A System Dynamics-based Study on Elderly Non-Acute Service in Norway

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1. Abstract

Modern non-acute service sector for old people is a highly dynamic and complex system. Currently in Norway, it includes nursing home service, community house service and home-based service. Patient flow between different service sectors is influenced by various factors like population composition, waiting time and relative satisfaction. Traditional analyses and comparisons between these services ignore the dynamics and complexity underlying the patient flow and fail to properly represent the structure of non-acute service sector for old people. Other researches on the flow in public health service system, although from a dynamic view, usually take the non-acute care system as a supplement to acute care system. Thus they do not differentiate the non-acute services and make comparisons for the investment decision-support purpose in non-acute sector.

This research uses the system dynamics methodology to map the dynamic patient flow in elderly non-acute caring system in Norway. The model will differentiate the characteristics of non-acute service sector and thus can increase understanding of the complexity and dynamics caused by influencing elements in the system. The ultimate purpose of this research is to deliver a tool to all local communities in Norway for their long-term budget planning in non-acute service sector for old people.

2. Introduction

2.1 Health condition and elderly caring capacity in Norway

There has been considerable improvement regarding health status of Norwegian people. One manifestation of this is the fact that life expectancy at birth is six to seven years longer than it was 50 years ago. In 1998, the average life expectancy for males was 75.5 years and 81 years for women. However, if compared with other countries in Western Europe, life expectancy in Norway changed from ranking highest during the period 1950–1970 to average levels at the end of the 1990s. (Health Care Systems in Transition (Norway) 2000) This implies that the increase in life expectancy during the last decades has been far more moderate than the average within the European Union.

And behind that, Norway had over 10 nursing home beds per 1,000 population in the mid of 1990's, which is the highest among developed countries for which data were available. It also has exhibited much higher expenditure on nursing home care at over US$250 per capita and that amount accounts for over 15% of its total health expenditure.(Health services and resources 2000) See Figure 1

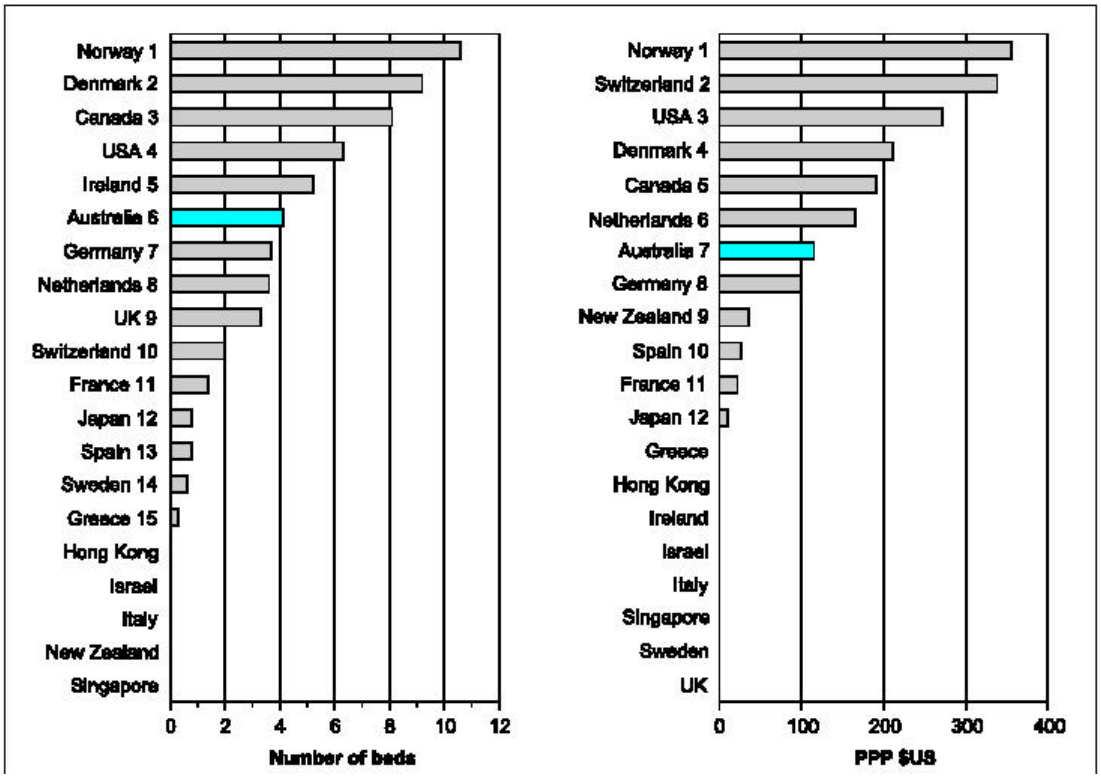

Figure 1: Nursing home beds per 1000 population (left)
Expenditure per capita on nursing homes (right), mid-1990s

But with such high absolute capacity in Nursing home service, there are still some communities in Norway reporting that they are suffering from having to set up a waiting list for those who want to move into nursing homes. Sometimes the waiting list is really long that patients currently in the nursing homes could only get limited service amount and then just be transferred to other lower-level service compartment, like community houses or home-based service. (Eldreomsorg 2001) And that may partly explain why the increase in life expectancy in Norway has been slowed down during the last decades.

So it is the time for the government and communities in Norway to think about whether there are some structural problems causing the delivery of elderly non-acute service less efficiently.

2.2 Responsibility and type of elderly caring service in Norway

Norway has a small population and is sparsely settled. The responsibility for the Norwegian health service is therefore decentralized. The country has five health regions, 19 counties, and 435 municipalities/communities. Each is responsible for its part of the health service. (Bolstad 2000)

The Local Authority Health Care Act was passed in 1984 and made local communities responsible for all primary health care. In 1988, the task of managing

nursing homes was shifted from counties to communities. So right now local communities in Norway should take the responsibility for all the non-acute caring service for the old people, as shown below:

Social welfare schemes (Health Care Systems in Transition (Norway) 2000)

Public social security
Pension schemes
Acute-care in hospitals
} **administered by the central government**

Home-based service
Community-based care
Nursing Home Service
} **administered at the local community level**

The health care for old people can be divided into two groups: acute and non-acute service care. Acute care refers to the surgery operation in professional hospitals, which normally lasts for a short period of time. Non-acute care refers to the longer-term service provided to those who cannot take care of themselves due to physical or mental disabilities.

The non-acute health care service in Norway mainly consists of: (a) nursing home care; (b) community house care; (c) home based care. Nursing homes provide specialized medical, nursing and social services in an institutional setting. In a community house, old people live together in a specialized house where there are some self-serviced medical facilities, easy for old people to use. Nurses will come by regularly and they will only come with a higher frequency if individual patient needs them. For home-based care, people just stay at their own homes and nurses will only come by if they call for ask.

The main difference between these three services is the service level providing and service capacity flexibility. For providing nursing home service, communities need to establish a fixed staff and some physical facilities, like houses, beds and medical equipments. For providing community houses, communities just need to set up some physical facilities, but do not need to have a fixed staff, so the capacity in community houses enjoys a more flexible attribute than in nursing homes. And for giving home-based service, communities neither set up any physical facilities nor a fixed staff, and so it enjoys the highest capacity flexibility but it can only deliver low level of caring service.

2.3 Problem Identification

Sometimes, people do not really need much service but still stay in some high-level service compartments, like a nursing home or a community house. Figure 2 describes the service need by patients in a community house in Norway. Over half of all the patients need less than 200 minutes' service every week, which means they can be just sent back to their own home and get the home-based service. Only 25% of the patients need more than 600 minutes' service per week.

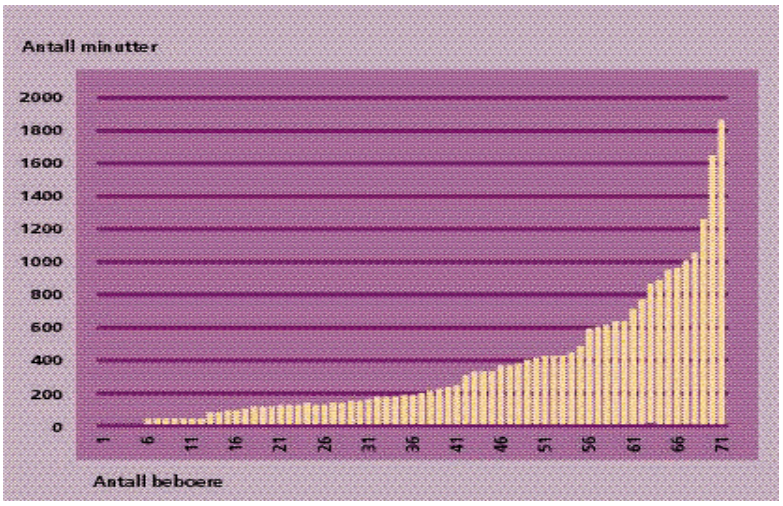

Figure 2 Service need by patients in a community house in Norway

Therefore, to make the delivery of elderly caring service more efficiently, we must firstly find out what is the real reason for some communities to be unable to service the people just in time even though their capacity is not low, compared with other countries. This is the first part of the problem can be called as the capacity problem in the non-acute elderly service system in some Norwegian communities.

After the reason is found, then comes the second question needs to be answered: What the local community should do to prevent this problematic situation from happening? And what is the cost of implementing different policies?

Last, since the local communities' goal in providing non-acute health care service can be generally stated as: to gain a high level of public satisfaction at a relatively low cost, this research also needs to find out how should local communities build different non-acute service capacity to satisfy the demand for different types of caring from the old people in a relatively long run.

The time horizon chosen in this research is 10 year, which is long enough because the performance of local communities will be assessed by the central government every 4-5 years. And the boundary should first of all include all three non-acute service type compartments as endogenous structures, which are of most interest to the local communities. And then take population, acute hospital and funding system as some exogenous inputs.

2.4 Hypothesis

It is normal to have a waiting list in the health service system, if people want to get the service but cannot get it due to the capacity limit, they will be just put onto a waiting list. The waiting list will be expanded by new arrival of patients, either from people newly having health problems or people transferring from other level of service compartment. And it can be depleted by the admission to nursing homes, which depends on service capacity limits and the number of current patients living in the nursing homes. The average time people need to wait before they can get into the nursing homes is termed as Waiting Time.

There exist some psychological effects of Waiting Time on people, as shown in Figure 3. Firstly, when the waiting time is long, people will be reluctant to leave even if they feel they are ok. Because they know it will take them quite long time to get in the nursing home again if they need the service again. (Wait long, Stay long) Secondly, if people perceive a long waiting time, they will tend to apply for the service earlier. (Wait long, Arrive earlier) And this will make the waiting list artificially long because not everyone on the waiting list really wants the service right now.

These two effects actually block the flow of patients in nursing home system, forming two reinforcing loops that will lead to even more expanded waiting list and more serious shortage of service capacity with the time passing.

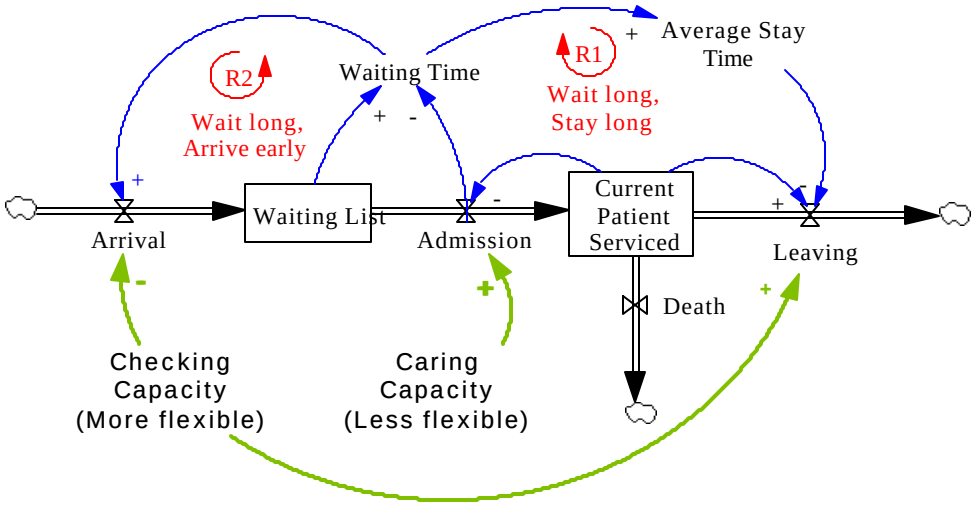

Figure 3 Patient flow in Nursing Homes

One policy to break the vicious cycles is that to set up some service capacity for checking function. This checking capacity is used to check if the people really want the service when they arrive and after they have stayed some time in the nursing homes. Of course this policy need communities to increase some capacity first, like extra nurses and some equipment need to be used to check those people health condition. But these checking capacity are usually flexible, which means they can be discarded easily and never cost any more once they are not needed. And if checking can help reduce the waiting list and waiting time successfully, and the system can benefit from these reinforce loops, then communities may not need to have so much inflexible caring capacity. So in the long run, they can reduce the service capacity in nursing home service, which can save the maintain cost of capacity for them.

The shortcoming of the policy lies in that in the public service sector, it is impossible to enforce people not to stay longer and arrive earlier if they really want to do so. And if the policy pushes people very much to do otherwise, it will turn down the public satisfaction towards local communities, which brings other problems.

So some communities in Norway have adopted the idea of “Old people at right

place" (Hestnes GE 2000). The idea mainly refers to that caring service should be provided at different levels with different service intensity and facility occupancy, which can thus satisfy the different demands from different old people. Actually this idea focuses on the flow between different service level compartments within elderly caring sector. It is intended to realize that the service is only provided to those who need it most. People in a higher-level service compartment who do not need so much service can be transferred to a lower-level service and on the other hand, people can first get some lower-level caring when they are waiting for higher-level service. And by doing so, the patient flow within sectors can be controlled without loss of public satisfaction.

Figure 4 describes the patient flow between different services and some decision rules of people when they choose different services. (Intermediate Service in the figure aggregates the home-base service and community house service)

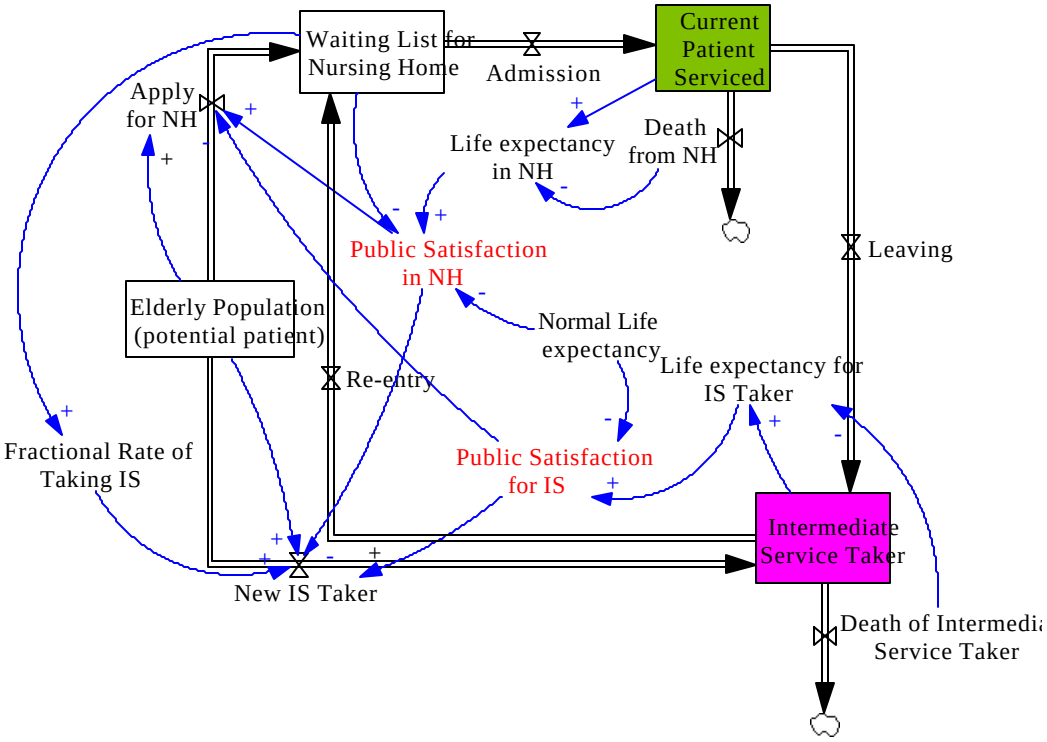

Figure 4 Patient flow between different services

3 Literature Review

Different types of elderly caring services have long been discussed. Before 1980's, the prevailing philosophy on welfare emphasises what was then termed "indoor relief" in institutional settings(Trattner 1974). During a long-time period, non-acute care and relief for the elderly was only provided in kind of indoor settings, like Nursing Homes, which provide nursing care, assistance with personal care activities, and room and board. However, from the later 1980s, more and more

countries had a significant reduction in the proportion of elderly people in institutional care together with a strong emphasis on expanding home care services—"outdoor relief", which is intended to maintain as many elderly people as possible in their own homes for the reason of limited capacity of nursing homes.(Caring for Frail Elderly People Policies in Evolution 1996)

The difference between institutional care and home care service has been compared and various indicators concerning to the satisfaction level under both service conditions have been evaluated. (Ruusland 2001) Some surveys show that older disabled persons and their families prefer to receive services in their own homes and communities, rather than in institutional settings, because many seniors enjoy a higher quality of life in their own homes and communities. And some argue that more money should be put on increasing home- and community-based care because the average annual cost of nursing home care is twice as much as home- and community-based care and its capacity is less flexible. (Indiana's Need for More Home- and Community-Based Options and Fewer Institutions 2002)

These comparisons and analyses are very helpful to differentiate types of elderly caring service and model people's decision rules when choosing different services in this research. But they usually ignore the dynamics and complexity within the system and so cannot do not properly represent the structure of non-acute service sector for old people.

There is another group of researches related to the topic in this research, which is more specified on the patient flow in public health service system. Modelling the flow rate of Geriatric patients in health service system has been gradually developing during the last decade. In early 1990's, long stay patient and short stay patient were firstly differentiated in modeling the flow in health service system. A number of works have been done to create and solve a so-called two-stage dynamics model of flow through geriatric departments. (Harrison GW 1991) In a two-stage model, patients are initially admitted to the first stage, from which they may depart from the system, by death or discharge or move to the second stage, from which they eventually depart by death or discharge. (Millard 1989) Later studies showed that factors outside the service relating to the availability of alternative long term care placements has a major influence on the outcome of clinical care (Millard 1993). In 1996 a three-compartment model of flow was published which extends a two-compartment model by considering patients released from geriatric departments and their subsequent length of stay in the community. (Taylor G 1996)

Such models are all used to estimate the average numbers and lengths of stay for short-term and long-term patients and the average number and length of stay in the community for released patients, which allows for a significant improvement in the forecasting of future bed requirements to aid the planning of geriatric departments.

Thereafter, some researches argue that the average length of stay in the acute compartment will be artificially high if some who would be long-term patients are kept waiting in the short-stay acute compartment until beds become available in long-stay compartments, like community houses and nursing homes. (El-Darzi E 1998) And policy to reduce the waiting time for acute service was suggested to set up more

long-term non-acute services, like nursing home, which can serve as a secondary caring institution after old people receive a surgery operation. This policy was tested and demonstrated to have a much more profound effect on total patient wait times than more obvious wait time solutions, such as increasing acute hospital bed capacity directly. (Wolstenholme 1999)

In all, this group of models and researches, although from a system dynamic view, usually take the non-acute care system as a supplement to acute care (like surgery operation) in hospitals, which is more medical-oriented and can last for a shorter period of time. Because they do not look into and do not care the non-acute service sector very much, they never differentiate the services within this sector and make comparisons of them. So their results are of very little meaning to the decision-makers in non-acute service sector (like the local community leaders in Norway) and their suggestions to reduce the waiting time in acute service hospitals will be very likely to increase the waiting time in non-acute nursing home services and thus only shift the burden of problem to next taker.

In this paper, the three-compartment system dynamics models on the patient flow in acute service can be applied in non-acute sector with some modifications. E.g. the patient flow from hospital acute compartment to non-acute nursing home compartment should be conversely considered because the focus in this research is on non-acute rather than acute service sector. And attention also needs to be paid on other characters, which differentiate either type of service, like different flexibility of capacity, different waiting time attributes, etc.

4 Method and Research Design

This research may become a part of a bigger project, namely "Norwegian Community Project". The whole project deals with all responsibilities of local communities in Norway, which include education, infrastructure, industry and social welfare system. So the purpose of this research is to deliver a sub-model structure in a policy-testing tool applicable to all Norwegian communities for their long term planning in funds distribution.

Bearing this purpose, the research is designed as follows:

First of all, system dynamics should be implemented as a main methodology because it can promote two things at the same time, -system thinking and system dynamics modeling.

System thinking philosophy breaks the open loop and static thinking pattern. Therefore, in the light of system thinking, one type of service system is no longer seen as an isolated and distinct system but the one associated with other service systems dynamically. As we understand from the illustration of the hypothesis, the capacity problems in a high-level service compartment are highly interactive with other lower-level service compartments available within the same sector. So if the problem is not considered systematically, high leveraging policies can never be found.

System dynamic modeling enhances our ability to understand the capacity problems better by capturing and illustrating the iterative complexities. The stock and

flow network is a strong language in this case to represent various material and information flows and service process stages in the whole non-acute elderly caring system, so that it can successfully capture the associated accumulation, multiple feedbacks, delays and non-linearity whose implications are usually too difficult to understand if people only use their mental capacity. Moreover, a simulation model allows laboratory experiment under alternative scenarios and visualizes the outcomes, so that it can be used to exhibit the problems to the decision-makers in the local communities and to test and explain the effects of various policies developed to deal with the problem.

After a rudimental model has been set up, it should be reexamined in a group modeling workshop where all the experts in different domains, e.g. medical professionals, managers of service institutions, financial decision-makers in the community, etc. will come together to give their ideas and recommendations on the structure improvement. The workshop will be established several times during process of the whole project, and this research can benefit from getting continuous feedback and assessment from practitioners during different stage of modeling. And this will obviously help increase the validity of the model.

At the same time, data also need to be collected for some parameters. In this case, the data concerning the population distribution can be easily found, but the estimation of population evolution can be very different from different information sources since they use different methods to estimate. Second group of data of interest is related to the attributes for different types of service, which include cost, average construction time and loss rate. They can be easily found in the accounting records in the communities. Third group includes the factor indexes influencing patient satisfaction and their preference in choosing the service under different conditions. These data could be found in some reports related, but it will be ideal if some experiments or interviews are specifically established.

Finally, since the purpose is decision support, various policies of how much money should be invested on each service from the local communities need to be tested. For this purpose, an Interactive Learning Environment can be set up to facilitate the understanding of system structure and trial of their decisions without any real loss.

General stages of research are as follows:

1. Set up an SD-model based on the hypothesis
2. Let the model examined in a group modeling workshop
3. Interview the elderly and collect data for parameter estimation
4. Policy testing in ILE environment

5 Expected Results

First of all, the confirmation of the hypothesis concerning reasons of capacity problems in some Norwegian communities is expected. Then the results by using the Checking Capacity to solve the problem are also expected. Its advantage on the

flexibility and its possible negative effect on the public satisfaction should be shown to the decision-makers in local communities.

When it comes to problem of how much money should be invested on each service in the elderly non-acute sector, there may not be so-called optimal policies. Every different community may have different weights on cost, satisfaction and other elements. But the function of the model in this research is just to let the decision-makers try their trade-offs and see the forth-coming results in short-run and longer-run (up till 10 years) brought about by their different decisions.

Through trying different policies in the simulation model established by this research, the decision-makers in local communities can get a general understanding of why the capacity problems appear, how much capacity should be really invested for either type of service and which type of service should be focused on. This understanding will better their long-term budget planning in non-acute service sector for old people, to help make further progress in the health status of old population on one hand, and to keep the cost under control on the other.

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