An Application of System Dynamics Modeling to Immunisation Policy Analysis

By

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ABSTRACT

Simulation modeling is increasingly being used for strategy implementation, policy analysis and design in many application areas including health care management. Preventable childhood diseases and premature deaths still occur particularly in the developing countries due to low immunisation coverage. Although, various approaches have been applied to understand immunisation coverage problems, there are still acknowledged deficiencies in these approaches.

While the immunisation system like other healthcare systems is very complex and difficult to manage, the System Dynamics modeling approach is applied to improve the understanding of acknowledged problems and to support improved decision making. To determine the full range of activities, inputs and challenges associated with immunisation coverage, field studies were carried out. Problems influencing immunisation coverage included inadequate provision of healthcare service, low levels of immunisation awareness, economic factors and poor vaccine management. The research presents the overall architecture of the immunisation system which constitutes agents, key processes, activities and information flow. Causal loop diagrams and a simulation model (stock and flow) were used to capture the complex and dynamic nature of the immunisation process while a case study on the Ugandan healthcare system was used to test its effectiveness. National immunisation service providers validated the model and rated it as a useful communication and decision making tool. The above provide a deeper understanding of the immunisation system thus facilitating the development of health information systems that are appropriate.

Results of the study show that, the population, healthcare and vaccine management policies have overwhelming influence on immunisation coverage and form the foundations on which the success of immunisation policy is based. The study reaffirms the need to determine the current capacity of the health system and strengthen it to cater for the growing population. The designed application demonstrates the dynamics arising from complexity, delays and non-linearity which characterise the immunisation system and tests different policies towards the improvement of immunisation coverage. Based on the results of simulation experiments, suggested intervention strategies that could provide substantial effect on immunisation coverage include: strengthening of the healthcare system, design of relevant health information systems, adoption of ICTs innovations to improve operational efficiency, improvement of the livelihood of the population and increasing literacy levels.

The developed model and causal loop diagrams constitute significant knowledge in terms of structure and the understanding of immunisation coverage. The model captures requisite information requirements, key processes of the immunisation system which provide support for process improvement, operational management and training. The model provides tools that test different policies thus making it useful for strategic planning and policy debate.