



## Collaborative engineering decision-making for building information channels and improving Web visibility of product manufacturers



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### ABSTRACT

Product manufacturers have spent the last years improving productivity and process efficiency in order to face increasingly competitive markets. Today, the visibility of technological innovations has become essential to achieve the targeted market. It is now very difficult for a product manufacturer to reach customers without owning a website that is visible on search engine results pages. The goal of this paper is to build information channels between a company and its customers through improving both a company's content of information on the Web and its website rank on the Internet through search engine results pages. Company information and knowledge are distributed through multiple stakeholders. The problem of building information channels between a company and customers is solved through a collaborative and distributed approach, on the one hand, and is supported by decision-making tools, on the other hand. The paper proposes an engineering model for building information channels and improving the visibility of the company on the Web. Agents are used for the implementation of the approach. The proposed model and its implementation handle the requirements, constraints, functions and solutions for improving Web visibility. The prototype tool, called CAWIS (Computer Aided Web Information Sharing), examines Web visibility in real time and evaluates the performance of the proposed content of information. CAWIS allows an exploratory and open way for building information channels and improving the visibility of product manufacturers on the Web.

### 1. Introduction

The Internet affects the way people buy, enquire and express their opinions about various products. This transition from traditional business to e-business has forced product manufacturers to change their visibility strategy. Customers are now online, they use search engines to find products that meet their requirements and express their opinions publicly. To take advantage of this, product manufacturers have to have an online presence through a website presenting their expertise and products' characteristics. However this is not sufficient; to be visible on the Internet the website also has to be present on search engine results pages and, ideally, in the top positions. Indeed, information overload has made consumers highly selective [1]; in this way, Internet users are only between 5% and 10% to consult the second page of search engines [2]. Potential customers prefer to reformulate their query rather than looking at the other results pages.

To improve the position of their websites, product manufacturers can apply search engine optimization (SEO). By using some techniques

touching the source code and the website environment, SEO permits a ranking improvement. The objective is to rank a website on a list of keywords in order to attract qualified traffic through these new information channels. The final goal is to generate new contacts by promoting product expertise and technological innovation in order to acquire the voice of customers. Indeed, the design and manufacturing of the products in a company are results of collaborative and distributed processes. Distributed stakeholders work and interact actively on the design and manufacturing of the product according to the aspects and constraints of their domains [3]. In this way, the improvement of product visibility on the Web permits the gathering of online customer reviews and comments, which are useful for stakeholders in identifying their products' potential enhancement [4], and can motivate potential customer decisions.

A webmaster in charge of the SEO strategy faces a number of problems: search engines frequently update their search algorithms in order to always propose relevant results to the users, ranking models are not made public and the SEO process is unstructured. Moreover,

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collaboration between the webmaster and stakeholders working on product design and manufacturing is difficult due to knowledge differences. Finally, SEO results take time and are uncertain while product life cycle quickens and product manufacturers cut development time [5]. This leads to a situation where new innovative products are unknown because they cannot be found in time by using the right keyword on search engines. For all these reasons, the SEO process is considered complex [6].

The goal of this paper is to build information channels between a company and customers through improving both a company's content of information on the Web and its website rank on Internet search engine results pages. Company information and knowledge are distributed through multiple stakeholders. The problem of building information channels between a company and customers is solved through a collaborative and distributed approach, on the one hand, and is supported by decision-making tools, on the other hand. The paper proposes an engineering model for building information channels and improving the visibility of the company on the Web. The formalization of different steps of the SEO process through different bridged models creates consistency towards a collaborative SEO process assisted by computer Web information sharing tools. Agents are used for the implementation of the approach. The proposed model and its implementation handle the requirements, constraints, functions and solutions for improving Web visibility in real time. The prototype tool called CAWIS (*Computer Aided Web Information Sharing*), examines Web visibility and evaluates the performance of the proposed content of information. CAWIS allows an exploratory and open way for building information channels and improving the visibility of product manufacturers on the Web. In addition, CAWIS allows a better control of the SEO process.

The proposed model and the implementation through agent technology permitted the decomposition of the SEO process in several entities. Interactions that took place in this process allow the building of a collaborative and intelligent approach. In the proposed approach, the solution is the result of collaboration between the webmaster and stakeholders. It satisfies stakeholders' requirements as well as Web constraints that include: competition, technological evolution, and algorithm changes. The prototype tool CAWIS implementing the approach allows building bidirectional information channels between a company and customers as well as improving the visibility of the company through the ranking of a product manufacturer website.

The paper is structured as follows. Section 2 presents the literature review. Section 3 describes the proposed approach, including the use of an engineering meta-model to define and describe the SEO process, and the modeling of a multi-agent system to assist the SEO process. Section 4 presents a case study to validate the approach. The discussion and conclusion present and analyze the findings.

## 2. Literature review

In this section, an overview of different techniques used to improve the visibility of product manufacturers on the Web is provided and the engineering research gap is highlighted. Different techniques have been developed to improve website visibility on search engines, such as SEO (search engine optimization). SEO [7] consists of optimizing some technical criteria (off-site and on-site) according to the search engines' algorithm evolution to be visible in the organic results area. A product manufacturer can use SEO to maximize the visibility of its website.

The SEO implementation requires knowledge of ranking criteria [8]. Product manufacturers that do not have time or resources to apply SEO can resort to a SEO firm in order to improve their visibility in the organic results. On the contrary, product manufacturers that want a better control of costs and confidentiality as well as better reactivity in exchanges and the preservation of knowledge can insource their SEO activity to their webmaster [9]. However, this implies that the webmaster takes on extra work and requires knowledge she or he may not possess. Moreover, the technical optimizations proposed, even if they

are effective, will have to meet the stakeholders' needs.

The optimization of on-site criteria and off-site criteria is a fundamental step of increasing visibility [10]. Since the existence of search engines, researchers [11,12] have applied several studies on SEO criteria. They identify some SEO criteria touching the website content, structure, and source code called "on-site criteria". Improving on-site criteria is necessary to obtain a good ranking based on a specific keywords characterized by a high content of information. Keywords have to be relevant and in agreement with the page's theme. The targeted keywords also have to be present in the text content but also in the HTML source code of the webpage. The <TITLE> tag, for example, has to be unique for each webpage and must be completed using targeted keywords. It should also not be longer than 70 characters. The <H1> tag is also important, and contrary to the <TITLE> tag, it is visible on the webpage. The presence of targeted keywords at the beginning of these tags is preferable for good results.

Off-site criteria are criteria related to the website environment and popularity. The criterion "website popularity" which depends on the number of inbound links, also called backlinks, can be highlighted. The more a website acquires links from other websites, the more it will improve its ranking [13,14]. This criterion was first used in the Google ranking algorithm [15]. But this is not sufficient, as the quality of backlinks is also considered. Indeed, the theme of the website from which the backlinks are coming from has to be the same as the theme of the website that receives the backlink. A backlink between websites with different thematic content is not considered a good backlink by search engines, consequently there is no improvement in ranking. In fact, if the quality of backlinks is not good, the ranking of the website could decrease [16,17]. The creation date of the website is also important. Search engines give advantage to websites that have a long history. Moreover, after the optimization implementation, the ranking of an older website improves faster than a new one.

The SEO process is the process that permits optimization of the ranking of a website on search engines while responding to the stakeholders' requirements; it is a process that can be repeated. A SEO project is different from the SEO process because it is unique and temporary; it has a starting and an ending point [18]. In a manufacturing company, the insourced SEO process includes at least two types of human actors: the webmaster and the stakeholders working on product design and manufacturing. Other forms of organization can be found in the SEO process. In the case when a company outsources its SEO process, the involved human actors are the SEO practitioner and the client [9]. The SEO process is not clearly formalized and controlled [19]. In this way, there is no structured engineering method to conduct this activity. Moreover, webmasters adapt their work by using their own experience. Several authors proposed tools facilitating the SEO process. A system to predict ranking [20]; a content editing system working on relevant keywords collecting [21]; and a monitoring system to support SEO strategy [22] are proposed. However, these tools are only dedicated to SEO experts and neglect the stakeholder's role and requirements. Therefore, there is a necessity to design the SEO process such as to support the decision making while integrating the stakeholders' needs. Consequently, the development of a collaborative decision-making tool becomes also necessary [23,24].

In the insourced SEO process, the stakeholders are the people who express the need. According to future product development, the stakeholders give the webmaster a list of keywords to optimize. Additionally the role of stakeholders is to validate the actions to be implemented and to confirm the success of the SEO project. The stakeholders are not greatly involved in the SEO process because the SEO process is complex and requires a SEO expert assessment. Moreover, the knowledge difference between these human actors makes the exchanges and collaboration during the SEO process difficult [3]. Indeed, the webmaster has to satisfy the stakeholders' needs and respect the search engine rules, which are sometimes in conflict. Observations made on the webmaster SEO work shows that non-experienced

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