# Paper Review on “Modelling Population Growth, Shrinkage and Aging using a Hybrid Simulation Approach: Application to Healthcare”

1. Summary

This paper stresses the importance of accurate population projections for various fields and explores a hybrid simulation model aligning health policy with short-term demographic forecasts. Using various techniques, including Monte Carlo modeling, and based on Forrester's System Dynamics, the model spans from 2002 to 2014, focusing on Lower Silesia. It accurately represents population aging, offering insights into how changes affect healthcare demand.

1.1 Motivation: The motivation of the study came from the thought that demographic forecasts are crucial for various economic studies as demographic changes impact economic growth, social security, urban development, and health policy. The overall goal of the study is to build a hybrid simulation model that would allow alignment of short-term demographic forecasts with health policy models to predict the future demand for healthcare services.

1.2 Contribution: The study will investigate the credibility of the System Dynamic method, particularly the modification of the time step (dt) within the population module. Their contribution involves developing a framework for dynamically adjusting the time step (dt) based on feedback from the discrete module, emphasizing a commitment to enhancing system adaptability.

1.3 Methodology: The population under study is concentrated in Lower Silesia, the fourth largest region in Poland, and includes residents of the Wrocław Region (WR) and surrounding districts. Employing dynamic objects for accuracy, the simulation runs from 2002 to 2014, using Wrocław Region parameters and CSO projections post-2014. Cohorts F 0–4 and M 0–4 are influenced by various factors, while cohorts 5–19, 20–39, and 40–59 represent individuals aged four to sixty. The oldest population, cohorts F 60+ and M 60+, considers maturation, immigration, emigration, and deaths, using life expectancy at 60. Historical data is used until 2014, and hypothetical values start in 2015.

1.4 Conclusion: The study advocates for a hybrid simulation approach that integrates Discrete Event Simulation (DES) and System Dynamics (SD) in order to highlight the impact of population changes on healthcare demand.

2. Limitations: There are two limitations - Technical Constraints and Incomplete Model Calibration.

2.1 First Limitation: The extended time frame of around 25 minutes for each simulation run poses a notable technical challenge, particularly for stochastic simulations needing multiple replications. This constraint hampers swift execution, creating challenges in terms of computational resources and time management. Consequently, it curtails the exploration of diverse scenarios, compromising the thoroughness and comprehensiveness of the study.

2.2 Second Limitation: The cohort calibration limitation signifies an incomplete calibration of specific cohorts, leading to an imprecise representation of certain demographic segments and introducing uncertainty in model accuracy. This highlights a crucial need for refinement, urging additional testing and refinement of the aging chain population model. The lack of full calibration poses a risk of imprecise demographic projections, emphasizing the importance of addressing this issue for enhanced model accuracy and reliability.

3. Synthesis: The future scope includes refining the aging chain population model for more precise demographic simulations, addressing uncertainties in morbidity trends, and incorporating external factors like economic growth and education. Technical challenges in integrating simulation modules and optimizing run times will be addressed, and the research will expand for a comprehensive understanding of population dynamics and external influences.