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Swaton, E. and Renn, O.

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ATTITUDES TOWARDS NUCLEAR POWER: A COMPARISON BETWEEN THREE NATIONS

E. Swaton*
O. Renn**

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INTERNATIONAL INSTITUTE FOR APPLIED SYSTEMS ANALYSIS
A-2361 Laxenburg, Austria.

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*Joint IAEA/IIASA Risk Assessment Project, International Atomic Energy Agency, Vienna International Centre, Vienna, Austria.

**Kernforschungsanlage Juelich, Federal Republic of Germany.

PREFACE

The on-going worldwide discussions about the peaceful use of nuclear energy have clearly indicated that there is a gap between the expert's knowledge and the public's understanding. Studying the attitudes toward nuclear and their underlying determinants in several countries, utilizing the same technique for data collection, provides insights into people's awareness and anxiety, but also reveals trends which can be dealt with on an international level.

Over the past years, the Joint IAEA/IIASA Project has developed a methodology for quantitatively assessing the structure of public attitudes; see RM-77-54 (Otway and Fishbein, 1977), and RR-80-15 (Thomas et al., 1980).

This Working Paper presents the continuation of this line of research from national applications to international studies. Since the comparability of several samples depends on the similarity of their demographic structure, we have selected these student samples for comparison, while other samples from participating nations such as Brazil, Columbia, and Finland have been analysed independently.

ABSTRACT

The attitudes toward the use of nuclear energy of three student samples of roughly equal size (N=150) from FR Germany, Japan and the Philippines were elicited and compared by means of a questionnaire.

Concerning their overall attitudinal positions the Japanese students were predominantly in favour of nuclear energy, the German students were less unanimous while the Philippine students showed the most anti-nuclear resentment. These positions were equally influenced by considerations about benefits and risks; whereas the awareness of risks associated to the use of nuclear energy seems to prevail in all three samples, favourable or unfavourable attitudes are predominantly based on the acceptance or denial of perceived benefits. However, agreement about particular risks or benefits was found to be much stronger within each national level than among proponents and opponents of nuclear energy of the combined sample.

In addition, the relevance of the issues presented in the questionnaire for the debate about nuclear energy was demonstrated.

CONTENTS

1 INTRODUCTION: Attitude Concepts

The term 'attitude' can already look back onto several decades of research history. The first differentiation was made between defining the term 'attitude' as a physiological readiness of the body to react as opposed to conceptualising the same term as a mental state. While the former could be measured by finger-pulse, galvanic skin response or heartbeat rates, access to the latter was only possible by verbal response techniques. Nevertheless, the later concept of 'attitude' was adopted but a new issue emerged about the definition of attitude. One of the first definitions was proposed by ALLPORT (1935) encompassing all conceivable aspects of what attitude could be:

> Attitude is a mental and neural state of readiness, organised through experience, exerting a directive or dynamic influence upon the individual's response to all objects and situations with which it is related. (ALLPORT, 1935).

A more selective approach to define attitudes has been adopted by the behaviouristic school. According to DE FLEUR & WESTIE (1958), attitude refers to the probability of similar behaviour towards an object in similar situations. In substance, overt behaviour is being used as an indication for latent relations to the object in question. This approach has been contested since

- attitudes towards objects may exist without any overt behaviour ever having taken place (e.g. prejudices against foreigners, etc.)

- behaviour is not only determined by attitude toward an object or an action but is influenced by a set of other aspects which range from personal characteristics to social roles

- the actual behaviour is also influenced by external parameters (situation, object, time).

These obstacles cannot be compensated by the advantage of these approaches to include an operationalised measurement of attitudes within the theoretical definition.

In contrast to the behavioural concept, the mediative approach refers to the mental processing of external stimuli. SHAW & WRIGHT (1967) hold that "Attitude refers to a relatively enduring system of evaluative concepts of beliefs which have been learned about the characteristics of a social object or a class of social objects". The problem here is the difficulty to operationalise a mental state. In spite of this problem, the mediative approach has turned out to be the most promising.

Within the general framework of mediative attitude definitions, there are different concepts depending on the number and structure of components seen to determine attitude. The classical consistency theory distinguishes three equally important components of attitudes:

- cognitive
- affective
- conative.

Each individual tries to harmonise these three components into a holistic judgment which influences his actual behaviour without the particular response being determined (KRECH, CRUTCHFIELD & BALLACHEY, 1962). The three component concepts of attitude have been enlarged and partially modified by ROSENBERG(1956), ROKEACH(1968), TRIANDIS (1967) and others. In particular, the relation between attitude and behaviour has been specified by including situational and action-related parameters into their attitude models. As a viable alternative to these models, another concept has been proposed which regards attitudes as a composition of emotionally evaluated beliefs (SHAW & WRIGHT, 1967, MURPHY, MURPHY & NEWCOMB, 1937) .The concept most widely used was introduced by M. FISHBEIN (1963) based on the following definition: "A person's attitude toward any object is a function of his beliefs about the object and the implicit evaluative responses associated with these beliefs". The attitude theory developed relies on the following assumptions (FISHBEIN & AJZEN,1975):

(1) Any given object is related to various attributes.
(2) Associated with each of the attributes is an implicit evaluative response, i.e. an attitude.
(3) Through learning and experience, these evaluative responses are associated with the attitude object.
(4) These evaluative responses summate.
(5) On future occasions the attitude object will elicit this summated evaluative response, i.e. the overall attitude.

If these assumptions are regarded as valid, attitudes can easily be elicited by collecting data on the beliefs about the respective attitude object and the evaluative weight given to each attribute. Hence the affective and cognitive components are combined into one scaling dimension. Other one-dimensional attitude models rely solely on the composition of affective statements about the object in question.

Comparing the different models, it is evident that the multidimensional approaches have a more complex and realistic theoretical base but encounter enormous problems in establishing an appropriate measurement technique. In particular, the composition rule for combining the different dimensions into one holistic attitude cannot be derived by theoretical assumptions and is open to subjective variations. However, the simple affective scales to measure attitudes cover only partially the complexity of attitudes and have empirically been proven as bad predictors for general behaviour (WICKER, 1969).

As a good compromise between the theoretical complex multi-dimensional attitude concepts and the simple affective concepts based upon a single-scale measurement, we decided to choose the inbetween model of FISHBEIN which covers at least two dimensions of attitudinal patterns and in addition provides for a precise and well interpretable measurement procedure. The general drawback of the Fishbein model is the assumption that no response biases exist among the beliefs and that no interaction takes place between the evaluation and the beliefs. It is evident that

in reality this cannot be accomplished. In practical research, however, a feasible solution to this problem is to state the general theme prior to the measurement of evaluations and to introduce the concrete attitude object only when the beliefs are presented. The intercorrelations among beliefs can be detected by using special statistical techniques like multiple stepwise regression analysis. Another advantage of selecting the Fishbein model is its applicability for comparisons between samples from different nations since the formalized concept can be transferred to different cultural contexts without oppressing cultural variations in reasoning and object perceptions.

2. METHOD AND PROCEDURE

2.1 The Fishbein Technique

According to FISHBEIN & AJZEN (1975), the terms to be used in their technique are defined as follows:

An ATTITUDE represents a person's general feeling of favourableness or unfavourableness toward a given object and is composed of beliefs about the relation of an object to a set of attributes which are subjectively evaluated as being good or bad. A BELIEF represents the information a person has about a given object, i.e. it is a probability judgement whether an attribute is or is not, and to which degree, associated with the respective attitude object. The EVALUATION of the attributes indicates the subjectively felt goodness or badness of each attribute. Thus, by combining beliefs and evaluations, the cognitive component is subjectively weighted by the affective meaning.

Formally, beliefs and attribute-evaluations are combined as follows:

$$A_o = \sum_{i=1}^{n} b_i e_i$$

where

A_o is the attitude toward the given object;

b_i is the belief about this object, expressed as subjective probability judgment that the object is related to attribute i;

e_i is the evaluation of attribute i; and

n is the number of beliefs (units of information) a person holds about the attitude object in question.

This formal representation of the model suggests a twofold measure of attitude. Since the sum of the belief-evaluation products represents an indirect measure of attitude it can be validated by a direct approach to measure attitudes. The technique selected for this purpose is the "Semantic Differential" developed by OSGOOD et al. (1957) where a direct

measure of attitude is obtained through summating over responses to a set of bi-polar adjectives which have an evaluative connotation with regard to the given attitude object. The correlation coefficient between the direct and indirect measurement demonstrates the reliability of a chosen set of attributes as relevant units of information.

The scaling technique applied throughout the questionnaire is a bi-polar 7-place rating scale.

2.2 Application of the Technique

Design of a questionnaire pertaining to the Fishbein technique requires a careful selection of the attributes. The questionnaire applied in this study underwent the following stages: a first version was put together after extensive screening of mass media and relevant literature. In addition some 100 persons in Vienna were interviewed about what came to their mind when they thought of "nuclear power". Particularly this interview procedure is of considerable importance because it permits the researcher to select those concerns which are forwarded most often (in Fishbein-terminology: overall salient beliefs). Although a person's attitude will be determined by only a few salient beliefs, it is necessary to use a larger set of relevant beliefs in order to detect particular clusters of beliefs among various social groups . The identification of underlying determinants of attitudes via statistical procedures, like factor analysis, also requires a larger amount of items for the deduction of valid results. Considering these requirements a pilot questionnaire was designed and applied in Austria to a stratified sample (OTWAY et al. 1977, THOMAS et al., 1980). For the purpose of cross-national comparison the original questionnaire was revised to include issues which had been repeatedly raised in other countries. Furthermore the questionnaire was extended by two parts: first an even more direct measure of attitude was introduced in the form of a 7-place scale with the end points: "favourable - unfavourable". Here respondents could indicate straightforward their feeling about the use of nuclear energy; secondly all items were judged from the point of view of how important these issues were perceived to be in the on-going nuclear debate. This permits not only a better understanding (cross-validation) of the relevance of the selected items and the role these issues have in acceptance or rejection of nuclear power but also provides an interesting means for comparison between various national samples with probably different informational backgrounds.

2.3 Samples

Three student samples were taken from Technical Universities. The FRGerman students are enrolled in Aachen and Cologne (N=150), the Philippine students in Manila (N=174). The data of the Japanese students have been obtained from Tokyo (N=36) and Osaka (N=84).

The sample from FRG consisted of 63% males and 37% females. Among the Philippine students there were 26% males and 69% females (5% of the sample did not indicate their sex in the questionnaire) and in Japan 96% males and 4% females responded to the questionnaire.

The age distribution for the three samples is given in Table 1:

	FRG		PHILIPPINES		JAPAN	
Age Categ.	Absolute Values	Percent	Absolute Values	Percent	Absolute Values	Percent
18-29	94	62.7%	124	71.3%	107	89.9%
30-45	55	36.7%	18	10.3%	11	9.2%
46-59	1	0.7%	2	1.1%	1	0.8%
Missing Cases			30	17.2%	1	0.8%

Table 1: Age distribution: (three samples)

Cross-national surveys always run into the difficulty of finding appropriate samples which allow comparisons between countries. Any comparison relies at least on one common denominator from which differences can be accounted for. Since nations differ in their cultural heritage, in their social structure and their economic systems, it is essential to base any comparative research on some fixed background from where deviations can be interpreted. Such a background might be common knowledge, common values or social position. Since attitudes on energy systems are partly determined by the level of knowledge - which differs from country to country - and because there is no indication that nuclear energy is perceived in terms of identical values, it was necessary to restrict the scope of the social positions in order to create a homogeneous background.

This consideration led us to the conclusion that a randomly selected sample out of the general public would not be conclusive. Since the social structure, the dispersion of knowledge and the proportion of various class affiliations vary considerably between the three nations selected, results of a representative survey for one country could not be compared to one of the other two countries. Thus, in order to avoid the creation of artefacts we decided to confine our samples to students of technical and natural sciences. Students in engineering and natural sciences all over the world have at least a basic understanding of the functions and purposes of different energy systems. More knowledge is not required to respond to our questionnaire, so that the particular level of expertise among the students has no effect on the comparability of the results. Besides, students of these subjects will form the elite of technical decision makers in the future. Therefore the political climate of the general perception of nuclear energy can partly be described by our results and considers the future role of the students as technical experts.

3 RESULTS

3.1 Statistical Procedures

Apart from the normal statistical procedures such as frequency distribution analysis and correlations we applied three more sophisticated methods in order to reduce the large amount of variables to a smaller number of salient elements. The techniques involved are

- Factor Analysis
- Multiple Regression
- Discriminant Analysis

Factor Analysis is a method to determine the underlying cognitive structure in a given set of attributes by comparing the similarities of variance distributions resulting in a combination of items with high intercorrelations. The main purpose of a Factor Analysis is to derive dimensions which are inherent in a larger set of items.

Multiple Regression indicates the strength of a relationship between one dependent variable and a set of independent variables whereby the intercorrelations between the items of the independent variable set are excluded from the analysis. This procedure explains for each independent variable (e.g., attribute) the additional amount of the declared variance of the dependent variable (e.g., Semantic Differential as direct measurement).

Discriminant Analysis provides a viable yardstick for evaluating the relative distance between various sub-groups of a given sample. Like with Multiple Regression a whole set of possible discriminative variables can be investigated and the result of the analysis reflects the relative significance of items as explanators for group differences.

3.2 Validation of the Model

As indicated in the description of the Fishbein-technique the significance of the belief items can be tested by correlating the indirect measurement represented by the sum over the evaluated belief items with the direct measurement which is defined as the sum over the relevant adjectives of the Semantic Differential. The second direct measurement, the Pro/Con scale, is also included. This was done for the three samples separately. Table 2 shows the correlation coefficients between the two direct attitude scores (PC, Σ SD) and the indirect measure (Σ eb).

Attitude Measures	JAPAN	PHILIPPINES	FRG
PC $-\Sigma$eb	0.59684	0.47485	0.73599
PC $-\Sigma$SD	0.71027	0.65471	0.86473
Σ eb $-\Sigma$SD	0.68520	0.52331	0.81172

Table 2: Correlation Coefficients (Model Validation)

All correlations are significant on the 1% probability level indicating that the design of the questionnaire represents a valid instrument for investigating attitudes. The differences of the correlation coefficients between the three samples are probably due to the specific variance distribution of the three variables. The non-homogeneous responses are the lowest in any correlation with third variables. Since the Philippine and Japanese respondents had a stronger single peaked distribution (see Fig. 1) in the PRO/CON scale and the Semantic Differential than the German students, the weaker relation between the three measures of favourability in the Philippine and Japanese sample towards nuclear energy finds an adequate explanation.

Before analysing the data any further inspection of the direct attitude measures is expected to give some indication about the general favourableness or unfavourableness towards nuclear energy of the respondents.

3.3 Attitudinal Directions

The most direct measure of attitude introduced in the questionnaire is the PRO/CON Scale.

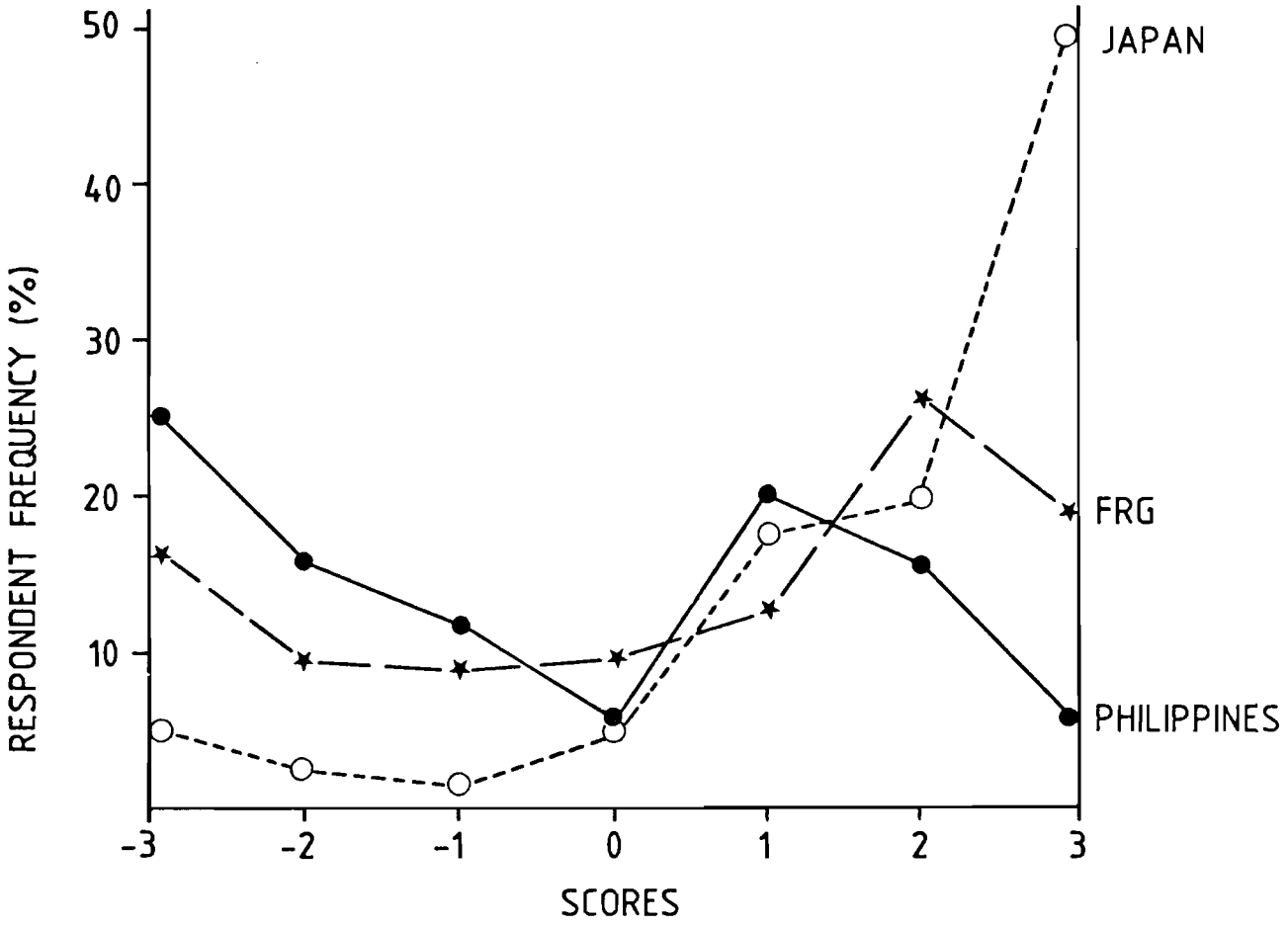

Fig. 1: PRO/CON Scale Frequencies

Examination of Fig. 1 where the respondent frequencies are given in percentages for each response category for each sample shows that the Japanese students were predominantly for the use of nuclear energy (categories 2 and 3 account for 68% of the sample), the Philippine student sample includes two groups - one very opposed (category -3 accounts for 25%) and one slightly in favour (category 1 represents 20%). The FRG students are also composed of two groups, with 45% of the sample being for the use of nuclear power (categories 2 and 3) and a smaller group of 25% (categories -3 and -2) being against.

As a general remark it could be concluded that except for the Japanese students who are predominantly in favour of the use of nuclear power, the other two student samples from FRG and the Philippines appear to include both interest groups, proponents and opponents.

The second direct attitude measure available are the adjectives of the Semantic Differential. Figure 2 shows the mean scores for the three samples. The favourable Japanese respondents see the use of nuclear energy as very important and useful, quite good, modern and worthwhile, but also realize that it is quite controversial and slightly dangerous. In contrast to this relatively clear perception Philippine students view the same concept as quite wrong, oppressing and useless, whereby they seem to acknowledge to a certain extent the importance of this energy source. FRG students have the least strong feelings about the use of nuclear energy perceiving it as quite modern and useful, slightly important and worthwhile, but slightly dangerous.

Taking the three samples together, they agree on nuclear power being important, worthwhile and good but also on being dangerous, oppressing and controversial.

Some clue for interpretation of the attitudes of the respective samples might be the fact that there is no nuclear power plant in operation and only one in construction in the Philippines, whereas there are about 15 nuclear power plants operating in the FRG and 24 in Japan*. Respondents from these two countries seem to have a more positive attitude towards nuclear energy.

3.4 Belief Structures

After having established the composition of the various samples with regard to their orientation PRO or CON the use of nuclear energy the following analyses concentrate on identification of determinants for these attitudes.

Application of factor analysis to the belief scores is expected to reveal the cognitive structure of the respondents concerning their perception of the issues pertaining to the use of nuclear energy. The method used is principal component analysis with subsequent Varimax rotation. This technique produces underlying dimensions which are

* (Status in 1982)

independent, i.e. orthogonal factors. Since the three samples differed in their attitudes towards nuclear power it is not anticipated that the factor structures will be identical. Nevertheless the clustering of items with high intercorrelations could be an informative indicator for general issues of interest in the respective societies.

3.4.1 Philippines

The results of factor analysis of the belief scores on nuclear energy are given in Table 3. Items with high intercorrelations cluster around two aspects, the risk considerations and the benefits, whereby the latter are distinguished by having an effect on the national level or a rather personal level.

Factor I represents the strongest concern with an eigenvalue (i.e., explanatory power for overall variance) of 7.15 and has been labelled: "Negative impacts of large scale technology". The issues involved include the lack of active control over the hazard and the involuntary exposure to it, the concern about large accidents, and the health hazards created either directly or indirectly through burdening the environment.

Factor II comprises issues of national interest such as progress and industrial development, prestige, and stimulation of research and has been termed "Progress in national development". This factor has an eigenvalue of 3.93.

Factor III seems to represent the more personal benefits respondents attribute to the use of nuclear energy. Thus the leading items for this factor are referring to the economic production of electricity and the capacity to cover the energy needs on a long-term basis. Another aspect of personal concern, the provision of jobs, is also included in this factor, labelled "Fringe-benefits". The eigenvalue of this factor is 3.27.

In order to determine the influence of the cognitive structure on the attitudinal committments a multiple regression analysis was undertaken with the Semantic Differential as dependent and the factors of the belief systems as independent variables. The purpose of the regression analysis was to detect the order of influential strength of each independent variable for the explanation of the dependent criterion. The stepwise procedure of the regression assures that only then will an independent variable be included in the analysis if it significantly adds to the amount of variance already explained by those variables which have been selected through the analysis so far.

For the samples from the Philippines it can be demonstrated that the best predictor for the sum of the Semantic Differential is Factor III, named "Fringe benefits" ($r = 0.54$; $p < 0.00$). This factor is followed by the other benefit related factor, "Progress in national development" ($r = 0.51$; additional $R^* = 0.12$; $p < 0.00$). Factor I "Negative Impacts of Large Scale Technologies", seems to play only a minor role with regard to

* R denotes the strength of the correlation after the first predictor has been introduced into the regression analysis. R = conditional correlation coefficient, r = simple correlation coefficient.

their attitudes, since the single correlation amounts to only r = 0.31 ($p < 0.01$) and the additional amount of declared variance is below one percent ($p < 0.12$). Considering the composition of the sample (about 50% pro - 50% con, see Fig .1) it is interesting to note that it is the two benefit factors which seem to be the predominant aspects in the attitude formation of the Philippine sample.

3.4.2. Germany

Factor analysis of belief scores on nuclear energy of FRG students yielded 4 factors as shown in Table 4. Only one of these factors emphasises the benefits of nuclear energy, whereas three express concern about the various negative consequences of this energy source. The beneficial aspects cluster in Factor I, termed "Economic Progress", whose eigenvalue of 6.33 indicates that a relatively large part of the total variance is explained by this factor. Items refer to cheap electricity production, improvement of standard of living and various benefits on a national level.

The second factor with an eigenvalue of 4.78 is very similar to Factor I of the Philippine students . Thus the same labelling "Negative impacts of large scale technology" was used.

Factor III represents a collection of concerns which could develop into a threat, probably not tomorrow but in the near future. Therefore it is described as "Potential for threat" including issues such as terrorist activities, passive exposure, international conflicts and the long-term radio-activity of wastes. The eigenvalue of this factor is relatively low (2.48).

The possible impact of nuclear power on society is expressed in Factor IV, termed "Restriction of social flexibility" with an eigenvalue of 2.42. Items loading high on this factor refer to the possibility of a restricted societal development and the dependency on big industry and their highly specialised professionals.

Computation of multiple regression coefficients as indicators for the attitudinal committment revealed that, in contrast to the Philippine sample, the perception of "Negative impacts of large scale technologies" turned out to be the predominant factor for attitude as determined by the direct measurement. The simple correlation was r = 0.83 ($p < 0.00$). "Economic progress" revealed to be the second best predictor, adding a surplus amount of 6 % to the declared variance ($p < 0.02$). Although the two other risk factors, "Potential for threat" and "Restriction of social flexibility",correlate highly with the Semantic Differential (r =0.80 and 0.81 respectively), they do not add any explanatory power to the multiple correlation coefficient, after Factor II (Impacts of large-scale technology) has been included as first predictor. The predominant concerns in Factors III and IV are thus covered by Factor II, at least in those areas which play a significant role in the formation of this sample's attitudes. Interpreting these results it seems evident that potential threat and social risks as highly complex beliefs do discriminate between different attitudinal positions, but are not the underlying reason

for the initial formation of a position towards nuclear. Rather both factors are seen as necessary consequences of the perceived negative impacts of large scale technologies. Respondents, who related highly negative impacts to the use of nuclear energy, were just as well convinced that the threat for political misuse and for social flexibility was connected with the general impacts of large scale technologies.

3.4.3. Japan

The factor structure of the Japanese student sample also comprises 4 factors, again with only one of them referring to beneficial aspects of nuclear energy but three dealing with threats, hazards and negative impacts. However,the factor with the beneficial aspects occupies first place among all factors. With an eigenvalue of 4.69 it refers mainly to economic advantages such as industrial development, standard of living and increased employment, thus Factor I was labelled "Economic prosperity".

Factor II deals with the "Impact on society " from the use of nuclear energy and has an eigenvalue of 3.41. Items of this factor include concerns about the national and international power distribution and health considerations.

The third factor, which combines possible impacts on society in the future has been termed "Long-term hazards" and has a relatively low eigenvalue of 2.79.

Factor IV consists of mainly the same items as Factor III of the FRG sample, thus it has been labelled accordingly "Potential for threat". This factor also represents a quite low eigenvalue of 2.57.

Regarding the relevance of these four factors for the attitudinal committment of this student sample from Japan, "Economic prosperity" has the highest correlation ($r = 0.64$; $p < 0.00$) and takes therefore the first position in the stepwise multiple regression. The third factor "Long-term hazards" has the second best predictive power , immediately followed by Factor II, "Impact on society". Both factors increase the share in the explanation of the dependent variable with three and two percent respectively; while the additional explanatory power of Factor III can be regarded as significant ($p < 0.04$), factor II does not add significantly ($p < 0.07$) to the overall declared variance of the Semantic Differential. Similar to the Philippine sample, economic considerations are the best discriminator for different attitudinal positions. Both risk factors, "Impacts on society" (with a simple $r = 0.40$) and "Long-term hazards"(with a simple $r = 0.45$), are definitely important for the formation of attitudes, but they are by far not as decisive as the benefit factor. The multiple regression analysis has demonstrated that - after the benefit factor has been accounted for - the two risk factors do not improve the prediction of one's attitude. The "Potential for threat" factor barely contributes as attitude determinant with a simple correlation of $r = 0.27$; $p < 0.05$). In the multiple regression analysis this factor has no predictive power at all.

3.4.4. Comparative Remarks.

As expected, the factor structures derived fom the three samples were not identical. While analysis of the beliefs from the German and Japanese students yielded 3 risk-oriented and 1 benefit factor, Philippine students differentiated between two benefit dimensions, but perceived only one risk dimension. In spite of this general difference in the factor structure, the benefit factor played a major role in all the samples regarding their relative influence on the explanation of the variance of the attitudinal direction. For the Japanese and the Philippine students the economic factor turned out to be the best prediction for their attitudinal position, for the German sample it was the second best. The negative impacts of large scale technology discriminated best between favourable or unfavourable attitudinal positions towards nuclear energy of the German students. In contrast the Philippine students did not share this concern.

Another factor, labelled "Potential for threat", was also represented in two samples, but made a relatively low contribution to attitude for both German and Japanese students.

3.5. Cross-National Attitude Determinants

To investigate the differences in the responses between the three student samples in more detail, two additional statistical procedures were applied. First the weighted belief items (e b) were used separately as independent variables for a stepwise multiple regression again with the sum over the adjectives of the Semantic Differential as dependent criterion. In order to have a larger range of variance of the independent predictors and to include evaluated beliefs, the scores of the e b scale were used instead of the simple belief-scores only.

Second, a discriminant analysis was performed to yield an order of belief items which discriminate most highly between the three samples. Also it seems interesting to investigate how precisely one can predict the membership of each individual case to one of the three samples only knowing the scores of some salient beliefs.

3.5.1 Multiple Regression

The five predictors which were found to be most relevant for the explanation of the attitude scores towards nuclear energy as derived from the Semantic Differential are presented in Table 6. As expected each sample has its own specific pattern of issues relevant for their attitude formation. In line with the findings of the previous chapter, a benefit-related argument occupied first place with the Philippine and the Japanese sample, whereas the German students chose a risk argument as most decisive for their attitude towards nuclear energy. For them, health considerations and a potential impact on the environment are prime issues, together with the realisation of the importance to produce energy in an

economic way. Japanese students put most weight on the accomplishment of technical progress, but are considerably influenced by the threat of large accidents, the hazards for future generations and the dependency on experts. Improvement of the standard of living is the key issue for the Philippine students, followed by the related reflections about economic energy production and the enhancement of research. However, concern about the environment is also an important part of their attitudinal committment.

In general it can be noted that, considering the five most important predictors for all three samples, benefit-related issues have the largest influence on the formation of attitudes with the sample from the Philippines, occupying the three top positions, while German and Japanese students consider both benefits and risks as decisive for their attitudes.

3.5.2 Discriminant Analysis of the eb-scores

The most important question in cross-national surveys is the distinction between typical belief and evaluation patterns which form the basic skeleton of each cultural identity. Identification of attitudes towards energy is certainly too confined a concept to permit in depth interpretation of cultural and social properties which influence the response patterns to new technologies. But at least the concerns which are predominant in one country compared to the others can be revealed.

In order to detect the main differences between the three samples, discriminant analysis was applied. Depending on the parameter that is used for the statistical calculation, all variables can be ordered according to the degree to which their variance discriminates between the samples. Table 7 shows the results obtained with the eb-scores of each item. In the first line the most discriminative item is listed followed by the second most discriminative and so on. In total, 15 items out of 30 proved to be significantly different. This rather large number of significant differences is a good indication for the importance of national particularities.

Inspection of Table 7 demonstrates that there are distinct differences with regard to the expected benefits of nuclear energy. Whereas German students emphasise the advantages of cheap energy supply and of conserving natural resources, the Philippine students apparently disregard these two benefits, but are convinced that nuclear energy can increase the industrial development of their country and the national prestige. Those two benefits are of no importance for the German students, though. The Japanese respondents lie in between. Similar to the Germans they regard nuclear energy as an inexpensive way of generating electricity, in agreement with the Philippines they believe in the stimulating role of nuclear energy for the development of the national industry.

Regarding the question of conserving natural resources and increasing national prestige the Japanese respondents relate both issues to the utilisation of nuclear energy, but not as strong as the Germans or the Philippines. In contrast to the German and Philippine sample the Japanese regard nuclear power as a long-term solution to their energy problems. All

three samples react more homogeneously on the risk side. But there are still some distinct patterns which are worthwhile mentioning. The Japanese respondents perceive hardly any risk in connection with radioactive wastes; the Germans show medium concern, whereas the Philippines have a rather negative view on the waste problem. This negative evaluation is also predominant in the question of environmental pollution and - rather unexpected - in the restriction of personal freedom. German and Japanese students are less concerned about environmental pollution as a consequence of nuclear power and do not believe that personal freedom might be endangered by the implementation of nuclear power. According to this response pattern German and Japanese students just as little fear the potential threat to society's freedom. This threat, however, has a large impact on the Philippine sample. Only the international threats seem to be more decisive for the German and Japanese negative view of nuclear power. Proliferation is seen as highly probable risk factor by these two samples, whereas the Philippines are not or at least not as much concerned with this possible menace to world peace.

Two more differences should be mentioned. First the Japanese students do not perceive nuclear energy as a competitor for alternative energy sources but as a compliment. But both Germans and Philippines believe that the use of nuclear power will restrain the development of alternative energy sources. Second, while the Germans feel that nuclear energy has the potential to increase scientific research, the Philippines reject this possibility, and Japanese respondents are somewhat undecided on that matter.

Most of the results fit into a consistent mosaic characteristic for each country. German and Japanese students reflect their industrial heritage by ascribing the role of a promoter to nuclear energy which helps to provide inexpensive electricity, encourage economic progress and to increase national independency. The Philippine sample perceives nuclear energy as an imported technology with rather doubtful economic advantages and high risks. But they do link nuclear energy with some positive symbolic attributes: increase of prestige as well as encouragement for modernisation and industrial development. The motivation to go nuclear is more functional on the German side, more symbolic on the Philippine side. The Japanese respondents react more like the German students, however, in some aspects concerning national prestige and economic development they agree with the Philippine statements. Functional attitudes are typical for highly industrialised western cultures; the Japanese are still partly influenced by traditional value systems, but at the same time highly motivated by modern functional evaluations. If the risk aspects had not such a strong impact on the Japanese attitudes, their overall judgement combining functional and symbolic aspects, tends to a rather well-balanced and stable attitude towards nuclear energy.

A further interpretation of the results could lead to substantial errors, since proponents and opponents of nuclear energy are not equally distributed in each sample. Thus some of the differences revealed in the discriminant analysis are due to differences in the attitude distribution

rather than to national differences. If one keeps the attitude distribution constant, some of the results would have to be modified. In particular, the social risks of restricting personal freedom and of adding more restraints to a flexible development of society are only related to negative attitudes towards nuclear energy. Therefore the emphasis of the Philippine sample towards societal risk is not originated by national differences, but caused by the higher frequency of opponents within the Philippine sample. If the distributional effect is eliminated by statistical procedures, there is no significant difference between the three samples with regard to societal and social risks. All other discrepancies between German, Philippine and Japanese students found in the discriminant analysis were still existent even when the distribution of attitudes and other factors were kept constant.

The importance of national properties in the attitude formation can further be demonstrated by the predictive power of the two discriminant functions. Using two discriminant functions which represent the differences between the three samples, 71% of all cases could be correctly classified. If the responses of one sample member with regard to his belief items are known, the membership to one of the three samples in 7 out of 10 cases can be predicted correctly. It is interesting to note that the discriminative power of the attitude distribution (over all three samples) is much lower. By knowing the responses to the belief items one can predict the attitudinal position (pro-con scale) only in 5 out of 10 cases. The conclusion is justified that the belief system does not only discriminate between proponents and opponents of nuclear energy, but even stronger between different national samples.

3.6 Importance of Issues

The objective of this part of the study was to investigate the importance attributed to the current issues in the nuclear debate. The information derived is intended to give an indication about the informational background of the three samples rather than attitudinal aspects. Table 8 gives the mean values of the importance ratings of each attribute for the three samples and the ranks assigned on the basis of the mean values.

Generally, it can be noted that the German students tend to have lower importance ratings than the remaining two samples, who appear to consider a substantial part of the issues presented as relevant in the debate about the use of nuclear energy. Inspection of the ranks as expressions of priorities, however, shows that there is an overall agreement between the three nations. This is also reflected in the rank correlation coefficients, which demonstrate a highly significant concordance of priorities (Philippines - Japan: $R = 0.79$, Philippines - FRG: $R = 0.77$, Japan - FRG: $R = 0.72$).

Taking the first four top ranking issues for each sample, it can be seen that Philippine and Japanese respondents want risks and benefits of nuclear energy to be discussed whereas German respondents mainly are interested in the benefits. With regard to the priorities expressed by

Philippine students, they have focussed their attention on potential health impacts and large accidents on the risk side, and on stimulation of scientific and technological research and progress on the benefit side. Japanese are also attentive to the potential of large accidents and to research in science and technology but furthermore deem more elaborate discussions on waste management and on economic ways to produce energy necessary. In the FRG, students appear to be concentrating their attention on the beneficial aspects of generating energy with nuclear power, with conservation of natural resources, long-term solution to energy needs, increased employment and stimulation of research being amongst their top priorities. This might be interpreted as an indication for their interest to hear more about the benefits operational nuclear power plants will ensure rather than being overwhelmed with information about low probability risks being reduced.

Regarding the lowest priorities assigned by the three samples they all agree that a concern about consumption-oriented society is negligible and that their nation's prestige is not at stake in the debate about nuclear power. Furthermore the often heard argument that advancement of nuclear energy might lead to a shortage of funds and interest for development of alternative energy sources does not appear to be a relevant issue.

4 SUMMARY

The objective of this report was a comparison between three student samples of roughly equal size from the FRG, Japan and the Philippines on their attitudes toward the use of nuclear energy. A first analysis of the attitudinal positions revealed that these three samples differed in their composition of pro- and anti-nuclear points of view. The Japanese students were predominantly in favour of the use of nuclear energy; the German students were divided in their attitudinal structure but with the majority being on the pro-nuclear side; whereas the Philippine student sample showed the most anti-nuclear resentment. Consequently, the more favourable Japanese respondents perceived the use of nuclear energy as very important, useful, modern and worthwhile, assigning only few negative attributes to this energy technology (controversial and slightly dangerous). In contrast, the Philippine students viewed nuclear energy as quite wrong, oppressing and useless, conceding, though, that this energy source might have some importance. The German students responded more ambiguously since they perceived nuclear energy as quite modern and useful, but also as dangerous.

A closer examination of the belief structures about nuclear power revealed three to four basic dimensions. The Japanese students expressed some concerns about this technology's indirect impact on society (e.g. concentration of power or proliferation), long-term hazards (e.g. harmful to future generations) and its potential for threat (e.g. accidents affecting large numbers of people) but simultaneously stressed the potential for economic prosperity. The German students were also aware of the negative impacts of large-scale technologies and the potential for threat, but furthermore were concerned about restrictions of social flexibility. Like the Japanese students they also emphasised beneficial

aspects of nuclear energy, namely its contribution to economic progress. The Philippine sample put even more emphasis on negative impacts of large-scale technologies than the other two respondent groups, but acknowledged the potential for progress in national development and indirect fringe benefits which could be associated with the extension of nuclear energy use.

Identification of factor structures only provides a general outline of attitudinal compositions. Therefore, the importance of those factors, i.e. clusters of beliefs, for overall attitudinal commitment was determined. The emerging picture turned out to be rather ambivalent: attitudes of all three groups were equally influenced by beneficial and risk attributes. Direct advantages, e.g. provision of cheap energy, and disadvantages, e.g. health effects and pollution, were found to be the most important considerations for the German students. More indirect advantages, e.g. technological progress and increased employment, and disadvantages, e.g. harmful to future generations and large-scale accidents, determined the attitude structure of the Japanese sample. Almost only beneficial items are crucial for the attitudinal commitment of the Philippine sample. Thus, only the acceptance or denial of associated benefits seems to discriminate between favourable and unfavourable attitudes.

Combination of the entire pool of items from all respondents to detect national trends or preferences yielded the following results: concerning the benefits of nuclear energy the German students emphasised the advantages of cheap energy supply and of conserving natural resources - two aspects which are perceived as less relevant by the Philippines. The latter acknowledged that nuclear energy could increase the industrial development of their country and the national prestige - aspects, which have no relevance for the German students. The Japanese students gave credit to all four aspects. Concerning the risks of nuclear energy, the respondents reacted more homogeneously. All of them, particularly the Philippine students, were disquieted about health effects and waste management problems. In total, concerns about political risks, such as proliferation, are more typical for the two industrialised countries (Germany and Japan) whereas concerns about social risks, such as potential threat to personal freedom were quite predominant in the Philippine sample. Generally, it was found that, according to the responses to the questionnaire, agreement on a national level was considerably stronger than among the proponents and opponents of nuclear energy of the combined sample.

Finally, it could be demonstrated that the issues presented in the questionnaire were judged to be most relevant in the debate about nuclear power for all samples. However, while Philippine and Japanese students are interested in discussing both risks and benefits, the German students have focussed their attention on the beneficial aspects of nuclear energy.

5 CONCLUSIONS

Comparison of attitudes from samples drawn from different nations inevitably is limited by the fact that social and cultural factors,which are an integral part of daily life, are not or not sufficiently taken into account. Thus, the presentation of results has been concentrated on the description of general structures underlying the beliefs and associations with respect to nuclear energy rather than trying to identify social or cultural determinants for a given position or belief. However, technologies tend to be judged in terms of risks and benefits - including indirect and symbolic concerns - hence focussing on cognitive patterns which are evaluated by the degree of emotional saliency. Using risks and benefits as a common denominator for comparison reveals the differences in the cognitive and affective structure of beliefs towards new technologies, but provides only a limited insight into the social or cultural roots which are the latent agents for the belief-forming process. On the basis of these limitations it is possible to describe and analyse the cognitive responses of the three different samples but only to speculate about some of the reasons which influence individuals to internalise some beliefs and neglect others. Overlooking the results, the basic finding has been, that all respondents agreed on the association of nuclear power with direct health risks, but also with political and social threats which were attributed to the overall impacts of large-scale technologies. If these threats were perceived as a major consequence of nuclear power, an unfavourable attitude was likely to be formed. However, the most decisive beliefs respondents held concerned beneficial aspects. Here it could be demonstrated that purely instrumental advantages like cheap energy supply, proved to be insufficient to compensate for the perceived risks. If the respondents were not convinced that in the long run their national society and economy would benefit from the use of nuclear energy, their attitudes were at least ambiguous, if not unfavourable. However, there was a clear distinction between the FRGerman sample and the other two samples. The German technical students based their judgment mainly on instrumental considerations, whereas indirect risks and benefit s were only perceived as an additional back-up for one's own position on the instrumental side. The Japanese students put equal weight onto instrumental and symbolic aspects and the Philippine students tended to emphasise the symbolic aspects of national development and long-term hazards/benefits.

This result seems to be counterintuitive. We would expect that representatives of affluent nations are more concerned with the environment, long-term consequences and social impacts as opposed to representatives of developing nations where basic needs are threatened in daily life and hence instrumental advantages and disadvantages should play a major role. As stated above we can only offer some speculative hypotheses to explain this result. First we only interviewed students of technical sciences and we might assume that technical students in a highly industrialized country like Germany are more strongly bound into the system of division of labour than in less industrialized countries. Since technical expertise in Germany does not necessarily mean a high social status and at the same time specialists for social concerns are available, there is no need for the technical student to consider more than the instrumental aspects. Secondly symbolic beneficial aspects usually refer to issues like national prestige, technological progress or long-term

economic prosperity. The overall feeling among the young generation in Germany tends to be very critical with regard to symbolic aspects of national identity. This might be due to the fact, that national symbols have been widely misused during the recent past and are associated nowadays with distrust and discomfort. It is also possible that younger people in Germany like to reduce the overwhelming complexity of daily life by confining themselves to the immediate consequences of technologies.

Thirdly there is quite a firm evidence in the literature that our intuitive view of industrialized and developing countries is simply false. Ethnologists have made the point that in so-called primitive societies long-term consequences (over several generations) are one of the prime considerations for behavioural judgments, because these societies have no tools or mechanisms to adopt to rapid changes of their environment. So it might be understandable that the Philippine students - partly influenced by their heritage - associated nuclear power with long-term consequences, which they perceive as a challenge for the survival of their society. The larger part of our sample interpreted this challenge as a societal threat, the smaller part as a societal chance. There seems to be more at stake than just a new form of energy generation. In contrast the German students do not perceive nuclear energy as something exceptional. If they are convinced that the instrumental advantages outweigh the disadvantages, they are in favour of this energy source and vice versa. Also the evaluation of the advantages and disadvantages revealed that the desirability of economic progress and long-term development is seen as ambiguous and hence do not contribute substancially to the saliency of the belief system.

The Japanese students have a lot in common with the German students, but the tradition of national pride and collective values is not yet interrupted, so that they can rely on both dimensions simultaneously. Also the standard of living as an indicator for the quality of life is still more widely accepted than in Germany. These general positions of concern about the effect of nuclear energy on a given nation we found to be more predominant and stronger within the national samples than the convergence between respondents opposing or supporting the use of nuclear energy of the combined samples.

A lot of questions remain to be answered. What are the determinants for the formation of a specific belief? Why do people differ in various countries? How is attitude towards nuclear power connected with perceptions of other technologies or technological change in general? One survey can certainly not answer all these questions. We hope that our study will encourage further research into this area and that insights derived from these studies will eventually improve understanding about the relationship between man and technology.

Table 3: Factor Structure of Beliefs (PHILIPPINES)

FACTOR LOADING	BELIEF STATEMENT: THE USE OF NUCLEAR ENERGY...
	FACTOR I: Negative impacts of large scale technology
.87	...exposes people to hazards which they cannot influence by any actions of their own
.78	...involves hazardous agents which cannot be detected by man's senses
.78	...leads to accidents which affect large numbers of people at the same time
.74	...leads to environmental pollution
.71	...has an impact on people's health
.71	...leads to dependency on small groups of specialists
.70	...is harmful to future generations
	FACTOR II: Progress in national development
.84	...leads to technological progress
.81	...promotes my nation's industrial development
.78	...increases my nation's prestige
.64	...prevents brown-outs*
.57	...stimulates scientific and technological research
	FACTOR III: Fringe-benefits
.78	...provides a cheap energy source
.67	...is a long-term solution to energy needs
.60	...leads to a more even distribution of income among nations
.55	...helps to conserve natural resources
.53	...leads to increased employment

*item only included in Philippine survey

Table 4: Factor Structure of Beliefs (FRG)

FACTOR LOADING	BELIEF STATEMENT: THE USE OF NUCLEAR ENERGY...
	FACTOR I: Economic progress
.75	...provides a cheap energy source
.75	...improves our standard of living
.71	...assures the economic independence of my country
.68	...promotes my nation's industrial development
.62	...leads to technological progress
	FACTOR II: Negative impacts of large scale technology
.74	...leads to environmental pollution
.68	...has an impact on people's health
.64	...leads to accidents which affect large numbers of people at the same time
.63	...has a long-term impact on climate
.60	...is harmful to future generations
	FACTOR III: Potential for threat
.71	...provides a source of threats from terrorists
.59	...exposes people to hazards which they cannot influence by any actions of their own
.44	...involves a technology which is usable as a tool in international politics
.42	...postpones the development of alternative energy sources
.41	...requires management of dangerous wastes
.40	...restricts personal freedom through rigorous security measures
	FACTOR IV: Restriction of social flexibility
.67	...leads to consumption-oriented society
.56	...leads to dependency on small groups of specialists
.51	...restricts options for future societal development
.47	...concentrates power in big industrial enterprises

Table 5:. Factor Structure of Beliefs (JAPAN)

FACTOR LOADING	BELIEF STATEMENT: THE USE OF NUCLEAR ENERGY...
	FACTOR I: Impact on society
.64	...concentrates power in big industrial enterprises
.61	...leads to diffusion of knowledge for construction of weapons
.58	...has an impact on people's health
.55	...leads to environmental pollution
.50	...involves a technology which is a tool in international politics
	FACTOR II: Economic prosperity
.71	...promotes my nation's industrial development
.70	...improves our standard of living
.69	...leads to technological progress
.63	...leads to increased employment
.62	...leads to a more even distribution of income among nations
.61	...increases my nation's prestige
	FACTOR III: Long-term hazards
.76	...restricts options for future societal development
.62	...has a long-term impact on climate
.61	...is harmful to future generations
	FACTOR IV: Potential for threat
.72	...requires management of dangerous wastes
.62	...provides a source of threats from terrorists
.57	...exposes people to hazards which they cannot influence by any actions of their own
.57	...leads to accidents which affect large numbers of people at the same time

TABLE 6: Multiple regressions (most important predictors in descending order)

		R(changed)
GERMAN STUDENTS		
13.	Having an impact on people's health	.73**
17.	Providing a cheap energy source	.79**
20.	Leading to environmental pollution	.82**
14.	Postponing the development of alternative energy sources	.84
5.	Leading to technological progress	.85
JAPANESE STUDENTS		
5.	Leading to technological progress	.50**
18.	Leading to accidents which affect a large number of people at the same time	.62**
4.	Being harmful to future generations	.69**
10.	Leading to dependency on small groups of specialists	.73**
25.	Leading to increased employment	.75
PHILIPPINE STUDENTS		
1.	Improving our standard of living	.46**
17.	Providing a cheap energy source	.55**
26.	Stimulating scientific and technological	.60**
20.	Leading to environmental pollution	.64**
21.	Restricting options for future societal	.65

** Changes in correlation significant (p 0.01)

TABLE 7: Discriminant Coefficients and Mean Differences Between the Three Samples

	EB	Lambda	Sig.	Mean German Students	Mean Japanese Students	Mean Philippine Students
1	Conserve natural resources (7)	0.86	0.00	4.42	2.09	-0.37
2	Increase nation's prestige (22)	0.77	0.00	0.09	1.34	2.64
3	Assuring economic independence (12)	0.69	0.00	1.92	1.33	-2.16
4	Technology as tool in international politics(15)	0.65	0.00	-1.28	-1.78	0.29
5	Management of dangerous wastes (6)	0.60	0.00	-0.08	1.73	-2.71
6	Leads to equal income distribution among nations (30)	0.57	0.00	-2.45	-1.14	-0.94
7	Promotes industrial development (3)	0.54	0.00	1.93	3.14	3.58
8	Restricts options for future societal development (21)	0.52	0.00	+2.27	+0.92	+0.31
9	Postpones the development of alternative energy sources (14)	0.49	0.00	-0.22	2.04	-1.15
10	Provides cheap energy (17)	0.48	0.00	2.45	2.59	-1.38
11	Long-term solution to energy needs (19)	0.48	0.00	0.35	2.21	-0.13
12	Restricts personal freedom (2)	0.46	0.00	1.9	1.3	-2.16
13	Leads to environmental pollution (20)	0.45	0.00	-1.95	-2.37	-4.84
14	Leads to proliferation (28)	0.44	0.00	-1.46	-1.35	-0.89
15	Uses up valuable land (9)	0.43	0.00	-1.28	-1.77	0.29

TABLE 8: Importance Ratings and Respective Ranks

		PHILIPPINES		JAPAN		FRG	
		means	rank	means	rank	means	rank
1	Improving our standard of living	4.57	13	4.55	13	3.03	20
2	Restricting personal freedom through rigorous security measures	3.89	25	3.27	28	3.06	19
3	Promoting my nation's industrial development	4.64	8	4.24	16	3.54	14
4	Being harmful to future generations	4.62	12	4.73	10	3.58	13
5	Leading to technological progress	4.74	4	4.79	8	4.19	7
6	Requiring management of dangerous wastes	4.56	14	5.44	1	4.54	6
7	Helping to reserve natural sources	4.69	5	4.66	11	5.14	1
8	Providing a source for threats from terrorists	4.16	22	4.08	19	2.79	26
9	Using up valuable land	4.12	23	3.63	25	2.53	28
10	Leading to dependency on small groups of specialists	4.19	21	3.69	24	2.86	22
11	Exposing people to hazards which they cannot influence by any actions of their own	4.66	7	4.55	13	3.43	16
12	Assuming the economic independence of my country	4.56	14	3.80	23	4.07	8
13	Having an impact on people's health	5.13	1	4.92	6	3.73	11
14	Postponing the development of alternative energy sources	3.76	28	3.20	29	2.85	23
15	Involving a technology which is a tool in international politics	4.25	20	4.12	18	2.83	25
16	Having a long-term impact on climate	4.30	19	4.49	15	3.22	18
17	Providing a cheap energy source	4.41	17	5.01	2	4.60	5
18	Leading to accidents which affect large numbers of people at the same time	4.83	3	5.00	3	3.71	12
19	Being a long-term solution to energy needs	4.63	9	4.81	7	5.07	2
20	Leading to environmental pollution	4.63	9	4.76	9	3.79	9
21	Restricting options for future societal development	4.38	18	3.57	26	3.03	20
22	Increasing my nation's prestige	3.53	29	2.51	27	2.11	30
23	Leading to a consumption-oriented society	3.46	30	3.10	30	2.27	29
24	Concentrating power in big industrial enterprises	3.99	24	3.86	22	2.65	27
25	Leading to increased employment	4.68	6	4.66	11	4.81	3
26	Stimulating scientific and technological research	4.98	2	5.00	3	4.79	4
27	Reducing the need to conserve energy	3.89	25	3.89	21	3.46	15
28	Leading to diffusion of knowledge for construction of weapons	3.77	27	4.18	17	2.84	24
29	Involving hazardous agents which cannot be detected by man's senses	4.63	9	4.98	5	3.74	10
30	Leading to a more even distribution of income among nations	4.45	16	3.99	20	3.74	10

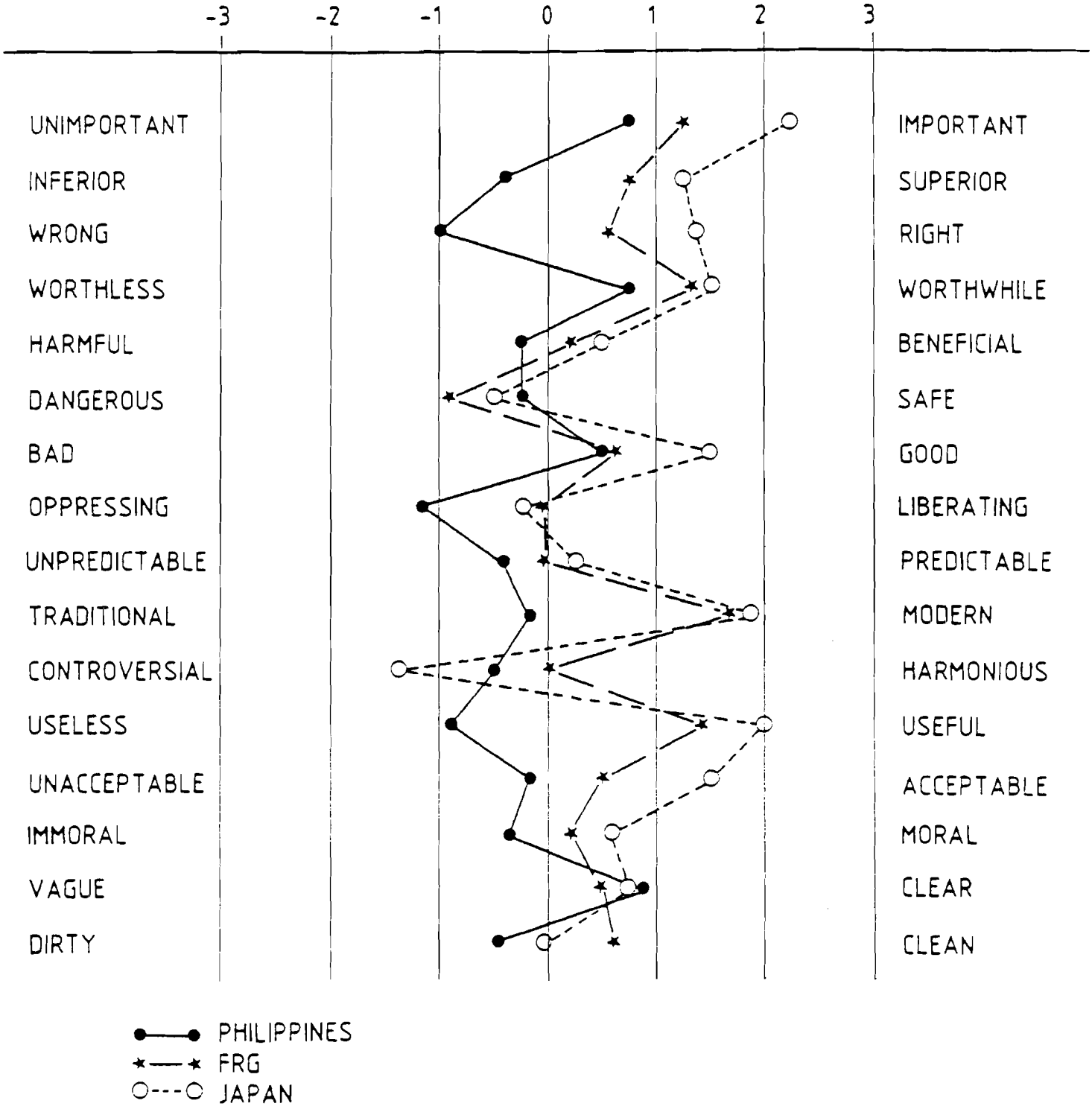

Fig. 2: Means of Semantic Differential Adjectives

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