A Collaborative Platform to Support the Enterprise 2.0 in Active Interactions with Customers

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In recent years a new model of Enterprise 2.0, which interacts actively with customers using web 2.0 tools (chat, forum, blog, wiki), is developing. The enterprises, listening opinions and suggestions of customers, can improve the product/service. For a company, customer's opinions are very important both for the improvement of products and also for the reinforcement of the customer loyalty. The customer will be motivated to be loyal if the enterprise shows a strong attention to his/her needs. This paper presents a model of a collaborative and interactive platform that supports the Enterprise 2.0 in the management of communications and relationships with all stakeholder of the supply chain and in particular with customers. A good e-reputation of the company improves business performances.
Keywords: *Web 2.0, Enterprise 2.0, Collaborative Tools, Opinion Mining, SOA, Legacy Systems*

1 Introduction

Recently, in the business sector, a new and advanced Enterprise 2.0 model is affirming. This model represents an open enterprise that exchanges information with all stakeholders and in particular with customers by web 2.0 tools (chat, forum, blog, wiki, and social media) to improve the product/service. Web 2.0 tools, before, were used only in a private sphere and not for business goals. Nowadays many websites of companies present their pages on Facebook, videos on YouTube and use virtual communities to exchange and share information with customers.

This paper presents a platform that supports an Enterprise 2.0 model where it is possible to distinguish two main sections: collaborative and opinion mining and analysis.

The collaborative section is used to exchange information with the external environment and in particular with customers and to transform in cooperative services legacy software applications like Enterprise Resource Planning (ERP), Supply Chain Management (SCM), Customer Relationship Management (CRM), Product Lifecycle Management (PLM).

The module of the opinion mining and analysis processes the customer opinions. At the corporate level it is important to elaborate these opinions and extract the polarity: positive, negative or neutral [1] [2]. Entrepreneurs/managers must mainly analyze negative opinions to correct defects and improve the customer satisfaction. It is also important to process opinions to find existing correlations and discover useful knowledge for business goals (Business Intelligence).

In Internet there are a lot of websites that collect and make available customer reviews: epinions.com, ciao.it, complaints.com, planetfeedback.com, ecomplaints.com, dooyoo.it, cnet.com [3].

Customer opinions are expressed in a textual and unstructured format. At the moment, Information Systems process only structured information of legacy applications. In future, it is important that they can also elaborate unstructured information coming from social networks, virtual channels or blogs.

The paper presents the following structure: the next sections focuses on the Enterprise 2.0 model. In the third section we describe, in detail, the collaborative platform 2.0 to support the new model of business. The fourth section analyses the technical features of the platform. Finally some conclusions are drawn.

2 Enterprise 2.0 model

The new model of Enterprise 2.0 (Figure 1) is an open enterprise that, for business goals, exchanges and shares information with all stakeholders (customers, suppliers, sponsors, partners).

Enterprise 2.0 is the use of emergent social software platforms within companies, or between companies and their partners or customers [4].

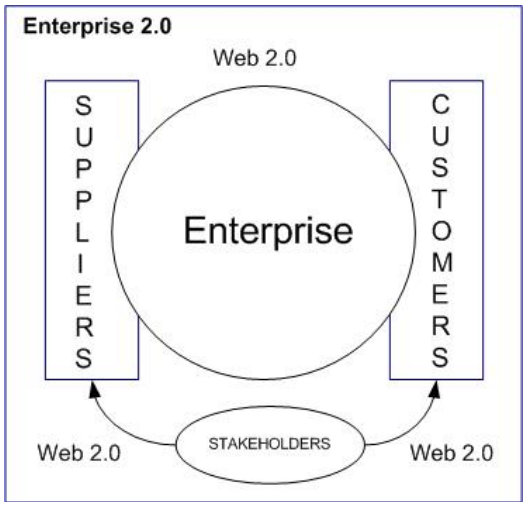

Fig. 1. Enterprise 2.0 model.

This enterprise uses intensely web 2.0 tools [5] that before were generally used only in a private manner and not for business goals.

In the web 2.0 we can take in consideration two aspects: technological and social. The social aspect is relative to people that interact and exchange information and the technological aspect is relative to digital tools. The Web 2.0 is a network of people and not of machines. The technology surely is the trigger but the people are the real core of this evolution. Every day, people exchange and share experiences, opinions, photos and video.

By web 2.0 tools a bi-directional channel between enterprises and customers is established and the customer can actively participate in the exchange of useful information.

The knowledge sharing, the collaboration and the development of social networks, inside and outside the company, are very important factors for the success of the enterprise. In fact the key features of an enterprise 2.0 are: sharing, collaboration, interactivity and agility.

An Enterprise 2.0 presents an architecture bottom up and uses a peer-to-peer communication while in a traditional enterprise (Enterprise 1.0) the architecture is top-down and the communication is hierarchical.

In the Enterprise 2.0, the customer is a central figure and he/she is involved in all processes: conception, design, development, testing, marketing, buying and so on. A customer more involved in the production process helps the company to find and eliminate errors/defects for improving the final product/service.

The Enterprise 2.0 model can be interpreted as a new way of doing business, a participative business where the company and the customer work together (co-operate, co-create, co-produce,...) [6].

Collaboration between companies and customers, in a context of co-creation and co-production, encourages the realization of the figure of the prosumer (producer and consumer at the same time) [7]. The consumer is becoming a co-creator of value [8] while in the past he/she was a passive responder to market supply.

In the era of Web 2.0 there is no clear boundary between who produce and who consume contents; everything is indefinite; “everything is miscellaneous” [9].

Nowadays, the customer, really, has an active role as prosumer. In IKEA, the customer participates in logistical and productive processes by transporting and assembling, individually, the furniture at home. In the John Fluevog company, customers participate actively and creatively designing new models of shoes. In the website "Fiat 500" (500 Wants You - www.fiat500.com) any consumer contributed creatively to the design of the new car. The Mulino Bianco is available to listen any proposal of new biscuits. Ideas can be proposed and voted; the best one will be realized.

The Web 2.0 also leads to a revolution in the content generation. Until few years ago,

users read only, in a passive manner, information from websites but now they have the opportunity to actively insert information, graphics and multimedia objects. The user can create contents, movies, express opinions and give advices. He/she becomes User-Generated Content [10] or Consumer Generated Content [11].

In the web, the contents' production is no longer the prerogative of media centers, press and traditional producers but everyone, by web 2.0 tools, can participate in the discussion and produce contents by simple platforms like Flickr, YouTube, Second Life, Facebook, Wikipedia.

To emphasize the role of users Grossman [12] in Time magazine affirmed "Person of the year are you: For seizing the reins of the global media, for founding and framing the new digital democracy, for working for nothing and beating the pros at their own game".

If we compare an Enterprise 2.0 with a traditional enterprise (Enterprise 1.0), there are the following main differences (Table 1).

Table 1. Enterprise 2.0 vs Enterprise 1.0

Enterprise 1.0 (traditional enterprise)	**Enterprise 2.0**
Closed and rigid structure	Open and flexible structure
Unidirectional	Bidirectional
Contents reading	Contents generation
Copyright	Sharing
Competition	Collaboration
Intranet – extranet	Web 2.0
IT- driven	User – driven
Top down	Bottom up
Contacts	Relationships
Stationary	Mobility
Product-oriented	Customer-oriented
Planning production	On demand production

3 A Collaborative Platform to Implement the Enterprise 2.0 Model

In this section, we describe, in detail, a digital platform to support an Enterprise 2.0 model (Figure 2). In Figure 1 we can distinguish three main sections: SOA/WS/RIA, Collaborative and Opinion Mining and Analysis. In following sub-sections, the components of the platform 2.0 are analyzed in detail.

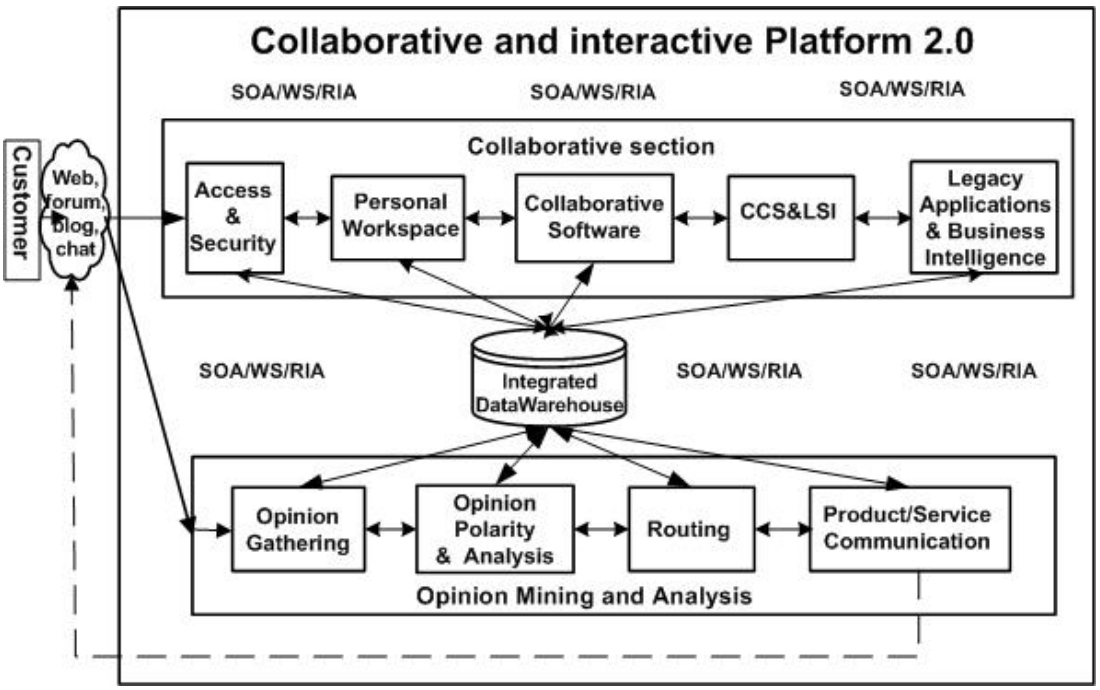

Fig. 2. Platform to support an Enterprise 2.0 model

The logical infrastructure of the platform 2.0 [13] can be schematized in 4 levels (see Figure 3):

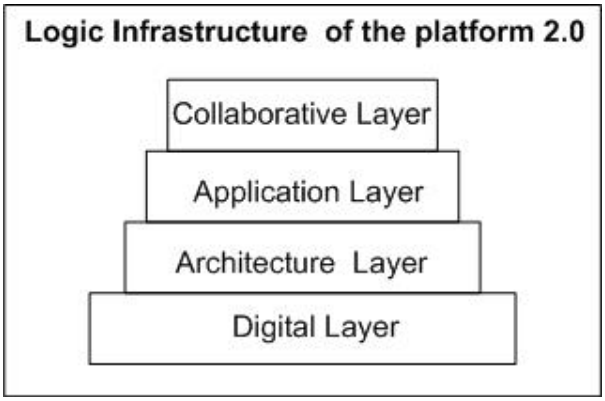

Fig. 3. Logic infrastructure of the platform 2.0.

The *digital layer* includes PCs, wifi/wired networks, operating systems and also mobile devices.

Architecture layer is an open and flexible substrate based on Service Oriented Architecture (SOA).

The *application layer* is a set of software applications like ERP, CRM, SCM, PLM and Business Intelligence that supports different functions and business processes. In the collaborative platform all applications are transformed in services.

The *collaborative layer* includes the social software to interact, inside and outside of the enterprise, with all stakeholders: employees, customers, suppliers, partners.

3.1 The Work Contest of the Platform 2.0

The platform operates in a context of Service Open Architecture (SOA), Web Services (WS) and Rich Internet Application (RIA).

The Service Oriented Architecture (SOA) [14] allows to switch from a monolithic system to a system based on different components that provides single services accessible from more applications. A service could be an online order or the monitoring/traceability of a product from the magazine to the end customer.

Services can be executed at interactive (controlled by users) or batch (controlled by process) level. Services can be published thanks to remote Web Services (WS) [15] in a cloud modality according the paradigm of software-as-a-service (SaaS).

Services can be reused, modified or combined (mash-up) to create new ones for satisfying workload changes and the applications trend.

In the services management the following techniques are important: the filtering, which allows to use the output of a service as input to another one and the orchestration which control the integration of different services in a sequence of an information flow.

Services can be invoked by browser using Rich Internet Application (RIA) [16] interfaces that improve the interactivity with users. RIAs are web applications that reside, in a large part, in remote web servers and have the features and functionalities of desktop applications.

The Service Oriented Architecture [13] presents the following main components:

- *Web Services (WS):* collection of services by a web technology
- *Universal Description Discovery and Integration (UDDI):* directory of available services (recorded and indexed)
- *Web Services Description Language (WSDL):* description of services and access modality
- *Simple Object Access Protocol (SOAP):* protocol for the service request. It is a protocol independent from the platform and programming languages.

The service provided by Web Services is described by a WSDL document and published into an UDDI repository. A business process requires a service (Service Request) to Web Services. The Web Service, found the service in the UDDI register responds and activates a Service Delivery [17].

3.2 The Collaborative Section of the Platform 2.0

All different components of the collaborative section of the Figure 1 can be grouped in 5 main services:

- *Security* (Access and Security)
- *Desktop* (Personal Workspace)
- *Collaborative* (Collaborative software)

- *Integration* (CCS&LSI interface with Legacy Software)
- *Datawarehouse* (Integrated Datawarehouse)

Security service

This module contains the applications that control the access to different services of the platform. The security policies protect the confidentiality, integrity and availability of information. All applications must comply with common security requirements and service levels necessary for the proper functioning of business processes.

The security service includes different tasks:

- definition of users and groups to structure hierarchically all users of the platform;
- definition of roles and privileges to define, in detail, hierarchical permissions on contents;
- management of the Single Sign-On (SoS) [18], an unique identification for allowing to users the authentication only once and gain access to all permitted resources.

Some guidelines to create secure web applications are:

- divide applications in components and each component must be armored;
- control user privileges for the access to different functions of single components;
- management of user session and maintenance to protect the id session and the simultaneous presence of the same user in different multiple sessions;
- management of the log file for tracking sessions, user behavior and the communication between components.

Desktop Service

The platform should contain interactive tools for the login, profile customization, context menu and search engine.

The main components of the desktop service are the followings:

- management of the own profile to customize personal home page as a container for widgets and RSS feeds
- dashboard to monitor personal activities
- tools to support multichannel audio, video, mobile devices
- calendar and agenda shared with other users of the platform with the possibility to create and share events, meetings and planned activities
- contact management to manage internal and external relationships
- context discussions for sharing comments and consultations on specific contents
- ratings and comments to allow additional modalities of participation around specific contributions
- search engine to find useful information
- tagging to facilitate the classification of information (content, documents, articles, etc..).
- reporting to monitor the use of services

Collaborative service

A collaborative module containing web 2.0 interactive tools [19] for sharing knowledge and experiences.

The main components are the following:

- *Wiki*: to collaborate and share knowledge
- *Blog*: to publish contents on the web space
- *Chat*: for instant interactions among system users
- *Forum*: to exchange views on topics and discussions
- *Social Network*: for information exchange with profiled users and groups
- *Tagging*: for the knowledge classification
- *FAQ*: to classify the answers to specific questions
- *Polls*: to consult user opinions
- *Votes and Comments*: to evaluate works and reviews
- *Syndication*: to subscribe and update some news

The collaborative software also includes:

- *Content Management System (CMS)* [20]: for managing unstructured contents as web pages
- *Document Management System (DMS)*: for managing and sharing files among users of the platform
- *Contents Search*: for searching all contents available in the platform

Integration service

The platform must be able to integrate digital interactive systems with legacy ones. A level of integration becomes essential to ensure uniformity and harmonization of different services. The integration will be among different heterogeneous information sources. Main legacy applications are:

- Enterprise Resource Planning (ERP)
- Supply Chain Management (SCM)
- Customer Relationship Management (CRM)
- Computer Aided Design (CAD), Computer Aided Manufacturing (CAM), Computer Aided Engineering (CAE)
- Product Lifecycle Management (PLM)

In the Figure 1 the module of Legacy Applications contains also tools of Business Intelligence (BI) to analyze and monitor big data for business goals.

To integrate and link together legacy and collaborative systems it is necessary an interface named Collaborative Contents Software & Legacy System Integration (CCS&LSI).

This integration is designed to share information and documents among different applications. In this way, the available knowledge, inside the organization, will increase and therefore will be possible to discover new business opportunities.

Companies that decide to transfer on the web (part of) their applications and transactions must transform software applications in services. Actually, many companies convert their legacy systems and develop applications to share with different stakeholders a part of the business process. In this way the full development of standardized and reusable components is implemented. To transform a legacy application in a web service, it is necessary to use appropriate wrappers [21] which add useful information to the old code in order to expose it as a service, easily accessible by browser.

Datawarehouse Service

All data of the platform is stored in an Integrated DataWarehouse. This database contains data managed by legacy and collaborative systems and therefore both structured and unstructured information. All different components and services (e.g. security, collaborative tools, contents management,…) of the platform save and read data from this data warehouse.

3.3. The Opinion Mining Section of the Platform 2.0

By web 2.0 tools, customers can express suggestions and recommendations useful to the company for strategic goals. It is important to process these opinion to extract the polarity (positive, negative or neutral) [2] and a new knowledge useful for Business Intelligence.

In the polarity extraction we can use two types of methods: statistical and semantic (Figure 4).

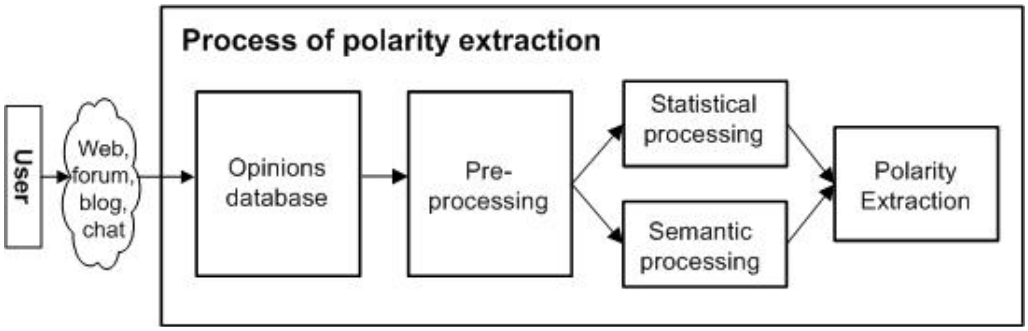

Fig. 4. Polarity extraction

In the first case we use statistical algorithms and in the second case semantic algorithms.

3.3.1 Statistical method

The statistical method is represented in Figure 5.

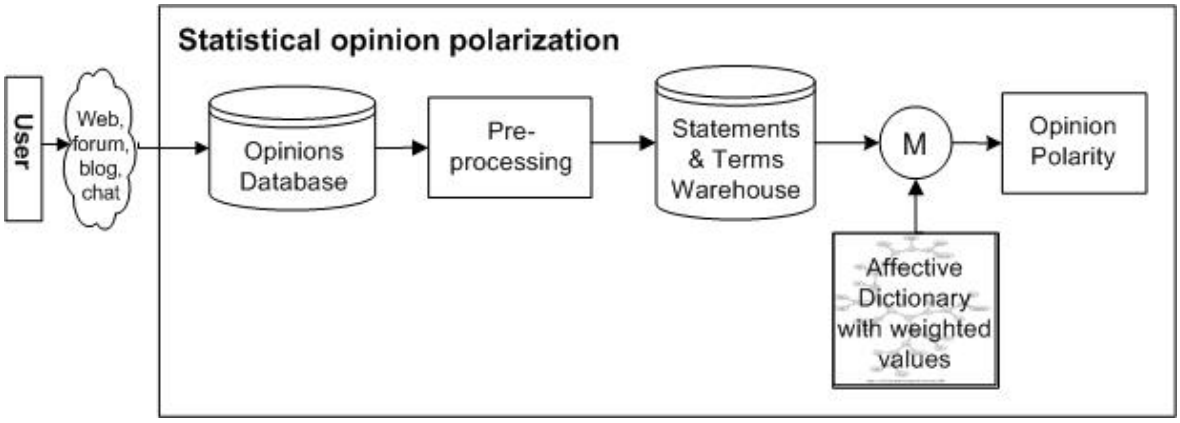

Fig. 5. Statistical opinion polarization

The methodology includes the following steps [1]:

- Preprocessing
- Affective assignment
- Polarization estimation

3.3.1.1 Preprocessing

The goal of this phase is to obtain, for each opinion expressed in a web post, statements and significant words. Since opinions are written in natural language, we need specific pre-processing techniques: elimination of stop-words (articles, conjunctions, prepositions), sentence extraction, division of the sentences in single words with the phases tokenization, stemming and lemmatization. To this end it is possible to use the General Architecture for Text Engineering (GATE) library.

Elimination of stop-words

In this phase the software identifies and removes the words with low discriminating capacity, such as articles, prepositions and conjunctions. These words are too common to be useful for the analysis and do not add any affective information.

Sentence extraction

From every post we extract minimum sentences. In this step we eliminate all interrogative clauses. These clauses do not carry affective information.

Statement extraction

The goal of this case is to divide the sentence in statements. A statement is an elementary sub-sentence that expresses a single positive, neutral or negative polarity. A single sentence can express more than one opinion. For example the sentence "The smartphone is good but the seller is ungracious" may be splits into 2 statements with different polarity: "The smartphone is good" (positive polarity), "but the seller is ungracious"(negative polarity). To divide the sentences in statement it is necessary to separate the words in the proximity of those conjunctions that link two propositions with opposite polarity; for example "but" (coordinative conjunction) or "although, even, thus, whereas, while" (subordinate conjunction).

Tokenization

In this stage various statements are divided into units called tokens where each token is a word or something as a number, a punctuation mark, a date, etc... The token boundary is represented by a whitespace (space, tab or the beginning of a line).

Stemming

This stage extracts the root of a word, removing affixes and endings. For example inhibits, inhibition inhibited have as common root *inhibit*. Stemming operates on single words.

Lemmatization

This stage aims to search single terms from word endings. Respect to stemming phase the lemmatization must disambiguate between different forms. For example songs come

from the verb sing or the word song? Lemmatization operates on words in a specific context.

3.3.1.2 Affective assignment

After the preprocessing phase, statements and single terms are saved in a specific warehouse. Next step is to assign an affective value to single term and therefore to statements to estimate the polarity [22].

The phase consists in matching single terms of the warehouse with a specific dictionary that contains affective terms with an assigned weight.

In the statistical method that uses a large affective training corpus [23], it is possible, for the system, to learn the affective valence of affective keywords (keyword spotting) and take in account the valence of other arbitrary keywords (lexical affinity). We can do an analysis on lists containing a lot of affective terms and after, with appropriate statistical techniques, reduce these words.

Esuli and Sebastiani [24] have created SentiWordNet, a lexical resource where they assign to each synset (set of synonyms) of WordNet a sentiment scores: positivity, negativity and objectivity (neutrality). The opinion is positive if the positivity of its terms is higher than negative scores. Another dictionary is WordNet Affect [25], a linguistic resource for a lexical representation of affective knowledge. In WordNet Affect each synset of WordNet is labeled by one or more affective-labels, representing the affective meaning of the synset. Examples of affective-labels are emotion, mood, trait, cognitive and physical state, etc…

3.3.1.3 Polarity estimation

All operations that are performed in this estimation process may be simplified as follows. All words included in a web post are searched in the affective dictionary. There are words that have a high positive affective weight like good (+1), happy (+1), nice (+0.9), words that have a high negative affective weight like bad (-1), disgust (-1), hate (-0.9), angry (-0.9) and others who have an intermediate weight like cake (+0.5), microwave (+0.5) (someone prefers the sweet, the microwave,..; others do not prefer them).

If customers express these opinions:

- I like the microwave
- I hate the microwave

In the first opinion the weights are: like (+0.9) and microwave (+0.5); the sum of the statement is 1.4 and therefore the opinion is positive. In the second opinion the weights are: hate (-0.9) and microwave (+0.5); the sum is -0.4 and then the opinion can be classified as negative. The opinion of the statement will be neutral when the sum of the weights of single terms is equal to zero.

3.3.2 Semantic method

The semantics studies the meaning of single words, sentences and texts and it is based on ontology. Ontology is an exhaustive and rigorous conceptual schema that represents all relevant entities, objects, classes and their relationships contained within a specific domain of knowledge [26]. Ontology can be understood from machines, software agents and humans [27]. Each resource of ontology must be represented by a triplet: *subject – predicate – object* or *resource-property-value*. For example: These companies (*subject*) supply (*predicate*) shoes (*object*); www.iloveyou.en (*resource*) has as author (*property*) Mister X (*value*).

The process to polarize customers' opinions, by semantic technology, is represented in Figure 6.

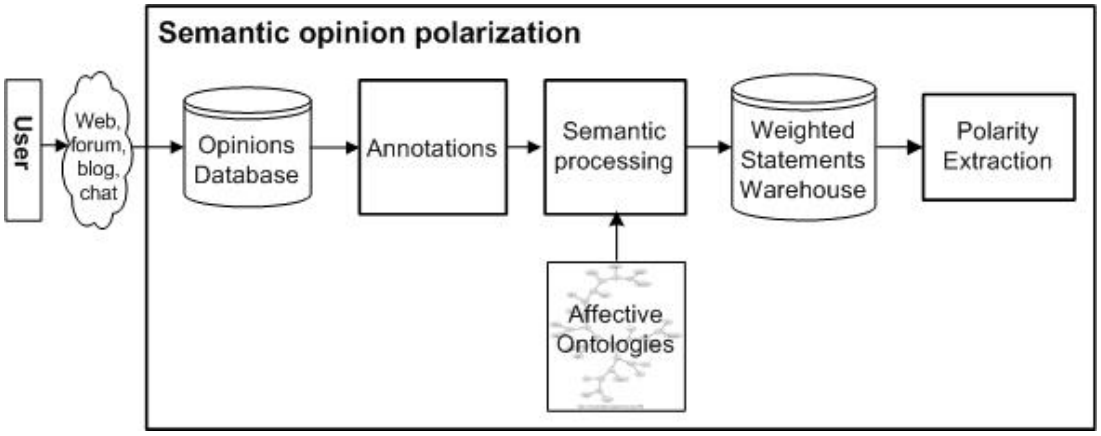

Fig. 6. Semantic opinion polarization.

To polarize a statement like "The smart phone is an intelligent mobile device", the first important stage is the annotation. The procedure of an automatic annotation is the following: The smart phone/*subject* is/*predicate* an intelligent device /*object*.

The statement will be processed by a semantic module to understand its meaning. The semantic module "interpreting" specific ontologies that contains affective words, weights and their relationships assigns a weighted polarity to statements and saves them in a warehouse. The polarity depends mainly from the weight of affective terms contained in each statement.

3.4 Routing and Communication

The output of the Opinion Polarity will be automatically routed to competence centers [28] to correct specific defects and improve so the product/service. For example the Optic Department is the most competent center for the problem regarding the "distorted images" of a camera.

The competence center, inside the enterprise, improves the products/services or answers to customers. In both cases, the enterprise gives a (indirect or direct) feedback to the customer. The improvement of a product is an indirect message, communicating that the enterprise acknowledged the customer complaint. On the other hand, the enterprise may give a direct answer to customers over the same virtual channel (dotted line in Figure 1) used by customers for expressing their opinions.

3.5 Analysis of Opinions for the Business Intelligence

Customer opinions can be analyzed also for business intelligence goals. From the corpus of opinions it is important to discover hidden relationships and new knowledge that can help entrepreneurs/managers to improve specific features of the product/service operating on specific variables. For this objective we can use a text mining procedure that exploits a data mining process after an appropriate transformation of the text into structured data [29][30].

The process is represented in Figure 7.

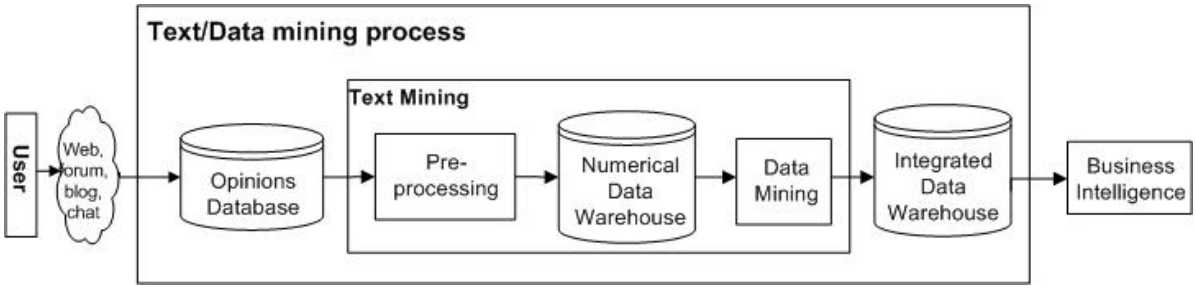

Fig. 7. Text mining process for Business Intelligence.

As in other cases, also in this context it is important the preprocessing phase. The pre-processing module is represented in the following Figure 8.

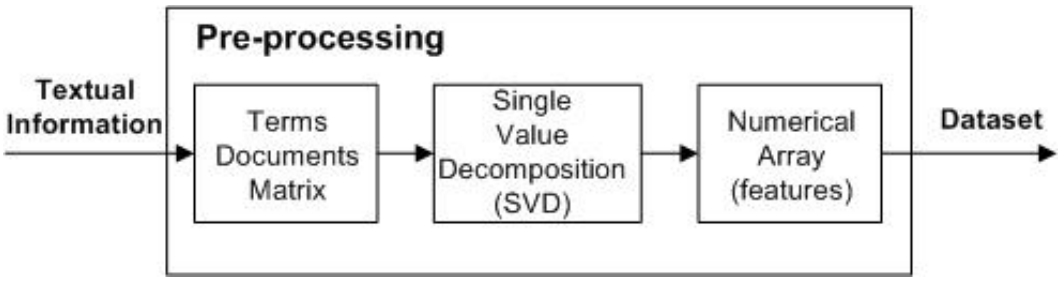

Fig. 8. Pre-processing of textual information

In the preprocessing phase we can distinguish the following stages:

- Terms-Documents Matrix. Each element of this matrix represents how many times single words occur in different web posts. Each numerical value identifies the significance or the attitude of the word (lexical unit) to be representative of the specific post (context unit).
- Single Value Decomposition [31]: compression of original matrix using main factors. In SVD algorithm, the indicator Term Frequency-Inverse Document Frequency (TF-IDF) is used. The TF-IDF [32] is a statistical measure used to evaluate, by weights, how a word is important in a specific document (post) of corpus (set of opinions). The importance increases proportionally to the number of times that a word appears in the document but is inversely proportional to number of times that the word appears in the entire corpus.
- Numerical array represents the features of the document. It is the dataset useful to apply Data Mining techniques. For describing a document (post) it is possible to use an array containing a list of the main features or keywords with a numerical weight indicating the importance of each term. The documents are described with a small set chosen from many terms.

The numerical array that represents the dataset will be stored in the Numerical Data Warehouse for applying data mining algorithms to discover hidden relationships.

The new knowledge obtained will be stored in the corporate Integrated Datawarehouse and then used by the module Business Intelligence of the Figure 1. The Business Intelligence is important for decision support systems and to analyze collected data for forecasting future events. The extraction of useful information can be done by extraction techniques that use specific wrappers and intelligent software agents.

4 Technical Features of the Platform 2.0

The main tools of the platform 2.0 are: an internal intranet between managers/ employees, a communication channel with external stakeholders to improve business processes, the integration between legacy and new interactive systems and the opinion mining and analysis for business goals.

Technically it is important that the platform meets the following basic requirements:

- *multi-database*: the platform should be compatible with different databases like Oracle, MySQL, SQL Server, PostgreSQL, DB2, Firebird, Sybase databases
- *multi-platform*: the platform should be implemented in different operating system like Microsoft, Linux and MacOSX
- *scalability*: to distribute the platform load
- *caching*: to improve performances of web applications
- *multiserver*: accessibility to web servers like Apache/Tomcat, IIS, WebSphere

The platform must present also the following technological components:

- Interface of user profiles with systems

like Open LDAP and Active Directory that manage users, groups, roles and permissions
- Interoperability with the Software Development Kit (SDK), an API-based access to the platform in Java, .Net, etc…, Ajax
- Integrated Development Environment (IDE) to develop software applications
- Mail server with the most common e-mail protocols: SMTP, POP3, IMAP.
- APIs to develop Enterprise Applications
- Object-Relational Mapping (ORM) to integrate systems of object oriented programming (OOP) with Relational Database Management System (RDBMS)
- Integration of document and web contents

5 Conclusions

Nowadays, in the knowledge era, by the new business model of Enterprise 2.0, the enterprise can acquire competitive advantages. The company interacting with customers can improve the product/service. This bidirectional communication, enterprise-customers, is supported by web 2.0 tools. It is important, inside the company, the implementation of a technological, interactive and collaborative platform that integrates new and legacy systems and processes both structured and unstructured data coming from virtual channels. The platform 2.0 works in a SOA environment where all functions that support the business can be used as services. In this way the enterprise becomes more agile in answering to market requirements and in improving the customer satisfaction.

In the future it is important the development of a Platform 3.0 based on the semantic web (web 3.0) and in particular on distributed computing and artificial intelligence techniques.

The Semantic Web is an extension of the current web where computers and people can work in cooperation. The knowledge, by new models of representation, can be read by humans and also, in large part, by machines. Smart agents are able to understand the meaning of texts and to directly guide employees, managers, entrepreneurs in the information searching and therefore in specific activities to reach competitive advantages and business goals.

In this way will be easier to process all type of information inside the platform, by a search engine based not on keywords but on sentences written in natural language. Intelligent agents will enable all users of the platform, inside and outside of the company, to participate in a smarter and collaborative conversation. Thus the platform 3.0 will be more adaptable and responsive to needs of the market and also of the single customer.

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