Understanding the Role of Family Doctors Using System Dynamic Simulation

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Abstract: In this study, a two-tier health service system is modeled with the objective of understanding the impact of family doctors in the health system in Turkey. Model is constructed to simulate patient flows in the system based on interviews with health officers and data obtained from Düzce for the time period 2006-2007. System dynamic methodology is used to formulate the relations between the components of the system with the purpose of analyzing both the role of the general practitioner in this primary health care system and the effects of system components’ decisions to the system’s performance. The general practitioner is the primary health care provider in the system that acts like the gate-keeper or not during the simulation period; state and private hospitals are secondary health care providers and these primary and secondary cares constitute the two-tier health service system. Dynamics of service quality, word-of-mouth and number of available family doctors are investigated in different scenarios. We are trying to define implications of changing policy parameters on the system performance measures which are demand at general practitioner, healthy population and waiting times at the general practitioner and the hospital.

1 Introduction

In this paper, a system dynamic model of two-tier health service system has been set up with the purpose of analyzing both the role of general Practitioner in the health care system and the effects of system components’ decisions to the system’s performance. As defined by Barlas (2002) system dynamic methodology is used to approach long-term policy problems as national economic problems, supply chains, project management, educational problems, energy systems, health care and many other areas. Because of these wide application areas and policies, it will be beneficial to use this methodology in our model. For the purpose of modeling this system dynamic model, city of Düzce has been studied and data have been collected as mentioned above. Düzce is the small city in Turkey where population is more than 300000 people. In 1999, there happened an earthquake with serious loss which brings the social therapy necessity for whole city. Because of this necessity, first general practitioner application has been started in September 2005 in Düzce.

In our study, interviews have been done with health officers and general practitioners to build up the model based on main problems. City has been studied from two sides as demand side and supply side. Demand side is the side of patients and supply side is the side of health centers. In this paper we studied on demand side which includes the patient flows and their choices in the model. In Düzce, health centers can be grouped into two main services as general practitioner and hospital – because of the limits of city as population, obtainable data from the city and number of health centers – and patient flows between these health centers are studied to understand the problems. From interviews, it is realized that there aren’t any gate-keeping policy for general practitioners that can cause high congestion to hospitals. In addition to this, there are dynamics parameters as word-of-mouth, service time and waiting time which can affect patients’ choice in the system.
2 Influence Diagram

An influence diagram has been developed to understand the effects of parameters and variables of Düzce case after the interviews which have been done with health officers in the city. From these interviews, it is validated that general practitioners and hospital which includes private and research hospitals in the city are taking the role of health service centers which can be called as two-tier health service system. In the system, there is a population with healthy people which becomes unhealthy depends on environmental conditions in time and causes negative-loop in the system as seen in Figure 1.

![Figure 1: Sickness Loop](image1)

Unhealthy people generate a demand for healthcare in the system which is being affected positively from number of unhealthy people since demand for healthcare increase at the same time when number of unhealthy people increase. This demand can be both for general practitioners and hospitals and patients have to decide whether to go general practitioner or hospital in which this choice can be seen in Figure 2.

![Figure 2: Patients Choice](image2)

At this point, we try to model dynamics of the system that influence the demand since we focus on patients’ choice of first point of contact in the health system. We determine the patients’ choice by attractiveness of general practitioner and hospitals and this attractiveness affect directly the probability of choosing general practitioner or hospital as seen in Figure 3. From our interviews that we made in Düzce, we assumed the factors that affect attractiveness are: trust, service time and waiting time.

![Figure 3: Attractiveness Effect at Health Centers](image3)

First factor is patients’ confidences to general practitioners and hospitals. In the system, when patients decides to go general practitioners at least twice that means they have confidences from their previous treatment. This confidence increases the number of visits to general practitioner and
they will decide to choose the general practitioner as a first contact. Same situation exists also for trust to hospital. When patients prefer to go hospital instead of general practitioner that means their previous treatment was successful or they are being affected from other patients. These effects can be named as word-of-mouth effects of general practitioners and hospitals. In both health centers, more demand causes higher attractiveness and higher attractiveness increase the demand for relevant health center. In Figure 4, word-of-mouth effects of health centers can be seen as obviously.

**Figure 4: Word-of-mouth effects**

Second factor is service time effects on attractiveness of general practitioners and hospitals. This service time affects the quality of treatment at health center since it is the average time that doctors at hospital or general practitioners cure a patient. If service time is higher than average service time, quality of treatment will increase by decreasing the treatment’s mistakes since doctor spend more time on patient. Also number of general practitioners and hospital doctors have significant role on service time since higher number of doctor means less daily demand per doctor by increasing service time. Figure 5 shows these negative loops of service times on attractiveness at general practitioner and hospital.

**Figure 5: Quality Effect on Attractiveness**

Third factor is waiting time which effects on attractiveness at health centers. Waiting time is the average time that patients waste time to be treated at general practitioners’ offices or hospitals. Waiting time has negative effect on attractiveness since patients always prefer less waiting time and longer waiting time decreases attractiveness. This decay will affect the future decisions of patients when they have to make decision on their first point of contact with general practitioner or hospital. Waiting time can be affected not only from daily demand for healthcare but also from service time and doctors quantity. If service time is high in the system, it causes congestion at health centers which increases the waiting time; however this waiting time can be decreased by increasing the number of doctors by preventing congestions. These influences can be seen in Figure 6.
Finally, gate-keeping policy changes the attractiveness of general practitioner. By the help of interviews from Düzce, it has been seen that introducing gate-keeping policy for general practitioner increase the demand for general practitioner treatment. Although patients need secondary primary care in hospital because of some diseases, they have to take referral permission from general practitioners to go hospital. Because of this obligation, we assumed a gate-keeping policy parameter which effects attractiveness of general practitioner. Therefore, if gate-keeping policy exists in the system attractiveness of general practitioner will automatically increase, if not it will have no effect on attractiveness. Influence diagram of healthcare demand and attractiveness can be seen in Figure 7. Behavior of the model is depending on the dominance of these loops. Dominant loop in the model will change the attractiveness which also affects the decisions of patients for their first contact.
Figure 7: Influence Diagram

Population +

Unhealthy People +

Demand for Healthcare +

Demand for GP +

Service time at GP +

Waiting time at GP +

Trust to GP +

Attractiveness of GP +

Gatekeeping Policy +

Demand for Hospital +

Service time at Hospital +

Waiting time at Hospital +

Trust to Hospital +

Attractiveness of Hospital +

GP Quantity +

Hospital Doctor Quantity +

Unhealthy People +

Demand for Healthcare +

Demand for GP +

Service time at GP +

Waiting time at GP +

Trust to GP +

Attractiveness of GP +

Gatekeeping Policy +

Demand for Hospital +

Service time at Hospital +

Waiting time at Hospital +

Trust to Hospital +

Attractiveness of Hospital +

GP Quantity +

Hospital Doctor Quantity +
3 Sensitivity Analysis

3.1 Analysis 1

Sensitivity analysis is being done for understanding the roles of general practitioners and some parameters which are assumed depend on data from city of Düzce. First analysis is done by changing just the gate-keeping policy in the system. G=1 has the meaning of general practitioners are acting as gatekeeper and G=0 means they are not. From Figure 8 and Figure 9, it can be obviously seen that gate-keeping policy is affecting probability of choosing general practitioner positively. At steady state value, probability to go general practitioner with gate-keeping is nearly 0.3 higher than without gate-keeping.

![Probability of Choosing GP in Analysis 1](image)

**Figure 8: Probability of Choosing GP in Analysis 1**

From Figure 8, it is also realized that there is difference between the behaviors of probability with or without gate-keeping policy. When general practitioner acts as a gatekeeper in the system, initial probability of choosing general practitioner will be higher than hospital choice which causes attractiveness of general practitioner depends on confidence will be dominant in the system. However, after service time effect will be more dominant than trust effect on attractiveness in the system, probability starts to decline until behavior reaches steady-state value. At the same time, it is necessary to explain the reason of higher probability to choose general practitioner. At the beginning of simulation, initial demand for general practitioner which causes more trust to general practitioner. Although hospital’s quality effect is higher than general practitioner’s, trust effect of general practitioner is more dominant than hospital which directs patient to have a first contact with general practitioner. Therefore, when there exists gate-keeping policy probability for choosing general practitioner is higher.

In addition to this, we should also analyze the probability when there is not any gate-keeping policy in the system. As seen in Figure 8 and 9, probability of choosing hospital is higher than general practitioner. The reason is when there is not any pressure on patients at the beginning, more patients choose hospital to go and this causes for hospital to have more daily demand and
more word-of-mouth effect. Although, there are more patients in the hospital, its service time
effect is also higher than general practitioner since the number of doctors in hospital is also higher
than general practitioner.

In both policy, we have not observed any waiting time effect on attractiveness for hospital and
general practitioner since there is not any exceedance for doctors’ and general practitioners’ daily
treatment capacity.

![Probability of Choosing Hospital](image)

**Figure 9: Probability of Choosing Hospital in Analysis 1**

### 3.2 Analysis 2

Second analysis has been done for understanding the role of general practitioners by changing
their numbers in the system. In Düzce, there are totally 97 general practitioners and we changed
this value from 50 to 150 to observe the system behavior. As seen on Figure 10, steady-state
values of probability of choosing general practitioner are increasing when we also increase the
number of general practitioners in the system. However, there are some different behaviors
because of different values and this behavior changes under the value of 97. So it is necessary just
to compare values under 97 and thus we can observe the effects on attractiveness. As seen in
Figure 10, at the beginning probabilities are increasing rapidly because of gate-keeping policy and
word-of-mouth effects of general practitioner. When we have more than 97 general practitioners in
the system probabilities decreases a little to reach the steady-state value because of service time
and waiting time effect. However, when we have less than 97 general practitioners in the system,
behavior of the probability is changing after a short time. As a result of fewer general practitioners,
patients are starting to wait at general practitioners’ offices which cause congestion at offices and
this congestion decreases the attractiveness of general practitioner. Dominance of waiting time
loop affects the behavior of system and less patients start to choose general practitioner which
means trust to general practitioner decreases. Decay in daily patient demand of general
practitioners cause to finish the congestion of offices and again waiting time effect looses its
dominance; therefore attractiveness of general practitioner is increased until it reaches the steady
state value. These increases and decreases can be seen in Figure 10 with Q1=50 (50 general
practitioner in the model) and Q1=75 (75 general practitioner in the model).
4 Conclusion

To conclude, gate-keeping have significant importance on patients choice. It can increase the probability of choosing general practitioner nearly 0.3 which means general practitioner can reach more number of people in the city and can follow their treatment results. On this choice, word-of-mouth, service time and waiting time acts as dynamic parameter which can change these choices depends on their dominant values.

References