IMPLEMENTING INTRANET/EXTRANET
Estimate of cost – Feasibility check

Synopsis

Whether Firms/Organisations decide to install Intranet, they perceive it as appropriate stimulus to improve their production process but they cannot give for granted in advance the economic benefit of such a move. Firms/Organisations mostly adopt the new technology not only to keep competitive level in the market but also to increase the effectiveness of their business.

A rough evaluation of costs involved by Intranet/Extranet system is considered very helpful to management of Firms/Organisations during the preliminary phase of choice. It may supply significant indicators that let estimate whether the cost requested by the new technology provides returns in terms of reduction of intermediate consumption, spare of labour resources, efficiency of personnel, improvement of productivity. In other words, management can evaluate the impact of Intranet/Extranet either on the operating structures of Firm/Organisation and on the external image to the market. Following step is the calling for consultancy and the preparation of a detailed project to define the implementation strategies.

The paper tries to produce a systematic approach to cost analysis. First, a provisional list of costs is given to help separate expenses as a function of the size and of the structure of Intranet/Extranet system: the presentation is, on purpose, general as to support possible selection of the appropriate items, case by case. Second, a simple model is developed which lets estimate total expected annual cost of systems, the average cost per user connected, the optimum number of users. Third, as costs are known, a "reference" economical benefit is estimated for the system assuming Intranet/Extranet as a stand alone system and imposing the condition that the system repays, over its lifetime, its own cost.

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1. Introduction

Intranet/Extranet are dedicated communication systems technologically developed so that, once introduced into the productive structure of an Organisation, may significantly affect the existing working procedures and may change the existing strategies of production process. Intranet/Extranet projects may give satisfactory return when they are supported by accurate plans of expansion and updating as to keep alive the interest of users

The promotion

The promotional basic messages that consultants usually address to their potential clients to support the adoption of the new technology, rely upon two significant concepts:

1. Intranet system lets automate working process;
2. Intranet lets deliver information, in real time and at low cost, to a large number of people even geographically dispersed;

Since the points above are very simple and general, as promotion must be, they are prudent and fundamentally true. Intranet lets inform a large number of people more quickly than the circulation of verbal or printed communication. And the relevant cost is limited as, by Intranet, reaching 100 people is not more expensive than reaching 1000.

Most Organisations perceive the inefficiency of their current procedures so that they accept the challenge of new technology from which they expect, at least, to get more labour efficiency through the rationalisation of their existing working procedures.

The investment

To justify investment necessary to install Intranet or Extranet, promotion adds that Intranet creates new value to Organisations, reduces costs and increases productivity.

When quantifying such benefits reference is made only to the improved ability to communicate: faster access to documents and information can reduce costs either in terms of time spare (speeding up procedures) and labour savings (better use of working time) but has nothing to do with productivity. Since productivity is the contribution to total revenue by a production factor (capital, labour) current literature is improperly using productivity instead of efficiency.

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The benefit
Another improper interpretation of existing literature is that the feasibility of Intranet/Extranet can be checked by analysing relevant capital and operating expenses as if it were a stand alone system; instead, as final output produced by a Firm depends from its organisational structure and from market behaviour, to evaluate the impact of the new technology upon the production process, expenses (capital + operating) and revenue (benefits) of the system should be included into Firm's budget as part of it. Economic advantage and derived productivity should be evaluated case by case: for instance it is expected that economic savings may represent a significant benefit to Organisations engaged in studies and research where the use of time is essential, but Firms producing goods cannot rely on it in case unless Intranet/Extranet is part of the main production chain.

2. **The cost-benefit analysis**
Frequently, especially in case of small enterprises, the analysis of costs and benefits produced by installing Intranet is considered useless, provided that:

- basic benefits of Intranet are accepted without evidence;
- if the solution for Intranet is cheap there is no need for check;
- Intranet is considered as a basic tool, like fax and word processing;

Whoever thinks so forgets that Intranet, with its technology, is taking fundamental cultural changes in the working process and that all the facilities supplied to the users of a Firm or of an Organisation come within this new frame.
There is, as well, a negative impact carried on by the new technology: as Intranet/Extranet provide time and labour savings, Firms/Organisations may realise redundancy in personnel. In this case, they can rebalance their production factors (capital and labour) by reducing personnel: the move lets them actually increase labour efficiency and improve profit.

3. **Approach to cost**
As a first exercise, we calculate in the following, the annual cost of Intranet taking into account the size of the LAN (number of users), the reference network structure and the number of features we want the system to provide. In this preliminary step we assume Intranet as a stand alone system so that we can consider only capital and operating expenses necessary and sufficient to install and to run the system itself. Total cost to create Intranet will involve fixed expenses to purchase equipment and variable expenses to support and manage the necessary software. We assume that:

- Capital costs are the purchasing costs of hardware and software. They are part of the Firm's budget and, normally, written off over a period of 4/5 years ahead;
- Operating costs involve the cost of a specific management team necessary to run the

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system and to provide promotion and training to users

Capital expenditure

The expenditure relates to the purchasing and installation costs of all those equipment necessary to create the Central Unit (Web server) and the interface with users (basic software). Depending upon the supply used (external consultancy or home made system), expenses may vary over a wide range so that a proper assessment of investment can be done only on a case by case basis. Figures below are tentative cost to fix ideas and to help understand the process of setting up a cost analysis.

Description	Investment	Annual cost
Web (hardware + software)	37500	9375
Operating system		
E-mail server	5000	1250
Database	62500	15625
Information publishing (application)	42500	10625
Document (applications)	75000	18750
Training (application)	22500	5625
Workflow (application)	52500	13125
Discussion (application)	15000	3750
Design consultancy	50000	12500
Total capital cost	362500	90625

The cost relevant to operating system was left empty. Whether Operating system were Linux/Unix its cost relates to the installation only as the system is, usually free of charge.

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Annual expenses relevant to capital recovery depend from the current interest rate and from the lifetime of plant: to simplify calculation capital is supposed to be recovered within 4 years at equal rates of 90625 (0,25*362625)

Operating expenses

The expenses relevant to manage, maintain and update an Intranet system refer, in general, to the cost of a special editorial team which has to be appointed recruiting skilled people either from work market or from own personnel, possibly with external support of Provider. Among the tasks the team has to comply with, there are:

- decide intranet policies
- take care of content to properly serve the users;
- keep Intranet efficient
- provide technical assistance;
- plan connections out to Internet.

The charge of "policy" activity within the tasks of management team, has the objective of smoothing possible resistance, in different sector of the Organisation, for the users to share products and solutions among them; that is, to avoid the creation, in the Organisation, of cultural islands which do not fit into the Enterprise working organisation. The minimum number of personnel necessary to provide a flexible working area is the following:

Description	Number of people	Annual cost
Editorial personnel	2	48000
Technical personnel	2	48000
Promotion	1	24000
Total	5	120000

Individual expenses

Among other costs, chargeable to the system, there are some other operating costs which refer to a single line connected: the expenses cover, other than terminal PC and individual line, the "e-mail" facility for internal communications, the "training on line" to let users gradually familiarise with internal communications, searching/retrieving documents or recalling and using applications, the "access to Internet" to connect users with external systems.

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Description	Initial cost	Annual expenses
Cost of a new PC	1500	375,0
Unit cost of line ($/m)	48	12,0
E-mail (per line)	100	25,0
Training (per line)	100	25,0
Internet access (per line)	100	25,0

A separate consideration is given to the unit cost of the line (12 $ per meter of length) that connects users to Web site. The cost of individual line might easily be considered as an average individual cost by assuming that users are all located at an average length from the Web Server within the premises of the Firm. But, since the distribution of users might not be uniform, the connection of users to Central Unit is, in the following, considered as a stand alone cost and is calculated as a function of users connected.

4. Cost of Intranet system

Total cost of an Intranet system is assumed to be the sum of three terms. The first one is constant and relates to all those costs independent from the number of users, the second one is variable and proportionate to the number of users, the third one concerns the individual line and the terminal equipment of a single user. Reference is made to figures of cost in para 3.

The reference structure

A reference structure of plant is necessary to simplify calculation of the term relevant to the junction network users-Web. The simplest model is a circular area, whose radius is "R", where the Central Unit is placed at the centre and the users are distributed over the surface with a density _ (users/squaremeter).

Fixed capital cost

The cost of basic structure (hardware and software) is represented as:

$$C_A = (A_1 + A_2 + A_3 + A_4 \ldots\ldots + A_i)$$

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where A_i groups all capital costs necessary to provide hardware and software of system and corresponds to the sum of all expenses independent from the size of Intranet. Total investment are: 362500 \$; the corresponding annual expenses are 90625 (= 362500*0,25).

Fixed operating cost
The operating cost of personnel necessary to run the system and provide facilities to users is:

$$C_B = (B_1 + B_2 + B_3 + B_4 \ldots\ldots + B_i)$$

where B_i groups all operating cost involved by the system and corresponds to the sum of all annual expenses relevant to the team in charge of running Intranet. Total expenses, including promotion, account for 120000 \$/year. The amount adds up to the operating expenses of the Firm when the team or the consultancy is supplied by the Provider, it is, instead, already included into the operating expenses of the Firm if the team is recruited from own personnel.

Individual cost
Relevant annual expenses relate to number "N" of users and account for the cost of a new PC (375 \$), the cost for training facility (25 \$), the cost of e-mail (25 \$), the cost to access Internet (25 \$). Total annual individual cost is, then:

$$C_I = 450*N$$

The cost of network
To calculate the cost of network we assume that users (or points of use) are scattered over the reference circular area in the premises of the Organisation, The distribution of terminal users over the circular surface is given by the density:

$$\_ = dN/dS = N/\_R^2 \qquad\qquad\qquad lines/sqmeters$$

If the unit cost of line is c_L the cost of junction network (integration 0 to R) is:

$$C_N = \_ c_L *2 * \_\_*xdx = (2/3)* c_L*\_\_*R^3 = (2/3)* c_L*N^{3/2}/(\_\_)^{1/2}$$

For a unit cost of line of 12 \$/m, total cost to connect users to the system is:

$$C_N = 0,6667* 12*N^{3/2}/(\_\_)^{1/2} = 0,6667*12*\_*R^3$$

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Total final cost

Total final cost is the sum of fixed, variable and network costs. That is:

$$C_F = 210625 + 450*N + 8* N^{3/2}/(\_\_)^{1/2} \qquad\qquad (1)$$

In case of 1000 users, total cost is:

$$C_F = 210625 + 450000 + 451352 = 1.111.977 \ \$$$

The formula (1) can be used to estimate the average cost:

$$c_I = C_F/N = 210625/N + 450 + 8*(N/\_\_)^{1/2} = 1111,98 \ \$/user$$

As well as the optimum radius (minimising network cost):

$$R_0 = (2*210625/\_\_ * c_L)^{1/3} = 55,14 \ m$$

or the optimum number of users:

$$N_0 = \_\_ * (R_0)^2 = 955 \ people$$

5. Application of model to Intranet (Annex 1)

A graphical exercise, made to show the flexibility of model proposed, is given in **Annex 1**. There, using the above formulas, the optimum surface and capacity of an Intranet system is calculated as a function of two variables: the radius of the area covered by Intranet and the density (users average distribution over the area).

The first graph illustrates how average cost varies, as a function of radius, in case the density is fixed at 0,1: the optimum radius corresponds to data above. It is about 55 meters for a surface of 9500 squaremeters (_ = 1000/9500= 0,1053) corresponding to about 955 users.
The second graph assumes the same cost separation but allows density to vary from 0,1 (already tested) to 0,5. The curves that summarise the exercise show an inverse ratio between the size of Intranet area and the density of employees distribution; that is, radius decreases as long as density increases. The model can be used to design the internal network either facing the first implementation and future expansion of the system.

6. Cost of Extranet system

When two or more groups of people, already served by Intranet system, have common

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working interests an Extranet system can be implemented by connecting together Intranet areas. In this way, different Organisation far located or far sites of same Company can develop projects and production processes in co-operation enjoying the same facilities and the same benefit provided by Intranet. The resistance of personnel to accept the new technology is still fundamental for the success of Extranet system. But, while this appears relatively easy to solve within the same Company, the harmonisation of different working cultures in case of different Organisms involved might need additional "policy" efforts. Again, we can say that the new tool will have a severe impact on the organisation of production processes.

The reference structure

The network scheme for Extranet is made by a set of Intranets areas connected together. Extranet allows project teams that develop collaborative projects, to communicate through discussion sites, to have access to e-mail, message board, file transfer, and directory listings with the objectives of speeding up production or study projects. If the area covered by an Intranet is assumed to be a circle, Extranet can be represented by a number of circles linked two by two in a star configuration. The advantage of the scheme is that when calculating the cost of Extranet, it will, theoretically, be composed by two parts: the sum of cost of "n" identical Intranet systems and the sum of cost of "n-1" links (star configuration) whose capacity is proportionate to the traffic flow. The cost analysis may be referred either to a whole system of "n" Intranet areas installed simultaneously or, alternatively, to an existing Extranet system which expands by addition of a new Intranet area.

Simultaneous installation

The reference structure of the system is represented by "n" Intranet systems connected in a star configuration to a central Intranet system. The parameters to define are: the distances from the star Centre "D_i" (length of junctions); the unit cost "c_j" (cost/km) of a link; the number of users per Intranet system "N_i"; the radius "R_i" of a single Intranet area.

Total cost of system is given by summing up two terms: the first one corresponds to the cost of "**n**" Intranet systems and characterised by functions like the (1), the second one is the cost total of "**m**" junctions over the public network.

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If the cost of a junction connection is c_j, we get:

$$C_E = \_(A_n + B_n*N_i + 0{,}667*c_L*(N^3/\_\_)^{1/2}) + \_ D_i * c_j \qquad\qquad (2)$$

The average unit cost is obtained when dividing C_E by the number "n" of Intranets areas connected and by total number of users "N":

$$c_E = (1/n)*\_(A_n/N_i + B_n + 0{,}667*c_L*(N/\_\_)^{1/2}) + \_ D_i * c_j /(n*N)$$

Whether for example, we assume for the Extranet structure "n_o" Intranet equal areas, all with the same radius "R_o" and equal number of users "N_o", connected by "m_o" junctions, all with the same distance "D_o" from the Centre, then we obtain the total simplified cost:

$$C_E = n_o* (A_o + B_o*N_o + 0{,}667*c_L*(N_o^3/\_\_)^{1/2}) + m_o*D_o*c_j \qquad\qquad (2')$$

And the average corresponding cost:

$$c_E = A_o/N_o + B_o + 0{,}667*c_L*(N_o/\_\_)^{1/2}) + m_o D_o* c_j /(n_o* N_o)$$

As an example, for an Extranet connecting 5 (n_o) Intranet system, whether the cost of an Intranet area is given by the (1), and the number of users N_o is 1000, total cost of Extranet, implemented over national territory (Italy e.g.) with $D_o = 300$ km; $m_o = 4$; $c_j = 200$ \$/km is:

$$C_E = 5*1111977 + 4*300*500 = 6159885 \text{ \$}$$

The average cost of Extranet per user becomes:

$$c_E = 1111{,}97 + 120{,}00 = 1231{,}97 \text{ \$/user}$$

Whether Extranet is implemented to connect Intranets belonging to different countries, all figures given above vary and the calculation should be made case by case. Whether only the cost of circuit changes we may get, in case of Europe:

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$$C_E = 5*1111977 + 4*300*600 = 6279885 \text{ \$}$$

$$c_E = 1111,97 + 144,00 = 1255,97 \text{ \$/user}$$

and in case of Africa:

$$C_E = 5*1111977 + 4*300*900 = 6639885 \text{ \$}$$

$$c_E = 1111,97 + 216,00 = 1327,97 \text{ \$/user}$$

With respect to reference solution (same territory) and under the working hypothesis made, the exercise shows an increase of 11% in case of Extranet within European countries and an increase of 19% in case of connection to Africa.

Additional installation
The system starts, this time, from an original structure where "n-1" Intranet areas are connected together. To estimate total and average cost of existing Extranet system we use same procedure above: for the "n-1" Intranet areas are known: the cost of each Intranet system, the distances from the star Centre "D_i" (length of junctions); the unit cost "c_j" (cost/km) of a link; the number of users per Intranet system "N_i"; the radius "R_i" of a single Intranet area.
The parameters of new Intranet, which adds up to the existing system, are: the number of users served "N_j"; the radius "R_j" of the area; the length of connection "D_j"; its cost "c_j".

Whether we assume, as per previous example, for the Extranet structure "n_0-1" Intranet equal areas, all with the same radius "R_0" and equal number of users "N_0", connected by "m_0-1" junctions, all with the same distance "D_0" from the Centre, the resulting cost of the whole system is the sum total of three terms. The first one is he cost of "n_0" Intranet areas:

$$C_I = n_0* (A_0 + B_0*N_0 + 0{,}667*c_L*(N_0^3/\_\_)^{1/2}) \qquad (3a)$$

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The second one is the cost of total junctions:

$$C_J = m_o * D_o * c_j \qquad\qquad (3b)$$

And the third one is the cost to expand capacity of existing junctions to match the new expected traffic:

$$C_J = (m_o-1) * D_o * c_j \qquad\qquad (3c)$$

As an example, for an Extranet connecting 5 (n_o) Intranet system, whether the cost of an Intranet area is given by the (1), and the number of users N_o is 1000, total cost of Extranet, implemented over national territory (Italy e.g.) with $D_o = 300$ km; $m_o = 4$; $c_j = 100$ \$/km is:

$$C_E = 5*611625 + 4*300*100 = 3178125 \text{ \$}$$

The average cost of Extranet per user becomes:

$$c_E = 611{,}625 + 24{,}00 = 635{,}63 \text{ \$/user}$$

Whether Extranet is implemented to connect Intranets belonging to different countries, all figures given above vary and the calculation should be made case by case. Whether only the cost of circuit changes we may get, in case of Europe:

$$C_E = 5*611625 + 4*300*150 = 3238125 \text{ \$}$$
$$c_E = 611{,}625 + 36{,}00 = 647{,}63 \text{ \$/user}$$

and in case of Africa:

$$C_E = 5*611625 + 4*300*500 = 3658125 \text{ \$}$$
$$c_E = 611{,}625 + 120{,}00 = 731{,}63 \text{ \$/user}$$

With respect to reference solution (same territory) and under the working hypothesis made, the exercise shows an increase of 1% in case of Extranet within European countries and an increase of 15% in case of connection to Africa.

7. Total expected benefits: the IRR estimate
A tentative measure is obtained by using the process of calculating the Internal Rate of Return

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of a system as stand alone; as the cash-flow is produced by the difference of investment, operating costs and benefits, the method lets evaluate revenue as a function of known costs and of a reference IRR. Two basic exercises were made over a period of 4 years: in the first, operating personnel was supposed to be recruited externally so that its cost was fully charged to operating expenses. The second accounts for operating personnel recruited from internal existing labour resources so that relevant cost was considered already included in the labour expenses of the Organisation.

Total Intranet benefit **(Annex 2)**
Reference is made to Annex 2 where the Internal Rate of Return is calculate and a Sensitivity Analysis was added as to explore all possible variation of final results.

Case: 1000 users distributed over a surface of 10000 m^2
To build up the IRR table, it was assumed that fixed capital corresponds to investment for Web server and for individual tools, capital expenses are the 25% of fixed capital (recover in 4 years), operating expenses include cost of management team for Intranet and 5% of fixed capital for maintenance. Revenue have been fixed as to produce an IRR = 0% thus meaning equality between cost and revenue over the lifetime of system. To obtain this result revenue should be 960000 $ per year which corresponds to about 3% saving:

$$960000 / (1000 * 25000 / 0,8)$$

calculated over total operating expenses of Firm/Organisation.
To check the output of reference solution, the variables (capital, operating cost and revenue) were supposed to vary within a range of –20% to +20% (Table 2 and Graph 3).
With reference to original figures, an increase in revenue or a decrease in fixed capital would take the system to a profit (revenue greater than capital and operating costs) while changes into the operating expenses would produce significant variations only at 20% decrease.
For example a decrease of 10% in fixed capital would give an IRR of 7%: capital would be recovered within 4 years and an economic advantage of 7% would result. In a similar way, a 5% increase in revenue (savings) would produce an IRR of 4%: again, capital would be recovered within 4 years and an economic advantage of 4% would appear.

Total Extranet benefits **(Annex 3)**
Case: 5 Intranet (as above) connected. 4 external junctions
To simplify calculation the working hypothesis was assumed that the Intranets connected are identical: so, each area has 1000 users and 10000 m^2 surface. The external network has a star configuration and the 4 junctions have an identical length of 300 km (distance of external Intranet from the Central one; cost 200 US$ per km)).
Fixed capital listed in Table 1 is 5 time the fixed capital of one Intranet: it includes the

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investment for web server and individual tools. Capital expenses are the 25% of fixed capital (recover in 4 years). Operating expenses include: 5% of fixed capital for maintenance of the system, 5 times the cost of a management team and the cost for renting the 4 junctions which connect the Intranet areas (4 * 300 * 200).

To produce an IRR = 0% (equality between cost and revenue over the lifetime of system) a revenue of 6250000 is necessary which corresponds to 4% saving:

$$6250000 / (5000 * 25000 / 0,8)$$

calculated over total operating expenses of Firm/Organisation.

A sensitivity analysis was added to explore economic results when the variables capital, operating cost and revenue change within a range of –20% to +20% (Table 2 and Graph 3).

With reference to original figures, an increase in revenue or a decrease in fixed capital would take the system to a profit (revenue greater than capital and operating costs) while changes into the operating expenses would produce significant variations only at 20% decrease.

For example a decrease of 10% in fixed capital would give an IRR of 7%: capital would be recovered within 4 years and an economic advantage of 7% would result. In a similar way, a 5% increase in revenue (savings) would produce an IRR of 4%: again, capital would be recovered within 4 years and an economic advantage of 4% would appear.

Final results are very close to those obtained previously and this depends from the working hypothesis assumed of connecting 5 identical Intranet areas with identical structure and costs.

8. Conclusions

Looking to an Intranet system think, for a moment, to existing users and to their possible increase over time: they tend to expand and to change density moving, regularly or irregularly their configuration. As well the equipment to match the growth of clients has to expand over time according to a discontinuous law passing through different configurations.

The economic aspect of such a dynamic move, drives to the following question: assuming, during a given period, that users increase according to an expected path, which are the most economic sets of successive implementation of equipment?

Within this scenario, the first step to do is to analyse all possible configuration that the system can assume and proceed to analyse costs, independently from the real opportunity and from the more adequate implementation of the system. All this by making recourse to schemes and models simple and representative.

The careful inspection of all the phases of development of the equipment and the knowledge of fundamental lows that regulate the mechanism of costs, supply a first valid instrument to move further for a consistent design of the system.

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