Using System-Dynamics-Based simulations for HIV/AIDS Prevalence in Thailand

Abstract

The main objective of this paper is to present the system dynamics simulation for HIV/AIDS prevalence in Thailand. The model is calibrated using Bureau of AIDS, TB and STIs Department of Disease Control; Ministry of Public Health statistics trends over the past 5 years and explores possible futures over the next 10 years. The result of this paper is to integrate both using simulations and creating System-Dynamics-Based simulations for Web-based services for discovery, access and processing learning. The gaps in theory and practice and contentious areas for ongoing research and refinement are explored and potential future enhancements of the simulation are discussed.

Keywords: system dynamics simulation, AIDS prevalence in Thailand, Web-based services for discovery, access and processing

1. Introduction

A methodology of system dynamics is to analyze the components of a system including cause-effect relationships and their underlying mathematics and logic, time delays, and feedback loops. System Jay Forrester formulated system dynamics in the 1960s at M.I.T. (Forrester, 1961, 1968, 1969, 1971). He generalized the approach and applied it to social issues such as economics and health (Forrester, 1969) and later to the physical and biological sciences such as ecology (Forrester, 1971). In the years since, far more powerful computer programs for System Dynamics modeling have been created for both Windows and Macintosh computers, including PowerSim (PowerSim, 1999), STELLA (High Performance Systems, 2000b), ithink (High Performance Systems, 2000a), Extend (Imagine That, 2000), and Vensim (Ventana Systems, 1999). Vensim provides a simple and flexible way of building simulation models from causal loop or stock and flow diagrams.

The current status of HIV/AIDS prevalence in Thailand is reported by the Bureau of Epidemiology in 1984, the cumulative number of AIDS patients to amount 307,114 cases and 85,459 AIDS deaths cases (December 31, 2006). Currently, the trends of AIDS morbidity and AIDS mortality show a decrease from 7 years ago. Based on a detail analysis, it is projected that majority of new infections occurred among female contracting the virus from their HIV infected husbands (38 %), men who sex with men (22 %), men who have sex with female sex workers (11 %), men contracting the virus from their HIV infected wives (9.6 %), intravenous drug users (6.4 %), female sex workers contracting the virus from their male customers (4.4 %) and male contracting virus from extramarital sex 7.2 %). With a continuous effort to interrupt transmission of HIV and AIDS during the past 20 years, Thailand has remarkably averted a huge number of HIV infections in the country. It is estimated that more than 6 million Thais have been protected from being infected with HIV. The projected current cumulative number of HIV infections is more than 1 million. Approximately 500,000 HIV infected individuals had passed away and around half a million is still living HIV infection and AIDS. The annual incidence of HIV infection has tremendously declined from more than 130,000 cases in early 1990s to less than
20,000 cases nowadays. It is forecasted that there are still around 17,000 new HIV infections occurring in the past year (Bureau of AIDS, TB and STLs Department, 2008). Thus, the main objective of this paper is to create system dynamics simulations and then to integrate the results from simulations with Web-based services for discovery, access and processing learning.

2. Material and Methodology

To collect the secondary data from the Bureau of AIDS, TB and STLs Department of Disease Control, Ministry of Public Health statistics over the past 5 years. To do the system dynamics simulations using Vensim as a tool and explores possible futures over the next 10 years. The results from simulation are converted to text then to demonstrate to result in term of Map using Flash as a tool. The framework of this paper is shown in Figure 1.

![Figure 1: The framework of this paper](image)

3. Results and Discussion

In this paper, there are only five parameters that are the number of population, birth rate, death rate, the number of HIVs infection and the number of AIDs death (76 provinces in Thailand). The correlation among AIDs death and others parameter using SPSS as a tool is shown in Table 1.
Table 1 The correlation among AIDs death and others parameter

<table>
<thead>
<tr>
<th></th>
<th>AIDS</th>
<th>POP</th>
<th>BIRTH</th>
<th>DEATH</th>
<th>HIVS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pearson Correlation</td>
<td></td>
<td></td>
<td></td>
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<td></td>
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<tr>
<td>AIDS</td>
<td>1.000</td>
<td>.796</td>
<td>-.397</td>
<td>.787</td>
<td>-.084</td>
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<tr>
<td>POP</td>
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<td>1.000</td>
<td>-.624</td>
<td>.918</td>
<td>.165</td>
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<tr>
<td>BIRTH</td>
<td>-.397</td>
<td>-.624</td>
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<td>-.514</td>
<td>.417</td>
</tr>
<tr>
<td>DEATH</td>
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<td>.918</td>
<td>-.514</td>
<td>1.000</td>
<td>.144</td>
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<tr>
<td>HIVS</td>
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<td>.165</td>
<td>.417</td>
<td>.144</td>
<td>1.000</td>
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<tr>
<td>Sig. (1-tailed)</td>
<td></td>
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<td></td>
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<tr>
<td>AIDS</td>
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<td>.000</td>
<td>.057</td>
<td>.000</td>
<td>.374</td>
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<tr>
<td>POP</td>
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<td>.000</td>
<td>.004</td>
<td>.000</td>
<td>.264</td>
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<tr>
<td>BIRTH</td>
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<td>.017</td>
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<tr>
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</tbody>
</table>

Where
- POP: number of population
- BIRTH: birth rate
- DEATH: death rate
- HIVs: number of HIVs infection
- AIDs: number of AIDs death

From table 1, The results of the study suggest that there are statistically significant only the number of AIDs death correlated with number of population and death rate equal to $R = 0.796$ and $0.787$, respectively.

The system dynamics simulations based on the using Vensim model is calibrated using Bureau of AIDS, TB and STLs Department of Disease Control, Ministry of Public Health statistics trends over the past 5 years and explores possible futures over the next 10 years is shown in Figure 2.

Figure 2: The simulation model of AIDs prevalence in Thailand
From Figure 2, the diagram above is inserted all parameters into the model and they are working on.

To demonstrate the results from simulation in term of map in province (76 provinces in Thailand) are shown in Figure 3.

From Figure 3, to group the number of AIDs death into 5 levels. Red color represented as the highest number of AIDs death and the yellow one is the least.

The results are identified the most probable region for the occurrence of AIDs in the province. This paper can serve as a bridge to fill this gap between the providers and beneficiaries.

To do the web application, the main page is shown in Figure 4. From Figure 4, there are 5 menus for selection that are AIDs Death Details, AIDs Patient Details, AIDs Death Simulation Details, AIDs Patient Simulation Details and Generating Details. The result of final map generation is shown in Figure 5. From web application, to do zoom in and out by region is shown in Figure 6.
From Figure 5 the web application demonstrates the map result in provincial and 5 colors. To do zoom the map in term of region and from each region they display the name of provinces and number of HIVs/AIDS as shown in Figure 6.
To generate the new map based on the user data by download the data from excel or designed form is shown in Figure 7.

Figure 7: Map Generation from user data

From Figure 7, the results demonstrated the same style as Figure 5 and 6. The present study has some potential limitations, too. It is not a survey-based study but sentinel surveillance. It is an established fact that the incidence of AIDs decreased.

**Conclusion and recommendation**

A Vensim model was used to estimate the underlying parameters, quickly and efficiently, in order to explore design alternatives. Integrating the System Dynamics approach into web application can be challenging. The results from simulation still have some error about 15%. However, they provide useful information on the prevailing AIDs prevalence in Thailand. As it is the most essential clue to success in HIV and AIDS programs, Thailand will be pleased to collaborate with local and international partners in implementing the necessary activities and programs at the national, regional and global level.

Future research could focus on the effect of various socio-economic and environmental factors on the high occurrence of AIDs in the hilly region of the state.
References