A Study of Potential Application of the Analytic Hierarchy Process in Nursing; Predicting the Future of Nursing Education in the U.S.

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INTRODUCTION

The rapid changes of society during the last several decades with accelated innovations in science and technology have tremendously influenced human life itself as well as the quantity and quality of scientific knowledge. Along with benefits, the rapidly changing society produced problems which can not be simply treated due to their complexity, interrelatedness and uncertainty. In addition, the people in the society have changed in terms of their attitudes, values, frames of reference and world views.

It is generally believed that life in our world is so complicated that we need to think in a complex way to deal with some problems which are particularly ill-structured (Mitroff & Sagasti, 1973). Ill-structured problems are messy (Ackoff, 1974), squish (Strauch, 1976), and wicked (Rittel & Webber, 1973) where many interrelated factors and many stakeholders with conflicting value systems are involved, and literally unlimited alternatives have to be considered with uncertainties in their consequences. Most of the important social and/or policy problems in these days are ill-structured problems (Dunn, 1981).

Most of us have difficulty even examining a very few ideas at a time. It is obvious that we are in need to organize our problems in complex structures which consider interactions and interdependence of the factors but still allows us to think about them one at a time. We need an approach that is conceptually simple to use easily and decisionally robust to handle real world complexities. The Analytic Hierarchy Process(AHP) developed by a mathematician Saaty(1980), can provide a framework and methodology for the decision-makings involved in contemporary complex problems ranging from individual's to public policy problems in various fields.

The purpose of this paper is to demonstrate the potential of application of the AHP to various nursing decision-makings. The first part of the paper describes the AHP and the second part illustrates the application of AHP to structure nursing education policy problem in the U.S. and to predict the near future (1990—2000) of the nursing education policy.

ANALYTIC HIERARCHY PROCESS

The Analytic Hierarchy Process (AHP) is a systematic procedure for representing the elements of any problelm. It breaks down a complex problem into its smaller constituents to organize the basic rationality and then requires simple pairwise comparisons to derive priorities in each hierarchy. It is a method to be employed to integrate different perceptions and purposes into an overall synthesis.

The Analytic Hierarchy Process is a recent development in late 1970's. The major strength of the AHP is the hierarchical capability of structuring any complex, multiobjective, multicriterion, and multiperiod problem.

Hierarchical structure is the distinguished idea

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associated with systems, and hierarchical organiza-
tion is crucial to the synthesis and survival of large
complex systems. Hierarchical systems have common
properties that are independent of their specific con-
tent (Miller, 1978 : Saaty & Rogers, 1976).

The AHP has four major component processes: 1)
structuring the hierarchy, 2) measuring the im-
portance, 3) calculating the priorities, and 4) cal-
culating the consistency.

Structuring the Hierarchy

The process starts by decomposing a complex
problem at hand into a hierarchy. Hierarchical
structuring of any decision problem is an efficient
way of dealing with complexity and of identifying
major elements of the messy problem. Elements are
classified on different levels, forming a hierarchy.
Conceptually the simplest hierarchy is linear, rising
from one level to an adjacent level. Each level
consists of a few manageable elements and each
element is decomposed further into another set of
elements. The process continues down to the most
specific elements at the lowest level of the hierarchy.

There is no standard hierarchical structure. The
simple 3-level hierarchy can be illustrated as follows.
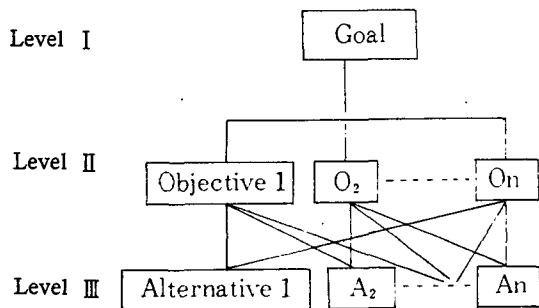
⟨Fig. 1⟩ Three level hierarchy

Measuring the Importance of the Elements

Importance of elements at a particular level of
hierarchy is evaluated by pairwise comparison of
each set of elements with respect to the strength of
influence over those in a next higher stratum. This
pairwise comparison provides the framwork for
data collection and, analysis thus, constitutes the
heart of the AHP. ; Specifically, the hierarchy is

broken down into a series of pairwise comparison
matrices, and the respondents are asked to evaluate
the off-diagonal relationship in one half of each
matrix. Reciprocal values are filled in the transposed
positions.

One pairwise comparison of n elements (Alterna-
tive 1 A_n) with respect to objective 1 can be illus-
trated as a matrix on Figure 2.

Objective 1	A_1	A_2	⋯⋯ A_n
A_1	A_1/A_1	A_1/A_2	⋯⋯ A_1/A_n
A_2	A_2/A_1	A_2/A_2	⋯⋯ A_2/A_n
A_n	A_n/A_1	A_n/A_2	⋯⋯ A_n/A_n

Judgments(A_2 vs A_1, A_n vs A_1, ⋯)

⟨Fig. 2⟩ Matrix of pairwise comparison

The respondent has to evaluate $n(n-1)/2$ times
when there is n elements in a matrix. Each pair is
evaluated separately as to the importance of influence
with respect to the element from the next level in
the hierarchy. Specifically, an instruction to the
respondent would be: which alternative (A_1 or A_n)
is more important to achieve the objective 1 and
how much is it important comparing with another ?

In order to provide a numerical judgment in such
pairwise comparisons, a reliable and workable scale
is needed. The 9-point scale used in typical analytic
hierarchy studies is shown on Table 1.

Using this scale the respondent assesses the rela-
tive importance of each element over the others
within the same level of the hierarchical structure
with respect to each element of the immediate
higher level of the hierarchy. Thus, pairwise com-
parison judgments based on this scale for a matrix
such as one illustrated on Figure 2 would offer the
necessary data for calculating the priorities of the
various elements. These elements can be the courses
of action, policies, objectives, and any decision
criteria.

Calculating the Priorities of Elements

The procedure of pairwise comparison based on
the scale is repeated by moving downward along
the hierarchy, assessing the weights of each element
at every level and using these to determine com-

〈Table 1〉   Intensity of Importance Scale

Intensity of importance	Definition	Explanation
1	Equal Importance	Two activities contribute equally to the objective
3	Weak importance of one over another	Experience and judgment slightly favor one activity over another
5	Essential or strong importance	Experience and judgment strongly favor one activity over another
7	Demonstrated importance	An activity is strongly favored and its domimance is demonstrated in practice
9	Absolute importance	The evidence favoring one activity over another is of the highest possible order of an affirmation
2, 4, 6, 8	Intermediate values between the two adjacent judgments	When compromise is needed
Reciprocals of above nonzero	If activity i has one of the above nonzero numbers assigned to it when compared with activity j, then j has the reciprocal value when compared with i.	

posite weights for succeeding levels. The final set of weights give a measure of their overall relative importance.

A brief mathematical explanation of the AHP is provided in the following paragraphs. A detailed description of the method can be obtained from the Saaty's Analytic Hierarchy Process(1980).

Let us assume that we have n alternatives, $A_1 \cdots A_n$, whose weights $W_1 \cdots W_n$, respectively, are known to us. A matrix of pairwise comparisons of weights is formed as shown on Figure 3.

$$AW=A_2 \begin{array}{c} A_1 \\ A_2 \\ \vdots \\ A_n \end{array} \begin{pmatrix} W_1/W_1 & W_1/W_2 \cdots W_1/W_n \\ W_2/W_1 & W_2/W_2 \cdots W_2/W_n \\ \vdots & \vdots & \vdots \\ W_n/W_1 & W_n/W_2 \cdots W_n/W_n \end{pmatrix} \begin{pmatrix} W_1 \\ W_2 \\ \vdots \\ W_n \end{pmatrix} = n \begin{pmatrix} W_1 \\ W_2 \\ \vdots \\ W_n \end{pmatrix}$$

〈Fig. 3〉 Matrix of pairwise comparisons of weights

It is noted that the scale of weights $W_1 \cdots W_n$, can be recovered by multiplying A on the right by W, obtaining nw, and then solving the eigenvalue problem.

$$AW=nW \text{ or } (A-nI)W=0$$

This has a nontrivial solution since n is the largest eigenvalue of A. (The matrix A has unit rank, hence all but one of its eigenvalues $\lambda_1, \cdots, \lambda_n$ are zero. Since $\sum_{i=1}^{n} \lambda_n = \text{trace}(A)=n$, n is the maximum eigenvalue).

Generally we do not know the ratios W_i/W_j but

we may obtain estimates of them from data and experiments or even from experienced judgments.

The estimated values by the respondents have perturbations of A which implies perturbations of eigenvalues. We now have to solve the following problem to obtain an estimate of the weights W. $AW=\lambda_{max} W$, where λ_{max} is the largest eigenvalue of A. A is the matrix of pairwise comparisons.

A pairwise comparison reciprocal matrix is used to compare the relative contribution of the elements in each level of the hierarchy to an element in the next higher level. The principal eigenvector of this matrix is derived and weighted by the priority of the property with respect to the respondent's comparison. The weighted eigenvectors can now be added componentwise to obtain an overall weight or priority of contribution of each element to the entire hierarchy.

This process of principal eigenvector extraction and hierarchical weighting leads to a unidimensional scale for the priorities of the elements in any level of hierarchy. The resulting priorities represent the intensity of the respondent's judgmental perception of the relative importance of the elements represented in the hierarchy considering the importance of and trade-offs among the criteria.

Calculating the Consistency in Judgment

The process left now is to assess the goodness of

⟨Table 2⟩				Average Random Index					
Order of matrix	1	2	3	4	5	6	7	8	9
RI	0.00	0.00	0.58	0.90	1.12	1.24	1.32	1.41	1.45

the respondent's judgments, i.e. consistency in estimating W. If the respondent made a consistent judgments, eigenvalue of matrix A, λ_{max}, should be close to n, since $\lambda_{max} > n$.

Since small changes in a_{ij} imply a small change in λ_{max}, the deviation of the λ_{max} from n implies a deviation of consistency. This is represented by

Consistency Index $(CI) = (\lambda_{max} - n)/(n-1)$

On calculating the consistency we compare the result with those of the random index(RI) which was developed by the numerical judgment of randomly generated reciprocal matrix from the scale 1 to 9, with reciprocals forced (Saaty & Mariano, 1979). The average RI by the order of matrix can be determined on the Table 2.

The ratio of CI to the average RI for the same order matrix is called the consistency ratio(CR).
CR = CI/Average RI A consistency ratio of 0.10 or less is considered acceptable (Satty, 1980).

It is important to check all the elements should be compared in making the estimates, and to keep the comparisons are relevant. It is known that there is a limited number of elements that the brain can process simultaneously. The range of numbers has been found by psychologists to be 7 ± 2 (Miller, 1963). Due to this limitation, when the number of elements is large, it has to be broken into groups which contain seven or less.

Summary of AHP

The following is a brief outline of the steps to proceed the AHP :

1. Define the problem and specify the solution desired.

2. Structure the hierarchy for the overall purposes of goal which is the highest level, through relevant intermediate levels to the level where control would resolve the problem.

3. Construct a pairwise comparison matrix of the relative importance of each element with respect to

the element in the adjacent higher level. Since people tend to prefer to give a judgment which indicates the dominance as an integer in comparing the i, j elements, if the dominance does not occur in the i, j position, the reciprocal of a position (which is integer) can be assigned to a_{ij}.

4. Obtain all $n(n-1)/2$ judgments about all elements through paired comparison.

5. Having collected the pairwise comparison data and entered the reciprocals together with n unit entries down the main diagonal, the eigenvalue problem $AW = \lambda_{max} W$ is solved and consistency is tested.

6. Repeat steps 3, 4 and 5 for all levels and clusters in the hierarchy.

7. Having hierarchical composition used to weight the eigenvectors by the weights of the criteria, the sum is taken over all weighted eigenvector entries corresponding to each element to obtain the composite priority of the element in a level. These are then used to weight the eigenvectors corresponding to those in the next lower level and so on, resulting in a composite priority vector for the lowest level of the hierarchy.

8. Evaluate the consistency for the entire hierarchy by simply multiplying each consistency index by the priority of the corresponding criterion and adding over all such products. The result is divided by the same type of expression using the random consistency index corresponding to the dimensions of each matrix weighted by the priority as before. The ratio should be about 10% or less for acceptable overall consistency. Otherwise, the quality of the judgmental data should be improved, perhaps by revising the manner in which questions are posed to make the pairwise comparisons.

In this approach the hierarchy needs not be complete, that is, an element at a higher level need not function as a criterion for all the elements in the lower level. Rather, it can be partitioned into nearly

disjoint sub-hierarchies sharing only a common top-most element (Gholamnezhad and Saaty, 1982).

Applicability of the AHP has been already demonstrated in the various fields including: the allocation of resources such as electricity (Saaty and Mariano, 1979) and country's (Sudan) resource (Saaty, 1977); conflict resolution (Saaty and Bennett, 1977), forecasting (Saaty and Vargas, 1980), planning, input-output analysis, choice behavior and many other cases discussed in the book cited above.

APPLICATION OF THE AHP TO PREDICT NURSING EDUCATION IN THE U.S.

An attempt to apply the AHP to the professional nursing education in the U.S. in this paper does not expect to solve the problem itself. Its purpose is to clarify whether the process could provide valuable results and increase insights, and, most of all, the better understanding of the nature of the problem to structure the policy problem rightly instead of wrongly. The judgments attributed in the process for structuring hierarchy and pairwise comparisons are made by the author based not only on a professional knowledge from the nursing but also on the literature review in the nursing education particularly on the issue of entry into practice in the U.S.

Description of Nursing Education in the U. S.

Today in America, there are generally two types of nurses i.e., Registered Nurses (RNs) and Licenced Practical Nurses (LPNs). Each is required to pass different state board examination to be licenced. However, for RN licence, there are three ways to satisfy the educational requirements, although there is only one examination to become RNs (Abu-Saad, 1979 : AJNA, 1982) :

1) Four-year college or university programs that lead to a bachelor of science degree in nursing(BSN), required for certain administrative, managerial and some community health positions;

2) Three-year hospital diploma schools combined on-the-job training and administred mostly by hos-

pitals; and

3) Two-year programs that lead to an associate degree in nursing(AD) focusing on technical nursing offered by community colleges or universities.

LPNs, are trained in various educational settings, including high schools, vocational schools, hospitals, and community colleges over periods of nine to eighteen months. The current nursing education system has been gradually developed over a century by responding to the need of society as well as the nursing profession itself (Abu-Saad, 1979).

Diploma program. Florence Nightingale's work in the Crimean War provided the basis for the modern professional organization of nursing throughout the world especially in America from 1873. Diploma nursing schools were established in hospitals as a response to the need of hospitals for trained nurses (Abu-Saad, 1979 : Nahm, 1981).

The diploma school was a practical and successful approach to nursing education for many years. However, since the beginning of AD programs in 1956, the diploma schools have been on the decline (695 schools existed in 1969 as opposed to 344 in 1978) (AJNA, 1982 : Levine, 1978).

The decline has been accelerated because of the increased educational cost. Often times an annual educational cost for diploma nursing student is even higher than that for BSN. Many hospitals with their own schools found that they could not financially afford to support the schools. In addition, the third party payers (e.g. government, health insurance company) become suspicious about paying patients care costs whether that directly and indirectly include the cost of the training for the nurses because it is considered an additional cost to patient care (Dolan, 1978 : Levine, 1978 : Nahm, 1981).

BSN program. Although the need for good theoretical preparation for nursing students in nursing in the science such as behavioral and social science, as part of collegiate education was recognized, nursing curriculum was not accepted as appropriate for higher education until 1909. Universities were reluctant to accept professional schools as part of their tradition-bound institutions. However as the concept of college programs grew steadily so did the num-

bers from 8 in 1919 to 353 in 1978(Abu-Saad, 1979 :
AJNA, 1982 : Levine, 1978).

The Federal Nurse Training Act contributed to
producing BSNs by providing funds to students and
schools in response to the shortage of quality nurses
in special fields such as nursing education and com-
munity health nursing during 1970's. In recent
years, the BSN has become widely accepted as a
necessary requirement for promotion to supervisory
positions and advanced level of education in nursing.
In 1979, 33% of the graduates of the nursing schools
were from BSN programs(AJNA, 1982:Levine, 1978).

AD program. The associate degree programs
which are wide spread in the U.S., were established
on the basis of the planned research and experimen-
tation initiated by Teachers College in Columbia
University as the Cooperative Research Project in
Junior and Community College Education for Nurs-
ing during 1952~57. This project, prepared nurses
in their own community in a short time, was an
attempt to meet the needs of society after World
War II for greater numbers of nurses to provide
better health care (Abu-Saad, 1979 : Nahm, 1981).

Although the AD graduates were prepared to
function as bedside primary technical nurses under
supervision, many employers place them in upper-
levels, even to such as supervisory positions. In
spite of the criticism of the quality of AD nurses,
the growth rate has been rapid from 8 experimental
programs in 1952 to 677 in 1978 (AJNA, 1982).

Licensed Practical Nurses. Meanwhile, the LPNs,
many of whom came from nurses aides, organized
their own association in 1949 and became a new
branch in nursing with separate licensureship in
the U.S.(Abu-Saad, 1979). Approximately one fourth
of all nurses are presently LPNs (Institute of Medi-
cine, 1981).

A problem becomes a public problem when it
begins to be considered among aggregates such as
stakeholders or when certain groups think that some
course of public action should be taken to solve the
problem, often times by government(Jones, 1977).

Until the year of initiation of the first national
study about nursing education in 1918 by Goldmark,

the nursing education system was perceived as a
problematic situation only by a handful nursing
leaders. The percieved problem by few of the leaders
as non-standardization in nursing curriculum which
led to non-establishment in academic standard and
various admission requirements (Matejski, 1981 :
Lysaught, 1981).

Through the Goldmark study from 1918 to 1923
with a financial support from Rockefeller Foundation,
the nursing education in the United States began to
be recognized as a public problem. The initial obje-
ctive of the Goldmark study was to indentify the
problems of public health nursing education in the
United States. However, it soon became clear to
extend the study to the entire nursing education.

The Goldmark study basically recommended that
nursing education has to be based on academic-
oriented education rather than practice and service-
oriented training which was predominant at that
time. Most of the nurses at that time were produced
by hospital nursing schools where their education
was based on the practices and services from appr-
enticeship. Although the recommendations were con-
sidered as reasonable and the nursing leaders tended
to support the recommendations of the report, its
(Goldmark report) impact on nursing education was
not significant. Therefore, subsequent national
studies were conducted by small groups, which were
basically for the same purpose with no major differ-
ences in findings or suggestions (Matejski, 1981).

During the period from Goldmark study in 1923
to ANA's position paper in 1965, numerous national
studies pointed out the problems and reaffirmed the
suggestion made by Goldmark study (Lysaught,
1981). These studies alerted and called for nursing
leaders to take some actions.

American Nurses Association(ANA), as a leading
organization of nurses, delegated its authority to
ANA house of delegates to initiate the process of
aggregation and organization of members, opinions.
House of delegates was certainly an "active minor-
ity" who emerged to interpret the needs and wants
of members. Although the opposition inside the
nursing profession to the position of the house of
delegates have not yet been resolved, the result

was "ANA's 1985 proposal"(Levine, 1978).

ANA's proposal had two prinicpal recom mendat-icns, i.e., 1) nursing education should take place in the institutions of higher education, and 2) nursing has to be distinguished between professional and technical aspects with different educational preparation (ANA, 1978).

Despite the fact that the basic concepts were neither new nor different from the previous national studies, the negative reaction from some nurses, some hospital administrators and physicians were immediate and bitter. Especially the anger of diploma schools escalated overnight(ANA, 1978). The Council of Diploma Programs of the National League for Nursing (NLN) activated to protect its members' interst, and was successful in getting support from NLN board for retention of all league-accredited programs, whethercollegiate or noncollegiate by the passage of a resolution for it (Lysaught, 1981). This problematic situation is represented as the Issue of the Entry into Practice among the nurses (ANA, .978 : Dolan, 1978 : Kalisch & Kalisch, 1982 : Levine, l978 : NLN : 1978).

Description of Factors Affecting the Nursing Education Policy in the U.S.

The issue of the entry into practice of profes-sional nursing in America is interesting illustration of the socio-cultural, economic, organizational and political processes involved in an effort to formulate the policy for the professional nursing education. Figure 4 presents the hierarchical structure of factors, actors and their motivating objectives which can be seen as a chain of influences to affect the future direction of nursing education. It would be a more reliable process and results produced during the process of application of the AHP if the deci-sions of hierarchical structuring of the elements and pairwise comparison judgments are made by the consensus of the group of people who are qualified. (saaty, 1980).

. Factors that play key role in the future of the nursing education in the United States are believed to be divided into four major factors, namely politi-cal, economic, social, and technological(Dolan, 1978:

Kalisch & Kalisch, 1982 : Levine, 1978 : Matejski, 1981 : NLN, 1978).

Factors

Political factor. Political factors play an extre-mely important role in the future nursing education. Political factors refer to those that are generated or related with governing bodies. Such influences cur-rently have a major impact upon the health care system where nursing is one component, as the pattern in the United States is toward increasing governmental involvement in the health care. At present, political control and influence are largely manifested in the areas of licence of health care institutions and personnel, budget for health care research , manpower training, subsidizing health care cost, and so forth.

Economic factor. Economy in general is a very important factor with regard to the future of the health care in the United States which in turn has significant bearing on nursing education. Health care cost has risen sharply during the last decade, and it continues to do so. This rise is due not only to inflation-which affects the cost of health care sup-plies, wage and salary levels, and educational costs but also to advancement in technologies and increased utilization of such expensive technologly. Addition-ally, the health care system is affected internally by inflation through excessive demand for institu-tional care, shortages of health care providers in general as well as these to produce quality care in relation to public accountability of economic resour-ces to the health care will dictate the amount of resources allocated to nursing education such as fed-eral and state fellowship and nursing student loans.

Social factor. Nursing as a profession is seriously affected by and reflecting social value system. If any one profession is viewed as prestigeous, for example, physicians or lawyers, the quality of the student will be improved. If a profession is fighting for its power and trying to upgrade its status within the system, in my point of view nursing is at this stage, there will be a lot of obstacles to overcome. Most widely pointed out reasons for nursing's lack of autonomy and its relatively low status within

Future of Nursing Education in the U.S.

Focus					
Factors	Political	Economical	Social		Technological
Actors	Supporting Nurses	Opposing Nurses	Government	Physicians	Hospitals	General Public
Objectives	1. Improve quality of Nursing care 2. Upgrade Professional Status 3. Increase Nursing Autonomy 4. Increase Career mobility 5. Increase Accessibility to Nursing Profession	same as those for Supporting Nurses	1. Protection of Public Safety 2. Reduce Health Care Cost 3. Improve Quality of Health Care 4. Increase Health Care Accessability 5. Manpower Supply	1. Maintain Physician's Status 2. Maintain Physician's Power within Health Care System	1. Secure Nursing Manpower 2. Control over Nursing Personnel 3. Minimize Nursing Cost 4. Improve Nursing Care Quality	1. Improve Quality of Nursing care 2. Reduce Health Care Cost 3. Increase Accessability of Nursing Care
Policy	1. Standardize Educational Requirement 2. Change License Law 3. Support Nursing Research 4. Unify Nursing Organizations 5. Lobbying 6. Increase Public Relations(P.R.) 7. Unionization	1. Lobbying 2. Increase P.R. 3. Get Support from other Health Professions	1. Conduct Investigative study and Public Hearing 2. Financial Support 3. Legitimation	1. Lobbying 2. Increase P.R.	1. Lobbying 2. Support Diploma Nursing Schools 3. Increase P.R. 4. Maintain Nursing Salary Scale 5. Anti-Unionization	1. Forming a Pressure Group 2. Participation in Policy Making Process
Scenario	Status Quo	Mandatory Bachelor Degree in Nursing for Entry Level Practice		Voluntary 4-year Education Program Domination	Voluntary Associate or Diploma Schools Domination	

· Composite Scenario

⟨Fig. 4⟩ Hierarchial Structure of Influencial elements on Nursing Education in U.S.

the health care system are 1) nursing is a women's profession and 2) majority of the students come from low to middle level of social classes in the U.S.

Technological factor. Technology, may be the least important factor, is, nevertheless, a key factor. During the last several decades, technological development in health care is tremendous. Nursing education has to keep up with all the technical aspects available and find its own way of improving health care delivery to the needy people.

Actors, Their Objectives and Policies

There are six groups of major actors who may have great impact on the future of the nursing education. They are; 1) nurses who would support the idea that definition and criteria of professional nurses should be baccalauriate holders in terms of the entry into practice essue stated by the ANA, 2) nurses who would oppose the proposed change by the ANA, 3) each state government (state legislaure) which will decide the minimum nursing educational preparartion for taking RN licence examination, 4) physcians, 5) hospitals which are the major employers of the nursing educational product, and 6) general public who are the consumer of the nursing services.

Nurses who support proposed change of ANA in position paper. The initial phase of the entry into practice policy issue involved mainly the elite college nursing educators who were active in ANA activities. Later, majority of the ANA members approved the policy. Their objectives included are; 1) to improve quality of nursing care, 2) to upgrade nursing profession's status within the health care system, 3) to increase nursing profession's autonomy within the health care system, 4) to improve career mobility of the nurses and nursing students, and 5) to increase the accessibility to the nursing profession.

In order to achieve objectives listed above, they may try to 1) standardize educational requirement for taking state licence examination, 2) amend the existing nurse training act, 3) encourage and support more scientific nursing research, 4) unify several nursing organizations, 5) lobby at the state legisla-

ture, 6) improve their public relations, and 7) unionize nurses in nursing practice.

Nurses who oppose. When the entry into practice issue was brought up to the voting body of ANA general assembly, opposition to the entry into practice was started to be organized. At the beginning, opposition primarily came from associate and diploma schools who have a lot at stake, based on the misperception or misinterpretation lay in the separation of nursing education and practice into professional and technical components. Because the term "professional" was reserved for the baccalaureate nurse, a large number of hospital administrators saw the omission as both degradation and a move to eliminate diploma education, which at that time comprised the largest number of nursing education programs in existence. Another reason of opposition from nonbaccalaureate nurses were some natural fears that they will lose status and job opportunities despite the grandfather clause and that those who desire baccalaureate education will find it too expensive, unavailable, or rigidly repetitive.

Even though they share same objectives as the nurses who would support entry into practice issue, their priority and methods are different. They may try to 1) lobby against entry into practice bill, 2) inform other health professionals and general public about their position, and 3) gain support from other health professions, notably physicians and hospital administrators.

Government. Since the authority for licensing nursing profession rests with state government, each state government becomes more important actor in the future of the nursing education in the United States. The objectives of each state government can be classified as 1) protecting the public, 2) reducing health care cost, 3) improving quality of health care receiving by general public, 4) increasing the health care accessibility, and 5) maintaining balance between nursing manpower supply and demand. Their policies to achieve those objectives might be 1) conducting investigative and evaluative study about nursing education and public hearing, 2) providing financial support, and 3) regulating minimum educational requirements by amending the state law.

Physicians. Physicians generally oppose the issue and try to maintain the status quo. They fear that upgrading educational requirements for nursing practice would enhance the power of nursing profession and give more autonomy to nursing therefore, they may lose control over nursing and lose some of their territory. Their main objectives are : 1) to maintain their status within the health care system, and 2) to maintain their power within the health care system. Their policies to achieve those objectives might be: 1) to lobby against entry into practice bill at each state legislature, and 2) to inform and formulate public opinion against the bill.

Hospitals. Hospitals are the major employers of the nursing education product. At the same time, many of them are the owner of diploma schools which provide cheap labor for the hospitals Major objectives of the hospitals in relation to nursing education are: 1) to guarantee enough manpower supply, 2) to maintain their control over nursing personnel, 3) to minimize nursing expenditure, and 4) to obtain high quality nursing care.

Their policies might include 1) lobby against the entry into practice bill, 2) formulate public opinion, 3) support diploma schools, 4) maintain nurses' salary scale, and 5) prevent unionization of nurses.

Gereral public. The most important group that has not been involved in the process but constitutes a very strong stakeholder is the general public who are directly affected by the quality of nursing care and quantity of nursing supply. General public's objectives in this issue are : 1) to improve quality of nursing care, 2) to reduce health care cost, and 3) to increase accessibility of nursing care. They may form a pressure group or actively participate in the policy making process.

Scenario

There are four possible directions in the future of the nursing education. They are: 1) status quo, 2) mandated bachelor degree in nursing to obtain Registered Nurse Licence, 3) nursing schools change their curriculum voluntarily as four-year programs, or 4) domination of 2 or 3-year programs. The

characteristics and elements were considered and calibrated so as to five profiles of the scnarios can be found in Table 3 as listed on the left side.

Status quo. As described in the earlier section, there are three different educational preparations to enter into nursing profession; associate degree, diploma and bachelor degree. This has been preferred by physicians and hospitals and some portion of the nurses.

Mandated bachelor degree. This can be realized if the entry into practice bill which was explained in the earlier section would be passed each by state legislature. This standardized educational requirement would most likely upgrade the nursing profession and bring more autonomy into the nursing profession.

Voluntary four year program. This scenario is similar to what happened in medical schools for their education. Flexner's report published in 1910, encouraged reforms (standardization and upgrading education) in medical education. The reforms were virtually completed by all surviving medical scools by 1920. Still some schools of nursing had yet to meet a majority of the recommendations of the 1923 Goldmark report. However, there is a growing support for this direction within the nursing and other health care professions.

Associate and/or diploma schools domination. As far as nursing education is concerned, this would be a step backward. However, there is a slight possibility of this happening.

ANALYSIS AND DISCUSSION

All judgments attributed in the pairwise comparison reflect the author's interpretation of each actors and their respective objectives and policies stated in various literatures. In spite of the relatively smaller consistency ratio for every judgimental matrix, above reason may allow containing some of the author's bias toward nursingsystem and overall health care system in the United States.

Pairwise dominance judgment, its relative weight, λ_{max}, consistency index, and consistency ratio were obtained and a vector of priority was calculated by

⟨Table 3⟩　　Four Scenarios and the calibration of their characteristics (Scale: −9↔+9)

Scenario weights	.330	.190	.303	.177	
Characteristics	S_1	S_2	S_3	S_4	
Student					
1. Number	0	−5	−3	4	−1.151
2. Type	1	+3	+3	−2	1.455
3. Social-Background	1	+5	+4	−3	1.961
4. Career Mobility(Job)	0	+3	+2	−5	0.291
Faculty					
1. Number	1	+3	+2	+3	2.037
2. Type(Ph'D)	+2	+5	+4	−2	2.468
3. Research Orienttaion	+1	+9	+8	−7	3.225
4. Vocational Orientation	0	−1	−1	+5	0.392
Institution					
1. Overall Number of Institutions	+2	−5	−3	+4	−0.491
2. Number of 4 year program	0	+7	+7	−2	3.097
3. Number of 2 & 3 year program	+1	−9	−7	+7	−2.262
4. Continuing Education	+2	+8	+3	+3	3.620
5. Value of Degree	+1	+5	+6	0	3.098
6. Educational Cost	+1	+1	+1	+2	1.177
Profession					
1. Accessibility to profession	+1	−3	−1	+5	0.342
2. Nursing Earning Power	+1	+3	+2	0	1.506
3. Nursing Autonomy	+1	+5	+3	−5	1.304
4. Professional Status	+1	+5	+4	−7	1.253
5. Nursing Care Quality	+1	+3	+3	−2	1.455

using an estimation method suggested by Saaty (1980, p.19). In order to calculate eigenvector, although computer program may be developed and available now, two better estimation methods are selected and described. In a matrix of pairwise comparisons of weights, 1) divide the elements of each column by the sum of that column, and then add the elements in each resulting row and divide this sum by the number of elements in the row, or 2) multiply the n elements in each row and take the nth root, and normalize the resulting numbers.

A pair of major factors were compared by asking which factor and how much greater impact on the future of nursing education based on the 9-point scale. The result illustrated on Table 4 shows that

importance of each factor in relation to the future of the nursing education, which is in the order of political (.549), economic (.250), social (.127) and technological factors (.075).

⟨Table 4⟩　Judgmental Matrix of major factors' importance for nursing education

Nursing Education	P	E	S	T	Eigen-vector	Weight Priority
Political	1	2	5	7	2.893	.549
Economical	1/2	1	2	3	1.316	.250
Social	1/5	1/2	1	2	.669	.127
Technological	1/7	1/3	1/2	1	.393	.075
					5.271	

λ_{max}=4.016　CI=.007　CR=.004

Next, each pair of actors was compared with respect to which of the pair had more influence to each of the major factors affecting the future of the nursing education. Government (.226), physician (.300), and hospitals (.337) had significant impact on political factors (see Table 5) whereas government (.376) and general public (.360) showed more impact on economic factor (see Table 6). For the social factors general public (.488) and government (.291) have more influence than other actors (see Table 7). Government (.337) affects technological factors more than physicians (.196), hospitals (.142) and general public (.215) (see Table 8).

Table 9 illustrates the importance of the actors

⟨Table 5⟩   Judgmental Matrix of actors' importance for political factor

Political Factor	N(S)	N(O)	G	P	H	G P	Eigenvector	Weight Priority
Nrs(Support)	1	1	1/5	1/7	1/7	1	.400	.045
Nrs(Opposed)	1	1	1/5	1/7	1/7	1	.400	.045
Government	5	5	1	1	1/2	5	1.992	.226
Physicians	7	7	1	1	1	7	2.645	.300
Hospitals	7	7	2	1	1	7	2.969	.337
General Public	1	1	5	1/7	1/7	1	.400	.045
							8.806	

λ_{max}=6.054 CI=.008 CR=.009

⟨Table 6⟩   Judgmental Matrix of actors' importance for economic factor

Economic Factor	N(S)	N(O)	G	P	H	G P	Eigenvector	Weight Priority
Nrs(S)	1	1	1/8	1/3	1/3	1/7	.354	.039
Nrs(O)	1	1	1/8	1/3	1/3	1/7	.354	.039
Government	8	8	1	5	5	1	3.420	.376
Physicians	3	3	1/5	1	1	1/5	.844	.093
Hospitals	3	3	1/5	1	1	1/5	.844	.093
General Public	7	7	1	5	1	1	3.270	.360
							9.086	

λ_{max}=6.111 CI=.016 CR=.018

⟨Table 7⟩   Judgmental Matrix of actors' importance for social factor

Social Factor	N(S)	N(O)	G	P	H	G P	Eigenvector	Weight Priority
Nrs(S)	1	1	1/8	1/2	1/2	1/9	.389	.040
Nrs(O)	1	1	1/8	1/2	1/2	1/9	.389	.040
Government	8	8	1	5	5	1/3	2.847	.291
Physicians	2	2	1/5	1	1	1/7	.697	.071
Hospitals	2	2	1/5	1	1	1/7	.697	.071
General Public	9	9	3	7	7	1	4.778	.488
							9.797	

λ_{max}=6.210 CI=.031 CR=.035

⟨Table 8⟩ Judgmental Matrix of actors' importance for technological factor

Technoloical	N(0)	N(0)	G	P	H	G P	Eigenvector	Weight Priority
Nrs(S)	1	5	1/3	1/3	1/2	1/2	.719	.091
Nrs(O)	1/5	1	1/9	1/9	1/8	1/9	.180	.023
Government	3	9	1	2	2	3	2.621	.332
Physician	3	9	1/2	1	2	1/2	1.543	.196
Hospital	2	8	1/2	1/2	1	1/2	1.122	.142
General Public	2	9	1/3	2	2	1	1.698	.215
							7.885	·

λ_{max}=6.340 CI=.051 CR=.057

⟨Table 9⟩ Actors' weight for the influencing factors

Actors \ Factors	Political (.549)	Economic (.250)	Social (.127)	Technological (.075)	Weight Priorty
Nrs(S)	.045	.039	.040	.091	.046
Nrs(O)	.045	.039	.040	.023	.041
Government	.226	.376	.291	.332	.280
Physician	.300	.093	.071	.196	.212
Hospital	.337	.093	.071	.142	.228
General Public	.045	.360	.488	.215	.193

relative to their impact on the factors which affect the future of nursing education. Surprisingly nurses, combined both supporting (.046) and opposing (.041), have less impact on nursing education than any other actors. This result indicates the low level of autonomy in nursing education. Government (.280), physicians (.212), and hospitals (.228) have almost equally significant impact on the future of the nursing education.

The importance of each actor's objectives and policies were calculated in the same manner. When each scenario's weight was calculated, status quo (.330) and voluntary 4-year education (.303) were more likely and mandated 4-year program (.190) and 2 and 3-year program domination (.177) were least likely in the near future (see Table 10).

The weight of each scenario was utilized to obtain the composite scenario. Each scenario's weight is multiplied with state variables measurement, which is reported in Table 3 to yield the composite characteristic measurement. An prediction on the

bases of these results (see Table 3) may be as follows:

* The number of nursing students will decrease in the near future. However, quality of the students; type and background will rise and their career mobility will slightly be improved in the near future.

* The number of faculty will be increased and their quality with doctoral degree will also be improved. There will definitely be more of research orientation among faculties than vocational orientation even though vocational orientation level would be about the current level.

* Overall number of nursing institutions will be slightly decreased, but there will be more number of 4-year collegiate programs and less 2 or 3-year programs. There will be more emphasis on continuing education which can be the trend in all other health care professionals. Value of the baccalaureate degree will be significantly more important than now and overall educational cost in nursing education will be increased moderately.

* Finally accessibility in nursing profession will

(Table 10) Weights of the actors' policies over the
scenario

Policies			Scenario			
			S_1	S_2	S_3	S_4
.011	N(S)	P_1	.089	.552	.310	.048
.013		P_2	.072	.553	.332	.043
.008		P_3	.242	.235	.430	.093
.003		P_4	.124	.283	.503	.090
.003		P_5	.116	.509	.300	.076
.008		P_6	.170	.472	.285	.073
.005		P_7	.116	.572	.314	.058
.013	N(O)	P_1	.452	.083	.144	.320
.015		P_2	.483	.088	.157	.272
.012		P_3	.368	.070	.193	.368
.066	G.	P_1	.223	.330	.375	.072
.112		P_2	.146	.271	.490	.093
.101		P_3	.173	.341	.412	.074
.141	Ph.	P_1	.490	.082	.137	.291
.141		P_2	.455	.092	.215	.238
.066	Hosp.	P_1	.483	.088	.157	.272
.022		P_2	.281	.041	.077	.601
.023		P_3	.460	.087	.158	.294
.042		P_4	.467	.095	.160	.278
.056		P_5	.385	.114	.229	.272
.097	G.P.	P_1	.218	.183	.482	.117
.097		P_2	.236	.167	.398	.199
			.330	.190	.303	.177

be almost the same as now and nurses' earning power will be improved moderately. Nursing professions' status among health care professions will be improved and autonomy of nursing will be improved moderately. These changes will be accompanied with higher nursing care quality.

CONCLUSION

As an attempt to examine the applicability of the AHP to nursing field, the future direction of the nursing education in the U.S. was assessed from the interpretation of the composite scenario (see Table 3).

It has to be very cautious in interpreting the result, since all judgments were drawn on the basis of the author's interpretation of each actors, their objectives, and policies stated or inferred in the literature. Caution of constructing the incomplete hierarchy of the elements influencing the future of the nursing education is not necessary because an element at a higher level need not function as a criterion for all the elements in the lower level. Rather, it can be partitioned into nearly disjoint sub-hierarchies sharing only a common top-most element (Saaty & Rogers, 1976).

In spite of the limitation, the final composite scenario through the AHP could be interpreted as the future direction of the nursing education based on the historical data unless there is an extraordinary unexpected events. Besides the application of the AHP to predict the future, it has been employed in the various areas to allocate the limited resources, to resolve the conflict, to plan, to study choice behavior and to analize input and output in a system.

The potential application of the AHP to the professional nursing should not be limited to prediction of the future and/or to those in the above. The AHP could provide the framework to deal with complex contemporary problems. The process of the AHP contributes to decrease the error of the third kind (E_{III}) (Dunn, 1981), referring the error committed by the analyst in formulating and solving the wrong problem when the right problem has to be solved, since the nature of the complex policy problem can be better understood.

Hopefully, this type of study will be performed by many researchers in the nursing field, since this approach can be undertaken at any level of the decision-making system from the level of individuals to that of groups and organizations and at various degrees of specificity included in the decision-making system.

REFERENCES

Abu-Saad, H. Nursing: A World View. St. Louis, Missouri: The C.V. Mosby Co, 1979.

Ackoff, R.L. Redesigning the Future: A Systems

Approach to Societal Problems. New York: Wiley, 1974.

AJNA. *Facts of Nursing: 1980~81*, Kansas City, Mo., American Journal of Nursing 'Association, 1982.

ANA. *ANA's Standpoint on Entry Into Practice*, ANA, 1978.

Dolan, A.K. The New York State Nurses Association 1985 Proposal: Who Needs It? *Journal of Health Politics, Policy and Law*, 1978, 2(4), 507~527.

Dunn, W.N. *Public Policy Analysis: An Introduction*, Englewood Cliffs: Prentice-Hall, 1981.

Flexner, A. *Report of General Education Board-State-Arted College in Maryland, to the Governor of Maryland*, 1921.

Gholamnezhad, A.H. & Saaty, T.L. A Desired Energy Mix for the United States in the year 2000: An Analytic Hierarchy Approach. *International Journal of Policy Analysis and Information Systems*, 1982, 6(1), 47~64.

Institute of Medicine. *Six-Month Interim Report by the Committee of the Institute of Medicine for a Study Nursing Education*, Washington, D.C.: National Academy Press, 1981.

Jones, Charles O. *An Introduction to the Study of Public Policy*. 2nd ed., Duxbury, 1977.

Kalisch, B.J. & Kalisch, P. A. *Politics of Nursing*. J.B. Lippincott Co., 1982.

Levine, E. Nursing Supply and Requirements: The Current Situation and Future Prospects. *Political, Social and Educational Forces on Nursing: Impact of Political Forces* (NLN Publication No. 1754). NLN Publisher, New York, NY, 1978.

Lysaught P. *Action in Affirmation: Toward an Unambiguous Profession of Nursing*. McGraw-Hill Book Co., 1981.

Matejski, M.P. Nursing Education, Professionalism, and Autonomy: Social Constraints and the Goldmark Report. *American Nursing Society*, 1981, 3 (April), 17~30.

Miller, J.G. *Living Systems*, New York: McGrow-Hill, 1978.

Miller, G.A. The Magical Number Seven, Plus or Minus Two: Some Limits on Our Capacity for Procesing Information, *Psychology Review*, 1963, 81~97.

Mitroff, I. & Sagasti, F. Epistemology as General Systems Theory: An Approach to the Design of Complex Decision-Making Experiments, *Philosophy of the Social Sciences*, 1973, 3, 117~134.

Nahm, H.E. History of Nursing-A Century of Change, in *Current Issue in Nursing*, ed. by J.C. McCloskey & H.K. Grace., Blackwell Scientific Publications, 1981.

NYSNA. *Brief Chronologly of the New York State Nurses Association's Entry into Practice Proposal* ("*1985 Proposal*") 1983.

Rittel, H.W. & Webber, M.M. Dilemmas in a General Theory of Planning. *Policy Sciences*, 1973, 4(2), 155~169.

Saaty, T. *The Analytical Hierarchy Process*, Mc-Grow-Hill, 1980.

Saaty, T.L. A Scaling Method for Priorities in Hierarchical Structures. *Journal of Mathematical Psychology*, 1977, 15(3), 234~281.

Saaty, T.L. & Bennett, J.P. A Theory of Analytical Hierarchies Applied to Political Candidacy. *Behavioral Science*, 1977, 22, 237~245.

Saaty, T.L. & Rogers, P.O. Higher Education in the United states States (1985~2000). *Socio-Economic Planning Science*, 1976, 10, 251~263.

Saaty, T.L. & Vargas, L.G. *The Logic of the Priorities: Applications in Business, Energy, Health, and Transportation*. Boston Mass: Kluwer-Nijhoff Publishing, 1982.

Saaty, T.L. & Mariano, R.S. Rationing Energy to Industries; Priorities and Input-Output Dependence. *Energy Systems and Policy*, 1979.

Saaty, T.L. & Vargas, L.G. Hierarchical Analysis of Behavior in Competition: Prediction in Chess. *Behavioral Science*, 1980, 25.

Staggs, K.G. *Problems and Issues Facing Nursing Education*. NLN Publication No. 23—1685. National League for Nursing, New York. 1978, 1~9.

Strauch, R.E. A Critical Look at Quantitative Methodology. *Policy Analysis*, 1976, winter, 121~144.

국 문 초 록

계층분석과정의 간호적용에 관한 연구
—미국의 미래 간호교육의 예견—

한 경 애*

복잡한 사회문제해결에 유용한 접근방법의 하나인 계층분석과정은 수학자인 사티(Saaty)가 개발한 것으로서 이미 사회과학의 여러분야에 적용되고 있다. 본 논문의 목적은 이 계층분석과정을 간호교육과 관련된 문제에 적용해 봄으로써 이 방법이 실제 문제해결을 위한 유용한 접근방법이 될 수 있는가를 고찰해 보는데 있다.

현대사회문제들은 다양한 관련요소, 그 요소들간이나 다른 문제들과의 복잡한 상호관계, 다수의 의사결정자의 참여, 무한한 대안, 문제의 결과에 대한 불확실성등으로 인하여 단순한 모델이나 간단한 논리적 혹은 직관적인 판단에 준하여 일시에 해결하기 어려운 경우가 많다. 이러한 상황하에서 문제와 관련된 요소들을 찾아내고 그 요소들을 계층적으로 분석하여 단계적으로 문제해결에 접근하는 계층분석과정을 활용함으로써 사회과학분야의 문제해결에 유용한 수단이 될 수 있다. 또한 문제와 관련된 요소를 규명하고 계층적으로 분화하는 과정에서 그 문제에 대한 보다 명확한 이해, 분석 및 현상의 흐름을 더 잘 이해하게 된다. 계층분석과정은 1) 계층구조의 설정 2) 구성요소들의 중요도 측정 3) 중요도에 따른 우선 순위의 산정 4) 우선 순위의 일관성 검토과정으로 요약된다.

본 논문에서는 이러한 과정을 통하여 미국 간호계에서 심각한 문제로 대두되어온 기본교육제도상의 쟁점(Issue of Entry into Practice)에 대한 문제 해결책이 마련되는지를 시도하였다. 즉, 기본교육 제도에 영향을 미칠 수 있는 요인들을 규명하여 계층화하고 계층내에

위치하는 구성요소들의 수평적 관계와 계층간의 수직적 관계를 체계적으로 검토하여 간호교육의 미래를 예측해 보았다. 간호교육제도에 영향을 미칠수 있는 주요 요인들의 계층화는 거시적 환경차원(factors), 관련 이해자집단차원(actors), 이해자집단의 목표차원(objectives), 목표달성을 위한 정책차원(policies), 그리고 간호교육제도의 미래를 예견한 시나리오(scenario)로 이루어졌다. 각 계층을 따라 단계적으로 중요도를 비교하여 최종적으로 각 시나리오의 우선순위 중요도(priority weight)를 구하였다. 각 시나리오의 우선순위 중요도를 간호교육과 관련된 4가지 차원들(학생, 교수, 교육기관, 직업)을 구성하고 있는 특성들에 가중하여 결과를 해석하였다.

간호교육의 미래에 정치적(55%)과 경제적(25%) 요인이 가장 강한 영향을 미치고, 관련자중에서는 병원(38%) 의사(33%) 그리고 정부(23%)의 순으로 영향을 미친다고 분석되었다. 의외로 간호원 자신들은 큰 영향력이 없는 것으로 보여졌다. 4개의 시나리오중에서는 그 우선순위 중요도가 현상유지(33%) 자발적4년제(32%), 강제 4년제(19%), 그리고 2~3년제의 우위(18%) 순으로 나타났다. 최종 시나리오 결과를 요약하면 1) 전체 학생수는 감소하나 양질의 간호학생수는 증가하며 2) 박사학위를 소지한 간호학 교수 및 전체 교수의 수가 증가할 것이다. 3) 전체 간호교육기관의 수는 약간 줄것이며 그중 4년제 기관이 증가하고 반면에 2~3년제의 기관은 감소할 것이다. 4) 전문간호원이 되기 위한 입학용이도에는 별차이가 없겠으나 간호원들의 보수, 지위 및 자율성이 증가하면서 전반적인 간호의 질이 향상될 것이다.

계층분석과정의 적용으로 미국 간호교육계의 가까운 미래를 위와같이 예견하여 보았으나 이 과정은 예견 뿐만 아니라 일반적인 의사결정이나 문제해결의 도구이외에도 복잡한 사회문제의 본질을 분석, 이해함으로써 보다 정확한 정책문제를 규정하는데에도 유용할 것이다.

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