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Why the Australian Government Does Not Use Decision Support Systems for Tobacco Control among Adolescents

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Abstract

The paper points to the decision support systems' application in improving the Australian Government tobacco control decision processes relevant to adolescents. Most smokers are recruited as juveniles. Once started, there is a tendency for this age group to become addicted to it (Bachman et al.*, 1997; QUIT, 2006). The research project findings indicate that the Australian Government tobacco control decision process may be influenced by interested groups, is not dealing with tobacco control for adolescents and is not using decision support systems. If applied, however, the theoretical contributions of decision support systems can improve tobacco control decision processes to prevent juveniles becoming smokers and decrease the high death rate caused by smoking-related illnesses.*

Introduction

Development of any government policy, including tobacco control policies, is a decision making process primarily supported by information available to decision makers. As a reasoning process, decision making leads to the selection of one course of action from among several considerations. The decision process is also a psychological construct consisting of different activities including intelligence, design, choice and implementation (Simon, 1960). Intelligence contributes to identifying and understanding the issue based on available information. Design establishes and explores possible solutions to resolve the issue. Choice refers to selection of available solution alternatives. Implementation consists of application of the chosen alternative and monitoring how well the alternative is working (Laudon & Laudon, 2006).

These stages of decision making do not necessarily follow one after the other. For example, when implementing the decision to control tobacco usage among teenagers, the chosen strategy may not be effective, leading to repeated efforts to research, design and choose a more successful approach. As a psychological construct, decision making is also subject to emotional or personal bias of the part of the decision maker. The bias may lead

to a subjective evaluation of the chosen consideration (OED, 1989) causing an unexpected outcome to the decision.

Government decision processes involve a large number of alternatives at both the design stage and choice stage of the decision making process. As such, they are not all to be taken into consideration in the decision process, since some of them can be understood as more important than others. The choice of the alternative can be based on intuition and/or subjective judgment. In order to make the decision process as objective as possible, the use of decision support systems can significantly help in identifying the appropriate solution to a given problem (Power, 2007).

Since the decision making processes are applicable in different domains, the concept of a decision support system is differently interpreted. One extreme interpretation is that a decision support system is a computerised system assisting the process of decision making (Finlay, 1994). To the other extreme, a decision support system is an adaptable computer-based information system specially designed to improve decision making (Turban & Aronson, 2001). Keen (1980) argues that there is no way to provide a proper definition due to the fact that it is impossible to take into account all the facets of the decision support system. Power (1997), however, believes that the term decision support system comprises a provision for many types of information systems that support decision making.

It seems that, internationally, decision support systems are little used in the development of government regulations (Turban & Aronson, 2001). The literature reports that decision support systems have been implemented in the form of neuro-fuzzy systems in energy policy planning (Gugor & Arikan, 2000), security policies (Hosmer, 1992) and health policy (Kroneman & Van der Zee, 1997). Research undertaken by Coghill and Petrovic-Lazarevic (2002), Petrovic-Lazarevic, Abraham and Coghill (2002, 2004) and Abraham, Petrovic-Lazarevic and Coghill (2006) suggest the use of decision support systems in the development and evaluation of government social policy regulations affecting tobacco control among minors in the Australian state of Victoria. However, no reports have been found on the use of the proposed decision support systems in Australia.

This paper aims to find out whether any of the decision support system theories relevant to tobacco control among adolescents is applied in the Australian Government tobacco control decision making process. The research project was conducted in each state and territory of Australia to identify the use of decision support systems. The paper is organised as follows: after the Introduction, section two provides a theoretical contribution to the decision support systems related to tobacco control among youngsters in Australia; section three explores the research project findings; and the paper ends with concluding remarks and future research intentions.

Decision Support Systems in Tobacco Control for Juveniles

Two types of computing models - fuzzy control model and neuro-fuzzy models - and evolutionary algorithms as adaptive computational techniques have been applied to investigate tobacco smoking policy regulations in the Australian state of Victoria (Coghill & Petrovic-Lazarevic, 2002; Petrovic-Lazarevic *et al.*, 2002; Petrovic-Lazarevic *et al.*, 2004;

Abraham *et al.*, 2006). The models were used to identify the factors influencing the effectiveness of measures to prevent tobacco smoking by individuals under 18 years.

Neuro-fuzzy systems comprise both fuzzy logic and neural networks. Fuzzy logic is a family of methodologies used in the analysis of incomplete, imprecise or unreliable information. It enables approximate reasoning in which the rules of inference are approximate rather than exact (Carlson, Fedrizzi, & Fuller, 2004). Fuzzy (*if-then*) rules represent knowledge concerning the relationships between variables. The accuracy of each rule is determined by membership functions (Cordon & Herrera, 1997).

The fuzzy control model that is extensively used in Artificial Intelligence programs (Coghill & Petrovic-Lazarevic, 2002) has been applied to estimate the type of social regulation of tobacco control in Australia. The model comprises the following variables: baseline condition (compliance rate by retailers' obedience); maximum enforcement according to protocol; and enforcement community education (no retailer education). Variables were presented in a membership form expressing explicit expert systems knowledge. *If-then* enforcement rules were introduced following the fuzzy control procedure. The applied model demonstrated an estimate of the outcomes of social regulation given its formal provision of the social regulation regime (Coghill & Petrovic-Lazarevic, 2002).

The accuracy of the model was tested with the data from six local government areas in the western suburbs of Melbourne (Australia) in 1998 and 1999. In two municipalities the programs of education were directed at both the community and at retailers, with enforcement through prosecution being underlined by a supportive media. In one municipality, there were no educational programs but there was enforcement through prosecution with supporting media. In the three remaining local governments no change was made to seek higher levels of compliance. However, the proximity of the approached municipalities might have been exposed to news of the successful prosecutions.

The model has limitations. First, it only covers explicit knowledge based on social policies and procedures. Second, it does not reflect tacit, indirect knowledge of communities based on local ethics and norms that can significantly reduce adolescent smoking rates. Third, the model does not provide government representatives with an answer as to what extent to concentrate on available social regulation measures in anticipating enforcement efforts.

In order to diminish limitations of the model, Petrovic-Lazarevic *et al.* (2004) concentrated on neuro-fuzzy modelling to further test what variables have significant influence on tobacco control among adolescents.

The neuro-fuzzy modelling is a type of Artificial Intelligence program based on neural networks and fuzzy models (Petrovic-Lazarevic *et al.*, 2004). Stergiou and Siganos (2007: 1) define a neural network as:

> *... an information processing concept that is inspired by the way biological nervous systems process information. The key element of this concept is the novel structure of the information processing system composed of a large number of highly interconnected processing elements (neurones) working in unison to solve specific problems.*

Neural networks combine basic information through a high level of interconnectivity which also handles scalar messages and high levels of complex interaction between multiple variables (Nguyen & Walker, 2000). Neuro-fuzzy modelling enables handling imprecision and uncertainty in data by using a learning algorithm (Bezdek, Dubois & Prade, 1999), creating fuzzy rules in easy-to-comprehend linguistic terms (Petrovic-Lazarevic *et al.*, 2002).

In neuro-fuzzy modelling, the derivation of *if-then* rules and corresponding membership functions depends heavily on the *a priori* knowledge about the system under consideration. The system can utilise human expertise by storing its essential components in rule base and database and perform fuzzy reasoning to infer the overall output value. However, since it seems there is no systematic way to transform experiences and knowledge of human experts into a knowledge base, the Adaptive Network Based Fuzzy Inference System (ANFIS) and Evolving Fuzzy Neural Network (EFuNN) models were introduced to apply the neuro-fuzzy support of knowledge management to social regulation (Petrovic-Lazarevic *et al.*, 2004). Thus, the explicit knowledge was based on social policies and procedures to reduce smoking among youngsters while the tacit knowledge was expressed through the applied membership functions.

Empirical results showed the dependability of the proposed techniques. Simulations were done with the data provided for the six local government areas. Each data set was represented by three input variables and two output variables. The input variables considered were the same as those used in the Coghill and Petrovic-Lazarevic (2002) fuzzy control model: compliance rate by retailers, enforcement according to protocol and community education. The corresponding output variables were compliance rate by retailers and compliance rate by retailers projected as estimated rate of smoking uptake by minors.

ANFIS performed better than EfuNN in terms of performance error. EfuNN performed approximately 12 times faster than ANFIS. Hence, where performance speed is the criteria to minimise time of a generated knowledge, EFuNN appears to be the ideal candidate. EFuNN is also suitable for online learning of new data sets. Depending on governmental requests it is possible to compromise between performance error and computational time. Disadvantages of ANFIS and EFuNN include the determination of the network parameters such as type of membership functions for each input variable, membership functions for each output variable and the optimal learning parameters.

In order to select optimal parameters, modelling comprising both tacit and explicit knowledge may be formulated as an evolutionary search, or the neuro-fuzzy systems. It will then be able to provide an answer for the government representatives as to what extent to concentrate on available social regulation measures in anticipating smoking enforcement efforts.

Evolutionary algorithms transform a set of objects, each with an associated fitness value, into a new population using operations based on Darwinian principles of reproduction and survival of the fittest, and naturally occurring genetic operations. The evolutionary algorithms learning technique can help optimise human knowledge from the database (Tran, Lakhami & Abraham, 2002). In particular, the evolutionary algorithms

technique may be helpful in cases where expert knowledge is explained by a natural language or written words. The usefulness of the evolutionary algorithms technique is in encoding the fuzzy rules of the method of automatic database learning in the fuzzy control and neural networks learning models and minimising the number of rules by including only the most significant ones (Cordon & Herrera, 1997).

The EvoPol (Evolving Policies), an evolutionary computation technique, was used to optimise the *if-then* rules to support governmental policy analysis in restricting recruitment of smokers. The proposed EvoPol technique is simple and efficient when compared to the neuro-fuzzy approach; however, EvoPol attracts extra computational costs due to the population-based hierarchical search process (Abraham *et al.*, 2006).

With the improvement of decision support systems, selection of optimal parameters may be formulated as an evolutionary search to make the neuro-fuzzy systems fully adaptable and optimal according to government representatives' requests by providing an answer for the question of to what extent to concentrate on available social regulation measures in anticipating smoking enforcement efforts related to adolescents. Such information would by all means help to make tobacco control related decisions in order to improve tobacco smoking legal policy formulation.

Tobacco Control Decision Processes in Australia

In order to find whether any of the decision support theories mentioned above were applied in decision processes relevant to tobacco control for adolescents in Australia, a research project was conducted in 2005/2006. The research project involved interviews with a Ministry of Health representative.

The Health Department is the primary agency that coordinates smoking prevention activities including social research and formulation of legislation. Although there were eight initial interviews, some interviewees were approached several times to clarify certain issues when necessary. Each interviewee held the top position in their respective branch (Table 1). The interviews were mostly conducted by a research assistant. Only South Australia and Queensland representatives were interviewed by the author of this paper. All interviews were carried out over the phone, except in Victoria where the interview was conducted face-to-face. Each interview lasted approximately one hour. Interviews were tape recorded and transcribed into case studies.

Legislation relevant to each state and territory was also used to support findings from the interviews. It was found that there was overall consistency between interviewees' responses and legislative requirements. The following questions/requests were asked in the semi-structured interviews:

- *Explain the procedure of collecting and processing information relevant to the change/s in existing tobacco control legislation or introducing new tobacco control enforcement.*
- *How are juveniles included in the tobacco smoking legislation?*
- *What part, if any, did the use of decision support systems have on the legislative procedure?*

Based on the responses, the research findings are summarised in the following sections.

Table 1: State and National Territory Government Departments and Divisions Responsible for Tobacco Smoking Control and Prevention

State /Territory	Department	Special Centre/Division	Branch
Australian Capital Territory	Australian Capital Territory Health Department	N/A	Health Protection Service and Drug Policy Section
New South Wales	New South Wales Health Department	Centre for Chronic Disease Prevention and Health Advancement	Tobacco and Health Branch
Northern Territory	Department of Health and Community Services	Alcohol and Other Drugs Program	Tobacco Action Project
Queensland	Queensland Health	N/A	Alcohol Tobacco and Other Drug Services
South Australia	Department of Health	N/A	Tobacco Control Unit
Tasmania	Department of Health and Human Services	N/A	Tobacco Coalition
Victoria	Department of Human Services	N/A	Alcohol, Tobacco and Koori Drug Policy Unit
Western Australia	Department of Health	N/A	QUIT Western Australia

Source: Original table.

Governmental Tobacco Control Decision Making Process

The Australian Federal Government has limited responsibility for the regulation of the advertising and promoting of tobacco products and selling cigarettes to minors, as the primary legislative authority rests with individual states. State and territory parliaments are: entitled to change laws relevant to smoke-free environments; responsible for monitoring tobacco smoking law enforcement; and responsible for providing education programs on the effects of tobacco smoking on health.

The legal steps to collect and process information relevant to tobacco control legislation procedure are similar throughout Australia. Although each state and territory health minister is entitled to decide whether to proceed with a recommendation to amend the existing enforcement regime or introduce a new enforcement measure, the use of subjective judgement is less likely to appear as a consequence of the enforcement procedure applied. The process includes several filtering steps through which the recommendation proceeds to become legislation (Petrovic-Lazarevic & Coghill, 2002). These steps include the following actions:

1. The initiative to change legislation at state/territory level can come from different sources, such as public pressure, non-governmental organisations, researchers and policy officers working on different aspects of tobacco control; state/territory minister or government policy initiatives; and recommendations arising through

the National Ministerial Council. A health minister is entitled to propose changes without consultation with anyone from the Health Ministry, which if adopted by the government can then be introduced into Parliament.

2. Ministers receive submissions proposing or opposing reforms from such diverse groups as health organisations, unions, the hospitality industry and the tobacco retailing industry.
3. Ministers usually refer the submissions to the health department, requesting advice on the possibility of amending the existing legislation or introducing new laws. Additionally, the health department in each state/territory reviews the legislation and programs and their effectiveness every fourth year.
4. The health department conducts a review that includes public discussion of papers exploring means of improving tobacco control, to which the department may respond. The health department representatives do not personally participate in the discussion.
5. Any legislation change follows usual legal process of Ministerial endorsement and Cabinet approval for drafting of the Bill.
6. The Minister authorises the drafting of amendments, which may then be subject to public consultation. Public submissions are generally sought through newspaper advertisements. The drafting of amendments in every state or territory includes consultation, embracing business, equity and social justice points of view.

From the research conducted it seems that since not all local governments are entitled to impose tobacco control, there is inconsistency related to state and territory tobacco laws and regulations. This may cause stronger or weaker influence of any of the two groups of non-governmental organisations - health organisations and industry associations - with opposing interests in tobacco control. The influence is supported by the procedure which legally entitles everybody to request a change to exiting tobacco control.

Legislation Related to Adolescents

The issue of youth smoking is a complex one on which opinions vary. One view is that too much attention is paid to youth smoking while another view is that since the behaviour of adult smokers influences younger people then something should be done to change the behaviour of adult smokers (Bachman *et al.*, 1997).

According to this research project's findings, policy and legislation are not specifically related to adolescents in any state or territory. However, they do so implicitly in two ways. One way is the control of selling, promoting and advertising tobacco products. The other way is educational school-based programs. The first way aims to protect non-smokers by encouraging social unacceptability of smoking, and to reduce the number of adult smokers which in turn helps reduce the number of young people who smoke. The second way, education programs, is applied in each state and territory. These programs cover alcohol, drugs and tobacco use. The tobacco-related programs focus on prevention by educating

minors about the effects cigarette smoking has on health. However, the school system in Australia is decentralised, so the quality of these programs varies from school to school and across states and territories.

Since the rules related to smoke-free environments and education among youngsters on the negative health effects of smoking do not exist in the relevant state and territory tobacco Acts, the municipalities are entitled to impose them. As such the municipalities may indirectly influence juveniles not to start smoking, or if they are already addicted to nicotine, then to quit smoking.

Decision Support System used in Legislation Procedure

None of Australia's states or territories rely on decision support programs in the process of developing tobacco smoking legislation. The findings of the research project indicate that the Australian Government tobacco control decision making process has several filtering steps through which the recommendation goes on to become legislation. The process may be influenced by interested groups and/or others. It does not include separate tobacco control for adolescents and it does not use any decision support system.

Conclusions

In order to analyse tobacco smoking decision making processes relevant to tobacco control for people under the age of 18 in Australia, a research project was developed around contemporary theory relevant to this field. The existing tobacco control legislation procedures and use of decision support systems in legislation procedure throughout all states and territories were investigated. Although the actual legislation seems to minimise subjective judgements in the decision making processes, it does not prevent the influence of non-governmental organisations over the amendment of the existing law or introduction of new laws to satisfy their own interests. That points to potential vulnerability in the procedure itself. The research found that decision support systems were unknown and unused, although they have the potential to assist in identifying, distinguishing and discriminating between the effectiveness of policy and legislative instruments. In terms of legislation related to adolescents, it was found that some existing legislation indirectly related to juveniles.

With the results obtained in works of Petrovic-Lazarevic *et al.* (2002, 2004), and Abraham *et al.* (2006), the use of decision support programs applied to tobacco control among youngsters in Australia may help in identifying what mostly influences youngsters to remain non-smokers or to quit smoking. Additionally, the use of such decision support systems could decrease the influence of pressure groups on legislation. Changing legislation based on adequate information will contribute to preventing juveniles becoming smokers and decreasing the high death rate caused by smoking-related illnesses. Further research is required to evaluate the potential value of decision support software based on data from all municipalities in each state and territory in Australia in improving the effectiveness of legislation on changing behaviour.

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