Forecasting and risk analysis in welfare institutions Using a dedicated expert system / Avital Zadok

Abstract

Objective: This study aims to explore whether an expert system can improve the process of data analysis and control in welfare institutions and the system's level of precision in predicting risk factors when comparing it to existing data from previous cycles. In this way, it is possible to evaluate the use and contribution of the system to implementing more efficient supervisory methods, such as facilitating decision making processes; saving time in decision making processes; and solving problems and dilemmas that were not previously resolved in the control process.

The Dilemma: National welfare supervisors in Headquarters are constantly flooded with huge amounts of data (there are over 400 questions in supervisory surveys) from welfare institutions, which often results in ineffective use of the findings received from the information systems. From past experiences, even when there were obvious faults in institutions to the point that they eventually collapsed, the system did not provide sufficient advance warning that enabled supervisors to identify risks in time, attend to them, and avert disaster. In most cases, local supervisors were actually aware of the situation due to their own impressions and intuition following visits to the institution. These incidents indicated the vital need to create a system to evaluate the large quantity of data effectively and issue warnings of potential risks.

Proposed Solution: The present study proposes use of a specific expert system called "Institution Profile" to forecast expected risks and failures. The system is based on artificial intelligence logic and created by questioning professionals, establishing rules of inference with the help of experts, and implementing these rules upon the data extracted from the surveys.

For this purpose, eighteen groups of indices were selected. These indices are based on criteria used to assess existing supervisory policies and create a "profile" for each institution which presents a comprehensive, inclusive description of the institution and all its aspects: Remedial educational programs; dormitory routine; human resources; building and infrastructure; low academic achievement; aberrant academic functioning;

runaways; external physical neglect; family communication issues; aggression; social functioning; theft; bed-wetting; alcohol; drugs; depression and anxiety; suicide; and sexual issues. Several of the above criteria evaluate aspects that are relevant to the institution and the impact of its level of functioning on the population of patients; and other criteria examine aspects that apply directly to the patient population and the quality of treatment that affects the institution's profile and, of course, the patients themselves.

There is a distinction between the criteria measuring an institution's risk factors that encompass problems and challenges faced by the population of patients and the criteria measuring the institution's level of functioning that indicates the quality of its functioning versus its risk factors. Each criterion receives a score on a grade of 1-5 with (1) representing the lowest risk factor and (5) representing the highest risk factor; or (1) representing the lowest level of functioning and (5) representing the highest level of functioning.

The institution profile is calculated according to two models: "Critical Item Model" and "Model by Item Weight."

There are two differences in the models:

The first difference is in the content of the questions/items characterizing each criterion: Questions chosen for the "Critical Item Model" are defined only as those that may critically influence the institution's level of functioning, whereas all questions are used for the "Model by Item Weight".

The second difference is the method of calculation using the rules of inference developed with the help of experts: The "Critical Item Model" evaluates the questions by percentage. The higher the percentage of correct data found, the higher functioning score the institution receives on a grade of 1-5. In contrast, the "Model by Item Weight" rates questions based on a weight assigned to each question. For every positive finding, the institution accumulates weight from each question, and the final tally is then divided by the number of questions. The grades received from this calculation are also subjected to the rules of inference with a range of 1-5.

The expert system features several capacities for comparison: Comparison within the profile – the institution's risk factor versus its level of functioning; comparison of the

profile versus several supervisory cycles of the same institution; and comparison of the profile versus the national average with specific criteria in the national average divided by a sample of the cost that indicates the level of challenge faced by the population in the institution: Rehabilitation; treatment-rehabilitation; treatment; post-hospitalization treatment; post hospitalization, ranging from the lowest to the highest level of difficulty, respectively. These assessments indicate trends of potential risks noted by supervisors versus events that occurred in former supervisory cycles. This evaluation, which utilizes both models, assesses whether the system is accurately predicting risk trends, and thus constitutes a tool that supports decision-making and solutions for problems within the control process.

Methodology: This study spans six supervisory cycles from 2011-2016 and integrates both the qualitative approach (interviews with professionals—supervisors and institution directors) and the quantitive approach (quantitive analysis of institution profile data). The research population throughout each supervisory cycle includes interviews and feedback from supervisors and institution directors, and analyses of surveys taken from patients in the institutions and supervisory surveys in the Ministry of Welfare.

The following are the chief components of the "Institution Profile" expert system:

- Information bank: This component imports data from an external database located in the information systems branch of the Ministry of Welfare. This database encompasses supervisory surveys; patient surveys; findings from surveys (results received after evaluating the answers from surveys) from all prior six cycles; basic characteristics (price, status, district) of the institution for the purpose of calculating the profile; and a list of criteria to assess the risk factor level and functioning level of the institution. In addition to the external database, the information bank also stores the rules of inference developed with the professional help of supervisors along with the criteria scores for each of the institution profiles post-processed by the control system.
- Control system: Encompasses the inference engine that makes use of algorithms written specifically for the purpose of calculating the institution's profile based on the two aforementioned models. With the operation of the inference engine,

the rules of inference are called up and activated on the findings from the surveys physically stored in the information banks.

- User interface: Comprised of input and output. The user operates the input element by selecting input variables on the screen. The input screen operates the control system in order to compute the institution's profile. Once the calculation is complete, the output element extracts the profile data from the information banks and rules of inference and presents it graphically, offering a clear portrayal of the institution's state.   The output element also provides an explanatory report of the grade assigned to each criterion based on the rules of inference.

Findings:

- The following criteria were found to have the greatest impact on risk trend level in an institution: Social functioning; depression and anxiety; suicidal behavior; sexual issues. Feedback from supervisors also indicated that licensing is another highly significant factor.

- It is possible to identify a negative trend that predicts the likelihood of risk in the functioning level of an institution. One prominent method of identifying such a trend is comparing the level of functioning in an institution's profile to the national average by specific criterion, given that the national average constitutes a realistic index for an institution's level of functioning. In the event that an institution's level of functioning is significantly lower than that of the national average, it is likely that the institution is at risk.

- It is possible to identify a negative trend that predicts the likelihood of an institution's risk factor in relation to the patients. One method is to compare inter-cycle profiles in which the level of functioning in two cycles is low, and the institution's patient population in the same two cycles, in contrast, is high. Low functioning scores in two consecutive supervisory cycles should sound the alarm with the supervisor. Even an institution's profile report compiled from one supervisory cycle can indicate a problem when the risk level is compared to the functioning level. A high risk level versus a low functioning level in a single criterion indicates a risk factor. Other means of identifying negative trends include assessing the institution's functioning level against the national average using criteria that are relevant to the patient population; and examining

the institution's risk factors (which, as aforementioned, includes the patients' problems and difficulties) versus the national average.

- The data obtained from the supervisory surveys requires consistent updates (following six supervisory cycles during which the questions were not revised.) However, it is still possible to supply reliable professional information, as long as appropriate, contemporary questions are chosen.

- The "Critical Item Model" presents a clearer, more precise portrayal of the institution's profile than the "Model by Item Weight" —albeit a comparison of the two models indicates that both present equal, non-conflicting risk trends.

- It is possible to anticipate risk factors on a national level by dividing them according to fees and comparing them to prior supervisory cycles.