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DEVELOPMENT OF A GENERIC SYSTEM DYNAMICS-DISCRETE EVENT SIMULATION HYBRID MODELLING FRAMEWORK

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ABSTRACT

The field of System Dynamics-Discrete Event Simulation (SD-DES) hybrid modelling is fragmented with no standardized or structured format for framing a SD-DES hybrid modelling-based study. This work develops a SD-DES hybrid modelling framework to address the research gap. The developed SD-DES hybrid modelling framework is one where the modelling process is an iterative and interactive one that evolves as the hybrid is developed, making it simple, straightforward and amenable to a variety of systems and problem situations.

1 INTRODUCTION AND BACKGROUND

SD-DES hybrid models are a unique type of mixed-method simulation modelling where the SD and DES sub-models are built to represent different aspects of the system, but both sub-models communicate and exchange data as they are run as a single unit, called the hybrid model. The exchange of data is necessary to mimic real-life interface between variables as represented by the different modelling paradigms.

Different types of frameworks have been advanced to guide one through a SD-DES hybrid modelling-based study. However, the SD-DES hybrid modelling frameworks that have been advanced previously by others are not so easy to replicate in situations other than where they were initially promoted because of their problem/context-specific nature. A number of attempts seem to have been ad-hoc with no clear methodology (Eldabi et al. 2016). The developed SD-DES hybrid modelling framework in the current research is one where the modelling process is an iterative and interactive one that evolves as the hybrid model is developed. By so doing, the modelling process as described by the framework is simple, straightforward and amenable to a variety of systems and problem situations.

2 THE HYBRID MODELLING FRAMEWORK

The developed framework is portrayed in Figure 1. The modelling worldview of the framework characterizes problems as having elements of feedback structures. Most decision-making problems involve feedback structures, whether instant or delayed. The preliminary enquiry phase of the framework is used to ensure that all the important variables, their interactions and the key feedback structures are captured in the intended model. The adopted modelling perspective allows one to use a Causal loop diagram/Stock and flow diagram (CLD/SFD) to conceptualize the hybrid model, with its key variables, elements, their interactions and feedback structures. Thereafter, the CLD/SFD is used to delineate the variables/concepts that are to be modelled using SD and DES respectively, on the basis of where variables fit, whether in SD or DES, how one intends to develop the SFD to a simulation-based model, and how the hybrid model would be used as a decision-making tool. In addition, the CLD/SFD concept helps one to easily visualize how variables in the individual sub-models would communicate and exchange data in the eventual hybrid model, bearing in mind that the sub-models originated from an initial SFD that was

modelled to represent the whole. These two aspects, delineating variables in the SD and DES sub-models respectively, and conceptualizing the data exchange have been ill-defined and unstructured up till now.

3 CONTRIBUTIONS TO KNOWLEDGE AND FUTURE WORKS

Prior to the developed hybrid modelling framework, there was no unifying framework or standardized way of framing a SD-DES hybrid modelling-based study. The developed framework in the current research, advances a set of standardized and structured formats for approaching each of the key steps in SD-DES hybrid modelling. The replicability aspect has been validated in a number of diverse case studies by the researcher (see for examle, Oleghe and Salonitis 2018). It remains to be tested and further enhanced by others, so that the field has a generic framework that can be used to guide researchers and modellers who undertake hybrid modelling of the type.

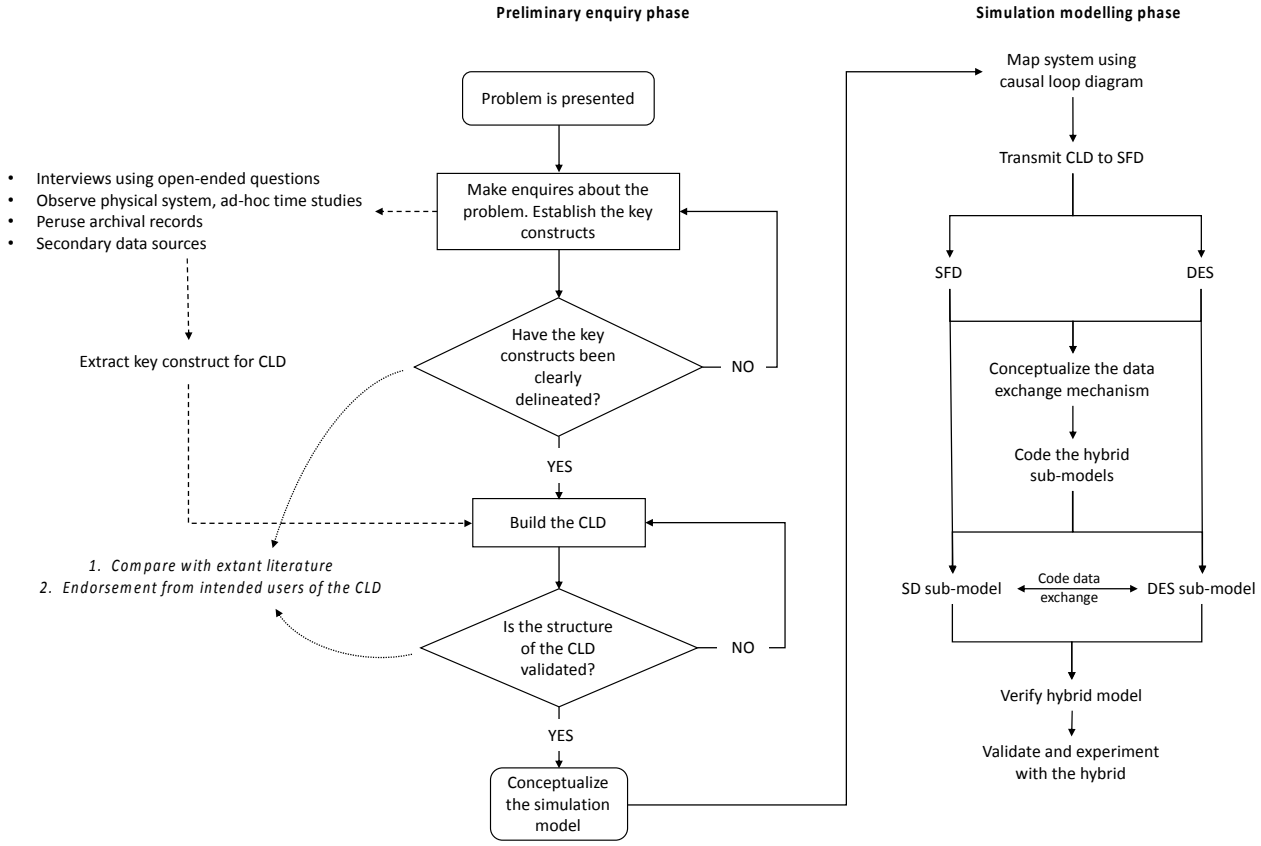

Figure 1: The developed generic SD-DES hybrid modelling framework.

REFERENCES

Eldabi, T., M. Balaban, S. Brailsford, N. Mustafee, R. E. Nance, B. S. Onggo, and R. G. Sargent. 2016. "Hybrid Simulation: Historical Lessons, Present Challenges and Futures." In *Proceedings of the 2016 Winter Simulation Conference,* edited by T. M. K. Roeder et al., 1388-1403. Piscataway, New Jersey: IEEE.

Oleghe, O. and K. Salonitis. 2018. "Application of Hyrbrid Simulation Modelling for the Implementation of Job Rotation in a Feedmill," In *Proceedings of the 2018 Winter Simulation Conference*, edited by M. Rabe, et al. *To Appear*. Piscataway, New Jersey: IEEE.