Commonality Analysis and Causal Modeling of New Community Program

Wha-Joon Rho*

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1. Purpose and Stages of Evaluation Research

The purpose of evaluation research is to measure the effects of a program against the goals it set out to accomplish as a means of contributing to subsequent decision making about the program and improving future programming. Within that definition are four key features[1]: "To Measure the effects" refers to the research methodology that is used. "The effects" emphasizes the outcomes of the program, rather than its efficiency, honesty, morale, or adherence to rules or standards. The comparison of effects with goals stresses the use of explicit criteria

* Assistant Professor, Graduate School of Public Administration, Seoul National University.

(1) Carol H. Weiss, *Evaluation Research: Methods of Assessing Program Effectiveness* (Englwood Cliffs, New Jersey: Prentice-Hall, Inc., 1972), p. 4. Cost-benefit analysis is often viewed as an alternative to evaluation research. But essentially it is a logical extension of it. In order to affix monetary values to the benefits of a program, first there has to be some evaluation evidence of what kinds of and how much benefit there has been. However, this cost-benefit analysis is not major focus of this study.

for judging how well the program is doing. The contribution to subsequent decision making and the improvement of future programing denote the social purpose of evaluation.

Programs are of many kinds. Not only do they range over a gamut of fields; they also vary in scope, size, duration, clarity and specificity of program input, complexity of goals, and innovaiveness. These differences in programs have important consequences for the type of evaluation that is feasible and productive.

Program evaluation shares with most emerging specialties an overabundance of definitions and a paucity of consensus. Furthermore, definitions of program evaluation tend to have a strong flavor of the disciplinary backgrounds of the definers.

Among the narrower definitions of program evaluation are those that limit the focus of evaluation to outcomes, It is suggested that "the focus is limited to outputs and only those outputs which are related to the achievement of program objectives".[2] Futhermore, outcome or impact evaluation is limited to "what those services actually do to and for the people who receive them."[3]

On the other hand, broader definitions incorporate some program elements determining the degree to which a program is meeting its objectives, the problems it is encountering and the side effects it is creating.[4] Thus, program evaluation can be defined as the determination and assessment of results (outcomes/impacts) of program activities. Any number of management strategies and activities become program evaluation when and to the extentthat they contribute to the improved assessment of program outcomes. The factors that contribute to or hinder those outcomes and the efficiency of their accomplishment are also included in program evaluation.

Then, what does evaluation research look like? In traditional formulation, it consists of five basic stages:

(1) Finding out the goals of the program;

(2) Translating the goals into measurable indicators of goal achievement;

(3) Collecting data on the indicators for those who have been exposed to the program;

(4) Collecting similar data on an equivalent group that has not been exposed to the program (control group);

5) Comparing the data on program participants and controls in terms of goal criteria.

2. Evaluation Designs and Methodologies

2.1. Design alternatives

Social programs are usually complex and difficult to describe, and models must be constructed to present programs in simplified form, to facilitate evaluation by limiting and specifying the variables to be considered. There are two conventional models used in evaluation of programs … the goal attainment and the systems model.[5] A goal attainment model contains the indended consequences of the program (official goals) and processes of the program that are considered to be highly influencial in determining the extent to which the program achieves these

(2) James A. Ciarlo,"A Performance-Monitoring Approach to Mental Health Program Evaluation," *Mimeographed* (January, 1972).

(3) Jack L. Franklin and Jean H. Thrasher, *An Introduction to Program Evaluation* (New York: John Wiley & Sons, Inc., 1976), p. 21.

(4) Ibid., pp. 21-22.

(5) Amitai Etzioni. "Two Approaches to Organizational Analysis: "A Critique and a Suggestion," *Administrative Science Quarterly*, Vol. V (September, 1960), pp. 257-278.

goals. A systems model takes into account the fact that programs pursue other activities besides those related to the attainment of official goals and that there is frequently competition among official goals for scarce resources.

Some of these activities center around maintaining the system and may or may not be related to official goal attainment.

System models are divided into two general types closed and open. A closed-system model is based on the assumption that a program exist as an entity and is relatively impervious to outside influences. The variables included in this model are intraprogram variables. In an open-system model, variables that are "imparted" from outside the program are consid ered in addition to intraprogram variables.

In designing the evaluation of a program, the evaluator seeks to determine the effects of an acti vity, a program, or any other variable of intere st and to establish that other factors do not explain these effects. In more technical terms, the evaluator is concerned with a study design with known internal and external validity.

Internal validity refers to the extent to which the design allows the effects of a treatment, a program, or any other variable to be accurately determined. The design with high internal vali dity is thus a tool for precisely answering the question: Did the treatment or program make a difference in this instance? Campbell and Stanley list seven threats to internal validity which, if not controlled by the design, could produce erroneous findings. These are effects of history, maturation, testing, instrumentation, selection and selection and selection-maturation interaction.[6] External validity concerns the extent to which the results of one evaluation can be generalized to other programs in similar settings.

The classic design for evaluation has been the experimental model. This model uses experimental and control groups. Out of target population, units are randomly chosen to be in either the group that gets the program or the "control group" that does not.[7] Measures are taken of the relevant criterion variable before the program starts and after it ends. Differences are computed, and the program is deemed a success if the experimental group has improved more than control group.

However, in the situations which evaluator does not have direct control of independent variables, he can use quasi-experimental designs that do not satisfy the strict requirements of the experiments.[8] The best designs are those that control relevant outside effects and lead to valid inferences about the effects of the program. Unlike experimental design, which protects against just about all possible threats to internal validity, quasi-experimental designs generally leave one or several of them uncontrolled. Time-series design and non-equivalent control group design are the good examples of quasi-experiments.

On occasion, however, it is impossible to use even quasi-experimental designs. The evaluator, in this occasion,has to resort to one of the three common nonexperimental designs: before-and after study of a single program,after-only study of program participants, or after only study of

(6) Donald T. Campbell and Julian C. Stanley, *Experimental and Quasi-Experimental Designs for Research*, (Chicago: Rand and McNally, 1966).

(7) The main technical function of research design is to control variance. Research design is therefore a control mechanism. The statistical principle behind this mechanism is: Maximize systematic variance, control extraneous systematic variance, and minimize error variance. Fred N. Kerlinger, *Foundations of Behavioral Research* (Second Edition, New York: Holt, Rinehart and Winston, Inc., 1973), pp. 306-313.

(8) Campbell and Stanley, *Op. cit.*, pp. 171-246.

participants and non-random "controls".[9] Their inherent weakness is that they fail to control for many of the rival explanations. Even though they leave considerable room for differing interpretations of how much change has occurred and how much of the observed change was due to the operation of the program, there are times when they may be worth considering. First, they can provide a preliminary look at the effectiveness of a program. A second reason for considering nonexperimental designs from current government practices for funding evaluations of major social programs.

Among these basic types of alternative designs, nonexperimental design was chosen for the evaluation research on Saemaul programs because their manifestations have already occurred. Inferences about relations among variables, therefore, would be made, without direct intervention, from concomitant variation of independent and dependent variables.

The basic emphasis of this study is on the explanation of the variability of a dependent variable by using information from one or more independeit variables. In other words, the emphasis is on formulating and testing explanatory schemes. Thus, it is within this context that questions about the relative importance of independent variables become particularly meaningful. Explanatory schemes may be enhanced by inferences about causal relations among the variables under study. Therefore, commonality analysis which is a method of analyzing the variance of a dependent variable into common and unique variances to help identify the relative influences of independent variables, and path analysis which is a method of studying the direct and indirect effects of variables taken as causes on variables taken as effects are fit for our study.

2.2 Commonality Analysis and Causal Modeling in Nonexperimental Research

Commonality analysis was developed by Mood and Mayeske et at. as a method partitioning the variance of the dependent variable into a set of components, some of which are unique, while the others are commonalities.[10]

The unique contribution of an independent variable is defined as the variance attributed to it when it is entered last in the regression equation, Thus, the unique contribution is actually a squared semipartial correlation between the dependent variable and the variable of interest, after partitioning all the other independent variables from it. With two independent variables, the unique contribution of variable 1, for example, is defined as follows:

$$U(1)=R^2_{y\cdot 12}-R^2_{y\cdot 2} \quad \cdots\cdots(1)$$

Where $U(1)$=unique contribution ofvariable 1; $R^2_{y\cdot 12}$=squared multiple correlation of Y with variables 1 and 2; $R^2_{y\cdot 2}$=squared correlation of Y with variable 2. Similarly, the unique contri bution of variable 2 is defined as follows:

$$U(2)=R^2_{y\cdot 12}-R^2_{y\cdot 1} \quad \cdots\cdots(2)$$

Where $U(2)$=unique contribution of variable 2. The definitionof the commonality of variables 1 and 2 is

(9) *Ex Post Facto* research(after only study) is systematic empirical research in which evaluator does not have direct control of independent variables because their manifestations have already occurred or because they are inherently not manipulable. Inferences about relations among variables are made, without direct intervention, from concomitant variation of independent and dependent variables. Kerlinger, *op. cit.*, pp. 378-393.

(10) A.M. Mood, "Macro-analysis of the American Educational System", *Operations Research*, Vol. 17 (1969), pp. 770-784; A.M. Mood, "Partitioning variance in Multiple Regression Analysis as a tool for developing learning models", *Americam Educational Research Journal* Vol.8(1971), pp. 191-202.

$$C(12)=R^2_{y\cdot12}-U(1)-U(2) \quad \cdots\cdots\cdots\cdots\cdots\cdots(3)$$

Where $C(12)$=commonality of variables 1 and 2. Substituting the righthand sides of formulas (1) and (2) for $U(1)$ and $U(2)$ in formula (3), we obtain $C(12)$

$$C(12)=R^2_{y\cdot12}-(R^2_{y\cdot12}-R^2_{y\cdot2})-(R^2_{y\cdot12}-R^2_{y\cdot1})$$
$$=R^2_{y\cdot2}+R^2_{y\cdot1}-R^2_{y\cdot12}$$

As a result of determing unique and common contribution of variables, it is possible to express the correlation between any independent variable and the dependent variable as a composite of the unique contribution of the variable of interest plus its commonalities with other independent variables. Thus, $R^2_{y\cdot1}$and $R^2_{y\cdot2}$ in the above example can be expressed as follows:

$$R^2_{y\cdot1}=U(1)+C(12) \quad \cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots(4)$$

$$R^2_{y\cdot2}=U(2)+C(12) \quad \cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots(5)$$

The commonality of variables 1 and 2 is referred to as a second-order commonality. With more than two independent variables second-order commonalities are determined for all the possible pairs of variables. In addition, third-order commonalities are determined for all possible sets of three variables, fourth-order commonalities for all sets of four variables,and so forth up to one commonality whose order is equal to the total number of independent variables.

Path analysis was developed by Sewall Wright as a method for studying the direct and indirect effects of variables taken as causes on variables taken as effects.

Path analysis is useful in testing theory rather than in generating it. Wright elaborated the purpose of the method in subsequent papers:

> The method of path coefficient is not intended to accomplish the impossible task of deducing causal relations from the values of the correlation coefficient.(11)
>
> Path analysis is an extention of the usual verbal interpretation of statistics, not of the statistics themselves. It is usually easy to give a plausible interpretation of any significant statistic taken by itself. The purpose of path analysis is to determine whether a proposed set of interpretation is consistent throughout.(12)

Thus, one of the virtues of this method is that in order to apply it the researcher is required to make explicit theoretical framework within which he operates.

In working with these models it will be necessary to make use of a whole series of untestable simplifying assumptions. Clearly,a causal relationship between two variables cannot be evaluated empirically unless we can make certain simplifying assumptions about other variables.(13)

Simon prefers to confine the notionof causality to hypothetical "models" that are not subject to many of the limitations and criticisms that would apply to discussions of the real world.(14) He suggests asymmetry between causes and effects as one necessary condition for establishing causation. Simon wrote that:

> The causal relationship is conceived to be an asymmetrical one…an ordering…while "functional relationship". and "interdependence" are generally conceived as entirely symmetrical. When we say that A causes B, we do not say

(11) Sewall Wright, "The method of path coefficients", *Annals of Mathematical Statistics*, Vol. 5 (September 1934), 161-215. Especially see p. 193.

(12) Sewall Wright, "The treatment of reciprocal interaction, with or without lag, in path analysis", *Biometrics*, Vol. 16 (September 1960), p. 423-445. Especially see p. 444.

(13) Hubert M. Blalock, Jr., *Causal Inferences in Non-Experimental Research* (New York: W.W. Norton & Company, Inc., 1964), pp. 3-21.

(14) Herbert A. Simon, *Models of Man* (New York: John Wiley & Sons, Inc., 1957), pp. 10-13.

that B causes A; but when we say that A and B are functionally related(or interdependent), we can equally well say that B and A are functionally related (or interdependent).[15]

Simon further suggests that a patterned causal ordering can and should be described as a recursive set of simultaneous equations dealing sequentially with each of the variables in the causal ordering and describing each in terms of the regression of its causal antecedents upon it. Thus, if one had four variables, X_1, X_2, X_3 and X_4, in which X_1 was considered causally independent of all of the rest, and X_4 was considered causally dependent upon all of the rest, and in which X_2 and X_3 were causally intervening, this could be described as follows:[16]

$$X_1=e_1$$
$$X_2=b_{21}X_1+e_2$$
$$X_3=b_{31\cdot 2}X_1+b_{32\cdot 1}X_2+e_3$$
$$X_4=b_{41\cdot 23}X_1+b_{42\cdot 13}X_2+b_{43\cdot 12}X_3+e_4$$

The non-zero regression coefficients describe the impact of the causal antecedents upon a given variable; the pattern of impacts is inferable from the zero regression coefficients, and asymmetry is accomplished in that manipulation of the value of a given variable leaves unaltered the relationships among its causal antecedents affecting only causally subsequent variables.[17]

Since it is the case that causal impacts should appear as non-zero value regression coefficients, causal models in which any of the variables contribute directly to less than the full set of subseouent variables have implied zero value regression coefficients. Blalock points out that such regression coefficients imply zero value correlation coefficients.[18] It thus becomes possible with the aid of partial correlation coefficients to make an empirically based decision among alternate causal models purporting to describe the causal relationships within the same set of variables.

To construct a linear, recursive model one must be able to specify which variables are causes and which variables are effects, and in chains of causation, one must be able to specify which variables come first, second, and so on in the chain. In recursive systems the specification problem reduces to the problem of ordering the variables in terms of causal priority so that structural equations can be set up with a triangular format.

Since a path analysis requires a theory of causal priorities, and a meaningful path analysis requires the correct theory, the following assumption is necessary: The causal law governing the system are established sufficiently to specify the causal prierites among variables in a way that is undebatable.[19] It is note-worthy here that the requirement is not for a fullscale theory in the sense of specifying every causal path, but rather for a partial theory which simply permits ordering variables in terms of their causal priorities.

Furthermore, in order to make recursive systems identifiable, it typically is assumed that the disturbances coming from outside the system are uncorrelated except for inputs.[20] This implies that all input variables have been included explicity in the model.

Path analysis is an important analytic tool for theory testing. Through its application one can

(15) *Ibid.*, p. 11.
(16) *Ibid.*, pp. 13-25.
(17) Blalock, *op. cit.*, pp. 52-60.
(18) *Ibid.*, pp. 52-60.
(19) David R. Heise, "Problems in Path Analysis and Causal Inference," Edgar F. Borgatta (ed.) *Sociological Methodology* (San Francisco: Jossey-Bass, Inc, Publishers, 1969), pp.50-52.
(20) Simon, *op. cit.*, (1957), pp.26~35; Heise, *op. cit.*, pp.52~57.

determine whether or not a pattern of correlations for a set of observations is consistent with a specific theoretical formulation. The crucial point is that the theoretical formulation is not derived from the analysis. All that the analysis indicates is whether or not the relations in the data are consistent with the theory. Thus, objectives of causal modeling can be narrowed down to the following: (1) A search for the most important cause(s) among variables satisfying necessary conditions of causation, and(2) a reformulation of the causal structure among the variables to (a) exclude spurious relationships, (b) revise erroneous directions or links,and (c) add new links among variables.

3. Research Design and Data Collection**

3.1. Program Goal and Quality of Life Indicators

As described in objectives of this series study, the main goal of "Saemaul Movement" is to create an affiuent community.[21]

The degree of improvements of circumstances of a community can be represented through the community indicators of quality of life which have been developed in first part of this study.[22] This community indicators are designed to measure the conditions of housing, education, income, nutrition, health, job satisfaction, family relations, social relations, security, and leisure. The degree of perceived improvements of life conditions of each community was measured by the differences of average scores of quality of life indicators between two time periods that is, December 1970 and December 1975.

3.2. Hypotheses

It was assumed that quality of life of a community can be improved through the increment and/or enhancement of following factors: mass communication, knowledge of agricultural technology, area of agricultural land, agricultural market structure, way of reasonable thinking, cooperative spirit, diligence, saemaul spirit, women activities, anti-waste spirit,expectations for future life, reliance on community leadership, etc.[23] It is also assumed that there would be some causal relationship among these variables in the processes of giving influence on the community development being represented in increments of quality of life indicators.

3.3. Operationalization of Variables and Construction of the Instruments

Operational definitions of the variabls included in the hypotheses will be presented in terms of specific questions (OQ).

Operational Definitionof Mass Communica-

** Author thanks to the Professor Hae-Dong Kim for the permission of using his data for this analysis.

(21) *Saemaul Movement* (The Central Federation of Saemaul Undong, 1972), p. 20; For the argumnet that the purposes of Saemaul Undong are the economic development through improvement of rural enviromental structure, creation of political support, and increasement of national security, See Dong-Suh Bark, "Objectives of New Community Movement", *Korean Journal of Public Administration*, Vol. XI, No. 2 (1973), pp. 5-15.

(22) Hae-Dong Kim and Kwang-Woong Kim, *An Evaluation and Field Experimentation of Saemaul Movement in the Republic of Korea* (Mimeograph, Research Institute of Public Affairs, Seoul National University, 1976).

(23) see, for example, Woon-Tai Kim, "Rationale and System of New Community Movement", *Korean Journal of Public Administration* Vol, XI, No. 2 (1973), pp. 16-26; Dong-Suh Bark, *op. cit.*, pp. 5-11; "Guidelines of Saemaul Undong", Central Federation of Saemaul Movement, *op. cit.*, p. 38.

tion: The degree to whicha village people reads daily newspaper and/or hears radio.

OQ: Q. How often do you read daily newspaper?

Q. How often do you hear raido?

Operational Definition of Knowledge on Agricultural technology: The extent to which a village people trys to get knowledge on agricultural technology.

OQ: Q. How many books and magazines do you read on agricultural technology?

Operational Definition of Agricaltural Land: The width of arable land which a village people owns.

OQ: Q. How much farm land do you have?

Operational Definition of Agricultural Market Structure: The extent to which a village people satisfys with the ways of selling agricultural products and of drawing in loans.

OQ: Q. How do you feel about the ways of selling agricultural products and of drawing in loans?

Operational Definition of the Ways of Reasonable thinking: The degree to which a village people does not believe superstition.

OQ: Q. Do you think that peoples in this village have strong belief on the superstition?

Operational Definition of the Cooperative Spirit: The degree to which village peoples actively participate in cooperative works and help each other.

OQ: Q. Do you think that peoples in this village consult with other people about one's difficult personal matters?

Q. Do you think peoples in this village have strong cooperative spirit and help each other?

Operational Definition of Diligence: The extent to which a village people does constant and careful effort to achieve his purpose.

OQ: Q Do you think that peoples in this village work hard and have strong will to live better in the future?

Operational Definition of Saemaul Spirit: The extent to which a village people understands "Saemaul Spirit"…the will of self-hlp, self-reliance and cooperation.[24]

OQ: Q. Do you think that people in this village understand "Saemaul Spirit" and put it into practice?

Operational Definition of Women Activities: The degree to which women in avillage participate in community activities.

OQ: Q. Do yout hink that women in this village participate actively in village affairs?

Operational Definition of Anti-waste Spirit: The primacy a village people places on the way which he uses money to the matters of high profit and urgent needs.

OQ: Q. Whenever I have penny-cash,I feel to use up.

Q. If I could get one thousand won unexpectedly, I would go sightseeing.

Operational Defenition of Expectations for Better Life: The degree to which a village people is looking foward to having better life compared with that of urban people in future.

OQ: Q. Do you think that lives in farming villages compared with those in urban communities will be better?

Operational Definition of Reliance on Community Leadership: The degree to which a village people depends upon for support from village leader.[25]

(24) For the more detailed descriptions of "Saemaul Spirit", see Hae-Dong Kim and Kwang-Woong Kim, *op. cit.*; See also Dong-Suh Bark, *op. cit.*, p. 5.

(25) The higher score in this measure means a village people depends upon less for support from village leader.

OQ: Q. Do you think that being better off of a village depends on for support from village leader?

Q. Do you think that decision on major village affairs have been made according to the village leader's opinion?

3.4. Sample Selection and Data Collection

In order to properly test the hypotheses, a multi-stage clustered random sampling procedures was used to collect data.

Of the ten provinces of Korea, four provinces were selected. And then three counties (Kun) were selected randomly from each of the four provinces and five township (Myon) from each of these counties. Finally, six villages were selected from each of these townships. A total of 360 villages among 34,665 villages were sampled in this study.[26] Ten individuals representing in each household out of these individual villages were selected as the respondents of the questionaire and interview. Therefore, scores of variables of each village were got by taking the means of village respondents' scores. The size of the sample used in this study is large enough to allow the principles of "randomness" to work. Kerlinger, for example, contends that "a rough and ready rule is: Use as large a sample as possible".[27] The sample size advocated by Kerlinger is based not on the premise that large numbers are necessarily good in and of themselves, but that a large number allows the principles of randomization to work.

Questionnaires were administered at the sampled villages in December 1975. The data collection phase was terminated on January 1976(with an overall return of 3535 questionnaires).

4. Test of Hypotheses

4.1. Statistical Procedures and Correlation Analysis

All the hypotheses were tested using Pearsons's Product Moment Coefficient of Corrolation (r). In testing each of these hypotheses, a one-tailed test was used and the decision was made to reject or failed to reject hypothes at 0.05 confidence level.

The results of tests are summarized in Table 1.

The data supports the following hypotheses that the increments of indicators of quality of life in rural communities from the year 1971 to the year 1975 are positively related to the degree to which a village people reads daily newspapers and and/or hears radio, to the extent to wich a village people trys to get knowledge on agricultural technology, and to the degree to which a village people does depend less on for support from village leaders.

Other nine variables were not significantly related to the increments of indicators of quality of life in rural communities during those time periods,even though they were hypothesized to have positive correlations. However, the extent to which a village people understands "Saemaul Spirit" and the width of arable land which a village people owns are judged to have reasonably large positive correlations with the increm ents of indicators of quality of life during those time periods. Theorefore,these two variables as well as other three variables significantly related are included in commonality analysis and causal

(26) For the more detailed descriptions for sampling prodedures, see, Hae-Dong Kim and Kwang-Woong Kim, *op. cit.*

(27) Fred N. Kerlinger, *Foundations of Behavioral Research* (2nd, ed.) (New York: Holt, Rinehart and Winston, Inc., 1973), pp.127-28; John T. Roscoe, *Fundamental Research Statistics for Behavioral Science* (New York: Holt, Rinehart, and Winston, Inc., 1969).

Table 1. Correlation Matrix between "QLI" Measures and Selected variables

	1	2	3	4	5	6	7
1. QLI	1.0000	0.1672**	0.1303**	0.0370	0.0179	−0.0182	0.0001
2. Mass Communication		1.0000	0.5558**	0.2498**	0.1161*	0.0927	−0.0399
3. Agricultural Technology			1.0000	0.2439**	0.0773	0.1102*	−0.0013
4. Agricultural Land				1.0000	0.0439	0.0193	−0.0483
5. Market Structure					1.0000	−0.0045	0.0107
6. Resonable Thinking						1.0000	0.6072**
7. Cooperative Spirit							1.0000
8. Diligence							
9. Saemaul Spirit							
10. Women Activities							
11. Anti-waste Spirit							
12. Expectations for Future							
13. Reliance on Leadership							

	8	9	10	11	12	13
1. QLI	−0.0700	0.0622	0.0328	0.0059	−0.0470	0.1750**
2. Mass Communication	−0.0126	−0.0945	0.0326	−0.1263*	0.1867**	0.0012
3. Agricultural Technology	0.0000	−0.0455	0.1301*	−0.1630**	0.2109**	−0.0582
4. Agricultural Land	−0.0876	−0.1118*	−0.0850	−0.1133*	0.0827	−0.0732
5. Market Structure	0.0385	0.0333	0.0663	−0.0611	0.1493**	−0.0361
6. Resonable Thinking	0.6489**	0.5809**	0.3071**	0.1961**	0.1055	−0.1709**
7. Cooperative Spirit	0.7925**	0.7258**	0.4458**	0.3459**	−0.0613	−0.1191*
8. Diligence	1.0000	0.6962**	0.3535**	0.3720**	−0.0364	−0.1325*
9. Saemaul Spirit		1.0000	0.3630**	0.3445**	0.0009	−0.1637**
10. Women Activities			1.0000	0.1715**	0.0697	−0.0887
11. Anti-waste Spirit				1.0000	0.0149	0.0316
12. Expectations for Future					1.0000	−0.2832**
13. Reliance on Leadership						1.0000

modeling designed to explicate more rigorously their influences on changes of indicators.

4.2. Commonality Analysis

The objective of this analysis is to analyze the variance of the dependent variable into common and unique variances to help identify the relative influences of independent variables.

The rule for writing the formulas for the various components is applied to this analysis.[28] In order to avoid cumbersome symbolism, however, this study uses following symbols; X_1=Agricultural Land; X^2=Mass Communication; X_3=Knowledge of Agricultural technology; X_4=Reliance on Leadership; X_5=Saemaul Siprit; Y=Indicators of Quality of Life.

Table 2. Data For a Commonality Analysis[a]

I. Correlation Matrix

	1	2	3	4	5	Y
1. Agricultural Land	1.0000	0.2498	0.2439	−0.0732	−0.1118	0.0370
2. Mass Communication	0.0624	1.0000	0.5558	0.0012	−0.0945	0.1637
3. Knowledge of Agricultural Technology	0.0595	0.3089	1.0000	−0.0582	−0.0455	0.1303
4. Reliance on Leadership	0.0054	0.0000	0.0034	1.0000	−0.1637	0.1750
5. Saemaul Spirit	0.0125	0.0089	0.0021	0.0268	1.0000	0.0622
Y. QLI	0.0014	0.0280	0.0170	0.0306	0.0039	1.0000

a) The entries above the pincipal diagonal of the correlation matrix are zero-order correlations, while those below the diagonal are squared zero-order correlations.

II. Squared Multiple Correlation

$R^2_{y.1}$=0.0013	$R^2_{y.2}$=0.0280	$R^2_{y.3}$=0.0169	$R^2_{y.4}$=0.0307	$R^2_{y.5}$=0.0039
$R^2_{y.12}$=0.0280	$R^2_{y.13}$=0.0169	$R^2_{y.14}$=0.0331	$R^2_{y.15}$=0.0058	
$R^2_{y.23}$=0.0300	$R^2_{y.24}$=0.0586	$R^2_{y.25}$=0.0342	$R^2_{y.34}$=0.0505	
$R^2_{y.35}$=0.0216	$R^2_{y.45}$=0.0392			
$R^2_{y.123}$=0.0301	$R^2_{y.124}$=0.0587	$R^2_{y.125}$=0.0342	$R^2_{y.134}$=0.0507	
$R^2_{y.135}$=0.0218	$R^2_{y.145}$=0.0430	$R^2_{y.234}$=0.0619	$R^2_{y.235}$=0.0361	
$R^2_{y.245}$=0.0704	$R^2_{y.345}$=0.0605			
$R^2_{y.1234}$=0.0619	$R^2_{y.1235}$=0.0631	$R^2_{y.1245}$=0.0708		
$R^2_{y.1345}$=0.0613	$R^2_{y.2345}$=0.0737			
$R^2_{y.12345}$=0.0739				

(28) The rule offered by Mood and Wisler can be explained by an example. Suppose there are three independent variables, X_1, X_2 and X_3 and a dependent variable, Y. The unique contribution of X_2 can be got by using following product:

$$-(1-X_2)X_1X_3=-X_1X_3+X_1X_2X_3$$

$$U(2)=-R^2_{y.13}+R^2_{y.123}$$

Similarly, the commonality of two variables, namely X_2 and X_3, can be got by using follow-wing product:

$$-(1-X_2)(1-X_3)X_1=-X_1+X_1X_2+X_1X_3-X_1X_2X_3$$

$$C(23)=-R^2_{y.1}+R^2_{y.12}+R^2_{y.13}-R^2_{y.123}$$

See A.M. Mood, "Macro Analysis of the American Educational System" *Operations Research*, Vol. 17 (1969), pp. 770-784; C.E. Wisler, "Partitioning the Explained Variation in Regression Analysis", In G.W. Mayeske et al. *A Study of our Nation's School*, (Washington D.C.: Dept. of Health, Education, and Welfare, Office of Education, 1969).

The number of components,in general,is equal to 2^k-1, where k is the number of independent variables. Thus, with five variables, there are $2^5-1=31$ components, five of which are unique, ten are second-order, ten are third-order, five are fourth-order, and one is a fifth-order commonality

Data for a commonality analysis are summarized in Table 2.

The unique contributions of X_1, X_2, X_3, X_4 andX_5 can be obtained by using the rules and these data.

$$U(1)=-R^2_{y.2345}+R^2_{y.12345}=-0.0737+0.0739=0.0002$$

$$U(2)=-R^2_{y.1345}+R^2_{y.12345}=-0.0613+0.0739=0.0126$$

$$U(3)=-R^2_{y.1245}+R^2_{y.12345}=-0.0708+0.0739=0.0031$$

$$U(4)=-R^2_{y.1235}+R^2_{y.12345}=-0.0361+0.0739=0.0378$$

$$U(5)=-R^2_{y.1234}+R^2_{y.12345}=-0.0619+0.0739=0.0120$$

The ten second-order commonalities of variables X_1, X_2, X_3, X_4 and X_5 are as follows:

$$C(12)=-R^2_{y.345}+R^2_{y.2345}+R^2_{y.1345}-R^2_{y.12345}=0.0006$$

$$C(13)=-R^2_{y.245}+R^2_{y.2345}+R^2_{y.1245}-R^2_{y.12345}=0.0002$$

$$C(14)=-R^2_{y.235}+R^2_{y.2345}+R^2_{y.1235}-R^2_{y.12345}=-0.0002$$

$$C(15)=-R^2_{y.234}+R^2_{y.2345}+R^2_{y.1234}-R^2_{y.12345}=-0.0002$$

$$C(23)=-R^2_{y.145}+R^2_{y.1345}+R^2_{y.1245}-R^2_{y.12345}=0.0152$$

$$C(24)=-R^2_{y.135}+R^2_{y.1345}+R^2_{y.1235}-R^2_{y.12345}=0.0017$$

$$C(25)=-R^2_{y.134}+R^2_{y.1345}+R^2_{y.1234}-R^2_{y.12345}=-0.0014$$

$$C(34)=-R^2_{y.125}+R^2_{y.1245}+R^2_{y.1235}-R^2_{y.12345}=-0.0012$$

$$C(35)=-R^2_{y.124}+R^2_{y.1245}+R^2_{y.1234}-R^2_{y.12345}=-0.0001$$

$$C(45)=-R^2_{y.123}+R^2_{y.1235}+R^2_{y.1234}-R^2_{y.12345}=-0.060$$

The ten third-order and five fourth-order commonalities of variable X_1 X_2 X_3 X_4 and X_5 are as follows:

$$C(123)=-R^2_{y.45}+R^2_{y.345}+R^2_{y.245}+R^2_{y.145}-R^2_{y.2345}-R^2_{y.1345}-R^2_{y.1245}+R^2_{y.12345}=0.0028$$

$$C(124)=-R^2_{y.35}+R^2_{y.345}+R^2_{y.235}+R^2_{y.135}-R^2_{y.2345}-R^2_{y.1345}-R^2_{y.1235}+R^2_{y.12345}=-0.0004$$

$$C(125)=-R^2_{y.34}+R^2_{y.845}+R^2_{y.234}+R^2_{y.134}-R^2_{y.2345}-R^2_{y.1345}-R^2_{y.1234}+R^2_{y.12345}=0.0004$$

$$C(134)=-R^2_{y.25}+R^2_{y.245}+R^2_{y.235}+R^2_{y.125}-R^2_{y.2345}-R^2_{y.1245}-R^2_{y.1235}+R^2_{y.12345}=-0.0002$$

$$C(135)=-R^2_{y.24}+R^2_{y.245}+R^2_{y.234}+R^2_{y.124}-R^2_{y.2345}-R^2_{y.1245}-R^2_{y.1234}-R^2_{y.12345}=-0.0001$$

$$C(145)=-R^2_{y.23}+R^2_{y.235}+R^2_{y.234}+R^2_{y.123}-R^2_{y.2345}-R^2_{y.1235}-R^2_{y.1234}-R^2_{y.12345}=0.0003$$

$$C(234)=-R^2_{y.15}+R^2_{y.145}+R^2_{y.135}+R^2_{y.125}-R^2_{y.1345}-R^2_{y.1245}-R^2_{y.1235}+R^2_{y.12345}=-0.0011$$

$$C(235)=-R^2_{y.14}+R^2_{y.145}+R^2_{y.134}+R^2_{y.124}-R^2_{y.1345}-R^2_{y.1245}-R^2_{y.1234}+R^2_{y.12345}=-0.0008$$

$$C(245)=-R^2_{y.13}+R^2_{y.135}+R^2_{y.134}+R^2_{y.123}-R^2_{y.1345}-R^2_{y.1235}-R^2_{y.1234}+R^2_{y.12345}=0.0003$$

$$C(345)=-R^2_{y.12}+R^2_{y.125}+R^2_{y.124}+R^2_{y.123}-R^2_{y.1245}-R^2_{y.1235}-R^2_{y.1234}+R^2_{y.12345}=0.0001$$

$$C(1234)=-R^2_{y.5}+R^2_{y.45}+R^2_{y.35}+R^2_{y.25}+R^2_{y.15}-R^2_{y.345}-R^2_{y.245}-R^2_{y.235}-R^2_{y.145}$$
$$-R^2_{y.135}-R^2_{y.125}+R^2_{y.2345}+R^2_{y.1345}+R^2_{y.1245}+R^2_{y.1235}-R^2_{y.12345}=-0.0011$$

$$C(1235)=-R^2_{y.4}+R^2_{y.45}+R^2_{y.34}+R^2_{y.24}+R^2_{y.14}-R^2_{y.345}-R^2_{y.245}-R^2_{y.145}-R^2_{y.234}$$
$$-R^2_{y.134}-R^2_{y.124}+R^2_{y.2345}+R^2_{y.1345}+R^2_{y.1234}+R^2_{y.1245}-R^2_{y.12345}=-0.0007$$

$$C(1245)=-R^2_{y.3}+R^2_{y.35}+R^2_{y.34}+R^2_{y.23}+R^2_{y.13}-R^2_{y.345}-R^2_{y.235}-R^2_{y.135}-R^2_{y.234}$$
$$-R^2_{y.134}-R^2_{y.123}+R^2_{y.2345}+R^2_{y.1345}+R^2_{y.1234}+R^2_{y.1235}-R^2_{y.12345}=0.0001$$

$$C(1345)=-R^2_{y.2}+R^2_{y.25}+R^2_{y.24}+R^2_{y.23}+R^2_{y.12}-R^2_{y.245}-R^2_{y.235}-R^2_{y.125}-R^2_{y.234}$$
$$-R^2_{y.124}-R^2_{y.123}+R^2_{y.2345}+R^2_{y.1245}+R^2_{y.1234}+R^2_{y.1235}-R^2_{y.12345}=0$$

$$C(2345)=-R^2_{y.1}+R^2_{y.15}+R^2_{y.14}+R^2_{y.13}+R^2_{y.12}-R^2_{y.145}-R^2_{y.135}-R^2_{y.125}-R^2_{y.134}$$
$$-R^2_{y.124}-R^2_{y.123}+R^2_{y.1345}+R^2_{y.1245}+R^2_{y.1234}+R^2_{y.1235}-R^2_{y.12345}=0.0002$$

Finally, the fith-order commonality of variables X_1, X_2, X_3, X_4 and X_5 can be obtained as follows:

$$C(12345)=R^2_{y.1}+R^2_{y.2}+R^2_{y.3}+R^2_{y.4}+R^2_{y.5}-R^2_{y.45}-R^2_{y.35}-R^2_{y.25}-R^2_{y.15}-R^2_{y.34}-R^2_{y.24}-R^2_{y.14}$$
$$-R^2_{y.23}-R^2_{y.13}-R^2_{y.12}+R^2_{y.345}+R^2_{y.245}+R^2_{y.145}+R^2_{y.235}+R^2_{y.135}+R^2_{y.125}+R^2_{y.234}+R^2_{y.234}$$
$$+R^2_{y.134}+R^2_{y.123}+R^2_{y.124}-R^2_{y.2345}-R^2_{y.1345}-R^2_{y.1245}-R^2_{y.1235}-R^2_{y.1234}-R^2_{y.12345}=0.0004$$

The analysis is summarized in Table 3. Several observations may be made about this table. Each term in the last line, the line labled, is equated zero-order correlation of the variable with which it is associated and the dependent variable. Other observations will be analyzed in the part of discussions.

Table 3. Summary of Commonality Analysis of Data of Table 2.

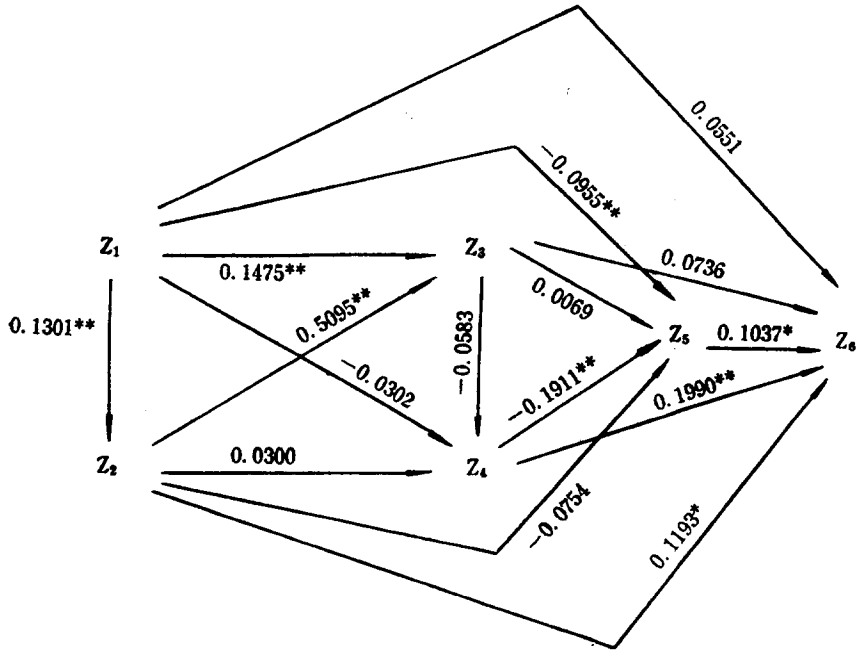
	Variables				
	X_1	X_2	X_3	X_4	X_5
Unique to X_1	0.0002				
Unique to X_2		0.0126	0.00		
Unique to X_3			0.0031		
Unique to X_4				0.0378	
Unique to X_5					0.0120
Common to X_1 and X_2	0.0006	0.0006			
Common to X_1 and X_3	0.0002		0.0002		
Common to X_1 and X_4	−0.0002			−0.0002	
Common to X_1 and X_5	−0.0002				−0.0002
Common to X_2 and X_3		0.0152	0.0152		
Common to X_2 and X_4		0.0017		0.0017	
Common to X_2 and X_5		−0.0014			−0.0014
Common to X_3 and X_4			−0.0012	−0.0012	
Common to X_3 and X_5			0.0001		0.0001
Common to X_4 and X_5				−0.0060	−0.0060
Common to X_1, X_2 and X_3	0.0028	0.0028	0.0028		
Common to X_1, X_2 and X_4	−0.0004	−0.0004		−0.0004	
Common to X_1, X_2 and X_5	0.0004	0.0004			0.0004
Common to X_1, X_3 and X_4	−0.0002		−0.0002	−0.0002	
Common to X_1, X_3 and X_5	−0.0001		−0.0001		−0.0001
Common to X_1, X_4 and X_5	0.0003			0.0003	0.0003
Common to X_2, X_3 and X_4		−0.0011	−0.0001	−0.0011	
Common to X_2, X_3 and X_5		−0.0008	−0.0008		−0.0008
Common to X_2, X_4 and X_5		0.0003		0.0003	0.0003
Common to X_3, X_4 and X_5			0.0001	0.0001	0.0001
Common to X_1, X_2, X_3 and X_4	−0.0011	−0.0011	−0.0011	−0.0011	
Common to X_1, X_2, X_3 and X_5	−0.0007	−0.0007	−0.0007		−0.0007
Common to X_1, X_2, X_4 and X_5	0.0001	0.0001		0.0001	0.0001
Common to X_1, X_3, X_4 and X_5	0.0000		0.0000	0.0000	0.0000
Common to X_2, X_3, X_4 and X_5		0.0002	0.0002	0.0002	0.0002
Common to X_1, X_2, X_3, X_4 and X_5	0.0004	0.0004	0.0004	0.0004	0.0004
Σ :	0.0020	0.0288	0.0169	0.0307	0.0047

4.3. Test of the Hypothetical Causal Model

The purposes of this analysis are threefold. The first objective is to test each path as to whether or not the relevant path coefficient(partial coefficient) is statistically significant at 0.05 level.[29] If not, we will set the path coefficient equal to zero. The implication is that we regard the correlation between the two variables whose connecting path is deleted as being due to indirect effects only. By deleting certain paths, a more parsimonious causal model is offered. If after the deletion of some paths, it is possible to reproduce the orginal R. Matrix, or closely approximate it, the conclusion will be that the pattern of correlations in the data is consistent with the more parsimonious model.

The second objective, therefore, is to construct a more parsimonious causal model. This does not mean that the theoretical formulation is derived from the analysis of data. All that the analysis indicates is whether or not the relations in the data are consistent with the theory. If after the

Fig.1. Hypothetical Causal Relationships



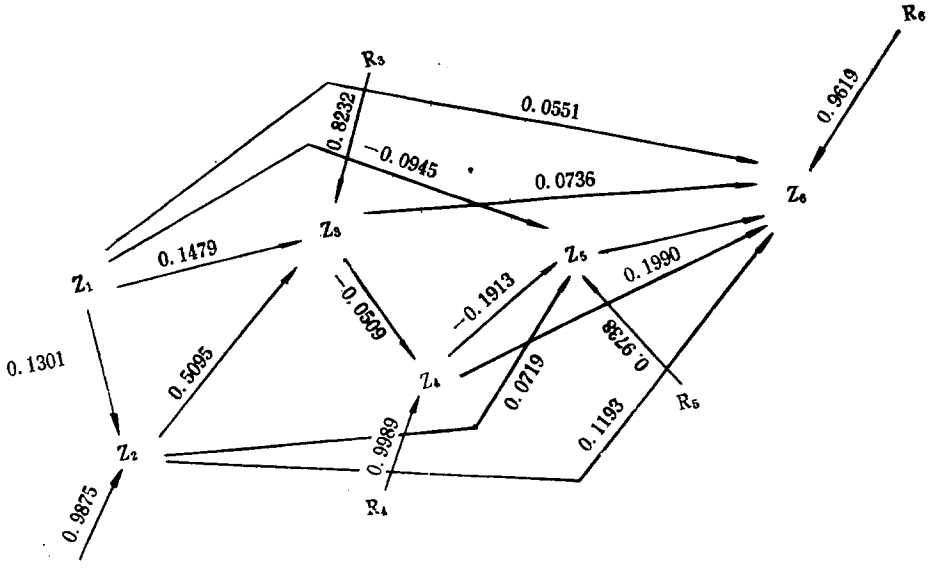
*P<0.05 **P<0.01

Notation: ⟶ Causal Relationships

Z_1=Agricultural Land
Z_2=Mass Communication
Z_3=Knowledge of Agricultural Technology
Z_4=Reliance on Leadership
Z_5=Saemaul Spirit
Z_6=Indicators of Quality of Life

(29) For the theory trimming, see David R. Heise, "Problems in Path Analysis and Causal Inference", *Sociological Methodology*,1969, Edgar F. Borgatta (ed.) (San Francisco: Jossey Bass, 1969), pp. 38-73. Heise suggests two kinds of criteria for theory trimming that is, statistical significance and meaningfulness. In the absence of any guidelines for the criterion of meaningfulness, Land suggests that path coefficients less than 0.05 may be treated as not meaningful. K.D. Land, "Principles of path Analysis", *Sociological Methodology*, 1969, *op. cit.*, pp. 3-37.

Fig.2. A Path Diagram Showing Dependence of "QLI" on the five Selected Variables



Notation: see Figure 1 R_2, R_3, R_4, R_5 and R_6: Disturbance terms

deletion of some paths there are large discrepancies between the original R matrix and the reproduced one, the conclusion will be that in the light of relations among the variables the more parsimonious theory is not tenable.(30)

The third and final objective is to decompose a correlation into direct and indirect effects. It will be then possible to study the magnitude of each of these components and discern the roles they play in the system.

Figure 1 presents the path diagram together with path coefficients and their significant levels. The numbers are path coefficients.

Note that seven path coefficients (P_{63}, P_{61}, P_{53}, P_{52}, P_{43}, P_{42}, and P_{41}) are not significant at the 0.05 level, indicating that zero-order correlations between these relative variable were mainly due to indirect effects. The observations regarding these seven path coefficients lead to the conclusion that the present model can be trimmed.(31) The more parsimonious model is presented in Figure 2.

In the new model, the path coefficients are calculated and used in an attempt to reproduce the original correlation matrix. The equations that reflect the model in Figure 2 are as follows:

$$Z_1 = e_1$$
$$Z_2 = P_{21}Z_1 + e_2$$
$$Z_3 = P_{32}Z_2 + P_{31}Z_1 + e_3$$
$$Z_4 = P_{43}Z_3 + e_4$$
$$Z_5 = P_{54}Z_4 + P_{52}Z_2 + P_{51}Z_1 + e_5$$
$$Z_6 = P_{65}Z_5 + P_{64}Z_4 + P_{63}Z_3 + P_{62}Z_2 + P_{61}Z_1 + e_6$$

It is now possible to calculate the zero-order correlations between all the variables to reproduce the original correlation matrix. Table 4 presents the original and reproduced correlations for a six variable model.

In the correlation matrix, the original correla-

(30) For the more detailed discussions, see Wha-Joon Rho, "The Developmental Process of Organizational Identification: A Causal Model", *Korean Journal of Public Administration*, Vol. XIII., No. 1. (1975), pp. 122-139.

(31) Path coefficients less than 0.05 were treated as not meaningful and deleted in the more par simonious model.

Similarly, "Knowledge of Agricultural Technology" has practically 'no unique contribution to the "QLI" changes. Most of its contribution to the "QLI" changes comes from the commonalities with "Mass Commication".

In contrast, "Saemaul Spirit", "Reliance on Leadership", and "Mass Communition" have relatively large unique contributions. Even though variables with small commonalities and large unique components are perferred, it should be noted that the uniqueness of variables depends on the relations among the specific set of variables under study because the unique contribution of a variable was defined as the increment in the proportion of variance accounted for when it is entered last in regression equation.

The policy implication of findings through commonality analysis is that "Saemaul Spirit," Reliance on Leadership and "Mass Communication" are the strategic variables for Rural Chan ge.[33]

Even though causal model in this study, is significant at 0.01 level (overall F=5.3978), the explanation power of increments of indicators of quality of life in sampled villages was relatively low (R=0.2734, R^2=0.0739). This fact also points out that at this stage of "Saemaul Movement", there might be some other important factors which were not included in this causal model. These might be the political support, administrative guidance, etc.

Assesing the direct and indirect effects on the degree of increment of quality of life in rural community, we note that village leadership have the largest direct effect in the rural community change.[34] The second largest direct effect comes from mass communication. The third largest direct effect comes from the "Saemaul Spirt." This means that these three variables are strategic variabes in rural community change. Further more this result of causal analysis is exactly congruent with the result of commonality analysis. The results of both analyses can be interpreted as indicating in future policy directions of Saemaul programs.

(33) Simple correlation analysis shows that correlation between "Saemaul Spirit" and "QLI" was weak. However, unique contribution of Saemaul Spirit in increment of "QLI" was relatively high compared with other variables.

(34) However, the knowledge of agricultural technology has the largest indirect effect. Total indirect effects of five variables on the changes of quality of life are as follows:

TIE_{61}=0.0370−0.0551=−0.0181
TIE_{62}=0.1672−0.1193= 0.0479
TIE_{63}=0.1303−0.0736= 0.0567
TIE_{64}=0.1750−0.1990=−0.0140
TIE_{65}=0.0622−0.1037=−0.0415