PAPER • OPEN ACCESS

Pairing clients and psychologists using stable marriage problem approach

View the article online for updates and enhancements.

IOP ebooks™

Bringing you innovative digital publishing with leading voices to create your essential collection of books in STEM research.

Start exploring the collection - download the first chapter of every title for free.

Pairing clients and psychologists using stable marriage problem approach

S N Huda

Department of Informatics, Universitas Islam Indonesia
Yogyakarta, Indonesia

sheila@uii.ac.id

Abstract. Health is an important thing in human life, it includes not only physical health, but also mental health. Choosing the right psychologist will help individuals with mental problem to overcome the problem. Choosing a psychologist is important, because the psychologist's personality will influence the process of psychotherapy. This research paper will describe our approach in building a Decision Support System model that will compute the pairing of clients and psychologists. In this study, Weighted Sum Model is adopted to calculate the preference value of each individual, both psychologists and clients. Then based on this preference value, the client-psychologist pairing will be calculated using the Stable Marriage Problem approach. The Gale-Shapley Algorithm is used in this system to solve the Stable Marriage Problem and has been able to produce a stable matching between one set of Clients and one set of Psychologists, and there is no blocking pair from the results of this algorithm.

1. Introduction

Health is an important thing in human life, it includes not only physical health, but also mental health. Mental health can be disrupted with a mental disorder, such as depression. As an example, based on [1], in the UK around 18% of the population in working age experience mental health problems.

Depression and anxiety have a correlation with hopelessness [2]. Hopelessness is defined as a symptom that originates from negative experiences and leads to a perception that the person is powerless and have no future [3]. Hopelessness also has a relationship with suicidal behavior [4]. Therefore, it is very important for someone with a mental disorder to get treatment from experts, such as psychologists and psychiatrists.

There is difference between psychologist and psychiatrist, the basic thing is that a psychiatrist is basically a doctor who studies mental disorders. As a doctor, a psychiatrist can prescribe medications which will work chemically to stabilize hormones in the body. Psychologist is an expert who studies human's psychology. Psychology emphasizes on the pattern or behavior of human life along with the reasons compared to the biological side as in the psychiatrist. Solutions offered by psychologist are more likely about mindset and lifestyle changes.

However, based on WHO estimation in developing countries, the proportion of psychologists in lower to middle income countries is 2-14 psychologists per 1,000,000 people, while in middle to higher income countries, this proportion increases to 147-379 per 1,000,000 people [5][6]. Even in developed countries like US, it is estimated that only 20.9% individuals with 12-month major depressive disorder get adequate handling [7].

High pressure in life can also results in depression. Furthermore, if depression conditions are not handled properly, they will also affect work status [8]. This becomes a chain of circles that needs to be disconnected. By knowing where to look for help, someone with psychological problems can be courageous to get handling from experts. One of them is through a psychological counseling bureau which is a company where a group of psychologists open counseling therapies (psychotherapy).

Choosing the right psychologist will help individuals feel comfortable. Choosing a psychologist is important, because the psychologist's personality will influence the process of psychotherapy [9]. According to [9], there are several things that become factors which affects the pairing of therapists to maximize the progress of psychotherapy. One of the consideration is a pairing based on therapists' field of interest (A-B dichotomy). Suppose therapist A is more successful in dealing with the problem of chronic depression, while therapist B is more successful at handling family and child problems, or therapist C is more successful at handling problems with addiction. In addition, similarity in race and social class between clients and therapists also often the criteria for selecting client-therapist partners, but there is no evidence that this variable has a positive influence on successful psychotherapy. Other factor that influences the pairing of clients and psychologists is gender. For example, the majority of clients from male therapists are women. Female therapist has a tendency to be more empathic and active, whereas male therapist tends to be more confrontational.

In this paper, we choose one psychology counseling bureau as a case study, a group of psychologists opened a joint practice in Yogyakarta. In the bureau, there is one person who work as the customer service and first interviewer. Client who wants to counsel needs to register first, then the client will be "interviewed" about the general idea of the problem by the customer service. The customer service will then choose the suitable psychologist for the client and arrange the consultation schedule. Through this mechanism, pairing client-psychologist tends to be a tacit knowledge, and if the person who is in charge of interviewing the initial client changes (for example, if the previous customer service stop working), this tacit knowledge will be lost along with previous customer service. In addition, this pairing can also be subjective with the officer tendency and can result in an imbalance load of the counseling among psychologists. It would be better if the clients can provide criteria of their desired psychologist, and the psychologists also give the client preference they want to handle, then some computation is done to pair clients and psychologists that will allow for equal distribution of counseling load and satisfy both clients and psychologists preferences.

This research paper will describe our approach in building a Decision Support System model that will compute the pairing of clients and psychologists. This DSS model uses Stable Marriage Problem/Stable Matching Problem (SMP) approach. Stable Marriage Problem is a problem to find a stable pairing between two sets of the same size given the order of preference of each element. The order of preference for each individual is computed using Weighted Sum Model. With this DSS model, it is expected that the pairing of client-psychologist becomes more appropriate to each preference and balances the workload of psychologists in the counseling bureau.

2. Related Works

Problems with pairing or matching have many applications in the real world. For example, [10] discussed about matching children who graduated from elementary school in Singapore to junior high schools. This matching takes into account the preferences of these children with school preferences in the form of grades of primary school graduation (Primary School Leaving Examination).

In other case, matching issue also exists in the economics domain, for example in [11] where a group of firms had a requirement for a group of workers candidate, while a group of workers candidate had a set of firms that they wanted to go to. This problem was also solved using stable matching approach.

While in the health domain, one of the most famous research in stable matching implementation is the study of [12] to pair the resident doctor to their first hospital, it took into account the pairing from two sides, both from the resident's preferences and hospital's preferences.

3. Methodology

3.1. Weighted Sum Model

Weighted sum model [13] is a widely used method for multi-criteria decision making. This method was introduced more than 50 years ago, but remains as a fundamental and most popular method for multi-criteria decision making [14]. In this study, WSM is adopted to calculate the preference value of each individual, both psychologists and clients. Then based on this preference value, the client-psychologist pairing will be calculated using the Stable Marriage Problem approach.

The value of each alternative is calculated from the sum of the values for each criterion multiplied by the weight of the criterion. The optimal value is taken based on the minimum value if the criterion is a constraint, or based on the maximum value if the criterion is profit, in accordance with Equations (1) and (2).

$$x = \genfrac{}{}{0pt}{}{min}{(x_1, \dots, x_n) \in D} \sum_{i=1}^{m} w_i a_i \quad (1)$$

Or

$$x = \genfrac{}{}{0pt}{}{max}{(x_1, \dots, x_n) \in D} \sum_{i=1}^{m} w_i a_i \quad (2)$$

Where x is the optimal value achieved, which is the minimum value (if the criterion is a constraint or a cost) or the maximum value (if the criterion is an advantage) of n alternatives available in domain D, where the value of each alternative i is the sum of each criterion from m number of criterion alternative multiplied with criterion weight w.

3.2. Stable Marriage Problem

Stable Marriage Problem is a well-known problem in the game theory with broad applications covering the fields of mathematics, economics and computer science. Stable Marriage Problem is a problem in finding a stable matching between two sets with the same size, given a sequence of preferences for each element. Matching is a one-to-one mapping from elements in one set to the elements on another set. A matching is said to be unstable if:

  a.   There is an element A in the first set that prefers an element B in the second set than the A's paired element, and
  b. B also prefers element A compared to the element which become B's partner

This problem is generally called a Stable Matching Problem, where specifically called a stable marriage problem when the number of elements in the first group is the same as the number of elements in the second group. A Stable Marriage Problem involves two separate sets with size n, namely the set of men and $women$. Each individual has associated preference list of all members in the opponent set. For example, individual p prefers q than r, where q and r are members of the opponent set, and if and only if q precedes r from the list of property preferences of p [15].

For this example, a matching M is a one-to-one correspondence between the set of men and women. If men m and women w are a pair in M, then m and w are called $partner$ in M, and is written as Equation (3) below.

$$m = PM(w), w = PM(m) \quad (3)$$

Where:

$PM(m)$ is $M - partner$ of m;

$PM(w)$ is $M - partner$ of w.

Men m and women w are said to be a blocking pair of M when m and w are not a pair in M, but m prefers w than $PM(m)$, and w prefers m than $PM(w)$. A matching with at least one blocking pair is called unstable, whereas otherwise it is called a stable matching.

3.3. Gale Shapley Algorithm

Gale and Shapley [16] formulated an algorithm to obtain a stable matching solution of SMP. In the first iteration, every man from the set of Men submits a proposal to the woman he likes most. Every woman who receives a proposal will say "maybe" to the man she likes most from the entire sender of the proposal, while she will say "no" to the other man. By saying "maybe", this woman and the man have been "temporarily bond". In the next iteration, men who do not have a temporary partner submit a proposal to the woman who has not refused him according with his preference list, then every woman who receives the proposal, if she has been "temporarily bond" and accepts proposals from other men who she prefer than her temporary partner, she may break the temporary bond and say "maybe" to the new person whom she prefer. This process is repeated until there is no individual without partner. When all individuals have been paired, the problem is resolved and a stable matching is obtained.

3.4. System Architecture

The decision support system in this paper consists of 4 modules. The first module is the client registration module. This module consists of a registration page or login page, as well as input page for client data and preferences. The second module is the admin module, which contains data management pages, including psychologist data, and client data. The third module is a module for calculating the order of clients preferences for psychologists and psychologists preferences for clients. This module uses the Weighted Sum Model to calculate the order of preferences. The fourth module is the calculation of Stable Marriage Problem solutions using the Gale-Shapley algorithm. The general architecture of this system can be seen in Figure 1.

Weighted Sum Model is used to calculate client's preference towards psychologists with the attributes such as field of expertise from psychologists, race origin of psychologist, and psychologist's gender, and age. The same algorithm is used to calculate psychologist's preference towards client with the attributes such as client field problem, and client's gender.
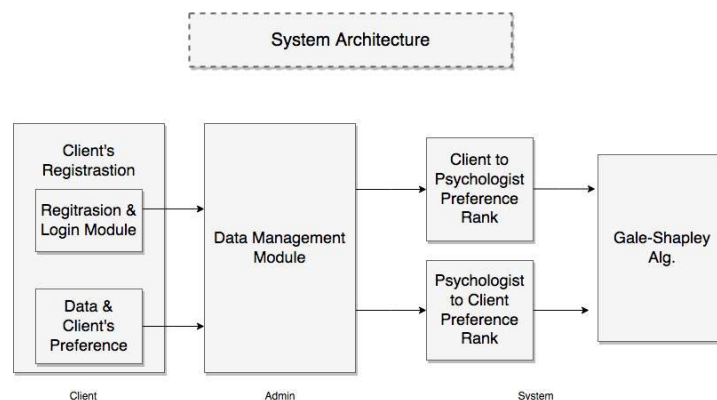

Figure 1. System architecture

4. Results

This application is created using the PHP programming language and MySQL database. The main page for visitor is a one landing page with several sections. In the Client's Registration Module, new client is required to complete his/her personal data and enter psychologist preference data which they prefer. The process of entering the client's personal data and preferences is shown in Figure 2.

Figure 2. Client registration module

In the Data Management Module, system admin can manage the Psychologists and Clients data. Example of Psychologist data management is shown in Figure 3.

Figure 3. Data management module

Module 3 computes the preference rank from Clients to Psychologists and preference rank from Psychologists to Clients. Weighted Sum Model is employed to compute the clients' preference order with several attributes, such as field of expertise from psychologists, race origin of psychologist, and psychologist's gender, and age. Each attribute is given a proper weight based on the client's choice in the Client Registration Module. For example, a client named "Kiky" has depression problem, and she prefers female psychologist with race from Kalimantan and around 45-55 years old. This client feels that Psychologist's field suitability with her problem is high important while the suitability of gender and age is medium important and the suitability of race origin is low important. Using the Weighted Sum Model as in Equation (2), Kiky's preference order towards all psychologists is obtained. The same Model is used to compute the psychologists' preference order but with limited preferences. Psychologist preferences toward clients are computed using variable such as the suitability of client's problem with his/her expertise, and psychologists can state their preference for client's gender. For example, a psychologist named "Sarah" is a 30 years old female psychologist originated from Sumatera. Sarah has expertise in children psychology, teenager psychology, marriage psychology, depression, addiction, abnormal behavior, and phobia, with the order is taken into account. She prefer female clients over male clients. The suitability of client's problem with her expertise has more influence than the suitability in client's gender. Using the Weighted Sum Model, Sarah's preference order towards all clients is obtained.

Result from Module 3 is passed to Module 4 to compute the stable pairing between Clients and Psychologist. Given the preference order for both of Psychologists to Clients and Clients to Psychologists, the next step is to obtain a stable matching from this two sets using Gale-Shapley Algorithm. Example result of these module is shown in Figure 4. This calculation is also verified using manual calculation and resulted in the same pairing. The manual calculation is not written in this paper

due to the page limitation. The result is also verified as a stable matching, since no blocking pair is appeared in the result.

Figure 4. Pairing results

5. Conclusion

Decision Support System Model using the Weighted Sum Algorithm has resulted in Clients preference order for the Psychologists and the Psychologists preference order for the Clients with the Psychologist's attributes include expertise field suitability and gender preference, and attributes for the Client include expertise field suitability, gender preference, age preference and the preference of the race origin of the psychologist. The Gale-Shapley Algorithm used in this system has been able to produce a stable matching between one set of Clients and one set of Psychologists, and there is no blocking pair from the results of this algorithm.

In the future, the algorithm for calculating the order of preference can be made more complex, for example by using a combination of several methods other than simple Weighted Sum Model.

References

[1]   van Stolk C, Hofman J, Hafner M and Janta B 2014 *Psychological Wellbeing and Work*
[2]   Hope V and Henderson M 2014 Medical student depression, anxiety and distress outside North America: a systematic review *Med. Educ.* **48** 963–79
[3]   Oyekcin D G, Sahin E M and Aldemir E 2017 Mental health, suicidality and hopelessness among university students in turkey *Asian J. of Psychiatry* **29** 185-9
[4]   Bagge C L, Lamis D A, Nadorff M and Osman A 2014 Relations between hopelessness, depressive symptoms and suicidality: mediation by reasons for living *J. Clin. Psychol.* **70** 18–31
[5]   Kakuma R, Minas H, van GInneken N, Dal Poz M R, Desiraju K and Morris J E 2011 Human resources for mental health care: current situation and strategies for action *The Lancet* **378**
[6]   World Health Organization 2014 *Mental Health Atlas*
[7]   Kessler R C, Merikangas K R and Wang P S 2007 Prevalence, comorbidity, and service utilization for mood disorders in the United States at the beginning of the twenty-first century *Annual Review of Clinical Psychology* **3** 137–58
[8]   Tefft N 2012 Mental health and employment: the sad story *Economics and Human Biology* **10** 242-55
[9]   Anderson L and Carter J H 1982 Psychotherapy: patient-therapist matching reconsidered *J. of The National Medical Assoc.* vol **74** no **5** p 461
[10] Teo C P, Sethuraman J and Tan W P 1999 Gale-shapley stable marriage problem revisited: strategic issues and applications *Integer Programming and Combinatorial Optimization IPCO 1999 (Lecture Notes in Computer Science)* vol **1610** ed G Cornuéjols et al pp 429-38
[11] Sotomayor M 2004 Implementation in the many-to-many matching market *Games and Economics Behaviour* vol **46** no **1** pp 199-212

[12] Roth A E 1986 On the allocation of residents to rural hospitals: e general property of two-sided matching markets *Econometrica: J. of the Econometric Society* vol **54** no **2** pp 425-7

[13] Zadeh L 1963 Optimality and non-scalar-valued performance criteria *IEEE Transactions on Automatic Control* vol **8** no **1** pp 59–60

[14] Filatovas E and Kurasova O 2011 A decision support system for solving multiple criteria optimization problems *Informatics in Educ.* vol **10** no **2** pp 213–24

[15] Gusfield D and Irving R W 1989 *The Stable Marriage Problem, Structure and Algorithms* (The MIT Press)

[16] Gale D and Shapley L S 1962 College admissions and the stability of marriage *American Mathematical Monthly* vol **69** pp 9-15