SYSTEM TECHNOLOGICAL ASSESSMENT

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Abstract

A task occurring rather often is to have to choose among several possible technical alternatives, according to more of different target functions and criteria. The system of preferences seems the most suitable basis for selecting the more anvantageous alternatives, where the plan modifications fulfilling requirements, are judged. In the course of assessment procedures individual preferences have a differing importance, this can be expressed by weighting the preferences. In the frame of a numerical example we wish to introduce the use of the described comparison methods, also with the aid of a microcomputer.

A task occurring rather often is to have to choose among several possible technical alternatives, according to a single target function and/or criterion. In case of the system technological assessments to be realized, over and above the exact, e. g. monetary effects also other, important quantitative and qualitative ones have to be considered. These procedures therefore endeavour to express the joint effect of different assessment factors in the given multidimensional assessment field with a single value.

In literature such procedures — though with no great consistency — are known as value assessment, value planning and investigation of complex systems.

A basis for assessing alternatives can be but a suitable developed target system.* It contains on the one hand the requirements the fulfillment of which are a basic criterion of the acceptability of the plan-variation. The non-fulfillment of any of these requirements precludes as such the alternative of further investigation. On the other hand, the target system contains the preferences, demands, that give the assessment aspects of the variations under investigation. To sum up: the target system consists on the one part in an unambiguous definition of the basic requirements and on the other selection of preferences to be kept in mind. The target system should be — as far as possible — formulated to embrace the complete technical life time of the object to be investigated (and/or the planned utilization period), as a result of social, economic and

* E. g. Jándy: Basis for system technological assessment. Építés- Építészettudomány. 1982/1—2. (In Hungarian).

technical changes certain preferences may solidify into requirements, and/or new preferences and requirements may crop up. As an example let us mention the period of intensive industrialization, when the environmental protection expectations that are already requirements in our days, manifested themselves, in the best of cases, as preferences, only.

Thus the system of preferences seems the most suitable basis for selecting the more advantageous alternatives, where the plan modifications fulfilling requirements, are judged. The preferences that form the basis for assessment are to be selected in a way that the number of assessment factors does not exceed the limit of easy handling. Attention should also be paid that the preferences be independent from each other, as far as possible, that no factor which perhaps may not be expressed but figures in several preferences should be assessed in a cumulative way. The preferred directions of assessment factors should correspond to each other (every target function should aim to achieve the maximum or the minimum) or else the differing target function is to be transformed (e. g. multiplied by one).

According to the above, the choice between alternatives should be made in each case when the alternatives fulfilling the requirements are already known (viz. usable, realizable alternatives), meaning we know the possible solutions, the aspects of assessment, together with their advantages and disadvantages expressed in differentways by the preferences. The satisfaction of individual criteria can be identified by different, suitable dimension numerical gauge scales (so-called proportion and/or interval scales), some basic physical scale or derivated scale. All assessment factors not having a measuring unit (the so-called imponderables) can be measured but on a sequential-, and/or subjective interval-scale.

Before applying any of the assessment procedures it is expedient to exclude from among the potential plan variations the alternatives that from every assessment factor aspect are less good than some other alternative. This means, that we set off from the aggregate of potential solutions that of efficient solutions and henceforward only work with these.

In this respect we rely on the following definition: Solution "A_1" $\in L$ is regarded as more efficient than solution "A_2" $\in L$, if $\mathbf{Q}(A_1) \neq \mathbf{Q}(A_a)$, but $\mathbf{Q}(A_1) = \mathbf{Q}(A_2)$. Viz. "$A_1$" is a more efficient solution than "A_2", if it is not worse by any of the assessment criteria, namely by any selection criteria, but better by at least one. The definition can also be formulated in a way by producing a semi-positive vector, i. e. a nonnegative vector concerning the difference of $\mathbf{Q}(A_1) - \mathbf{Q}(A_2)$ that has at least one positive component. It is obvious that in case of several target functions two solutions cannot always be compared unanimously from the point of their efficiency, namely we cannot state that one of them is more efficient than the other on basis of the above definition.

Solution $\mathrm{A}_0 \in \mathrm{L}$ is regarded as efficient if no $\mathrm{A}_i \in \mathrm{L}$ solution exists where

$\mathbf{Q}(A_i) - \mathbf{Q}(A_0)$ vector is semipositive, where $i = 1 \ldots\ldots\ldots. n$ and the number of possible solutions is "n". In other words: "A_0" is an efficient solution if a not more efficient one can be found in aggregate "L" of the possible solutions. In the special case when only a single target function has to be taken into consideration the concept of efficient solution coincides with that of the optimal solution. If the aggregate of efficient solutions is denoted by "E", the relation $E \in L$ is obviously valid, i.e. the aggregate of efficient solutions is a part aggregate of the aggregate of possible solutions.

In the course of assessment procedures individual preferences have a differing importance. This can be expressed by weighting the preferences. No attention has as yet to be paid when excluding the non-efficient solutions to the differing weight-figure of individual assessment factors.

1. Weighting the assessment factors

In the following we will consider the procedures, methods for determining the relative weight — related to each other — of individual assessment factors. The most simple method is a direct rating on a sequential scale, in the course of which serial numbers are directly ordered to the assessment factors. It is a major disadvantage of this method that the inconsistency of opinions concerning the order cannot be investigated. This deficiency is eliminated by the method known as paired comparison where the assessment factors are also weighted on a sequential scale. In case m number assessment factors are to be ranked

$$\frac{m(m-1)}{2}$$

number possible pairs are formed and in this way the direct ranking task is transformed in to a series of dichotomous decisions. If, in the course of paired comparison the preference number of a certain assessment factor is denoted by k, then the number of order of the investigated factor is

$$r = m - k.$$

A major element of this method is that the *index number of consistency* can be determined.

Weighting on the sequential scale is not sufficient in the majority of assessment procedures. A better possibility is offered by applying the *interval-scale.* Weighting on the interval scale is made easier if the order of assessment factors is already known. Though prescribing a condition concerning the amount of weights is not necessary, it still has a number of benefits, as certain multipliers can give information of their relative importance only in this way and also the effect of subsequent changes in preferences and weights is more easy to survey. For this purpose let the amount of weights be, in general, 100 or 1, viz. it is expedient to select zero as the starting point of the interval scale and 100 or 1 as its end point. The most simple way of weighting on the interval scale is direct assessment when the person undertaking weighting, order a weight number to the assessment factor in a way that their amount be one and/or 100. Thus the person doing the weighting quite simply determines as to with what percentual weight the preference under investigation should figure in a future comparison.

A more complex weighting on the interval scale is the method developed by *Churchman-Ackhoff* and/or *Guilford.*

Churchman-Ackhoff's method is essentially a methodical realization of direct assessment. At the start, the relative weight of all factors is determined one by one and independently from each other as compared to the assessment factor standing on the first place of the order. The weight numbers obtained are related individually and/or groupwise to each other and the starting assessment undergoes a potential modification. When the thus received weight numbers may already be regarded as being consistent, it is expedient to transform them on a scale that their amount equal 1 and/or 100.

Guilford's method is based on the mentioned paired comparison. The method supposes that the weights of importance of individual preferences follow a normal distribution. From the preference amounts (k_j) obtained as assessment factors as a result of paired comparison, preference proportions are determined and these are transformed into "u" values of standardized normal distribution. The "u_j" values indicate the values measured on the interval scale. The obtained weight numbers can be transformed without difficulty to values of the interval scale to be used more simply in a way that their amount be 1 or 100, or, that the starting point of the scale take value zero and its end point that of 100. This method is suitable if there is a possibility for a technical public opinion, poll. Viz. the number of specialists undertaking the comparison is at least five. The use of the method will be shown later also by a numerical example.

In the course of *paired comparison methods* to ascertain preference weights, when forming the pairs and determining their orders, care need be taken to eliminate regular repetitions as well as to place pairs containing identical members as far from each other as possible. Should this requirement not be fulfilled, verifiable distortions will occur in the choices. To eliminate regular repetitions, *randomization* is applied widely, this, however, does not guarantee the fulfillment of the conditions concerning greatest distance. Randomization may be brought about by ballot or the help of even distribution pseudo-random numbers. If it is our intention to fulfill the condition concerning distance, too, the potentially best possible arrangement of pairs can be achieved with *Ross' method.*

In literature [1] Ross' pair-arrangement tables can be found. To make clear what has been said, we will give the Ross arrangement applied to compare the ten preference pairs occurring in our numerical example (individual numbers are preference identification numbers).

1—2	10—4	9—5	8—6	7—1	3—2
5—10	6—9	7—8	1—3	2—4	10—6
9—7	8—1	4—3	5—2	7—10	8—9
1—4	3—5	2—6	10—8	9—1	5—4
6—3	7—2	9—10	1—5	4—6	3—7
2—8	10—1	6—5	7—4	8—3	9—2
1—6	5—7	4—8	3—9	2—10	6—7
5—8	4—9	3—10			

2. Expert opinion poll

In the following we intend to give some ideas about the reliability of methods to determe preference weights based on expert opinion poll, as well as about the conditions that guarantee the usability of these methods and improve their results.

As with each statistical assessment, here also determining the number of experts participating in the investigation, viz. the element-number of the pattern, is of extreme importance. It has to be kept in mind that the opinions reflect actually the suppositions characteristic of the subject matter, the individual belief of the experts. Over and above a suitable size expert group, this condition can be fulfilled by the correctness, the unanimity of putting the questions, by the authenticity of those giving answers. Also the complexity of the phenomenon, object under investigation may influence the suitable number of experts to be polled.

Another major condition is to ensure the independence of individual expert opinions. Professional orientation, workplace, organisational and/or hierarchy interlacings, a one-sided approach to the subject, may bring about unrealistic opinions. If a suitable number of independent expert opinions cannot be guaranteed, a reliable utilization of intuitive expert methods becomes entirely impossible.

If the above conditions are complied with, the results obtained may serve as basic information basis of further comparison techniques. Prior to a further methodical elaboration of export opinions an effort is necessary to reveal, to filter out the internal contradictions hidden in these opinions.

Obviously, expert opinions contain both qualitative and quantitative value judgements. To eliminate individual expert uncertainties the method of opinion weighting may be used where, by taking into consideration the decision decidedness of the experts polled, individual opinions may have differing weights.

Summing up what has been said about the reliability of methods based on expert opinion poll, the fact has to be emphasized critically that however statistical assessment methods are "refined", the data system giving their input is the result of subjective value judgements. In view of this, the justifiability of applying the mathematical-statistical apparatus here may be questioned in a number of cases, as the subjectiveness of individual opinions may contain critical uncertainties concerning the result of the investigation.

3. Assessment according individual selection criteria

Having obtained the preference system concerning the alternatives to be investigated, the qualification of plan-variations, as assessment factors, has to be realized with the aid of the pertaining measuring scales. In the course of this task the question of preferences that can be measured in an exact way has to be separated from the assessment of qualitative assessment factors that cannot be quantified directly (the imponderables). Starting from known measuring theoretical considerations while in the first case afforts are needed to apply the proportion scale (and/or some natural interval scale) enabling the most tinged qualification, when measuring the imponderables we have to content ourselves with the less sensitive order scale (or perhaps a subjective interval scale). Having obtained the measuring scales serving as preferences, the qualification of individual alternatives, as assessment factors, can be realized. Following this, the efficient solutions may be selected.

The values of preferences that can be characterized quantitatively can be determined in general without any great difficulty, in an exact way. However, it is suggested to take into consideration the joint opinions of experts in case of imponderable assessment factors, as these are basically founded on subjective value judgement.

Knowing the possible solutions and the preference system, individual variations, by judging according to all assessment factors (preferences) separately, the nonefficient solutions may be excluded from further investigation. Next, to be able to undertake a complex comparison of efficient alternatives, individual assessment factors have to be weighted. This enables a complex evaluation of the alternatives.

4. Comparison methods

In the following we shall give a short survey of comparison methods usable in technical practice. This is undertaken on the basis of two books: [1] Kindler, I.—Papp O.: Investigation of complex systems, and [2] Mistéth, E.: System technical assessment (a study).

Traditional mathematical programming methods can be realized and give correct results, if the numerical data are given on a *proportion scale* or at least on/an *interval scale.* It is also essential that the conditions and target functions may be formed in an exact way in the form of equations or inequalities. If the data are only given on an order scale, the objective may only be reached by *ordinal programing.*

The *Combinex-method* is due to *Fallon* and scores all features on basis of weighted assessment factors. The most advantageous is the greatest weighted score-value variation.

The closed method of complex assessment on a proportion scale was summarized by E. Mistéth [2]. When applying the method we suppose that the assessment factors of different variations are *probability variables* given on a *proportion scale*, characterized by a *potential value* and *scatter*. It is further supposed that the components of the weighting vector have been determined statistically based on empirical conclusions of professional experts and thus their potential value and scatter have been computed. Concerning all probabilities it was assumed that they follow a *normal distribution.* With the aid of theoretically proven mathematical expressions the potential value, scatter and slope of the usability function may be determined for each variation. On this basis it may be defined how far for instance the usability function value of the first and second highest chance variation differ from each other in relation to the scatter.

From here — supposing a normal distribution — or by taking slope into consideration, (Pearson III) — the degree of possibility can be defined to make the difference between the usability values of the two variations disappear. Whether the preference order of the two alternatives investigated may be decided, can be determined in relation to a previously assumed threshold value. If it cannot be decided whether variation i or k is the more advantageous, the difference between variation i and k has to be defined by changing the independent variables (time, risk assumed, geometrical dimensions, etc.), through a new, more detailed investigation.

The above method can be used even if the values of assessment factors are given by subjective assessment, or at least on an interval scale (e. g. related percentually to an ideal state.)

Kendall's rank-correlation method can be used successfully if the assessment factors can only be measured on an order scale. Let us suppose n variations: every variation is valued according to m assessment factors. In the following the rank numbers $R_i (i = 1, 2 \ldots\ldots, n)$ are computed for each variation and the lowest rank number amount results in the most advantageous variation: $\min R_i = I$. This decision is, however, accepted only in case Kendall's rank-concordance coefficient, $W > W^x$, where W^x is a previously determined threshold number. W rank-concordance coefficient can be computed, in a normal case by the following relation:

$$W = \frac{\sum_{i=1}^{n} (R_i - \bar{R})^2}{m^2(n^3 - n)}$$

where R_i ($i = 1, \ldots\ldots, n$) is the rank-number amount of variation i

$\bar{R}$ is the mean of the rank number amount

m is the number of assessment factors

n is the number of alternatives considered in the assessment.

If the assessment is given on an order scale, the only advantage of the method is that it does not consider the different weights of assessment factors. If, however, the assessment is given on the intervalor order scale, its utilization may entail a major loss of information.

The assessment method ELECTRE is based on a *multiple criteria algorhythm.* To compare the variations it suffices to qualify the assessment factors on an interval or perhaps an order scale. The method was first used by two Frenchmen, Laffy and Roy.

As a first step the different n A_i variations had to be qualified on a five or six grade verbal scale according to all (m) assessment factors. It then has to be determined as to how many scores the different grades mean at the different assessment factors. In the following weight g_j of the different assessment factors has to be determined in a way that the amount of weighting numbers: 1 be $\sum_{j=1}^{m} g_j = 1$. As the next step the weighting assessment score numbers have to be computed for all variations. This amount results in the score value of the relevant variations that figure in the table also used for the Combinex method. The highest chance goes to the variation with the highest score number.

For a paired comparison of the alternatives two matrixes have to be prepared. The members of the first are the consistency indices or preference indices (c_{ik}), which indicate in how many percents of the weigted assessment factors variation i is preferred or indiffent as compared to system k, viz. $A_i \rightleftarrows A_k$ reflects the preference relation. Members d_{ik} of the second matrix are the difference indices or disqualification indices. When computing d_{ik} we do not take into consideration all assessment factors where $A_k \rightarrow A_i$, but only the highest assessment difference is used in the computation. This maximum difference is to be divided by the scale dimension of the highest weight number assessment factor. After defining the threshold level of preference and disqualification $c_{ik} \geq p$ and $d_{ik} \leq q$, where p and q are the threshold values. To compute the most advantageous variation values p and q are changed by step wise approximation. We start from conditions $p = 100$ and $q = 0$, followed by $p = 90$ and $q = 10$, etc. And finally the assortation graphs pertaining to different p, q threshold levels are drawn, until not a single alternative can be found which at threshold values $p > 50\%$ and $q < 100 =$ is more advantageous than all the others. The method can be used with success if there is a high number of imponderables among the assessment factors. In this case all variations are compared by pairs, according to different assessment factors. If all assessment factors are indicated on the proportion scale then a major information loss has to be considered in the end result.

The *method KIPA* is essentially an improved variation of method Electre. The development of procedure steps was undertaken by József Kindler and Otto Papp [1]. With this method the assessment factors have to be defined first of all.

When defining the assessment factors (target functions) the essential features of the system have to be indicated. The discrete assessment factors have to be mutually independent from each other but should not exclude each other completely. The well-defined assessment factors, not higher in number than 15 and at an identical level, if possible, should contain all essential features.

Weighting of the assessment factors can be realized with the already discussed Guilford method. If there are m factors and z decision makers present, preference number $z \frac{m(m-1)}{2}$ db has to be processed in a table. This is followed by determining the fivescale classification of assessment factors. The range of individual scales has to be defined according to the weight numbers of assessment factors. The scales are graded as even interval scales. In the next step the basic table (Combinex table) of the method has to be prepared.

From the basic table, the preference indices (c_{ik}) and the disqualification indices (d_{ik}) are prepared from the Electre method. These are unified in the KIPA matrix. The KIPA matrix essentially serves to unify the consistency and divergency matrixes introduced with the Electre method. The further steps are completely identical with the construction of different threshold level (p, q) assortation graphs introduced with the Electre method.

The KIPA method has an advantageous use in case of different investment, product development, company target decisions, in general where not only defining the most preferred system is of importance but also that of order and continual approach of differences and also where there is a high number of imponderables among the assessment factors. In case the assessment factors are given on the proportion scale the method results in loss of information.

Summing up it can be said that the procedures mentioned are able to help successfully in preparing investment decisions, a well-founded choice among alternatives. It must be emphasized, however, that a basic and inevitable part of suitable investment decision preparation is an analysis of efficiency, a comparison of costs changing in time. Obviously, the tasks of efficiency analysis can be built into the model we introduced, but in this case their weight, their role is of decisive importance in complex assessment.

In the following we wish to introduce the use of comparison methods on a concrete numerical example.

5. Numerical example for application in system technical assessment methods

In the frame of the numerical example the selection of rubber-wheel, articulated front loaders will be shown that are suitable to realize practically identical loading tasks and can be judged as most suitable for our purposes.

Based on technical opinion, after the necessary research work, we took into consideration, as assessment factors, the following quantifiable and non-quantifiable (imponderable) characteristics. The assessment factors (their technical, interpretation content, characteristics) are given according to the ABC, (in the Hungarian ABC) as this order does not contain any ranking (preference).

1. Price of investment

The value of the new machine expressed in value, at the central site, in an operative state.

2. Ergonomical aspects.

The smallest revolution (curve) radius m of the articulated arrangement basic machine.

Physical, psychical effect of work (operation) in the man-machine relationship.

3. Manoeuvrability

The lowest revolution (curve) radius (m) of the articulated arrangement basic machine.

4. Bucket volume

The volume resulting from the geometrical dimensions of the loading bucket, according to DIN (m^3).

5. *Environmental* (environmental protection) aspects.

The effect of work (operation) on the natural and the constructed (artificial) environment (as exhaust-gas composition, environmental pollution, etc.).

6. *Engine performance*

The performance measured along the main shaft of the built in (gear) motor (KW).

7. *Reliability*

Reliability, stability concerning operation, despite unfavourable terrain and weather conditions, as well as the supply ability for components (manufacturing plant), the network of servicing.

8. *Loading height (max)*

The upper extreme position of the loading bucket from which it is able to load onto a vehicle standing at the same level as the machine (m).

9. *Self mass*

The operative mass (weight) of the machine (kg).

10. *Servicing demand*

Demand concerning maintenance, care, based on cyclicality of repeated maintenance, down times for care.

Factors 1, 3, 6, 8, 9 are numerical data to be found in machine books, catalogues and are thus unanimously characteristic of machines under investigation.

Factors 2, 5, 7, 10 are imponderables.

In the course of analysis, more than the enumerated ($m = 10$) factors turned up as assessment aspects on the part of the team members. From among these we wish to introduce the rather characteristic ones which reflect the machine system and environment-system technical, economic, ecological interactions in a way that touches the essential. The analysis and processing of $m = 10$ factors can be realized, in our experience, in a simple and rapid way and also surveying, assessing the results causes no problem.

Defining the weight of individual assessment aspects, preferences (which were defined in detail for the investigation) was realized according to Guilford with the aid of eight experts ($Z = 8$). The paired comparison serving as basis of the procedure was according to Ross' pair-arrangement. The experts denoted by underscoring the factor in a given pair of factors they deemed the more important from the point of qualifying the loader. The questionaries filled in by them were processed concerning each expert with the aid of a preference table, defining the value of consistency index. Among the experts there was a completely consistent one ($k = 1$), the consistency of the most inconsistent expert was 0, 73, with 11 inconsistency triades. By inconsistency triade we mean an arrangement of the three investigated factors, where "*a*" is preferred compared to "*b*", "*b*" is preferred compared to "*c*", however "*c*" is preferred compared to "*a*" ($a \rightarrow b \rightarrow c \rightarrow a$).

The mean of individual consistency indices R = 0.89.

The aggregated preference table was received by summing up the individual preferences tables. From the data of the table the dimension of consistency can be computed and also how far this consistency may be attributed to chance as well as the weight numbers (g_j) pertaining to individual assessment factors can be obtained which had been produced on basis of the standardized normal distribution that their amount be one.

The assessment embraced nine (n = 9) universal front loaders, their indices, according to assessment factors are to be seen in Table 1. As to the imponderables, the experts assessed the machines on five grade scales:

very good	5
good	4
mediocre	3
suitable	2
unsuitable	1

Table 1

Basic Assesment Table of Investigated Systems

	Net cost in monetary unit	Ergonomic aspects	Manoeuvrability m	Bucket volume m³	Environmental protaction aspects	Engine per-performance kW	Reliability	Max. loadding height m	Self mass 1000 kg	Service requirement
A1	310	3	6.50	2.70	2	121	4	3.70	14.50	3
A2	370	3	6.80	3.10	2	147	4	3.90	16.30	3
A3	260	4	6.30	2.40	3	117	4	3.90	14.87	3
A4	450	4	6.80	3.50	3	149	4	4.10	19.88	4
A5	530	4	7.90	4.00	3	201	4	4.30	26.82	4
A6	270	3	6.50	2.40	4	118	4	3.80	13.80	4
A7	470	3	7.20	3.50	4	169	4	4.20	20.00	4
A8	350	4	6.50	2.80	2	132	3	3.80	15.50	3
A9	390	4	7.00	3.20	2	162	3	4.00	18.15	3
Weight numbers	0.15	00.3	0.12	0.14	0.02	0.17	0.10	0.10	0.09	0.08

As six assessment factors can be measured on a proportion — and/or interval scale, it does not seem expedient to revert to a subjective interval scale, the imponderables, however, are assessed percentually. For simpler handling, it is expedient to transform the basic table into a normalized form in a way that every target function have a maximum direction.

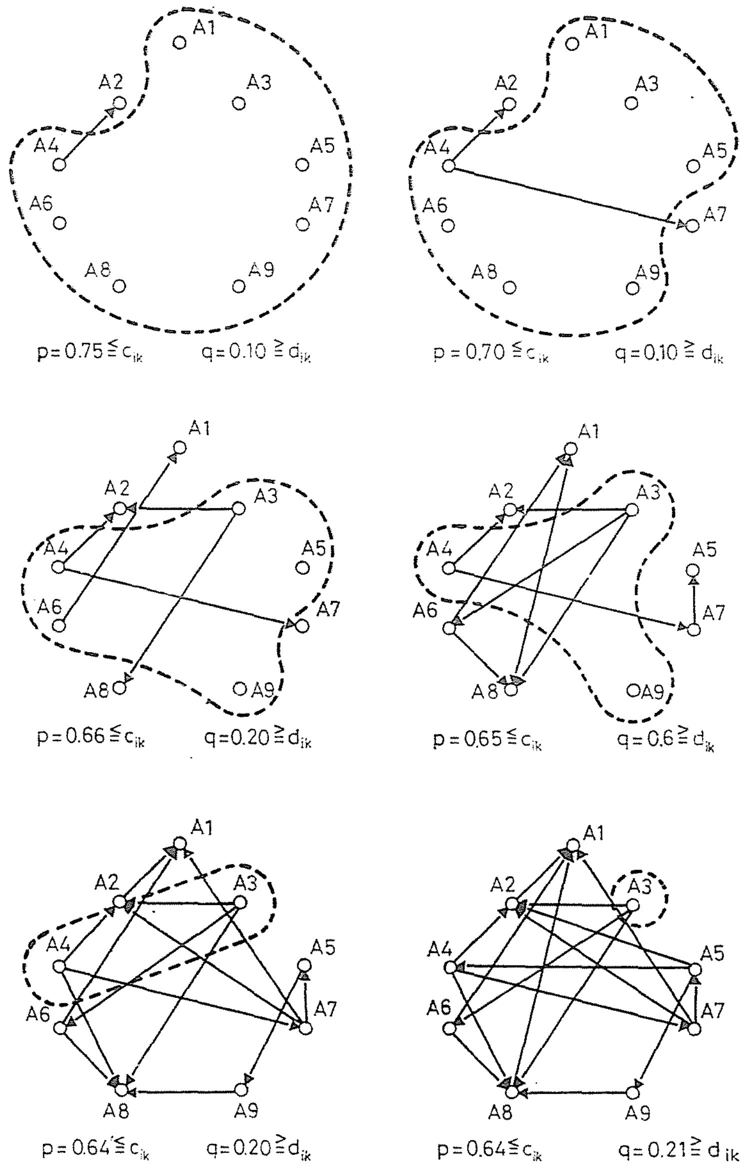

Fig. 1. Assortation graphs concerning the nine investigated front loaders

Following the complex assessment with the aid of a micro-computer:

— The first task is to fill in the table, matrix, of the preference index table. The members of the matrix (C_{ik}) indicate the proportion of preferred or indifferent weighted assessment factors in variation i compared to variation k. (The weight numbers of assessment factors are added up where $A_i \rightleftarrows A_k$.)

— The second step is to compute the table, matrix of disqualification indices. The members of the matrix (d_{ik}) the inconsistency indices are obtained by determining the highest, weight-number depending difference from the cases where A_k is preferred to A_i ($A_k \rightarrow A_i$).

— In the following the formation of "cores" can be investigated by so-called assortation graphs on basis of values c_{ik} and d_{ik} figuring in the matrixes. The core is the aggregate of points that are not connected in the graph by an edge expressing preferredness, viz. the aggregate of systems that cannot be compared at the given level of investigation, as there is no preference relation among them. To be able to investigate the development of cores we have to indicate the threshold figure relating to the required measure of advantages ($p - c_{ik}$) as well as the one for the maximum, supportable disadvantage ($q - d_{ik}$). In Fig. 1 the iterative process of limiting off the core is shown, the way one can finally reach a core containing but a single system, by changing values p and q.

As a first step, when assuming values $p = 0.75$ $q = 10$, machine A_2 is obtained from the core. With the second, third and fourth graph ($p = 0.70$, $q = 0.10$, $p = 0.66$ $q = 0.20$ and/or p = 0.65, q = 0.20) we reached a three-element core containing machines A_3, A_4, A_9. By further easing the threshold values $p = 0.64$, $q = 0.20$ also machine A_9 could be excluded from the machine. And finally, at threshold value $p = 0.64$, $q = 0.21$, only machine A_3 remained in the core, thus this one may be deemed as the most preferred system, its acquisition may be suggested, as a result of the decision preparing process. Obviously, prior to making a decision, the information obtainable from the assortation graphs should be studied, first of all the measure of preference.

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