AN INFORMATION SYSTEM CHECK-UP MODEL FOR SMALL AND MEDIUM ENTERPRISES

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Introduction

In the ’80s, Information Technologies (IT) evolution mainly affected large companies, able to invest many resources in their Information System (IS) development. Large information centers and specialized staff were required to effectively manage the IT introduction and development in such companies.

The initial advantages, which led the IT introduction in many companies, were mainly related to the productivity improvement that technologies were able to achieve. In the following years the impact on a number of other strategic functions became evident [Thompson 92]:

- the information and the critical data availability in shorter time;
- the improvement of the service supplied to clients because of the reduced production and delivering times;
- the improvement of the management flexibility, through the investigation of a larger set of alternatives by means of tools such as Management Information Systems and Decision Support Systems;
- the improvement of control over different resources and their more effective use exploitation.

In recent years, IT evolution affected also Small and Medium Enterprises (SMEs[1]), often forced to introduce advanced information systems to keep their ability to compete within rapidly evolving markets. IT investments became critical for many companies, and even more critical is their evaluation in terms of the costs/benefits ratio. However, such evaluation can not be accomplished adopting the traditional approaches proposed for the production processes: in fact, to correctly analyze the IT impact a number of intangible effects must be considered. This problem is even more harsh within SMEs, often characterized by a limited number of specialized staff or no IT technicians at all: either the management or the ownership should be provided with a well defined procedure for the evaluation of the IT investments and for the assessment of the existing IS. Moreover, effectiveness is not the only requirement. This procedure must also be simple and quick:

- it should not require any technical knowledge, in fact it must be adopted by non-technical personnel (management and/or ownership);
- it should be applied with a reduced investment in terms of time, since it must be performed by people devoted to other tasks, which are considered more critical by the management.

The approach presented in this paper fulfills such requirements, taking into account the current situation of Italian SMEs. A *functional* separation of the company has been considered, even if the more recent approaches in the IS evaluation field are based on the *process* separation of the company. In fact, a previous research did show that the organization of most Italian SMEs better fits in the functional separation [Ravarini 94]; moreover this approach results to be more comprehensible by most of the enterprises' owners, which in most cases adopted by themselves the proposed evaluation procedure.

In the following, we will refer to the concept of *Information System* as the whole set of hardware and software tools adopted to *automatically* manage data acquisition, storage and processing; the term *Information System* is therefore adopted instead of *Automated Information System*.

The following section presents a number of previous approaches proposed for the IS evaluation which are more strictly related to the one proposed in this paper. The third section describes in detail the proposed check-up model, specifying the current state of each functional area and the practicable improvements. Finally, the last section summarizes the results of the model application within a meaningful set of SMEs.

Previous approaches to IS check-up

The economic evaluation of IT investments is still an open problem: the costs/benefits analysis, as suggested by traditional approaches, may not drive to correct results, mostly because of the *intangible* costs and benefits characterising the IT field. As a result, different evaluation models have been developed in the past; in particular, the model described in this paper refers to three approaches:

- the business performance indicators approach;
- the performance/priority models;
- the cost/utilization model.

The business performance indicators approach

The approach based on business performance indicators compares the performance improvements achieved by IT adoption with the related costs [Nolan 82]. To make the final results really effective, both functional and economical analyses are performed.

The *functional* analysis evaluates the advantages provided by the business procedures automation through the appraisal of three performance indicators:

- the system coverage percentage, defined as the percentage of data and processes automatically managed with respect to the total amount of data and processes managed by the business unit;
- the automation degree, an estimation of the time saved thanks to the automation of the business procedures;
- the system integration rate, introduced to take into account the benefits achieved by the integration of automated procedures.

On the other hand, the *economic* analysis aims at evaluating the amount and the distribution of the IT expenses, considering both the investments (capitalised value of automated applications) and the annual costs (current expenses and amortisation). This analysis is based on some important indicators such as:

- the absolute value of IT expenses;
- the percentage of such value with respect to the sales;
- the costs related to single units (produced or sold);
- the costs per manpower.

Moreover, a complete economic analysis requires the estimation of the costs per shared resource (machinery, staff, and others) and the costs per business function (analysis and development, maintenance, support and co-ordination).

The performance/priority models

The performance/priority models (such as [Broadbent 93] and [Miller 87]) introduced a new performance indicator of the IS based on the subjective evaluation of personnel (managers, staff, end users) dealing with the IS itself.

As an hypothesis which is often left implicit, people concerned with this evaluation should be aware of the benefits related to the use of automated procedures and should be able to estimate them from a quantitative point of view. The application of such models requires two basic steps:

1. identification of the present and/or desired IS features defined as *result areas*;
2. definition of two numeric scores for each result area: the assigned priority and the perceived performance.

The evaluation of the total score assigned to each area and of the mean score assigned by each class of users provides two useful information: the *level of satisfaction* (that will be lower as the difference between priority and performance grows) and the *degree of importance* assigned to each area (that could be helpful for the future development of the IS).

To make easier the identification of the required changes, the PAPE model (*Performance And Priority Evaluation* [Broadbent 93]) uses a priority/performance matrix (figure I): each result area is represented by a point whose co-ordinates are calculated as the mean of the scores assigned by each user.

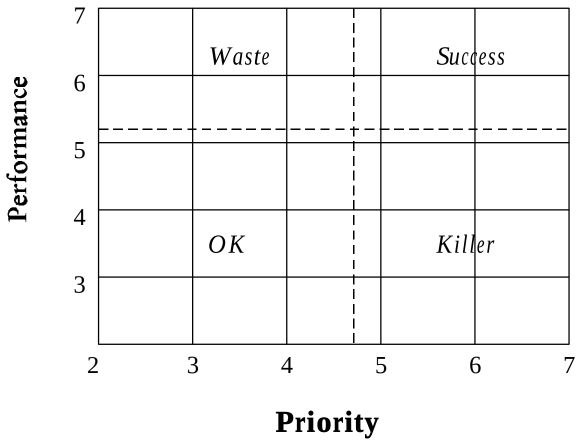


Fig. I. Priority/performance matrix from the PAPE model.

For each result area positioned in the *waste* region the IT investments can be reduced, while the *killer* region contains the result areas considered more strategic but characterised by low performance. The IS managers will have to work on these result areas which could become, in the near future, critical success factors.

The cost/utilisation model

The cost/utilisation model focuses on the evaluation of the IS efficiency: it provides useful information about the performance of each element of the system and the procedures required to improve it. The model, proposed by Borovits and Giladi [Borovits 93], is based on the percentage values of cost and utilisation of each system's component with respect to the total (where "each component" means hardware, software, and users). The model can be roughly separated into three parts.

The first one describes the cost and the utilization of each *hardware* component by means of two indexes: the *utilization index* and the *balance index*. In order to estimate such indexes, it is necessary to evaluate, for each component of the system, the percentage of the cost and the percentage of the utilization (i.e., the ratio between the actual use and the capacity of the component) with respect to the total.

The second one includes the *software* components of the system. Instead of the cost of each software component, it considers the utilization forecast determined during the planning phase: the result is a *plan/utilization* model based on homonymous indexes but computed in a different way, through the utilization forecast of each software component and its actual utilization.

Finally, the third part evaluates the IT costs considering also the IS *users*, that are becoming increasingly important from the economic point of view. A research carried out on the distribution of data processing costs [Ein-Dor 87] determined that the costs allocated for the IS staff amounts to a percentage varying from 30% to 50% of the total budget assigned to the IS area. The utilization index for the whole system is calculated as the weighted mean of the utilization indexes for the hardware components, the software components, and the users. To evaluate the organizational impact of the IS, the utilization and balance indexes must be determined for each functional area. Moreover, an aggregated index can be computed as a weighted average of the functional areas indexes, by considering the allocated budgets as weights. In fact such values can be used as indicators of the relative importance assigned by the management to each functional area.

Applicability of the evaluation models to SMEs

Typically, the application of these models requires the availability of a large amount of data with a high level of precision. In fact, they have been developed mostly for large, well structured companies with a composite organisation; their application in SMEs often becomes very expensive and may not achieve any effective result.

As an example, the approach based on business performance indicators requires a deep (thus expensive) analysis of the indicators: they must be evaluated from a quantitative point of view and their interpretation is not always suitable for SMEs. Moreover, it is often difficult to summarise a diagnosis for the whole system starting from the results of each indicator analysis. On the other hand, the performance/priority models often require the involvement of too many people in the evaluation process, thus their application results to be very difficult and time consuming for SMEs. Finally, the cost/utilisation models are based on subjective variables (such as the actual utilisation of a component) thus their results could be not meaningful enough.

Because of cultural, economic, and organizational reasons, small enterprises rarely make use of *formal* business strategies: as a consequence, the definition, the introduction, and the management of the IS is rarely approached in a formal way. Even when a formal decision process is adopted, strategic choices depend on the entrepreneur’s experience, the clients requirements, or the suppliers proposals. In such a poorly structured environment, the retrieval of data required for the above mentioned models results to be very difficult and time consuming; moreover, the model application and the results evaluation often require skills that can not be found within SMEs, thus increasing the application costs.

A research carried out on a meaningful set of Italian SMEs [Ravarini 94] has demonstrated that most of them do not dedicate human resources to the IS management, and sometimes the IS area is not even provided within the business organizational structure. For all these reasons, it is necessary to define a methodology for the evaluation of the business IS suitable to SMEs requirements: next sections will introduce a proposal of evaluation model.

The Information System Check-Up Model for Small and Medium Enterprises

Introduction

The Information System Check-Up Model (ISCUM) for Small and Medium Enterprises is essentially characterized by a preliminary data acquisition phase followed by the proper check-up procedure (figure II). The data acquisition phase is composed of three steps:

- identification and ranking of the functional areas according to their strategic importance order;
- collection of the indicators values for each defined area;
- graphical representation of collected data.

The results of the preliminary phase are used as input of the evaluation process, which is based on two different check-up levels: the *strategic* check-up and the *operating* check-up. The preliminary phase can also be separated into three basic operations:

1. *strategic alignment analysis*, which aims at verifying if the IS support to each functional area grows as the strategic importance of the same area grows;
2. *disposition of the functional areas into an evaluation grid*, which allows to highlight the inefficiencies of each area and to identify the strategic choices required to improve the IS performance;
3. *evaluation of the IS development trend*, which verifies if the IS has been correctly developed, by comparing the indicators values with the ones computed in the previous application of the model.

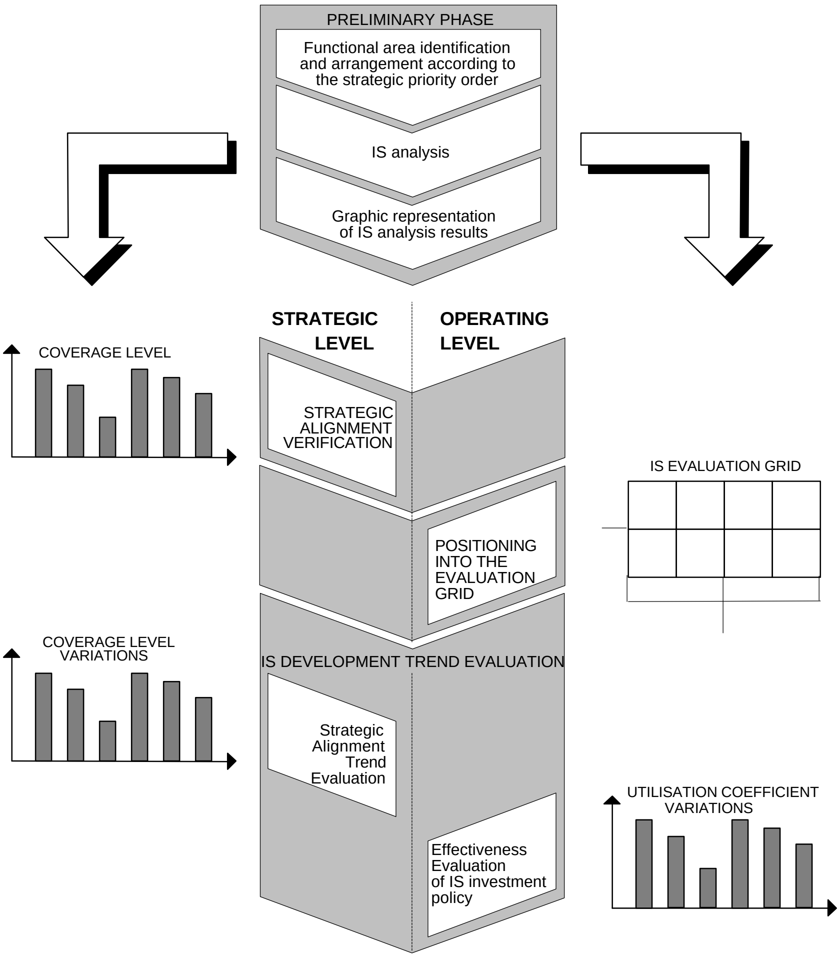


Fig. II. Overall scheme of the Information System Check-Up Model for Small and Medium Enterprises.

It is important to underline that the model should be applied by the EDP manager supported by the entrepreneur or a high-level manager: in fact, information like the strategic importance of each functional area can be correctly provided only by high-level managers. Nevertheless, the model has been designed to make the collection of required data as simple as possible, with the aim of allowing its application even by non-specialized personnel, such as the entrepreneur alone or anyone concerned with the IS area.

Moreover, the model should be applied before each important investment involving the IS or, alternatively, with an annual frequency in order to provide the management with the information necessary to correctly allocate the business resources.

Next sections will introduce each phase of the model, from the definition of each indicator to the detailed description of the strategic alignment verification process, the positioning of each area into the evaluation grid, and the development trend evaluation of the IS.

Preliminary data acquisition

The ISCUM makes use of both quantitative and qualitative evaluations. The preliminary phase aims at simplifying its application by collecting and graphically representing the input data necessary to the subsequent phases.

The *first preliminary phase* requires to determine the functional areas into which the company can be separated (a typical example of the areas belonging to a small Italian company [Ravarini 1994], is shown in table I, page 12. The model does not consider the administration and personnel function which is a typical company area indeed; the reason of such a choice will be presented in the next section). Then, the functional areas have to be carefully arranged in a decreasing strategic importance order[2]: such operation requires a deep knowledge of the company organization and of each functional area. This is the reason why it is up to the entrepreneur (or a high-level manager) to provide a qualitative assessment of the perceived strategic importance of each area.

This procedure has to be repeated each time the model is applied: though strategic choices typically affect medium-long term results, there could be unexpected events (such as relevant innovations, introduction of new competitors, legislative actions) producing serious changes to the company strategies.

The *second preliminary phase* requires, for each functional area, the evaluation of three important indicators:

1. the IS Coverage Level $CL(i)$;
2. the IT Investment Level $IL(i)$;
3. the Automation Impact Level $AIL(i)$.

Although the origin of such indicators is the IS performance indicators approach (described in the previous section), their meaning introduces an essential innovation: in order to compare data referring to different functional areas, the *absolute values* of the indicators have been converted into *relative levels*.

The IS Coverage Level

The system coverage level $CL(i)$ evaluates the IS "dimension" in each functional area i, i.e. the extent of the support provided by the IS to the activities carried out in such area. $CL(i)$ depends on the values of three quantitative indicators defined, for each functional area, as follows:

1. POTENTIAL COVERAGE RATIO: $Pot.Cov.(i) = 100 * D_i^{*}/D_i$
2. IS UTILIZATION COEFFICIENT: $UC(i) = 100 * DA_i/D_i^{*}$
3. ACTUAL COVERAGE RATIO: $Act.Cov.(i) = UC(i) * Pot.Cov.(i)$

where D_i^* represents the number of activities of a given functional area that *could be supported* by the existing IS, DA_i is the number of activities *actually* supported by the IS in that area, and D_i represents the whole number of activities carried on within the area.

The Potential Coverage Ratio *Pot.Cov.(i)* can be employed as an efficiency measure (in terms of planned performance), but it does not consider how the system performance can be affected by the users behaviour. It can also be assumed as a measure of the IS theoretical organizational impact, considered proportional [Busetti 1993] to the IS extension and width.

On the other hand, the Actual Coverage Ratio *Act.Cov.(i)* is useful to evaluate the real IS dimension[3], because it considers both the system characteristics and the users capability of completely exploiting them. Nevertheless, the different values of the Actual Coverage Ratio can not be compared, since they could be extremely different from one functional area to another: in fact, the maximum level of *Act.Cov.(i)* depends on the peculiar characteristics of the functional area procedures. In order to make these values homogeneous (thus comparable), an upper and a lower bound for the Actual Coverage Ratio of each area have to be defined: we will call these limits the Maximum Level of Possible Automation *MLPA(i)* and the Minimum Acceptable Level of Automation *MALA(i)*.

The *MLPA(i)* is a technological limit which can not be exceeded because of the current state of technology. Some functional areas (such as marketing, research and development) can only be partially supported by the IS, because of the complexity of the activities concerned. Therefore, the benefits caused by IT investments for these areas are more easily subject to saturation: any further investment beside a certain level of expenditure does not lead to any meaningful improvement.

The *MALA(i)* is settled by the typical efficiency requirements of each functional area. In other words, the value of this indicator can be determined by answering to the following question:

> *which is the minimum level of automation for each functional area necessary to avoid serious inefficiencies (in terms of time and money)?*

It is important to underline that this factor does not refer to any kind of strategic or external effectiveness issue (as it could be, on the contrary, the need of an EDI link with customers, that implies a commercial function strongly supported by the IS). Such topics are already considered in the preliminary phase, with the definition and arrangement of the functional areas. Instead, the *MALA(i)* refers to operating requirements, i.e. to internal efficiency problems.

These values often depend on the specific company characteristics: as an example, the minimum level of automation required by a commercial department will be low if the company receives 50 orders per year (for instance, companies realizing industrial machinery), while it will be much higher if the annual orders volume is several thousands (like in machining companies). Therefore, these factors vary not only from one functional area to another, but are also time dependent.

The *MLPA(i)* increases according to the technological progress (substantially exogenous to the choices of a small or medium enterprise). On the other hand, the *MALA(i)* depends on the industry characteristics the company belongs to, and on the strategic/organizational decisions, hence it represents a variable which managers can potentially control.

The existence of different maximum and minimum levels of automation for different functional areas justifies the need of a new indicator for the IS coverage, which could take into account these values. This indicator (the above mentioned IS Coverage Level) can be defined through a qualitative assessment process. Firstly, creating a chart representing the *Act.Cov.(i)* values and drawing two horizontal lines representing the percentage values of the *MLPA(i)* and the *MALA(i)* for each area; then, the IS Coverage Level *CL*(*i*) of each area is obtained by means of a qualitative evaluation of the position of the *Act.Cov.*(*i*) values with respect to the upper and lower bounds. We defined six different values for *CL*(*i*) (from 0 to 5, corresponding to inefficient, very low, low, medium, high, and very high) assuming to assign the value “0” when *Act.Cov.*(*i*) is lower than the *MALA(i)* (figure III).

There is only one case in which this kind of assessment is not useful: it happens when the *MALA(i)* and the *MLPA(i)* value are both set to 100%. In such case the IS Coverage Level assumes, according to its definition, an undetermined value, thus it is no more proper as a measure of any characteristic of the information system. The testing phase of the ISCUM model, realized within a survey of the SMEs (see the last paragraph for more details), pointed out that such a situation is typical of the administration and wages function, which means that such area should be excluded by the assessment.

The IT Investment level

The IT Investment Level *IL*(*i*) is an estimation of the financial efforts toward the business processes automation: the estimation of such indicator requires the quantitative evaluation, for each functional area, of two indexes:

1. the *IT investments*, i.e., the capitalized value, obsolete elements net, including *hardware* (PCs, networks, minis, workstations, data acquisition tools, etc.), *software* (operating systems and applications), *IS staff and users* (training activities);
2. the *IS costs*, such as hardware and software maintenance, IS staff wages, costs due to new hires, communication (for local or wide area networks), consultants, etc.

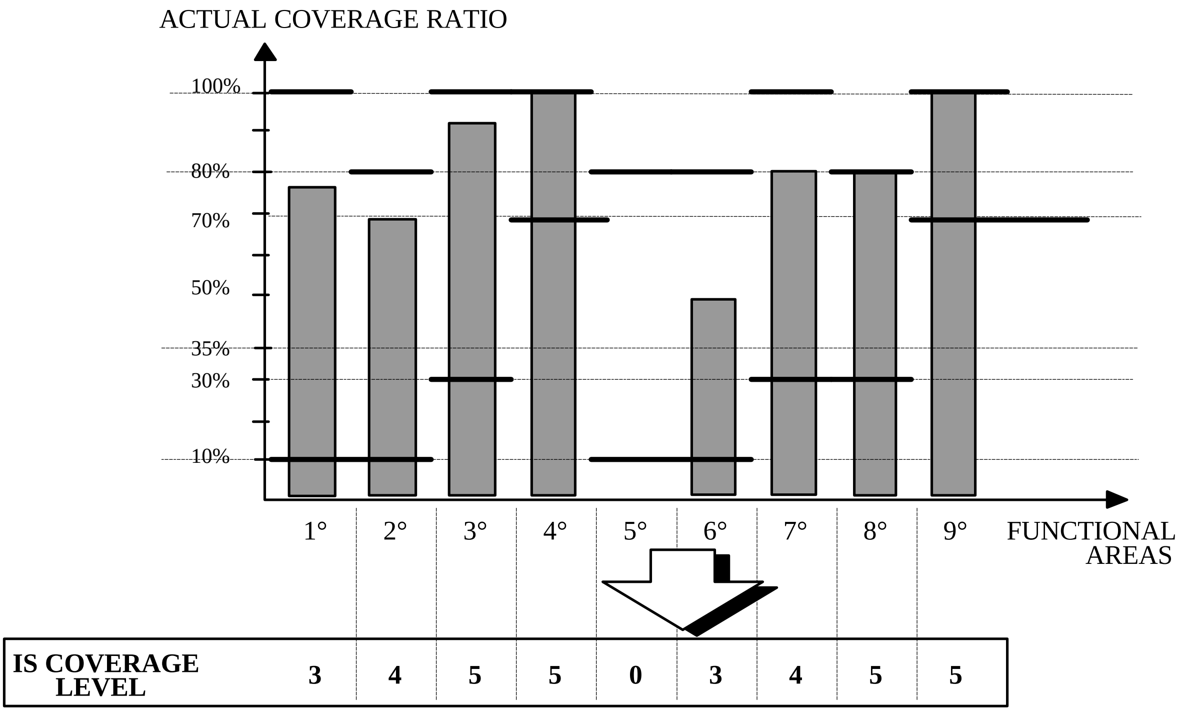


Fig. III. Definition of the IS Coverage Level values.

The meaning assigned to these values is inevitably subjective, since it depends on the strategic importance of both the IS and the functional areas. To better employ such information, the model makes use of an important *objective* factor concerning the IT investment and cost values: the *Average Cost per Coverage Unit ACpCU*(*i*). The higher the cost (in terms of hardware and software components or for the staff training) needed to raise the coverage level of a given area, the higher is the value of *ACpCU(i)* for such area: in other words, the efforts necessary to raise the coverage levels are not the same for all the functional areas. Therefore, there is a direct proportion between *ACpCU(i)* and the IT Investment Level of each functional area. That is to say:

- low coverage levels, together with high investment absolute values, are not necessarily caused by inefficiencies, if the area is characterized by a high value of *ACpCU(i)*;
- high coverage levels, together with low investment absolute values, do not necessarily correspond to a successful IS management, if the area is characterized by a low value of *ACpCU(i)*.

As a consequence, to make comparable the investments of different functional areas, the investment and cost *values* must be converted into investment *levels.*

Firstly, it is necessary to determine the absolute values of investments and costs, taking into account the costs related to those IS components shared between different functional areas[4].

Then, the model requires the identification of two threshold values, one for the IT investments and the other for the IS costs; these values should be determined according to the following criteria:

«according to the characteristics of the company, beyond which value the IT investments and costs of each functional area can be considered "high" ?»

For each functional area, the values of investments and costs must be compared with the threshold values: if at least one of them is higher than the related threshold, the investment level *IL*(*i*) of that area will be considered "high".

Finally, it is necessary to evaluate the values of *ACpCU(i)* (through a three levels scale: high, medium, and low). For those areas with the investment level *IL*(*i*) equal to *ACpCU(i)* (both *high* or both *low*) it should be assessed qualitatively whether the investments and costs values are mainly justified by the value of *ACpCU(i)*: in that case, the *IL*(*i*) value should be changed (from *high* to *low* or vice versa) (Table I).

FUNCTIONAL AREAS	TOTAL INVESTMENTS VALUE (thousands USD)	COMPARISON WITH THRESHOLD VALUES (HIGH-LOW)	ACPCU(I) (HIGH-MEDIUM-LOW)	INVESTMENT LEVEL (HIGH-LOW)
1. technical department	120	***HIGH***	***HIGH***	***LOW***
2. commercial department	25	HIGH	MEDIUM	HIGH
3. time/methods office	11	***LOW***	***LOW***	***HIGH***
4. planning department	33	HIGH	MEDIUM	HIGH
5. production department	0	LOW	MEDIUM	LOW
6. assembly support center	6,5	***LOW***	***LOW***	***LOW***
7. stock accounting	13	LOW	MEDIUM	LOW
8. purchase office	13,5	LOW	MEDIUM	LOW
9. data processing center	20	LOW	HIGH	LOW

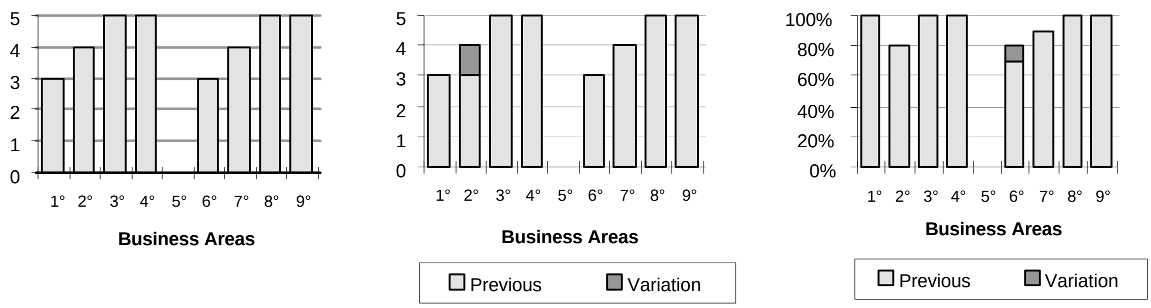
Table I. Example of the IT Investment level evaluation, based on a threshold value of 24.000 USD. Note that the investment level of the first area (technical department) has been set to "low" since the management identified the high value of ACpCU(3) as the main reason for the corresponding high investment value. Such a situation actually occurs in the SMEs belonging to the mechanical industry, as shown by the research performed to test the applicability of the model within real companies.

The Automation Impact Level

The Automation Impact Level *AIL*(*i*) is a subjective evaluation[5] of the time savings due to the introduction of the IS in each functional area. For a correct application of the model it is crucial to ask this evaluation not only to high-level managers and to the IS staff but to end-users too: in fact, this indicator should be considered an approximate estimation of the service level perceived by the IS users, that is an estimation of the IS actual performance versus the expected one.

Thus, the *AIL*(*i*) is influenced by the users satisfaction degree; the comparison of the impact level with the coverage level values provides an evaluation of the IS *effectiveness*.

Once determined the values of the three indicators for each functional area, the preliminary phase ends with the graphical representation of collected data. More precisely, it is necessary to create three charts representing respectively the *Coverage Level values*, the *Coverage Level variations* and the *IS Utilization Coefficient variations*, where the variations are related to the previous application of the model (figure IV provides an example of these charts). The functional areas should be arranged according to the previously assigned strategic importance, in order to be used for the following steps of the model application.



Coverage Level Values (0–5) (a) — Coverage Level Variations (b) — IS utilization coefficient variations (c)

Fig. IV. Graphical representation of collected data.

Strategic alignment verification

The information system *strategic alignment* [Henderson 1992] is achieved when the priority assigned to a functional area is proportional to the support provided by the information system to that area.

The problem of the strategic alignment verification has been already analysed: the scientific literature (e.g. see [Nolan 82]) often suggests the use of indicators based on the investment level of each area. The implicit assumption is the existence of a direct proportionality between the IT expenses allocated to an area and the support provided by the IS for such area: the considerations presented in the definition of the Average Cost per Coverage Unit *ACpCU(i)*, described in the previous section, show that this assumption is not always true.

This is the reason why the strategic alignment verification can be related to the evaluations concerning the coverage level of each functional area: such evaluations surely show a lower precision than the ones based on investments (which do not require any qualitative assessment). However, recalling the important constraint of this work (the applicability within SMEs), precision is not an essential performance factor for the model: it is rather more important that the model provides meaningful than exact results. The IS Coverage Level should provide a correct measure of the IS support to each functional area. Moreover, the evaluation of the Coverage Level $CL(i)$ according to the values of the minimum and maximum automation levels (*MALA(i)* and *MLPA(i)*) makes comparable the results of the different areas.

The strategic alignment verification is therefore carried out using data referred to the last observation period, as depicted in figure IV.a: the strategic alignment is obtained if the histograms appear in a decreasing height order. Otherwise, a corrective action aimed at decreasing the distance between the present and the ideal situation (progressively lower histograms) would be needed.

After examining the IS through a *strategic* perspective, the model requires the analysis of its *operating* characteristics. At this level the IS check-up is separated into two distinct phases: the positioning of each functional area into the evaluation grid and the IS development trend evaluation.

Positioning into the Evaluation Grid

To better take advantage of collected data, a new tool called *Evaluation Grid* has been introduced: it integrates the gathered information concerning the IS, providing a detailed picture of the current state of each functional area and helping to outline the possible solutions required to improve its performance.

First, the values of the three main indicators (the Coverage Level $CL(i)$, the Investment level $IL(i)$, and the Automation Impact Level $AIL(i)$) have to be adapted in order to be inserted into a two levels scale (high and low levels). It is suggested to execute the conversions as follows:

I. IS Coverage Level *CL*(*i*)	$0 \leq CL(i) \leq 2$	➔	*LOW* COVERAGE LEVEL
	$3 \leq CL(i) \leq 5$	➔	*HIGH* COVERAGE LEVEL
II. IT investment Level IL(i)	already valued in terms of *HIGH* and *LOW* levels		
III. Automation Impact Level AIL(i)	$0 \leq AIL(i) \leq 2$	➔	*LOW* IMPACT LEVEL
	$3 \leq AIL(i) \leq 5$	➔	*HIGH* IMPACT LEVEL

The grid is obtained by crossing the binary values of the three indicators, thus identifying eight possible situations (figure V): each functional area can be positioned within the grid by means of the corresponding indicators values. The resulting map provides a complete description of the IS state of the art (diagnosis) and supports the identification of the possible solutions that could improve the IS performance within each functional area.

The grid boxes have very different meanings from one each other, therefore it is essential to evaluate with particular accuracy the indicators values near to the boundaries, since a little variation of these values could produce very different interpretations.

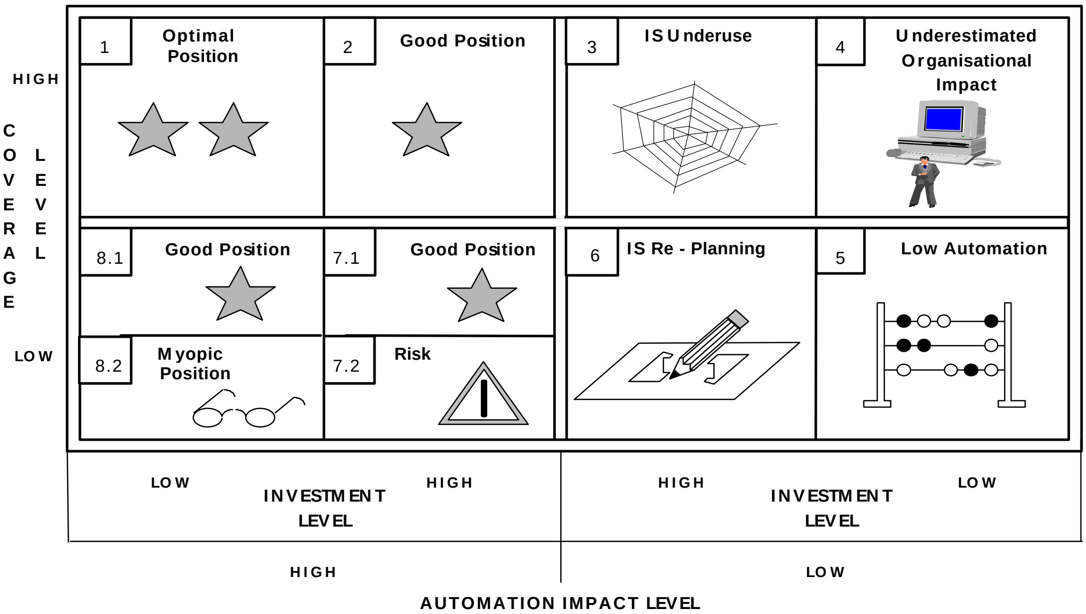


Fig. V. The ISCUM Evaluation Grid.

To better describe the positioning of the functional areas into the grid boxes, it is worth summarizing some basic concepts conforming to the meaning of the three indicators.

1. *Coverage Level*: proportional to the *efficiency* and to the *theoretical organizational impact* of the IS on each area; to respect the strategic alignment, the Coverage Level should be proportional to the *strategic importance* of each area.
2. *Investment Level*: proportional to the *extent of the IT investments and costs* for the area.
3. *Automation Impact Level*: proportional to the *IS effectiveness*, that is the perceived service level provided by the information system. The evaluation of this index strictly depends on the users opinions and estimations.

Further details on the meaning of each grid position are supplied by the IS Utilization Coefficient (*UC*(*i*)). At a first analysis this indicator shows a direct proportionality with the system service level, the presence of training activities, and the solicitation toward the system utilization. On the other hand, the values of *UC*(*i*) are inversely proportional to the users change resistance and to the turnover rate of specialized personnel. Referring to the previous procedure, the *UC*(*i*) percentage values should be translated into a two levels scale:

IV. Utilization Coefficient *UC*(*i*)	0% ≤ *UC*(*i*) < 70%	➔ *LOW* UTIL. COEFF. LEVEL
	70% ≤ *UC*(*i*) ≤ 100%	➔ *HIGH* UTIL. COEFF. LEVEL

Next sections will outline the meaning of each grid box, the reasons that could have driven a functional area in that situation, and the measures required to move it toward a better position.

Position 1: Optimal Position

From the operating point of view, the situation corresponding to Position 1 is the *optimal* situation since it represents the achievement of high results in terms of efficiency and effectiveness, with low expenses.

Areas positioned in this box do not require any action to modify their positioning, rather to maintain it. In fact, the system is subject to technological obsolescence as well as physical wear out. Actions should be therefore oriented to the constant revision of the IS, both at the technological and human resources level, taking care the corresponding expenditure level, to avoid to move the area toward Position 2.

Position 2: Good Position

The positioning of a functional area into this box should be considered a *good* result: it refers to a correct employment of the high IT investments. In such a situation, the management has considered the weight of the IS organizational impact: the high IS performance, planned for the interested area, have been effectively achieved.

This situation should not need any shifting-oriented action: if the area satisfies the strategic alignment, the activities of technological and human resources renovation will be sufficient to keep the position. In particular, if the value of the Utilization Coefficient *UC*(*i*) was not maximum, then the IT investment mix could be redefined, for example by increasing the user training activities. Otherwise, managers could try to shift the area toward Position 1 by increasing the IT expenses for that area.

Position 3: IS Underuse

This situation is characterized by high resources employment determining the automation of most activities. On the other hand, the misunderstanding of the usefulness of such resources produces a low utilization of the IS. The solution to this situation depends on the Utilization Coefficient *UC*(*i*) values.

If *UC*(*i*) was significantly lower than 100%, then it would be necessary to verify whether the users dissatisfaction (implicit in the low Automation Impact Level) is related to a low service level. In that case actions should be oriented to improve the quality of IT investments; otherwise an improvement of the system use by means of training activities could be required.

If $UC(i)$ was near to 100%, then it would be necessary to verify whether the users dissatisfaction is due to a change resistance behaviour: in that case, managers should try to stimulate the IS users.

Position 4: Underestimated Organisational Impact

This grid box could be virtually placed between positions 1 and 3: since lower effectiveness levels are achieved, its situation is surely worse than Position 1 (the optimal position), but unlike Position 3, such levels can be justified by the limited IT investments. Therefore, it may happen that the management underestimated the organisational impact of the IS in the functional areas placed in Position 4. Thus, further investments should be allocated to improve the organisational environment of such areas, for example through training activities and/or the enhancement of the software ease of use: the exam of the UC(i) value should direct the actions toward one or the other solution. The consequent effect should be a shift of the area toward Position 2.

Position 5: Low Automation

The positioning of a functional area into this grid box is subject to different interpretations.

The simplest case is symmetrical to the one in Position 2: the low IT investment Level determines insufficient IS performances. If the area satisfies the strategic alignment no corrective action will be needed.

On the other hand, if the low Coverage Level and Automation Impact Level values came from planning inefficiencies and/or low User Information Satisfaction (UIS)[6], the analysis of the Utilisation Coefficient should help understanding whether to detail the analysis (low $UC(i)$), or to consider the current situation correct (high $UC(i)$).

Anyway, actions should improve significantly the performance of at least one of the two indexes (Coverage Level and Automation Impact Level). Probably, this improvement implies an increase of the Investment Level, therefore it corresponds to a shift toward Position 3 or Position 7.1.

Position 6: IS Re-planning

The problem related to the positioning into this box is the discrepancy between the Coverage and the Investment Levels. This situation highlights errors related to both the adoption of ITs and the evaluation of its organizational impact; such errors probably determine the low service level manifested by the low Automation Impact Level.

The responsible of such a situation could be the low skill of the staff developing the system or, as it often happens within small companies, a bad management of the relationships with the hardware and software suppliers, which often provide an essential support to the entire IS development process.

The suggested therapy depends on the importance of these suppliers. If the supplier had a low influence, then the internal IS planning skills should be improved by a proper training program; otherwise, it could be necessary to review and to make corrections to the suppliers work.

The final goal is to bring the IS Potential Coverage Ratio to values adequate to the resources employed in the functional area, according to its strategic priority; that means a shift of the area toward Position 2.

The meaning of the positioning of a functional area into one of the adjacent boxes (Positions 7 and 8) depends on the quality of the Automation Impact Level assessment. Its evaluation is strongly influenced by the users perception: they could declare to be satisfied with the IS only because the tools they use are particularly sophisticated for the area in which they operate. On the contrary, their low skills or their change resistance could lead them to be satisfied with an IS that does not force them to leave their old work habits.

Therefore, the positioning into one of these boxes can be evaluated in a different way, depending on the value of the IS Utilization Coefficient: if it is high, then the perceptive component of the *AIL*(*i*) assessment match with the effective situation (i.e. the same results achieved by considering user perception, would be achieved if objective criteria were adopted).

Position 7: Good Position/Risk

7.1 ***UC*(*i*) = *high***. The high Investment Level could be the consequence of an expensive training activity aimed at exploiting the functions of a restricted IS: hence this positioning represents an acceptable situation for the area.

Moreover, if its Coverage Level were to satisfy the strategic priorities provided by the management, then the effective situation would result to be even better than it may appear from the analysis. In this case, a review of the IS planning procedure would allow the analysis to better match the effective situation.

In the other cases, it would be necessary to extend the IS, shifting the area toward Position 2.

7.2 ***UC*(*i*) = *low***. The presence of a functional area within this position implies a situation of *risk*, because of the difference between the real and the perceived qualities of the IS. The high Automation Impact Level shows that the users are satisfied with their system, while the real problem is the same as the one in Position 6: the IS inefficiency, pointed out by the disparity between the low Coverage Level and the high investment effort. If such inefficiency was not pointed out, the system could decrease its performance with an uncontrollable trend.

Once this problem has been identified, it is necessary to introduce training activities or incentives to the system utilization to bring users to a greater consciousness of the IS limits (thus shifting the area toward Position 6).

Position 8: Good Position/Myopic Position

8.1 ***UC*(*i*) = *high***. In this case the limited automation effort confirmed by the low Investment Level is consistent with the low Coverage Level, while the high Automation Impact Level is probably determined by an effective adequacy of the system to the users needs. Therefore, if the considered area did not require to increase its *CL*(*i*) value for strategic alignment reasons, Position 8.1 could be considered an acceptable situation: the therapy should simply consist in system maintaining activities.

8.2 ***UC*(*i*) = *low***. This position can be named *myopic* because of the Automation Impact Level value contradicting the limited performance of the IS, outlined by the other two indexes. In this case a reduction of the automation effort could be explained assuming it has been influenced by the incorrect users evaluation, who declare to be satisfied although the IS small dimension (if the Potential Coverage was anyway low) or scarce use (if the Potential Coverage was high). This situation seems to be dangerous because the managers do not analyse in detail the actual company’s needs. The therapy should be aimed at making more objective the decisional process that brings the management to the IT investments allocation; then, some training activities could improve the users capability of evaluating the IS performance. The objective should be a shift of the area toward Position 5. Furthermore, if the strategic priorities required an increase of the Coverage Level, it could be necessary to raise the IT investments, that means a shift of the considered area toward Position 2.

Comments

Figure VI provides a table summarizing the effects of the suggested actions for each grid position. Dotted lines represent actions that could determine meaningful changes of the Coverage Level, which require particular attention since they must be carried out according to the IS strategic alignment. Actions aimed at keeping the position already occupied are represented by targets.

It is worth noting that the considerations about the positioning of each functional area into the evaluation grid are amplified as much as the area is strategically relevant. In such case any IS problem risks to determine the decrease of the performance of the activities representing strength points of the company, threatening the strategic positioning itself. Besides, regarding those suggested shifts implying a variation in the IS coverage value, it is suggested to pay attention to the induced variations of the Coverage Level: the evaluation of the correctness of such shifts should also consider their consequences on the strategic alignment of the areas.

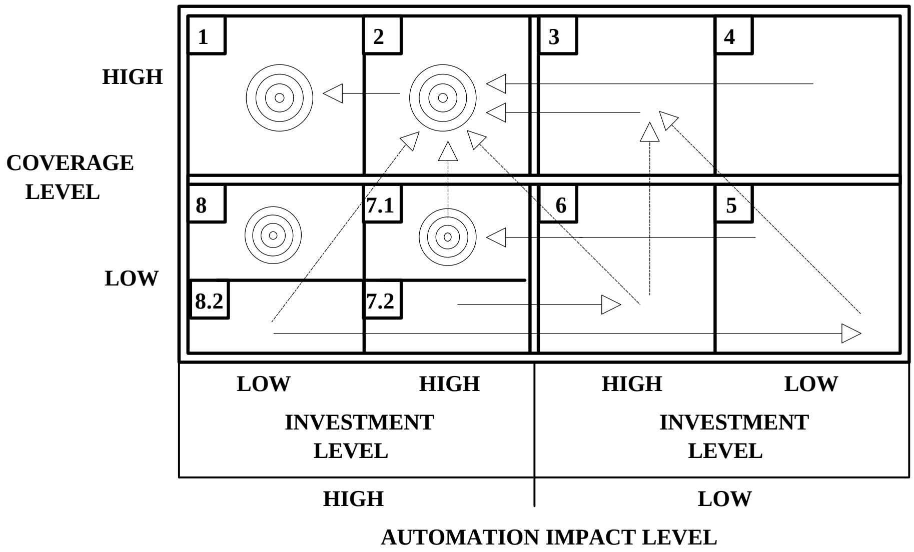


Fig. VI. Representation of the consequences of suggested actions for each position.

Finally, it is important to highlight that rather than using the expression "shift in" a position, it has always been used the expression "shift toward" a position: suggested actions identify the improvement direction, while its achievement is conditioned by the extent of such actions.

This analysis pointed out that some of the grid positions are characterized by important organizational problems (figure VII): the study of the functional areas occupying such boxes should be properly detailed in order to research the organizational problems influencing such positioning, and to achieve further suggestions for the therapy.

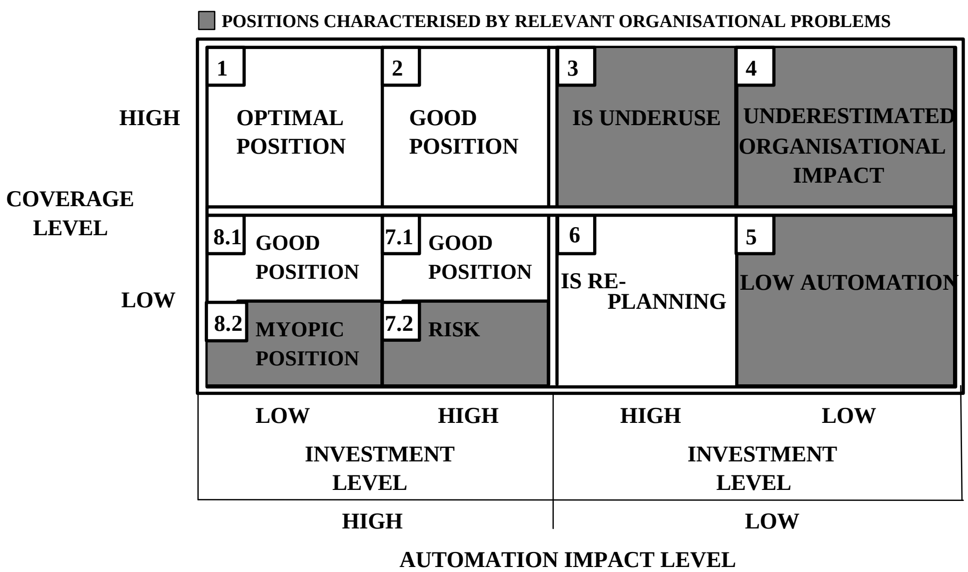


Fig. VII. Identification of the critical positions from the organizational point of view.

Evaluation of the IS development trend

While the just described check-up procedure is based on the most recent observation period (static use of the model), its last step aims at predicting the IS development trend (dynamic use of the model). This kind of analysis should be performed both from a strategic and an operating point of view.

Strategic Level: evaluation of the strategic alignment trend

This phase aims at verifying the changes occurred in the strategic alignment referring to the previous observation period by means of the histograms representing the “Coverage Level Variations” depicted in figure IV.b. The variations of $CL(i)$ should lead to the ideal situation in which the height of the histograms is increasingly lower (i.e., the strategic importance and the coverage level of a given area should be directly proportional).

The presence of IT investments aimed at aligning the functional areas according to their strategic importance is a demonstration that the company is aware of the discrepancy between business goals and IS characteristics, and has taken correct decisions to solve this problem. The distance between the present and the ideal situation measures the extent of actions yet to be done.

Operating Level: IT investment policy effectiveness trend

From the operating point of view, to evaluate the effectiveness of IT investments for each functional area, it is necessary to compare the potential and the actual coverage levels since last application of the model. The ideal situation is obtained when IT investments determine:

an increase of the Coverage Level of all the functional areas in which such investments are allocated (figure IV.b); to achieve the operating efficiency, the ideal solution would be an extension of the IS support to any possible firm activity: the need to define priorities is obviously determined by the scarcity of financial resources.

an increase of the Utilization Coefficient for all the functional areas, bringing it as near as possible to its maximum value (100%). The higher the value of $UC(i)$, the more effective will be the IT investments, with the Potential Coverage values near to the Effective Coverage values of each area. An example of variation of the Utilization Coefficient is graphically represented in figure IV.c.

The compared analysis of the histograms representing “Coverage Level Variations” and the “Utilization Coefficient Variations” (figures IV.b and IV.c) highlights the effectiveness of IT investments and the IS overall performances. The analysis of these charts should be followed by a more detailed study through the Evaluation Grid (figure VIII): the dynamic use of the model consists in examining the movement of each functional area within the evaluation grid. The above mentioned comments could help evaluating how much the change of the Investment Level of each area has induced the desired effects, eventually suggesting the proper therapy.

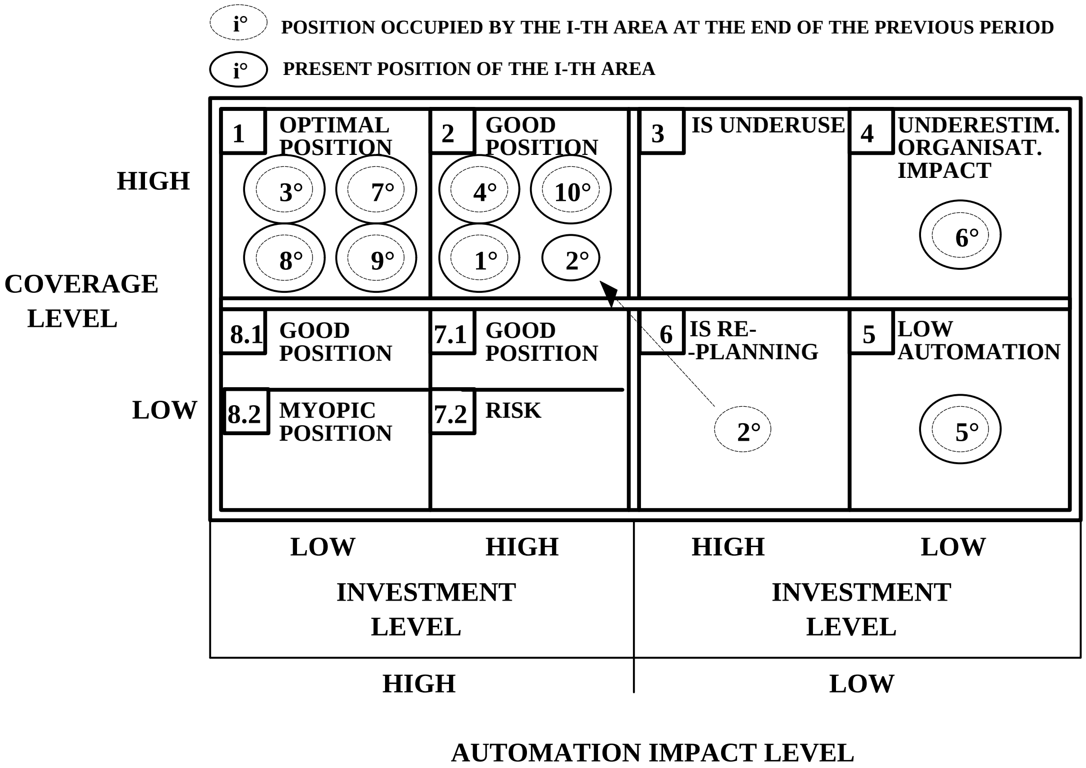


Fig. VIII. areas position changes in the Evaluation Grid regarding to the previous period.

Results

A survey within a meaningful set of companies was accomplished to verify the applicability of the ISCUM model and its significance. An application handbook and a driving questionnaire for the model application, were realised and provided to a set of SMEs belonging to the mechanical industry and located into the Province of Brescia, in Northern Italy.

The application of the IS check-up model was carried on in about half a day in each company, requiring the engagement of the EDP manager, supported by a high level manager (or the company owner himself) only during the identification of the functional areas strategic priorities.

Such a survey highlighted two main points involving the model effectiveness:

- even if it requires only few indicators and a reduced application time, the ISCUM model was acknowledged to be able to describe the present state of the IS, the associated problems and the future trends;
- the application of the model forces a SME to highlight also problems not directly related with the IS; in particular, problems associated with the organisational and strategic levels were often detected during the survey. The reticence itself, shown by the EDP managers

in admitting such problems, indicates that they are often underestimated. This side-effect result increases the usefulness of the model.

From the operating point of view, no particular problems were noticed: both the comprehension of the procedure and the collection of required data were easily understood by the involved personnel. On the other hand, the on-the-field application pointed out the possible wrong interpretation of the model results: the EDP managers sometimes showed a lack of objectivity by charging the limits of the present IS to previous managers, often minimizing any problem which should falls under their own responsibility (e.g. the IS future trends). Such an approach could compromise the entire analysis effort, not allowing the detection of wrong IS assets distribution before they become structural. In such a situation, the model therapy step could not include the actions needed to correct the IS trend, and may even make the IS situation worse than the current one.

These considerations suggest a dual utilization of the model, as shown in figure IX. On one hand, the ISCUM model provides the EDP manager with a resuming view of the system he manages. On the other hand, it also allows the company owner (or the higher level management) to obtain an objective and understandable report on the IS investment situation and on the EDP manager evaluation.

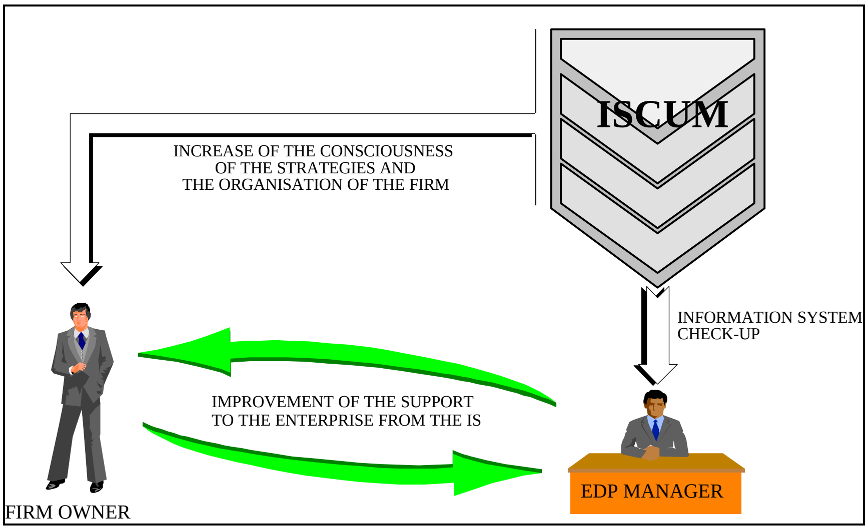


Fig. IX. Possible users of the model are either the EDP manager or the company owner (or any high-level manager).

References

Benjamin, R.; Levinson E. (1993), *A Framework for Managing IT-Enabled Change*, «Sloan Management Review», Summer 1993, 23-33.

Borovits, I.; Giladi R. (1993), *Evaluating cost/utilization of organizations' information systems and users*, «Information & Management» 25, 273-280.

Broadbent, M.; Lofgren H. (1993), *Information delivery: identifying priorities, performance and value*, «Information Processing Management», Vol. 29, 6, 683-701.

Bullinger, H.J. (1988), *La diffusione delle tecnologie informative nelle SME: aspetti strategici ed organizzativi*, in Corno, F. (curatore), *Tecnologie informatiche: nuove fonti del vantaggio competitivo*, Padova, CEDAM, 27-66.

Burk, C.; Horton F.W. (1987), *Infomap: a complete guide to discovering your corporate information resources*, Englewood Cliffs NJ, Prentice Hall.

Busetti, A. (1993), *Informatizzazione come progetto organizzativo*, «Economia & Management» 2, 42-58.

Eason, K. (1988), *Information technology and organisational change*, London, Taylor & Francis.

Henderson J.C.; Venkatraman N. (1992), *Strategic Alignment: A Model for Organisational Transformation Through Information Technology*, in Kochan T.A. and Useem M. (eds.), *Transforming Organisations*, New York, Oxford University Press.

Ives, B.; Olson, M.; Baroudi J. (1983), *The measurement of User Information Satisfaction*, *Communications of the ACM*, 785-793.

Miller, J.; Doyle B. (1987), *Measuring the effectiveness of computer based information systems in the financial services sector*, «MIS Quarterly», March 1987, 107-124.

Miller, J. (1993), *Measuring and aligning information systems with the organisation. A case study*, «Information & Management», 25, 217-228.

Nolan, R.L. (1982), *Managing the data resource function*, St. Paul, West Publishing Co.

Orna, E. (1990), *Practical information policies: how to manage information flow in organizations*, Aldershot, Gower.

Porter, M.; Millar V. (1985), *How information gives you competitive advantage*, «Harvard Business Review», July-August 1985, 149-160.

Ravarini, A.; Sciuto D.; Tagliavini M. (1994), *Valutazione dei sistemi informativi nelle piccole-medie imprese*, «Liuc Papers», 14.

Semich, J.W. (1994), *Here's how to quantify IT investment benefits*, «Datamation», January 7, 45-48.

Thompson, D. (1992), *Reorganizing MIS: the evolution of business computing in the 1990s*, Indianapolis, SAMS Publishing.

Tsuji, S. (1988), *L'uso strategico della IT nelle piccole e medie imprese giapponesi*, in Corno F. (curatore), *Il computer da strumento tattico ad arma strategica*, Padova, CEDAM, 133-140.

Notes

[1] In this paper we will call SMEs companies with less than 500 employees and an annual profit return of less than 50 million ECU (about 100 billion ITL).

[2] In this paper we assume that the strategic importance of each functional area is comparable with each other, thus it is possible to arrange them in a decreasing strategic importance order.

[3] It is important to compare this definition with the theory of the IS functional analysis. In this paper, the coverage refers precisely to the IS *dimension*, an indicator summarising the IS *extension* (the percentage of the activities of a given area supported by the IS with respect to the total), and the *width* (the extent of automation provided to each activity supported by the IS).

[4] To determine how to distribute the costs of shared resources, it is suggested to evaluate the utilisation ratio of each shared resource; the cost fraction to allocate to each area will be the product of the resource total cost and its utilisation ratio.

[5] The experiences of the model application suggested to define a range of six values, from 0 to 5.

[6] These two aspects are detailed afterwards, in the presentation of Position 6 and Position 7.2.