume we are looking for the group that records the highest number of characteristics. We will not record the typical characteristics here to avoid ruining the tutorial experience. The benefit of the exercise is that it helps train participants in the use of Padlet for brainstorming and creates a team playing atmosphere where everyone is contributing information they know about the three men. This exercise can be used with students also to demonstrate the possibility of working in groups in a virtual workshop environment.

4.2 The safari park modelling exercise: Exillirous Safari

The safari park modelling game is aimed at helping those that have simulation expertise consider the modelling team challenges trying to collaborate in the virtual workshop environment. During this game groups of modelers get to work on a fictional problem and interact with a fictional stakeholder group representing the problem owners. The aim of this game is to develop a conceptual model. We ran this game

at the Simulation Workshop 2021, which took around 45 minutes, with some participants continuing after the session.

Prior to the tutorial the Padlet is made available (Figure 3), which also includes the case study description. The case study describes a Safari theme park struggling to survive post pandemic and needing operational support. Participants are told the aim of the game is to describe the conceptual model in the best possible way. The description needs to be software independent and include: Objectives, Inputs/Outputs/Model content, Assumptions/Simplifications and to provide a communicative model. For those that complete the exercise they are able to take part in a competition. Participants are next allocated to work in a small team (less than 6 members). Teams are encouraged to continue collaborating throughout the conference on the problem. They are told to consider the issues that the management team are facing and develop a conceptual model to include objectives, inputs (experimental factors) & outputs (Key performance indicators), model contents, assumptions and simplifications and to provide a communicative model (i.e. diagram) of a simulation model. Groups can choose any simulation method (discrete-event, system dynamics, agent-based or hybrid) preferred or considered suitable for this problem. During the tutorial groups are able to question/interact with a panel of problem owners/stakeholders to get any additional questions asked in addition to the case study provided.

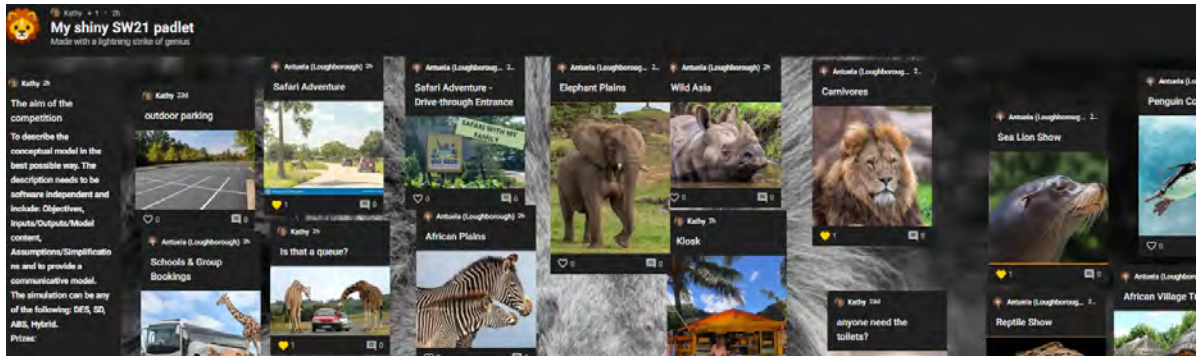


Figure 3: The Padlet to support communication and questions between the modelling team and stakeholder team (e.g. Safari park Manager)

Competing teams were given a couple of days following the tutorial to work on the problem independently in their groups prior to submission. On the last day of the conference, a panel of experts in simulation (the authors and 3 other simulation practitioners) assessed the conceptual models submitted for the competition. We also invited the audience to vote following a short presentation that competing teams were asked to make. The following criteria are used for the competition:

- Completeness and Clarity of the CM: are all the components of the CM described adequately for the type of simulation chosen by the group? Here the panel will consider if a modeller could convert the CM to a functional model;
- Creativity and Imagination of the representation of the CM outputs. We encourage the groups to put forward here new and innovative ideas in the communication of the various elements of the CM.

The teams reported that they worked very well together, and an unofficial representative quickly arose (a sort of team leader), who was also in charge to communicate with the problem owners. The game helped the teams to recognise the complementary skills between them and to establish a symbiotic relationship to work together. The practical exercise offered the team the experience of working in an online environment. Two teams submitted their conceptual models, which the judging panel rated equally good in terms of the

judging criteria, with a very small difference in total score. This indicates that modelling collaboratively in an online environment is possible and teams engaging in this way can be equally successful.

5 PRACTICAL TIPS FOR VIRTUAL FACILITATION

As shown in this tutorial, building simulation models collaboratively in a virtual environment is possible and we believe that the simulation community should consider this as an opportunity which can help to improve current modelling practice and engage more closely with study stakeholders. We have had the experience of facilitating workshops with different stakeholder groups. We have found that moving workshops to a virtual environment means that there is physical and social (i.e. no coffee breaks) distance between participants and as a result it takes longer to create a personal rapport and trust among participants and/or the facilitator (Duarte and Snyder 2006). In addition, there is an element of dependence on the technology working and the participants having a good internet connection. It furthermore requires more concentration from participants and cognitive load (Fosslien and Duffy, 2020). On the other hand, we note also that there are benefits to virtual workshops. These include, it is easier to bring the right people at the workshop, sessions can be more effective, and more equal contributions can be achieved. The virtual environment creates a more plain level field for team members to share their views, regardless of sex (male vs female) or hierarchical position in the organization, due to the lack of social cues (van Den Hooff and de Ridder 2004, Duarte and Snyder 2006). Furthermore, using interactive tools such as Padlet, and/or the MS Teams chat facility, it is more flexible and easier for participants to express opinions at any point (before, during or after the workshop).

We conclude this tutorial with some practical tips for using the virtual workshop PartiSim approach and its tools for potential adopters to consider. These are listed below:

- Identify from the outset of the study whether the stakeholder team are able to participate virtually. For example are they able to access the virtual platform as some organizations do not allow access due to security issues for some platforms.
- Offer a simple and detailed introduction to the brainstorming platform to be used so that stakeholders feel comfortable and accustomed to the platform.
- Be flexible with the stakeholder interaction, offer stakeholders the opportunity to post their comments on the chat and one of the facilitators enters their contributions on the brainstorming software.
- Many stakeholders struggle with bandwidth issues and/or lose concentration. Be flexible and offer opportunities to review contributions and add their contributions on the brainstorming software (in our case Padlet).
- Create a good rapport with the stakeholder group by offering opportunities for informal chats at the breaks.
- Offer games to support group formation and trust in place of coffee breaks and informal chats which are not possible in a virtual environment.
- Keep workshops as short as possible, ideally approximately two hours with breaks, especially because online sessions require a higher cognitive load (Fosslien and Duffy, 2020).
- At least 3 people are needed to support the virtual workshop: 2 facilitators work closely together to manage and record the conversation and one person to manage the chat and support those with technical issues. We find that compared to face-to-face workshops, the facilitator roles are different. In a face-to-face workshop, it is possible for even 1 facilitator(ideally 2 to share session facilitation) can , to manage the process as there are not as many technical aspects that need to be taken care of. However, a note taker is very important to take notes, which is not as necessary in a virtual environment because the technology can support that In the virtual environment the two facilitators need to work together in managing the process and information sharing.

The PartiSim materials, user guide, tools and manuals are available for interested modellers to access for free in the following link: www.partisim.org. We hope that DES modellers and analysts will be

interested to adopt a PartiSim simulation project and be able to share and reflect with us on the facilitation skills needed and the requirements. We believe that using the overall framework and tools is especially useful for novice modellers. We note that we are currently adapting the PartiSim workshop activities to reflect the approach we have recently used. In our future research will aim to move to a virtual modelling environment and to do so we aim to further develop our existing tools. We aim to present the adapted workshop activities and tools in future papers. This will enable more geographically dispersed modelling teams to work together, but we also hope that more modellers will be encouraged to adopt virtual facilitation in their simulation studies.

REFERENCES

- Andersen, H. H., Nelson, I. & Ronex, K. 2021. *Virtual Facilitation: Create more engagement and impact*. Chichester, West Sussex, United Kingdom: John Wiley & Sons.
- Checkland, P. 1999. *Systems thinking systems practice*. Chichester: Wiley.
- Currie, C. S. M., J.W. Fowler, K. Kotiadis, T. Monks, B.S. Onggo, D.A. Robertson, and A.A. Tako (2020) "How Simulation Modelling Can Help Reduce the Impact of COVID-19". *Journal of Simulation* 14(2): 83-97, DOI: 10.1080/17477778.2020.1751570.
- Duarte, D.L. and N.T. Snyder. 2006. *Mastering virtual teams: Strategies, tools, and techniques that succeed*. John Wiley & Sons.
- Fosslien, L. and D. Duffy. 2020. How to Combat Zoom Fatigue. *Harvard Business Review*. <https://hbr.org/2020/04/how-to-combat-zoom-fatigue>, accessed 15th May 2021.
- Kotiadis, K and A.A. Tako. 2021. "A Tutorial on Involving Stakeholders in Facilitated Simulation Studies". In *Proceedings of the Operational Research Society Simulation Workshop 2021 (SW21)*. M. Fakhimi, D. Robertson, and T. Boness (eds). 22-26 March 2021 p. 42-56. Online DOI: <https://doi.org/10.36819/SW21.005>.
- Kotiadis K and A.A. Tako 2018. "Post-model coding facilitation in DES: A case study in Healthcare". *European Journal of Operational Research* 266 (3):1120-1133.
- Kotiadis K and A.A. Tako. 2010. PartiSim User Guide to Facilitation Version 1 (December 2010), DOI: 10.13140/RG.2.1.3659.1201
- Kotiadis, K., A.A. Tako, C. Vasilakis. 2014. "Participative and Facilitative Conceptual Modelling". *Journal of the Operational Research Society*, 65(2): 197-213.
- Phillips, C. J. and K. Nikolopoulos. 2019. "Forecast quality improvement with Action Research: A success story at PharmaCo", *International Journal of Forecasting*, 35(1): 129-143.
- Proudlove, N, S. Bisogno, B. S. S. Onggo, A. Calabrese, and N. Levaldi-Ghiron. 2017. "Towards fully-facilitated discrete event simulation modelling: Addressing the model coding stage". *European Journal of Operational Research*, 263(2):583-595.
- Puntambekar N. 2016. Exploring the efficiency of a UK ambulance service through Discrete-Event Simulation, MSc Dissertation, Loughborough University.
- Robinson, S., C. Worthington, N. Burgess, and Z.J. Radnor. 2014. "Facilitated modelling with discrete-event simulation: Reality or myth?". *European Journal of Operational Research*, 234 (1): 231-240.
- Siebers T. 2018. What Is Google Docs and How to Use It. <https://www.makeuseof.com/tag/google-docs-faq/>, accessed 15th May 2021.
- Tako, A and K. Kotiadis. 2018. Participative simulation (PartiSim): A facilitated simulation approach for stakeholder engagement. In *Proceedings of the 2018 Winter Simulation Conference*, edited by M. Rabe, A.A. Juan, N. Mustafee, A. Skoogh, S. Jain, and B. Johansson. 192- 206. Piscataway, New Jersey: Institute of Electrical and Electronics Engineers, Inc..
- Tako AA and K. Kotiadis. 2015. "PartiSim: A Framework for participative simulation modelling". *European Journal of Operational Research*, 244(2): 555-564.
- Tako AA, K. Kotiadis, C. Vasilakis, A. Miras, and C. W. le Roux. 2014. "Modeling patient waiting times for an obesity service: a computer simulation study". *BMJ Quality and Safety*, 23 (5): 373-381.
- van Den Hooff, B. & J. A. de Ridder. 2004. "Knowledge sharing in context: The influence of organizational commitment, communication climate and CMC use on knowledge sharing". *Journal of Knowledge Management*, 8(6):117-130.
- Wiley. 2020. Prepare for virtual meetings, as pandemic looks to last awhile. Board & Administrator for Administrators Only, 37: 1-2. <https://doi.org/10.1002/ban.31171>, Accessed 14 May 2021.

AUTHOR BIOGRAPHIES

ANTUELA A. TAKO is a Reader in Operational Research at the School of Business and Economics, Loughborough University. She holds a PhD in Simulation and an MSc in Management Science and Operational Research from the University of Warwick. Her research interests include the comparison of simulation approaches (discrete-event simulation and system dynamics), facilitated and participative simulation modelling, conceptual modelling and health care modelling. She is Associate Editor of the Journal of the Operational Research Society (JORS), Journal of Simulation and Health Systems. Her email address is a.a.takou@lboro.ac.uk and her webpage is: <http://www.lboro.ac.uk/departments/sbe/staff/anthi-antuela-tako/>.

KATHY KOTIADIS is a Reader (Associate Professor) in Management Science/Operational Research at the Kent Business School, University of Kent. She graduated with a BSc (Hons) in Management Science and went on to do a PhD in Operational Research at the University of Kent. Her main research interests include discrete event simulation modelling applied to health care and the development of the simulation methodology through Problem Structuring Methods. In 2009 she was awarded the KD Tocher Medal by the OR society for the best simulation paper published in the Journal of Simulation over the period 2007-8. She is the co-EiC of Health Systems (journal). Her email address is K.Kotiadis@kent.ac.uk.