Causality and Validation of System Dynamics Models incorporating Soft Variables: Establishing an Interface with Structural Equation Modelling.

Santanu Roy

National Institute of Science, Technology and

Development Studies

Dr. K.S. Krishnan Marg

New Delhi 110 012

India

Email: santanu@csnistad.ren.nic.in

Pratap K.J. Mohapatra

Department of Industrial Engineering and

Management

Indian Institute of Technology

Kharagpur 721 302

India

Conventional methods and models are based on hard (quantitative, cardinally-measured) information. The problems are different in the analysis of soft, qualitative or categorically measured data. Social scientists have been more and more concerned with measuring qualities in order to graple with complex configurations and the ambiguities inherent in human perceptions and behaviour. The authors have earlier attempted to model the work climate of an R&D laboratory using the system dynamics (SD) framework. Problems occur at two stages in developing such a system dynamics model incorporating soft variables. First, most of the variables encountered in such systems are measured using a quasi-quantitative framework. The question of reliability and validity of such measurement would have to be addressed. Second, the causal relationships among the variables would have to be ascertained in a way that takes into consideration this quasi-quantitative measurement approach. Reliability refers to the stability of replicated measurements. Construct validity refers to whether the measure really measures what it is supposed to measure, as opposed to measuring some similar yet conceptually distinct variable. Causality or causal linkages are central to the paradigm of system dynamics. The causal relationships in the above-mentioned system dynamics model were largely derived from correlations, regression analysis, cluster analysis and multiple classification analysis. But in all these methods of analysis, causality cannot be inferred or verified. Further, there is the critical question of validating such a system dynamics model. Our approach towards soft system modelling is quite apart from the methodological thrust of soft systems methodology (SSM) and other problem structure methodologies. For one, SD itself has moved away from the hard system paradigm, with

the relativist/holistic philosophy of validation. Secondly, in SSM, the problem situation could be ill-structured and messy whereas the variables in the model need not be so. The central theme of structural equation modelling is the establishment of causal relationships among latent variables taking into consideration the reliability and validity of quasi-quantitative measurement of such variables. It is, therefore, argued that establishing and interface between system dynamics and structural equation modelling could be appropriate to address the problem of establishing causality in and validation of a system dynamics model incorporating soft variables.