Feasibility check of Intranet/Extranet

Synopsis
Intranet is defined as a network of heterogeneous calculators connected, within a local area, by reliable transmission links: in particular, it is a dedicated computer system built inside a Firm/Organisation that uses Internet technologies to connect employees among them.
Extranet is the linking, over public network, of two or more Intranet systems that facilitates the communication among areas far located (same Company or different Firms & Organisations) which support the same production process.

Both systems are conceived as to become the primary way for employees to obtain work-related documents, share knowledge, co-operate on projects, access training, learn Company news. As Intranet and Extranet become an important part of working activity into a Firm, their utilisation can significantly change the existing working culture

Because of their effects, such innovations should not always be introduced taking as granted the Suppliers' promotion. Intranet/Extranet are, in fact, presented as stand alone systems whose expected benefits would let recover, at least, their own cost over their lifetime. The assumption is mainly based upon the evaluation of benefits in terms of time and work savings which is not always easy and immediate to quantify.

So, the paper tries to produce a basic approach to feasibility analysis in case of introduction of Intranet/Extranet system into the operating structure of a Firm. First, a main separation of costs is given to help evaluate fixed and variable expenses as a function of size and structure of Intranet/Extranet system. 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 a "reference" economical feasibility is estimated, through the IRR model either assuming Intranet/Extranet as part of the general budget of Firm and as a stand alone system.

CONTENTS

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The introduction of Intranet/Extranet into the working structure of Firms might produce significant cultural changes into the existing organisation of their production process. The new technology, in fact, may modify the completion of tasks, the organisation of tasks into processes and the framing of those processes into standard procedures. Thus the Firm, either on its own or together with a selected Supplier, should think to adopt Intranet/extranet by preparing a plan where main objectives and actual indicators are defined as a function of economic final results (improve labour efficiency; increase profits) wanted.

1. **The phase of planning**
The features to demand to an Intranet/Extranet system depend upon the complexity of applications wanted. A number of decisions should be taken in advance to approach the gross design of the system to install and to have a base of discussion between Supplier and Client.

Basic objectives
It is necessary to define, into details, short and medium term objectives that the Firm wants to achieve (server is intended for internal and/or external communications; server must be connected to main database; server will be shared by part or by all departments of Firm; etc)

Size of the system
The number of users who will benefit from the new technology is an essential indicator to decide. It is, in fact, important to optimise labour resource within the lifetime of the system to ensure that organisation of work will not suffer unwanted shortages.

2**. The phase of decision**
The preliminary analysis above is necessary to decide the best way to match the production activity (goods, services, research) by the new technology. In this phase, the consultant has to return back a public image of the Firm/Organisation, has to re-design the internal circulation of information, has to suggest new flow of documents, has to estimate fixed and operating cost, has to show the possible benefits.

The Web content
To catch the attention and the interest of users, web pages need to be constantly changed as to provide new and updated content. So the Server must be designed, already from the beginning, with the necessary flexibility to vary content frequently. A special team, possibly from internal resources, should be provided for this purpose.

Maintenance
To face critical conditions of the system a dedicated team should be appointed. In case of internal resources, selected people must be sufficiently skilled as to be able to change the server's configuration if needed. Different solution can be explored: like to ask the Supplier of the system to train internal team or to take over maintenance activity.

Project management
Firm/Organisation have to appoint a counterpart who, face to consultant, is responsible for taking technical decisions, is involved in the selection of the contractor and has the duty for completing the project together with the Supplier.

3. **The phase of implementation**
To position and complete the analysis of Supplier, Firm/Organisation have to inform about the applications they would like to include into the main platform. So they should specify, for instance, software, operating system, applications, database wanted. Important, in this context, the specification of the characteristics of final users (production, research, services).

The Web
The Web site is the main Unit of the system. It is a fixed infrastructure that must be installed under its total capacity. Main components of a web are:

- the **web software** to store documents, sends back files or executes programs on request.
- **Hypertext Markup Language** (HTML) code to format text and move to other pages.
- A **graphic editor** to manipulate images and save them into proper file formats.
- A tool to **check links** to ensure that they are still valid.
- A tool to **trace access of users to files** recording IP address of origin, the date and time of the connection, the pages requested.
- an **animation tool** for producing video special effects.
- A **search engine** to find information and documents in the web.
- **IP desktop applications**, such as browser, e-mail, training, workflow, etc.
- A "**help applications**" client-oriented that expands web functions.

The facilities provided
The Web software is adapted to the company's needs either at the level of storing and maintaining data and at the operating level, where users put forward questions, research particular files, recall office automation supports, organise their working plan, interact with internal and external points. Through their individual line users can:

Access internet
Access central database
Access other nodes.
Access web site

The management team
A group of people is necessary to run the system: it decides how and when Central Unit has to store different version of documents and relevant manipulation. The smallest effective Web team has 3 people: the designer, the technical expert and the manager. Ideally, a Web group should have at least 5 people or more as follows:

The HTML Specialist which is considered the easiest task to perform;
The designer for image manipulation
The programmer *database access and e-mail functions*
The system/Database Administrator to care of Web configuration, revision, maintenance;
The manager with effective task management process.

The management team has the further objective of smoothing possible resistance, in different sector of the Organisation, of 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 will of optimising efficiency.

Updating the system
The potential of a Web site depends upon its regular updating. As the system has to provide a flexible working area always easy to access it is necessary to appoint another group of people in charge of keeping its validity over time and to improve interaction with users by continuous revision. In particular, the following basic facilities are of interest to employees as they get a continuous re-organisation of documents in terms either of tasks and processes.

Tracking documents – The control of documents produced facilitates management of files. When different version of documents under implementation are adequately marked (changes made, users visiting the files, dates and times of access) in the memory of Central Unit, employees can avoid making their own final provisional version.

Restricting access – When implementing a new process or studying a new project, the system must have the ability to let only selected group of users to access appropriate files: in this way, they can carry on their work, independently from other users, in a protected area.

Updating files – To avoid losing time or losing files, it is necessary to prevent employees to modify the same files at the same time. Users can have access to documents in the central Unit only under authorisation. When an updated and checked document is stored, then only the reading access to that file is usually allowed.

Growing of files – Since the number of managed files is assumed to increase over time, an efficient indexing and searching system must be available. Any new document/file added must, then, be classified, indexed and recorded as to facilitate, at any time, searching and retrieval.

4. Connection of far Intranet systems

The logical extension of Intranet, in a Firm, is to let other Firms/Organisations, pursuing same business interests, access own Intranet, over the public network, even under partial and controlled way. It is seen as a significant advantage since the communication among different Firms-Organisations might be as important as the communication among members of same Organisation: from practical point of view, the “expansion” of Intranet can help group of employees exchange documents and experience within a larger group of other people.

The establishment of an Extranet among different Entities involves two significant organisational moves: the protection of privacy over public network and the harmonisation of working procedures (storage of data; working process). From human point of view, as Extranet might involve two different working cultures, the working procedures should possibly turn uniform as to get the benefit of increasing labour efficiency.

5. Approach to cost

Annual cost of Intranet/Extranet accounts for the size of the LAN (number of users), the reference network structure and the number of features requested to the system. Total cost to create Intranet/Extranet will involve, other than individual expenses, fixed expenses to purchase equipment and variable expenses to manage the necessary software. In particular:

Capital expenditure
Capital costs are the purchasing costs of hardware and software. They are part of the Firm's budget and are, normally, written off over a period of 4/5 years ahead; the expenditure relates to all those equipment necessary to install 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. Annual expenses relevant to capital recovery depend from the current interest rate and from the recovery period chosen.

Operating expenses
Operating expenses involve the cost for specific teams in charge of editorial, maintenance, management, updating. The dedicated skilled personnel is recruited either from external market or from own personnel. Particular tasks are:

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

Network expenses
To simplify evaluation of network expenses, it can be assumed that users are distributed over a regular surface within the premises of the Firm: employees are connected to Central Unit by individual lines whose length depends upon their location in the area.

Individual expenses
Relevant 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, the "access to Internet" to connect to external users.

6. Annual cost of Intranet system (Annex 1)

Total annual cost of an Intranet system is assumed to be the sum of three terms. The first one (capital cost) is constant over the study period and relates to all those costs almost independent from the number of users, the second one (operating cost) is proportionate to the number of users, the third one (individual cost) concerns the line and the terminal equipment.
To account for the network, the premises of Firms/Organisations were figured as a circular area over which employees are distributed. At the centre is the Web server; users, with their individual terminations, are connected to the centre by junctions whose length ranges from 0 to the radius "R" of the area.

Capital cost - Investment necessary to introduce Intranet system are usually derived from the purchasing and installing cost of dedicated equipment. The cost of basic structure (hardware and software) is represented as:

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

where ΣA_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.

Relevant annual expenses are the annuities necessary and sufficient to recover the capital within the lifetime of the system installed.

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

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

where ΣB_i groups all operating cost involved by the system and corresponds to the sum of all annual expenses relevant to the teams in charge of running Intranet. Unit cost per line operated is c_B (= C_B/N). The amount adds up to general operating expenses of the Firm when the team or the consultancy is provided by the Supplier; it is, instead, already included into the operating expenses of the Firm if the team is recruited from own personnel.

The cost of network
The distribution of terminal users over the circular surface is given by the density:

$$\delta = dN/dS = N/\pi R^2 \qquad \text{lines/sqmeters}$$

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

$$C_N = \int c_L * 2 * \pi\delta * x dx = (2/3) * c_L * \pi\delta * R^3 = (2/3) * c_L * N^{3/2}/(\pi\delta)^{1/2}$$

Individual cost
Relevant annual expenses relate to number "N" of users and account for the cost of a new PC, the cost for training facility, the cost of e-mail, the cost to access Internet. If the sum total of these facilities is c_I per line, total annual individual cost is:

$$C_I = c_I * N$$

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

$$C_F = \Sigma A_i + (c_B + c_I) * N + (2/3) * c_L * N^{3/2}/(\pi\delta)^{1/2}$$

Annex 1 provides an exercise of cost calculation using formulas given above. A detail of average cost and of its components is given in graph 1 which accounts for a density of 10%. Final average cost is shown in graph 2 of same Annex for densities of 20%, 30%, 40%, 50%.

7. **Annual cost of Extranet system**

When two or more groups of people, already served by Intranet system, have common working interests an Extranet system can be implemented by connecting together Intranet areas. In this way, different Organisations 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 reference structure
The network scheme for Extranet is made by a set of Intranets areas connected together. If the area covered by an Intranet is assumed to be a circle, Extranet structure 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 "$\mathbf{D_i}$" (length of junctions); the unit cost "$\mathbf{c_j}$" (cost/km) of a link; the number of users per Intranet system "$\mathbf{N_i}$"; the radius "$\mathbf{R_i}$" 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.

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:

$$C_E = n_o * (C_A + c_B * N_o + 0{,}667 * c_L * (N_o^3/\pi\delta)^{1/2}) + m_o * D_o * c_j$$

And the average corresponding cost:

$$c_E = C_A/N_o + c_B + 0{,}667 * c_L * (N_o/\pi\delta)^{1/2}) + m_o\, D_o * c_j\, /(\, n_o * N_o)$$

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 "$\mathbf{D_i}$" (length of junctions); the unit cost "$\mathbf{c_j}$" (cost/km) of a link; the number of users per Intranet system "$\mathbf{N_i}$"; the radius "$\mathbf{R_i}$" of a single Intranet area.
The parameters of new Intranet, which adds up to the existing system, are: the number of users served "**Nj**"; the radius "**Rj**" of the area; the length of connection "$\mathbf{D_j}$"; its cost "$\mathbf{c_j}$".

Whether we assume, as per previous example, for the Extranet structure "n_o-1" Intranet equal areas, all with the same radius "R_o" and equal number of users "N_o", connected by "m_o-1" junctions, all with the same distance "D_o" 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_o" Intranet areas:

$$C_I = n_o * (A_o + B_o * N_o + 0{,}667 * c_L * (N_o^3/\pi\delta)^{1/2})$$

The second one is the cost of total junctions:

$$C_J = m_o * D_o * c_j$$

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

$$C_J = (m_o\text{-}i)*D_o*c_j$$

8. **Measuring benefits** (**Annex 2**)
Intranet/extranet may help saving money by reducing recourse to traditional facilities and may let additional savings in terms of time and labour as the system can provide more efficient time-consuming processes. Existing literature separates the benefits provided by Intranet/Extranet systems into three kind of savings: the first one relates to direct reduction of intermediate consumption, the second one accounts for the shorter time necessary to complete tasks and the third one is an increase in labour productivity. That can appear through an example (**Annex 2**) where the Budget of a fictive Telephone company is analysed under various hypothesis.

Intermediate consumption
The hypothesis is assumed, here, that the recourse to all those facilities necessary to produce and circulate documents/information corresponds to almost 10% of salaries paid. Great part of intermediate consumption relate to telephone (78%) that allows informal contacts inside and outside the Firms/Organisations; remaining expenses concern office supply, paper and courier by which documents (internal phone book, manuals, requisition forms, marketing material) are printed, photocopied, distributed or mailed.

According to some examples, provided by existing literature, the introduction of Intranet lets save almost 20% of expenses relevant to intermediate consumption. The benefit, once quantified, directly enters final balance as positive addendum. The effect is shown in the second column of the table in **Annex 2**: ratio profit/revenue increases from 6,84% to 7,51%, revenue per employee increase from 17828 to 18072. The ratio lines/employee (40,62) is unchanged as either lines and personnel did not change.

Labour savings (**Annex 2**)
When considering labour as one of the input variables in a production process, it is assumed that this resource is homogeneous in the sense that all workers are equally efficient. The number of hours per year worked by one man is fixed: no overtime is necessary. In this way an equivalence is established between labour forces and man-hours available in a given period and for a given process. Final costs can be expressed either in terms of hours saved or in terms of labour resource in excess. Evidence is given in the following exercise where the completion of document is considered before and after the introduction of Intranet. Time to complete Documents is supposed to involve the phases of: production, revision, printing out, approval and distribution: according to existing literature it was estimated, as an average, at 90' under paper-based process. Completion time is assumed to reduce at 80' when Intranet is introduced into the working structure. The following starting hypothesis are assumed.

	Paper-based	Intranet-based
Working hours/employee	1800/year	1800/year
Employees efficiency	80 %	80 %
Document completion	90 minutes	80 minutes
Expected waiting	45 minutes	40 minutes

The effect on the working process is shown in the following table where the task is analysed using a simple model of queuing theory: the scheme represents the flow of a number of documents per day arriving on the desk of a single employee that has to complete them.

Description of process indicators	Paper-based	Intranet-based
Actual working time: hours per day	4,80	4,80
Capacity of serving: documents per day	3,20	3,60
Units arriving: documents per day	2,40	2,40
Busy period to complete daily tasks	75,00%	66,67%
Units queuing: documents per day	2,2500	1,3333
Spare working time: hours per day	1,2000	1,6000

The table shows that the engagement of the employee reduces (from 75,00% to 66,67%) when moving from paper-based to Intranet-based working procedures. Under the same flow of documents arriving, the disengagement of employee increases from 1,2 hours per day to 1,60 hours per day. Every employee, then, enjoys an excess spare time of 0,40 hours (1,6-1,2) per day (120 hours/year = 0,40*300). With reference to the unit salary of 13910 $/year (**Annex 2**) and to a working time of 1800 hours/year, it corresponds to a loss of 927 $/year/employee (13910*120/1800) or to an equivalent excess labour of 1/15 (120/1800) employee.
Whether spare time in excess cannot be re-used to other tasks into the production process, Firms should be tempted to fire the corresponding excess labour; that would surely let recover the loss and improve efficiency of personnel.

Increase in productivity (**Annex 2**)
As productivity is intended the amount of revenue contributed to total output by the production factors (capital and labour). To simplify economic analysis, it is currently accepted that labour is the only factor producing revenue, so that the net contribution to total revenue provided by labour is given by the difference between total revenue and capital expenses.
Labour differs from other production factors in three main aspects. First, labour cannot vary in the short run because of social and political obligation Firms/Organisations have to respect. Second, labour is measured in terms of salary and salaries must be paid irrespective of the time actually worked by employees. Third, employees who are used to traditional procedures will oppose resistance to change their working activity slowing down the implementation and the effectiveness of Intranet.
To show the effect of firing excess personnel, the hypothesis is assumed that labour saving involves the whole labour resource. In this case, the excess personnel is quantified as 195 employees (=2919/15). The new budget provided in the third column of table in **Annex 2** shows a labour productivity of 39,15%. As a comparison, labour productivity accounted for 28,17% (**Annex 2**) under paper-based production process (first column of table) and for 29,92% after the introduction of Intranet. That is, a reduction of personnel, whether compatible with the

internal working organisation, might provide a significant improvement either of profit and of labour productivity.

9. Intranet/Extranet as stand alone systems: the IRR model

In the following, Intranet/Extranet systems are considered as stand alone systems: they are analysed separately from the activity and the budget of the Firm.
The exercise is carried out by using the IRR (Internal Rate of Return) model that compares, over a study period, investment (initial cost), operating costs (maintenance, management, other costs) and benefits. Assuming that benefits are unknown they can be evaluated, through the IRR model, as a function of expected annual costs and of a wanted Rate of Return.

Intranet (**Annex 3**)
Assume that an Intranet system, installed for 1000 users, has an expected lifetime of 4 years. If initial investment account for 2.162.500 $ and the system involves 228,125 $ per year to be operated and maintained efficient, the cash-flow that produces an IRR = 0% is obtained by an annual revenue of 1.200.000 $. If this is the benefit provided by the system, Intranet repays itself at the end of its lifetime. This is already an indicator that either a Firm and a Supplier should have had in mind when designing the introduction of an Intranet system.
A sensitivity analysis (-20% ; +20%) shows that the final result is almost independent (non affected) by variation occurred into operating expenses; it shows little variation when revenue vary; it is, instead, sensitive to variation of initial cost.

Extranet (**Annex 4**)
Whether an Extranet system is considered as four Intranet systems, as above, connected together we get a system of 4000 users which we assume having a star configuration. The expected lifetime is the same as above (4 years). Initial investment account for 10.812.500 $ and the system involves 1.380.625 $ per year to be operated and maintained efficient. The resulting cash-flow that produces an IRR = 0% is obtained by an annual revenue of 2.166.250 $. Again, the system Extranet repays itself at the end of its lifetime.
In this case, as well, a sensitivity analysis (-20% ; +20%) shows that the final result is almost independent (non affected) by variation occurred into operating expenses; it shows little variation when revenue vary; it is, instead, sensitive to variation of initial cost.