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Corporate Information Systems Architecture for Business Intelligence Solutions

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Abstract – One of the most important elements in decision-making is the availability of information which is used in the management of organizations. In this paper, we present the method SIMBIOSIS (System of Indicators for Managing Business Intelligence Oriented Strategic Information System). This method considers the two basic levels of decision-making in organizations; these levels are named strategic and tactical. In addition, the method looks at the minimal business intelligence objective of providing the right information to the right person at the right time as a variable. The conjugation of these two points of view permits us to generate a set of indicators. Using these indicators, with a system of information status identification we have proposed, help in the tagging of each component. The information analyzed by these indicators and the status identifiers provide the organization with an extended view of an information system that can aptly be adapted into business intelligence solutions. This also allows a vision of not only the organization but also the extended organization (i.e. organization that includes its environment).

I. INTRODUCTION

The importance of information in decision-making cannot be overemphasized [1]. Since this decision-making process is an integral part of the managerial and operational processes of an organization, then the management of the information flow necessary for this process is of equal importance. There are two basic domains that have been involved in this management, namely, Business Intelligence (BI) and Information Systems (IS). Whereas corporate organizations started to show interest in researches on BI as evidenced by the works carried out by Luhn [2] in the early 50's, the possibilities of better management of large scale information emerged when in 1957 IBM 305 was used with four terminals in a cluster [3]. These two domains have started to mutually influence each other to the point that some authors just refer to Business Intelligence Systems (BIS) as Executive Information Systems (EIS) [4] [5] [6]. In this paper, we have developed a system of indicators that can be used in building the BIS of a corporate organization, which we call SIMBIOSIS (System of Indicators for Managing Business Intelligence Oriented Strategic Information System). These indicators have been developed by taking into consideration the minimal qualities a system must have in order for it to qualify as an efficient BIS and then mapping these qualities with the levels of decision making within an organization. For these indicators to signal the fundamental elements required of the system, we associated them with four status indicators (not defined, defined, recognized and exploited).

II. FROM IS TO BIS

1) Information Systems:

These are the systems designed, developed and used by organizations in order to satisfy their information needs necessitated by their organizational attitudes/behaviors. To us, the IS of an organization refers to the group of [8]:

- **information**, which is, essentially, a representation (though sometimes partial) of the facts that interest the organization;
- **processing**, which groups all processes of acquisition, of memorization, of transformation, of search, of presentation and communication of information;
- **organization rules**, which govern the execution of information processing or treatment;
- **human and technical resources** needed for the functioning of the IS.

2) Business Intelligence (BI):

In our work, we consider the strategic use and the tactical use of BI rather than strategic and operational, because we associate operational use of BIS to the notion of technical operations and consequently, the notion of information to help in technical implementations, which is a little bit way off BI preoccupations. This is a view of BI similar to that of [9]. These authors described two types/levels of

BI as used in an organization. The first, a strategic use of BI, which is BI deployed across a functional department. This, according to the authors gives senior managers (decision makers) a holistic view of the organization and can help them to identify trends and growth opportunities. In this case, BI is used for monitoring the organization against its KPI (Key Performance Indicators) since it cuts across departmental boundaries and it encourages collaborative work within the organization. The second, described as a tactical use of BI, is the BI deployed within a functional department. It is usually used for the "pain" areas within the organization where the extra knowledge and insight provided by BI will bring quick and quantifiable results. BI could also be defined using the minimal objectives that an organization using it hopes to attain with it. From this point of view, many authors consider BI as the art of: "supplying the right information to the right person(s) at the right time" [10], [11]. This underscores the need to have a good ("right") representation of the three important "characters" of a BIS (i.e. right information, right person and right time). We look at these as the "what", the "who" and the "when" of an organizational system. In addition, after satisfying these three conditions (what, who, when), we could extend these characters as some other authors did, [12] for example, to include: "right place" (where to put it), "right way" (how) and "right contact" or right sources. The innovation here is the fact that this is done dynamically. Unlike other efforts that we have seen that are static [13] [14] [15] [16]. For the moment, our efforts are concentrated on the first three elementary characters of BI, as the basic elements that turns an IS into a Business Intelligence System. This demands therefore a definition of each of these three characters in correspondence with the information representation in the IS. In this paper, we are particularly interested in establishing this correspondence. We also hope to include the strategic and tactical levels noted by [9].

3) Information Systems and Business Intelligence Systems:

In the light of the various evolutions in the domains of IS and BI, it is evident that these two domains have helped in developing each other. In [17] BI was defined simply as "the use of information in decision-making". To them, a BIS regroups the two domains of Information Systems (IS) and Decision-making. Figure 1 shows a BI process as seen from this view. The BI process starts with the identification of a decisional problem which is transformed into an informational need. There is the need for an individual charged with the task of looking for the information to solve this problem (though the person demanding the information can also do this himself). He/she (the retriever) interacts with the IS that is in turn fed from an information world that includes, but not limited to, the information base of the organization. The interactions between the user and the IS are stored as a basis of "experience learning" between the two. The user has some expectations that should be met by the IS and the IS in turn expects a minimum information to be able to respond to the user optimally. The requests of the user emerges usually from a platform of potential knowledge in the concerned field (he may/may not have this knowledge) and we think that the responses of the IS (to users' requests) are strongly linked to this potential knowledge field (as is the case with the user, all of the information necessary or related to this field may not be present in the system, and so the need to go look for it). Our conclusion is that if an IS can be built with the objective of supplying the right information to the right person(s) at the right time then the IS can function as a Business Intelligence System (BIS). Also, we affirm that an IS that will respond to an organization's informational needs in BI will have to respond to both its strategic and tactical management. This makes us to assert that the present structure of IS will need to be amended to include information that will help in the resolution of both strategic and tactical decisional needs of management. In order to respond to this, the supporting base of the system must be highly updateable and must support highly rich information and the system must be able to analyze and propose solution that will be of immediate or future help in strategic and tactical management. We should understand that a complete strategic BI consideration must, in addition, situate each organization within its operating environment. We can then talk of an extended enterprise including: partners, suppliers, customers, competitors and actors, which the organization can be in relation with. Consequently, the IS implicated by information flow in an extended enterprise cannot be limited to computer-based information system. We can deduce from this remark that BIS is an IS that is also opened to the environment (the idea of open systems see [18]). The indicators proposed will be able to help in managing the system because they help in identifying the system itself and its evolutionary changes.

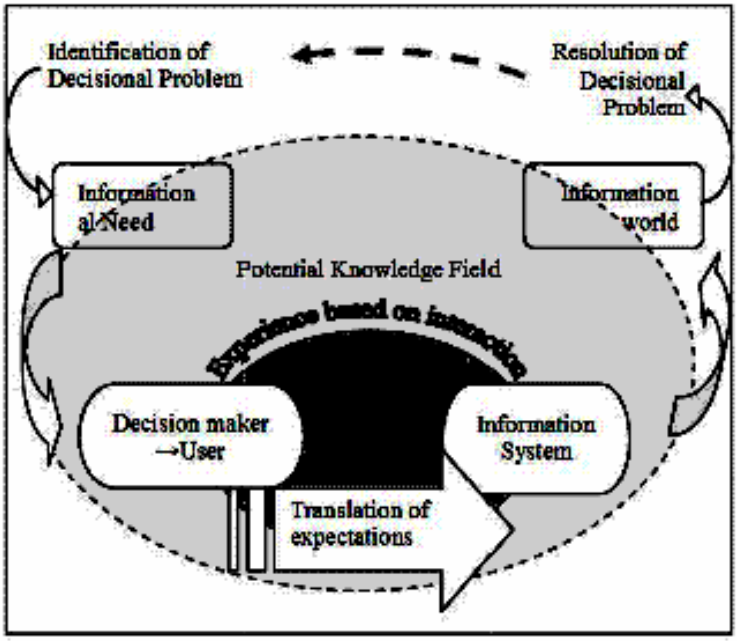

Fig 1: Business Intelligence Process

In this case, with the open environment that is offered by the Web, extended BIS is linked to some right information from the management's (or decision maker's) point of view, that is available on a competitor website for example. On tactical consideration, we just say that the extended IS could exist but this will be limited to an individual, project group or department need. Also in this sense, web sources and human sources outside of the enterprise can be considered too.

III. DEFINITION OF INDICATORS FOR A BIS

We have just looked at BI from two points of view. Of these two, we privilege the minimal objectives point of view, because it is more intuitively related to our view of BI. We will now consider each variation of this point of view with the other points of view i.e. strategic and tactical levels of BI processes for the organization. Before we do this, we will consider briefly the status choice for the system of indicators. Since an IS conception is nothing interesting without its data (information) contents and a means to differentiate these data, we identify four data status. For the first data status, if no data is signaled by a BIS indicator: we consider this data as "***not defined***", these are the type of data that give no information about all the characters (remember by characters we mean information, person, and time) of the BI objective of the organization. For the second data status, if the data signaled by BIS is "***defined***", i.e. there exists a definition, but no formal references to it in the system (in reference to a formal representation in the real world) or it is associated to only one of the characters involved; we consider this data type as defined. For the third data status, if the data signaled by the BIS is "***recognized***", i.e. there exists a definition in the real world (of the BIS) of this data and a formal translation of this data in form of a signal read by system. In this case, we can speak of establishing a mapping between the real world and system world; this mapping implies a link to the information, to the person and to the time i.e. all the three characters are involved. For the last data status, if the data signaled by the BIS is defined, recognized and used by the system; we name this data type as "***exploited***". This fourth type of data supply by our system of indicators could, for example, help us to know if there exists a system of records of events or decisions, reports etc. already generated using this data/information) and perhaps evaluate its efficiency. Indeed, if an information need is only defined and not recognized by the system, we have three choices:

a. the definition or the mapping with the system is erroneous;
b. the system is on stand by to exploit this data, but has not yet used/exploited it;
c. the data correspond to an ancient need and the system preserved a trace of it.

1) The right information: All BI definitions emphasize the place of information. We then based our definition of the term "information" on what was proposed by [19], "*Information is the group of formatted data, in other words data presented in a manner that will be more meaningful than the data alone (…) An information therefore links certain facts or events; this is done based on a principle, which is regarded as its stake (…) furthermore information is not produced for its creator; but it exists to inform other users*". We noted though, that the definition of

information varies according to its use. This brings to mind the fact that the definition of the information used in decision-making processes is not necessarily the same definition of information as used in ordinary Information systems. For a piece of information to be cited as the right, [20] argued that it is important that the rules of exploration be respected and that all information must be qualified in terms of:

- the degree of adequacy, that is the correct definition of the problem and the information need
- the reach of the event in terms of the actual problem
- the degree of urgency or the occurrence date of the event
- the degree of potential usability by the organization

A. The right strategic information

Based on the definition of BI by [17] earlier cited and the works carried out by [21] on decision-making process, which is an integral part of the BI process. According to their stance, decision-making is a process that involves the resolution of decisional problems. It involves the citing of a difference between a projected reality and a perceived reality. The resolution of decisional problems is associated with having the necessary information that can be used to solve this problem. (We also noted that, to these authors, there is an equivalence relationship between decision-maker and the person who makes the decisions that implicate the entire organisation.) At this level, this information is what we refer to as the "right information" and hence, the reason we have placed emphasis on having it. Having the right information (and of course knowing what to do with it) makes each organisation highly competitive as well as innovative. By consequence, the information that responds to an implicit need [21], [22] is considered strategic information. Recall that our point of view on the difference between the strategic and tactical levels of decision-making corresponds to the difference between holistic organisational view and individual or departmental view (within the organisation). Since to these authors there is really no difference between organization's information needs and decision-maker's information needs, we can then add that strategic information could be an expressed information need (asked) by the decision-maker on the behalf of the organization. We conclude that strategic information involves decision-making at organisational level. It can be identified as an implicit organisational need or as an explicit demand formulated by the decision-maker on behalf of his organisation. We are of the opinion that each activity of a user within a system must be noted so as to use it as a form of learning on the expectations of the user by the system, as is the actual practice in Knowledge management Systems (KMS). The closeness of these approaches can be found in [23], where the authors used status indicators called states. We believe that a good feedback from the user incorporated back into the information base of the system (either as a separate base or included in the earlier base) can aid in reducing the response time of the IS and can serve as a tool to know when the IS should alert or inform the user of the availability of information pertinent to his preferences.

B. The right tactical information

By our definition of strategic and tactical levels of BI consideration in organisations, we have associated right tactical information to information which helps to resolve the problem of an individual, or a project group or a department in an organization. In this case, the tactical information is in general, that information that responds to a demand that is expressed [24] by any of these groups. Each of these entities (individual, project group or department) is confronted with many medium and short term problems as opposed to the long term problems in strategic management. Unlike in the entire organisation, most of the dangers that weigh on these entities are linked to reaction related choices and much less, to anticipation related choices or innovation. However, some part of right tactical information can be deduced into an information need. In this case, we can obtain these information need with a benchmarking action on similar entities and quality demarches. But for the moment, our interests lie on the informational problem expression, i.e. the first case of right tactical information.

2) The right person: In all BI processes or systems, emphases have always been placed on the users or the individuals involved in these processes. The definition of a decisional problem depends on the person who first cited or made evident that problem (see [21]). Therefore, its resolution is also dependent on the satisfaction of this problem according to his point of view. Whatever the BI level considered, we can say that for information λ, the right person is the person who need to use λ and this use must be in relation with a decision-making process.

A. The right strategic person

At this level, the right person is the person who makes the strategic decisions of the organisation and/or the person who directly influences the decision-making process of the organisation. In this last

case, this intermediary will be the best person (because of his competences, his availabilities and relations with strategic decision-maker) who could identify, based on his expert knowledge, what or which information is important to the organisation. This person can be identified because he already has an influence in the area of strategic decision-making; he/she has been authorized by decision-maker to influence him, or on a particular competence domain where he/she is the expert of the organisation. Another right strategic person that we identified is the person in charge of the smooth running of the BIS. Indeed, if the BIS is an informational structure representation of the organisation, he/she runs it in its totality. Also, two types of right strategic person can be added:

1. Designer or reengineer (in case there is a difference between the designer and the person that carry out updates or that will reengineer the system): this is the person or group of persons who created the system are also involved with the redesign of the system if need be.
2. Manager of the system: this is the person charged with the overall functioning of the process. This personage is referred to by [25] as the "infomediary". The individual in this case animates the process, coordinates the needs expressed within the organisation, advises the decision maker and also trains those involved in the Watch centres. He does not have to be the designer but must be versed in the overall functioning of the system.

B. The right tactical person

As have been defined earlier, the tactical level implicates another type of the decision-maker. This includes heads of departments or heads of project groups, or the only one (or at least, at that point in time) to occupy a critical function of the organisation. A critical function is defined just as a function that if is not applied correctly could harm the entire organisation. In addition, we add as right tactical person, all of the persons charged with the handling of any of the key functions of CI cycle, which are:

1. Orientation, identification and generation of requests, need clarification/ translation.
2. Collection and retrieval actions
3. Analysis and processing.
4. Dissemination and communication.

In our conclusion the right person can be any of these individuals, but definitely it has to be the person that knows what to do with the information when he gets it. The decision maker should be able to take a decision with the information for him to qualify as this "right person". A watcher, for example, must know who to send the information to in order for that person to able to appropriate the usefulness of the information (in case of a group of decision makers) or be able to identify where to get this information from. The same goes for the infomediary. At the strategic level, the right person is the person or group of persons that look at the organisation from a global point of view whereas at the tactical level, it is the person concerned with the resolution of an immediate problem (or the problem that concerns that individual's department or mode of operation).

3) The right time: The time factor has a lot of role to play in BI as it is the measure of innovativeness of an organisation. A piece of information that could be termed innovative some few seconds ago may have become obsolete now! Information that bothers on innovation must neither come too early nor too late. Time can be expressed in a form that depends on the point of view that we accord to it. For all types of right time of a BI System, it is the time in which an information λ needed is usable in a decision-making process. In other words, the right times correspond to the classical period of time that the organisation and the individual know and recognise as such, the time for breaks/holidays is a classical period too and should be anticipated. Furthermore, the right time depends fundamentally on the time of the right person who will use the right information. Consequently, the right time is the time of information usability for all the right person identified to do so.

A. The right strategic time

Here, the right time is the time of the organisation. In fact, each organisation has within it a set of cycles, which includes: the life cycle of its products; the time of its technology; the time of its strategic decision-making; the time of its administrative information declarations. Since an enterprise evolves in an environment, it is necessary to identify the time of activities (researches, innovations, recruitments, laying-offs, exhibitions, tendencies, etc.) within the operating sector (environment) of the organisation, the time of its competitors or leaders, the time of its partners, suppliers and customers. This type of right time implies in its formal definition, a relation between the moment of deducing environmental changes and

the time to flag an alert on it, i.e. inform. This is why anticipation of its future orientation is a very important condition to be defined in a BIS at strategic level. This type of right time is then the set of potential time of environmental changes, which influences the life of the organization. Due to the fact that each enterprise at its strategic level have a reflection of potential environmental changes, it is possible to identify most of this strategic right time in advance.

B. The right tactical time

The right tactical time is the time span of the projects of the organisation. It can be the time needed by an individual within the organisation to accomplish a specified task (that can affect the existence of the organisation in an indirect way). Within each department this can be the time of its products, the time of R&D, the time of marketing, the time of information retrieval, etc. It is the time of the administrative life within the organisation. Also, as in the case with strategic time, the time of environmental changes/activities, this influences the person that has been identified as the right person. By consequences, the right tactical time is the time which right person can read and use the right information, but especially the time which the person hope to be informed.

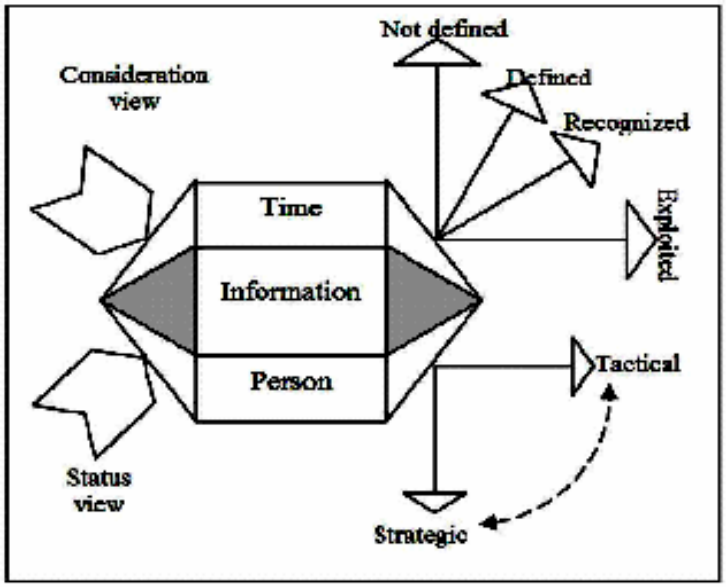

Fig 2: A general overview in a diamond format of a Business Intelligence System showing the indicators.

IV. BUILDING THE BIS

In our experimentation using an information retrieval system METIORE [26], we noted that there are some information needed to take certain decisions that are sometimes absent from the base. These types of information (absent) will have to be looked for to complete the IS so as to guide against such a reoccurrence. We then proposed a reincorporation of each couple of request/response back into the database for reutilization in the subsequent requests. With this, the IS can learn from the user based on the activities of the user and it can adapt more quickly to the system environment.

We adopted and extended these conceptions to our construction of BIS. Our BIS is then built first of all with a set of request/response corresponding to the indicators which we have presented above. And to develop this questioning phase, we use the two points of view in defining the BIS indicators. We recall that the first objective of the indicator definition is to make the BIS evident itself. We have identified at least twelve ways of valorising these indicators, corresponding to the order of posing questions on the work to be done. Indeed, there are two approaches either starting with the strategic before and the tactical after; or tactical before and strategic after. We have also, six combinations of the order of defining the minimal BI objective characters. We think the choice of the order of questioning, thus the BIS identification priority, depends on each case (i.e. type of application) and persons in charge of this questioning. From our reflections, whether in strategic and tactical decision-making, we think it is better to start with questioning on the right person (who gets what?), followed by the right time and then, the right information can be deduced from these two with the possibility of updating this as any new information arises.

This said; we will now summarize some of our explanations and implicit assumptions on the emergence of a BIS for an organization. First, a BIS can be defined with a set of indicators obtained by a combination of two points of view: minimal BI objective characters and the strategic/tactical levels of decision-making. Second, we link all of these indicators with one of four data status which permit each indicator to create an associated signal. These data status are: not defined (implying no signal), defined (signaled), recognized (signal and associated with an event) and exploited (signaled and already used). For one indicator to emit a signal, data which it implies should be at least defined. That means that there exists an explicit human description of the type of indicator associated (for example a right tactical information indicator). An indicator signals the presence of a recognized data in the system, if there is a formal description in the system of the human description associated with the data status defined. In addition, the formal system definition of a recognized data demands the putting in place of a link from a minimal BI objective character to the two others. Since the meaning of signals by a BIS make sense only if the three minimal BI objective characters are achieved as a whole. From this point of view, the questions guiding the recognition of a right information implies the linking of this information with the right person for it and the right time for it to be signaled. And this reasoning can be achieved using each of the three characters. For the exploited data, a classical feedback system will be able to show the ratio existing between data recognized by the system and the data exploited. We deduce from this classical feedback, a global feedback on each of the views of the system (Fig. 2). Its exploitation makes the system more dynamically oriented as compared with others. This global feedback acts as a sum of all feedbacks on each view (consideration and status) and as well as the overall BIS element.

Short example: We started testing this system of indicators using the documentation centre of our research lab. The lab is composed of research teams. We identified them as the tactical levels of decision making in the lab. A representative of each of these teams was asked what would be a "right information" to his/her team. In accordance with our BIS point of view, we asked: who would be the right person to have this information and at what time it would be needed (right time)? One of the responses was "a list of journals in which at least one member of the research teams has published in the last three years, to be supplied to new doctoral students, after about six months of their arrival" (the time for him to have an understanding of his/her scientific focus). Since this is a "tactical level" information which might interest other teams. Thus, in relation with our dynamic conception of BIS, we pushed this possible right information, after typifying it, to others teams, since they are at the same tactical level of decision making. We were then able to monitor its use and the feedback generated. At the end, a cartography of the overview of the various teams was used and we saw how this information has been memorized, used or ignored.

IV. CONCLUSION

BIS is a tool that is designed to facilitate decision-making in organizations due to the complexity of their operating environments. From the hypothesis, we supposed that BIS is complex too, not only in its implementation technologically, but also in its coverage and conception. Therefore, we have decided on its implementation by considering the indicators that revolves around the use that it will be put to. It does not matter, though, if the system is built to respond to tactical decision-making or strategic decision-making, the processes are the same with almost identical results.

We are actually in the process of developing this into a complete model that supports the type of questioning that is raised in this paper for this system. We are inspired from works already done on this in the domain of Knowledge Management as this is a domain that is much related to BI domain. In addition, since information protection is also a major objective of BI, we are thinking of including, as we have done for the minimal BI objective, a definition of indicators that will help in defining or establishing a complete representation of sensitive information in a BIS, which will be a better aid to the protection of such information. We intend to evolve this later to the French conception Economic Intelligence which include the protection of patrimony and the management of networks. This includes protection of information, person and time and a status to measure the degree of confidentiality of each of these.

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