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# Collaborative Information Retrieval among Economic Intelligence Actors

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## Abstract

*In this paper we present collaborative information retrieval (CIR) for decision making. We take Economic Intelligence (EI) as application domain and we propose an approach for managing CIR among actors in the domain. EI process has information as a central object. In EI, we consider the translation of a decision making problem to information search problem; retrieval of needed information and processing this information to determine indicators that can aid in decision making. All these stages require collaboration among the EI actors. There are two major factors that affect collaboration: collaboration technology and culture of openness. The question to be posed is how can we manage collaborative information retrieval among EI actors taking into consideration the technological and cultural constraints? In attempting to answer this question, we propose a framework and a model for facilitating and managing collaborative information retrieval among EI actors.*

## 1. Introduction

Socio-economic organizations in the 21<sup>st</sup> century are faced with the challenge of timely and effective decision-making due to globalization and the ensuing consequence of increased competitiveness. The problem becomes more complicated due to digital information boom and the attached problems of information source validity and information relevance. This challenge was one of the factors that led to the creation of Economic Intelligence (EI) as a practice as well as a research domain. EI is the process of collection, processing and distribution of information with the goal of reducing uncertainty in taking strategic decisions [15].

All actors involved in EI process must understand the process of changing data into information, information into knowledge and then to intelligence.

Data can be seen as raw, unconnected figures, words, events, existing without a conceptual framework [13].

Information can be said to be a contextualized data or group of data. Information is meant to be interpreted. When there is an understanding of the relationship between data, or pieces of data then we can refer to it as information. Information is produced within a context [11]. When a user or a group of users are able to realize and understand(s) the patterns (as well as their implications) that exist in data and information, then we refer to it as knowledge. Knowledge creates its own context and does not necessary depend on the context of the information [13] [14].

Intelligence can be referred to as actionable knowledge. It arises when the user understands the principle responsible for the pattern representing knowledge i.e. the cause and effect of knowledge. Understanding this helps the user to take effective decision [13].

For effective decision making, we must be able to derive actionable knowledge (intelligence) from retrieved information. Meanwhile it has been argued that knowledge production is a collaborative effort and not an individual task [10]. Juxtaposing these two implies that for effective actionable knowledge production for decision making, there is need for collaboration among the actors involved in information seeking and retrieval for decision making purpose. We submit that facilitating collaborative information retrieval among economic intelligence actors will aid in timely production of actionable knowledge for effective decision making.

This paper is organized as follows. Section 2 presents the concept of economic intelligence. EI actors and the interrelationship among them are presented in section 3. Section 4 presents collaborative information retrieval: what it entails. A framework for managing CIR is presented in section 5. In section 6, we present a communication model for managing CIR. The last section concludes the paper.

## 2. Economic intelligence

Economic intelligence is a process that embodies decision making. Decision making can be regarded as an outcome of mental processes (cognitive process) leading to the selection of a course of action among several alternatives [16]. In decision making, we identify a decisional problem and then take decision from the various alternatives or options available. From the starting point of identifying a decisional problem to the point of taking a decision, there are various processes involved. All these are taken care of in EI.

Economic intelligence is a process that has information as a central object. It has been related with similar concepts like competitive intelligence, business intelligence and knowledge management [2]. EI concerns the set of concepts, methods, and tools which unify all the coordinated actions of research, acquisition, treatment, storage and diffusion of information, relevant to individual or clustered enterprises and organizations in the framework of a strategy [13]. The goal of EI is to reduce uncertainty in decision making.

According to research team SITE (<http://site.loria.fr>) at LORIA in France, EI process is made up of the following stages:

1. Identification of decisional problems to solve in terms of threat, risk and danger.
2. Transformation of decisional problem into information search problem.
3. Identification of relevant information sources.
4. Validation of the information sources.
5. Collection and validation of information.
6. Processing the collected information for the calculation of indicators.
7. Interpretation of the indicators.
8. Decision making for problem resolution.

To explain these stages in EI process, we translate EI process into five phases:

- Translation phase
- Information search and retrieval phase
- Analysis phase
- Decision making phase
- Protection phase

Translation phase: concerns the identification of a decisional problem and translating it to an information search problem. It covers stages 1 and 2 above. In this phase, the objectives are defined by identifying the stake in decisional problem. If the decisional problem is not properly identified and not properly translated then all the activities involved in the remaining four phases will be a waste. MDP model [3] provides a way of representing stake. This model comprises of three main parameters for representing stake: the observed object, the signal and the hypothesis associated with the signal.

Information search and retrieval phase: this phase covers stages 3, 4, and 5 above. After translating a decision making problem into an information search

problem, there is need to identify relevant information sources, validate these sources and then collect necessary information.

Analysis phase: this is an important phase as it allows processing of collected information in order to calculate indicators necessary for decision making. These indicators are to be interpreted. It covers stages 6 and 7 above.

Decision making phase: this phase covers stages 1, 7 and 8 above. A proper interpretation of indicators will lead to better decision making.

Protection phase: in practice, this phase is not an isolated phase because it is present through out all the eight stages of EI process. For the purpose of explanation, we bring it out as a phase. Right from the decisional problem identification to the final decision taken, all the expressed information and collected information should be properly protected from unwise divulcation as well as from spies and competitors. This is what we refer to as protection of information patrimony.

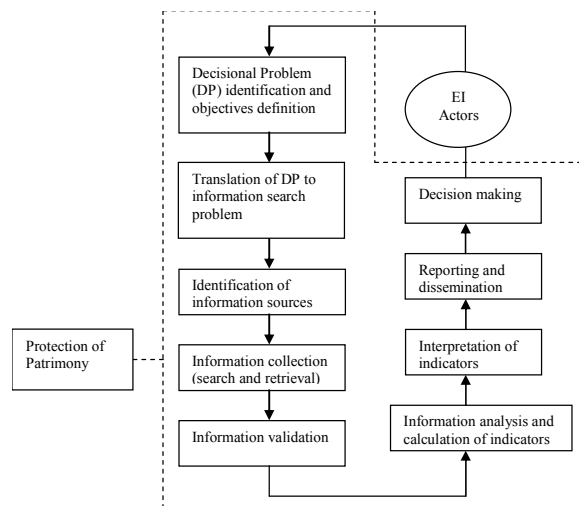


Figure 1. The EI process framework

In the next section we consider the EI actors and the interrelationship among them.

## 3. Collaboration among EI actors

All the EI phases involve actors who collaborate to produce actionable knowledge for decision making. Our focus is on managing the collaboration among these actors especially in information retrieval process.

We identify the following actors in EI process:

- Decision maker
- Information watcher
- Infomediary
- Analysts

Decision maker: the decision maker is the one capable of identifying and establishing the problem to be solved in

terms of stake, of risk or threat on the enterprise [3]. In other words, he knows the needs of the organization, the stakes, the eventual risks and the threats the organization can be subjected to [2].

**Information watcher:** this is the specialist within an organization responsible for collecting, analyzing and distributing information in order to make the internal and external environment of the organization more understandable. He is saddled with the responsibility of obtaining indicators (using information) or value added information that can help the decision maker in his decision making process. The information watcher works hand in hand with the decision maker right from the initial stage of making a decisional problem explicit. He translates this problem into information search problem so as to begin the collection of relevant information for solving the problem. He verifies with the decision maker the translation he made to ascertain if it really represents the decisional problem at hand. The watcher helps the decision-maker to discover the parameters that are not known and to check them [6].

**Infomediary:** another important actor in economic intelligence is the infomediary who acts as an intermediary among all the EI actors in an organization [9]. He is responsible for planning the work flow in EI process and coordinating the interactions among EI actors.

**Analyst:** this actor can be considered as a special watcher or an expert in information analysis and indicator calculation. He works in line with other watchers and the decision maker to ensure better calculation and interpretation of indicators.

Having known the actors involved in EI process, we present in the next section the concept of collaborative information retrieval.

#### 4. Collaborative Information Retrieval

Foster [8] defines CIR as the study of the systems and practices that enables individuals to collaborate during the seeking, searching, and retrieval of information. Fidel and others [7] see CIR as consisting of any activity that collectively resolves an information problem taken by members of a work-team, regardless of the nature of the actual retrieval of information.

We see CIR as consisting of methods and systems for managing collective activities of users in information retrieval process in order to facilitate direct collaboration among the users.

Collaboration in information retrieval is to enable users share their knowledge and to create new knowledge for solving information retrieval problem.

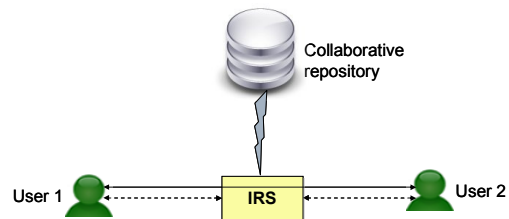
We agree with the point of view of Karamuftuoglu [10] that information retrieval (IR) is a knowledge production process and that knowledge production is a collaborative effort and not an individual task. Since EI process aims at producing actionable knowledge for decision making purpose, it implies that EI process

necessitates high level of collaboration among its actors in retrieving relevant information for solving decisional problems.

The schema in figure 2 gives a global view of CIR concept. In this schema, we see CIR as communicating to share knowledge and acquire new knowledge. The communication can take three possible forms:

- Communication between two or more users through an Information Retrieval System (IRS)
- Communication between a user and the IRS
- Communication between a user and the collaborative repository through the IRS

The users, the collaborative repository and the IRS can be considered as agents hence the communication can be between two or more agents.



**Figure 2. A global schema for CIR**

There are two major factors that contribute to the success of collaboration:

- Collaboration technology
- Culture of openness

Collaboration can be said to be an interaction between technology and culture. The cultural aspect involves the human aspect in collaboration which is the most difficult to handle. As regards to technology for collaboration, a lot of research is going on in this area.

The question to be posed is how can we manage collaborative information retrieval among EI actors taking into cognizance the technological and cultural constraints? This leads us to the next section where we present our approach for managing collaboration in IR. This approach can be used to develop any Collaborative Information Retrieval System (CIRS).

#### 5. Managing collaboration in IR

We consider two possible collaboration approaches in information retrieval:

- Formative approach
- Interactive approach

In formative approach, a user with an information problem discovers how he can solve the problem by exploring the information base as well as the collaborative repository where histories of past users' activities are kept. A user searches for solution to his problem by looking at the way others have solved similar problems in the past. He gets a description of their problem, the solution they got and how they got it. This is

similar to collaborative filtering. Another form of formative approach to CIR is the observation, in real time, of another user carrying out information retrieval activities.

In an interactive approach, the information problem owner demands for the aid of another user (may be an expert) in solving his problem. The difference here is that both users interact together in solving the problem. There is no ready made answer or approach. Both of them share their competence and knowledge to solve the problem. For example a user asking a librarian how he can get access to information on a particular problem. The user explains his information problem context, the librarian helps to clarify the context and they both formulate query to represent the information problem.

Based on the two approaches mentioned above, we propose a framework for CIR. This framework takes into consideration the four main aspects of CIR which include:

- Communication among collaborating actors
- Collaboration modes for information exchange
- Coordination of interactions among collaborating actors
- Management of the various forms of knowledge involved in the collaboration.

This framework is shortened as 3CM deriving its name from the four components. We present each of the components of our framework below.

### 5.1 Communication among collaborating actors

Every collaboration process starts by communication. Communication can be seen as a way of coordinating a collaboration activity. In our approach to CIR, we model the communication component based on the following perceptions:

Why – The why of the communication is the reason for the collaboration or sharing. This can be seen as the objective of the communication.

What – This is the object of communication which can be audio, text, image or video. To us in CIR the objects of communication are the knowledge expressed in form of queries, search results, annotations, messages and documents.

Who – This concerns the sender and the receiver of the object of communication.

How – The how of the communication concerns the interaction mode which can be either synchronous or asynchronous.

When – Date and time stamp of the communication is needed to be able to contextualize expressed knowledge in communication.

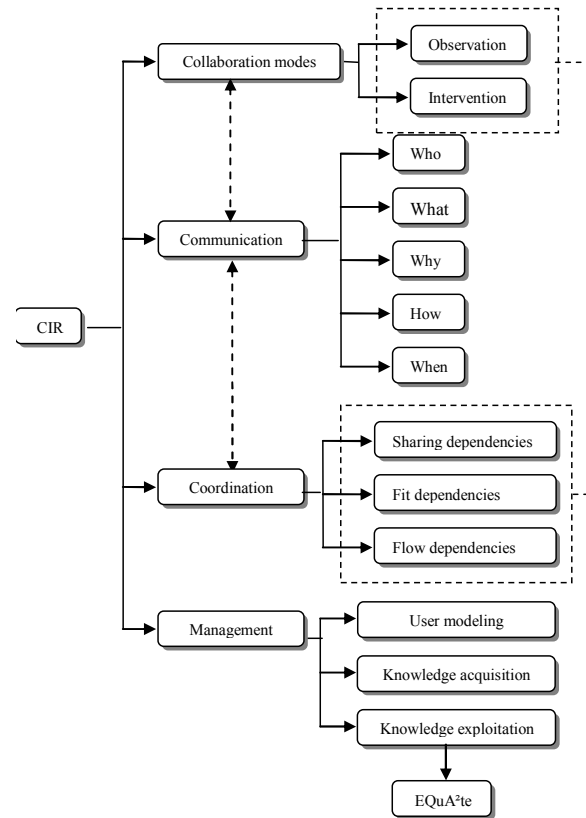


Figure 3. 3CM framework for CIR

### 5.2 Collaboration modes for information exchange

In our approach to CIR, we adopt two interaction modes in IR. These include:

- Intervention
- Observation

Intervention mode: in intervention mode of collaboration, a user can hook up with another user to solve an information retrieval problem. The two users work simultaneously on the problem. In this mode of collaboration, there is high level of dependency between the activities of both users. In this mode a user can put forward his information retrieval problem in the general work space where every other user can see it and then intervene in solving the problem. This allows for multiple users participation in solving an information retrieval problem.

Observation mode: in this mode of collaboration, a user can observe another user who is in the process of information retrieval. Also a group of users may observe another user in the process of information retrieval. The dependency level here is also high but not as high as the first one since the users are only observing but not intervening in the information retrieval problem resolution.

### 5.3 Coordination of interactions among actors

In the context of CIR, we see coordination as managing the dependencies among the activities of collaborating information workers (actors). If there is no inter-dependency among the activities of the collaborating actors, it implies there is nothing to coordinate.

There are various forms of dependency that manifest among users involved in CIR. Borrowing clues from Malone [12], these dependencies would be represented in three principal categories:

- Flow dependency
- Sharing dependency and
- Fit dependency

In flow dependencies, a user produces a resource that is used by another user. In sharing dependencies, multiple users share the same resource. In fit dependencies, multiple users produce a single resource. When two watchers work together to solve an information problem, their activities fit together to produce a resource. An information watcher observing another user solving an information problem may acquire some knowledge (resources) which may help him in performing some other IR activities hence a flow dependency is manifested. The resources in the collaborative repository are shared among the EI actors hence a manifestation of sharing dependency. Sharing dependency may also manifest when two or more users are interested in collaborating with another user at the same time.

### 5.4 Managing various forms of knowledge expressed in the collaboration

In collaboration, users share knowledge. This knowledge is expressed in form of queries, annotations, messages etc. Managing the various forms of knowledge involved in CIR will be based on three concepts

- User modeling
- Knowledge acquisition
- Knowledge exploitation and mining

We model users by their profile, their activities and the mode in which they are collaborating [4][16].

Knowledge acquisition entails capturing and codifying the various forms of knowledge expressed in collaboration [1].

To exploit the codified knowledge, we adopt the EQuA<sup>2</sup>e model [5] which is made up of four cognitive phases in information retrieval:

Explore: in this phase a user can explore the knowledge base to discover available information.

Query: the query phase allows a user to put the acquired knowledge (from exploration phase) into action by formulating query to express his information need

Analyze: this phase allows the user to infer new knowledge for problem solving from the retrieved

information. In this phase, there is creation of an added value to information.

Annotate: this phase allows for creation of new knowledge. A user can add comment or propose another solution to a problem.

## 6. Communication model for CIR (COCIR)

From our CIR framework, we propose a communication model for collaborative information retrieval. This model is made up of four attributes:

- Sender
- Object
- Receiver
- Context

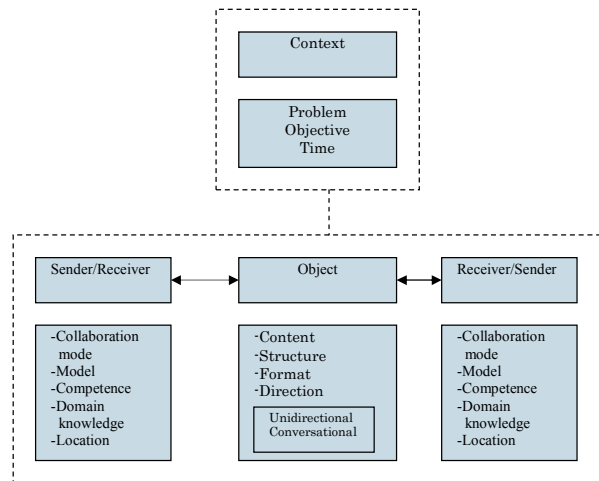


Figure 4. COCIR model

The sender is the originator of the communication object (the expressed knowledge in collaboration). For a sender, the following sub-attributes are defined: collaboration mode, model, competence, domain knowledge and location. The collaboration mode can be either observation mode or intervention mode as explained in the 3CM framework. A user model (or representation) consists of his identity, name and preferences. The competence of the user and his domain knowledge are part of attributes that help in determining the reliability of the information object coming from the user. They are derived from user's activities. The location is to determine the physical environment from where the user is communicating the object.

The context attribute allows capturing the objective of the collaboration, the problem that necessitated the collaboration, and the time of the exchange.

For each object of the communication, we consider the content, the structure of the object, the format and the direction. The object can either be communicated in a unidirectional manner or in a conversational manner. If the sender sends an object to a receiver without expecting a reply, the communication is unidirectional but if the

object was sent to one or many receivers with eventual response, it becomes conversational. A user in the receiving end can also change role by sending information.

We are currently building a CIRS based on the 3CM framework and the COCIR model presented above for facilitating and managing collaboration in IR among EI actors.

## 7. Conclusion

In this paper, we proposed a framework for managing collaborative information retrieval among economic intelligence actors. We emphasized that the goal of EI is to reduce uncertainty in decision making and that the core of EI is information. For effective decision making, there is need for actionable knowledge production which has been said to be a collaborative effort. Our proposal for managing CIR among EI actors consists of defining collaboration modes for information exchange, facilitating communication among actors, coordinating the interdependences among the actors and managing the various forms of knowledge involved in the collaboration. We also proposed a communication model for CIR.

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