COGNITIVE AND SOCIAL ASPECTS OF SOFTWARE DEVELOPERS NFORMATION BEHAVIOR: AN ANALYSIS OF THE LITERATURE

ASPECTOS COGNITIVOS E SOCIAIS
DO COMPORTAMENTO INFORMACIONAL DOS DESENVOLVEDORES DE SOFTWARE:
UMA ANÁLISE DA PRODUÇÃO CIENTÍFICA

¹Leonardo Pereira Pinheiro de Souza
¹Marta Lígia Pomim Valentim
¹Daniel Martínez Ávila
Universidade Estadual Paulista¹

Correspondence

Leonardo Pereira Pinheiro de Souza
Universidade Estadual Paulista
Marília, SP - Brasil
E-mail: leopinheirodesouza@gmail.com

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ABSTRACT

The software industry plays an important role in the Brazilian society as a profitable sector that employs hundreds of thousands of people. Programmers have special relevance in this context since they develop computational programs using knowledge and information. This literature review addresses the relationship of these professionals with information, i.e., their information behavior, as well as their needs and problems in this regard. We also emphasize the importance of contextualize the informational behavior in the social sphere, in this case, the organizational culture. We studied if the volume of the scientific production on the information behavior of these professionals in Information Science corresponds with the relevance of their profession to the society, compared to the production on the informational behavior of other knowledge professionals. As a methodology, we searched the papers on this subject indexed by online databases, analyzing their abstracts to verify the paradigms and approaches adopted. It is shown that few studies consider this subject in Information Science, revealing the need of more research on this topic.

KEYWORDS

User Studies. Information Needs. Computer Software.

RESUMO

A indústria de software tem papel importante na sociedade, sendo um setor lucrativo que provê centenas de milhares de empregos diretos no Brasil. Os programadores têm especial relevância neste contexto, pois são eles que desenvolvem os programas computacionais, utilizando conhecimentos e informações. Na presente revisão de literatura são abordados aspectos da relação desses profissionais com a informação, ou seja, seu comportamento informacional, suas necessidades e problemas neste respeito. Destaca-se ainda a importância de contextualizar o comportamento informacional no âmbito social, neste caso, evidenciado pela cultura organizacional. Foi ainda verificado se o volume da produção científica sobre o comportamento informacional dos referidos profissionais na Ciência da Informação é condizente com a relevância desse ofício para a sociedade, comparado à produção sobre o comportamento informacional de outros profissionais do conhecimento. Como procedimentos metodológicos, realizou-se uma pesquisa em bases de dados on line apurando a quantidade de trabalhos sobre a referida temática, analisando-se seus resumos para examinar os paradigmas e abordagens adotados. Evidenciou-se que poucos trabalhos consideram esta temática na Ciência da Informação, revelando que o tema necessita receber maior atenção no âmbito acadêmico.

PALAVRAS-CHAVE

Estudo de usuário. Necessidade de Informação. Software.

1 INTRODUCTION

Technology presents itself ubiquitously in almost every aspect of contemporary life. Embedded in technological equipment, sets of instructions that determine its operation are invariably found: the software. The relevance of the software becomes even more visible when confronted with the volume of produced and analyzed data, intensified with the Internet: the big data, as defined by Kaisler et al. (2013). As highlighted by the Association for Excellence in Brazilian Software (2015), the software industry is highly profitable and a direct source of employment for over six hundred thousand people in the country. This industry is precisely driven by the work of software developers, or programmers.

Software development professionals can be classified as what Drucker (1999) called knowledge workers, because knowledge and information are the main 'inputs' of their production and their main 'tools' of work. In this way, it is important to understand how the relationship between software developers (programmers) and information occurs, and what their needs are in this respect. In this perspective, the following research problems are presented: what are the typical characteristics of the information needs and behaviors of software developers? Is the volume of scientific production that considers the information behavior of programmers consistent with the relevance of their work to society, as is the case of studies in other knowledge workers, such as scientists and engineers?

For the first question, it is hypothesized that, as these professionals work immersed in a technological environment, technology has a preponderant role in their information search habits, surpassing the information obtained through communication with other human beings. Regarding the second question, the hypothesis is that the scientific production on the subject is small, since programmers are not among the professional categories traditionally considered in the studies of information users, such as scientists, engineers, health professionals, among others. (SPINK; CASE, 2012).

This paper aims to reveal some aspects of the relationship between programmers and information, that is, their information behavior, needs and problems as well as to analyze the scientific production on the theme in the scope of Information Science. In order to do so, we verified the number of articles on the theme on online databases and analyzed the abstracts of the selected articles, verifying elements that show an effective examination of the behavior and the information needs of these professionals.

The perspective of information behavior in this study is human-centered, considering

the contextual and social aspects of information seeking and use, that is, the work environment that surrounds the professionals. This perspective is consistent with Davenport and Prusak (1998), who claim that the use of technology is not enough for an effective use of information, but considering the involved human factors and the informational environment of the organization is needed. This view is in line with Salovaara and Tuunainen (2013) that software projects are commonly executed in self-organized teams, denoting that each member performs a specific role and, at the same time, collaborates with the cohesion of the group and with the success of the software project as a whole. The present investigation is not intended to be based on a merely technological understanding, but rather to value human intelligence, which effectively commands the machine.

2 INFORMATIONAL AVALANCHE AND INFORMATION TECHNOLOGY

Contemporaneously, an unprecedented availability of information and knowledge is presented, which is increasingly essential for the development of organizations and societies as a whole. Drucker (1999) discusses a Knowledge Society, not too far from the Age of 'Post Capitalism', in which knowledge, not capital or land, would be the mainstay of economics, a world where dichotomy no longer existed between the employer and the dependent employee. In the idyllic scenario the author describes, the worker with knowledge, the new 'means of production', would be almost self-sufficient, being able to move freely from one company to another, from one employer to another, according to his/her convenience. Although this dream-society still seems far from being realized in the way described above, by verifying the contemporary economic and social realities, it can be said that knowledge is increasingly of economic importance. Drucker (1999) mentions an emblematic event of this orientation to knowledge, the elaboration of the Bill of Rights for American Combatants, through which the US government began to finance higher education for soldiers returning from World War II.

Closely related to knowledge is information, considered the basic unit of its construction. According to Spink and Case (2012), information can designate any perceived difference in the individual or in the environment surrounding him/her, in the reality in which he/she is inserted. Clearly, this definition is neither absolute nor unquestionable. Information is such an omnipresent element in human existence, and it shows itself in so many forms that it is difficult to define it unquestionably. For Gleick (2011, p. 6): "[...] information is what our world runs on: the blood and the fuel, the vital principle. It pervades the sciences from top to bottom, transforming every branch of knowledge." In the present paper, the concept of information is the so-called 'even broader concept' elaborated by Saracevic (1999). According to the author, this concept determines information as a message processed cognitively and contextualized through the situation, the problem at hand and other contexts. Having discussed the role of

information and knowledge in the contemporary world, it is relevant to develop a historical contextualization which, in turn, will serve to briefly elucidate the roots of the current avalanche and the strategies designed to mitigate it.

2.1 The Advent of Computers and Information Science

The so-called 'information explosion' is a situation afflicting society for over half a century. Bush (1945) was already concerned in the immediate aftermath of World War II with the gigantic volume of information produced then, intensified by the central role played by science in the war effort. It was necessary to employ all this information and knowledge in the best possible way and generate development and wealth. In 1945, the author considered that if at that time several aspects of life and work had already been affected by technology, it was necessary to find a way to use it to make the relationship of human beings with information more effective. In this context, the genesis of Information Science (IS) is given, which, in the early decades was concerned with providing good information to scientists, and therefore, was also named Scientific Information Science, according to Araújo (2014).

Not long after, a solution to the information problem was presented. Gleick (2013) mentions that the English mathematician Alan Turing elaborated a concept of 'thinking machine', presented in 1936. According to this author, the machine would be able to read a set of symbols, represented by sequences of zeros and ones, depending on the state or configuration at the time of reading, it would perform an operation according to the input symbol. The concepts of the Turing machine are, to this day, the basic principles governing the operation of computers. Also, according to Gleick (2013), at the end of World War II, the first electronic computers were developed, such as the Electronic Numerical Integrator and Computer (ENIAC), with thermionic valves of twenty-five meters in length.

Gradually, computers began to develop capabilities beyond performing complex calculations, the purpose for which they were originally constructed. These machines became indispensable tools for managing large volume of information, as envisaged by Bush (1945). Although, according to Gleick (2013), Alan Turing and his colleague Claude Shannon discussed about the possibility of a truly thinking machine that could understand cultural elements such as music; to date, computers have not developed the autonomy to truly think. As seen in the analysis of the Turing machine, computers work through a set of detailed, previously programmed instructions: the software. Thus, it is necessary to briefly discuss the current software industry and its relevance.

2.2 The Software Industry and its Impact on Society

The software industry has great economic relevance worldwide, generating huge profits for its producing countries. An example of such strength was the purchase of Microsoft's professional social network, LinkedIn, for twenty-six billion US dollars in 2016, according to Johnston (2016). In Brazil alone, according to the Association for Excellence in Brazilian Software (2015), the industry generates about one hundred and ten billion US dollars annually.

The presence of computers in business has been relevant to increase efficiency of organizational processes since its inception. However, with the popularization of the Internet and social networks, the impact of software has taken on a new dimension that not only helps in managing existing information, but generates new information in large volume, at an indescribable speed. This new avalanche of information is called 'Big Data', which can be defined as "[...] the amount of data just beyond technology's capability to store, manage and process efficiently" (KAISLER et al., 2013, page 995).

Information overload can be a chronic problem for an organization, or an opportunity, if it possesses the means to take advantage from it. This amorphous heap of information from various sources can be useful to organizations when organized in a coherent way. Erevelles, Fukawa, and Swayne (2016) argue that organizations can advantageously use analytical tools to identify hidden patterns of consumer behaviors that may be useful in the strategic arena. For the second time after Bush's (1945) realization of the unmanageable amount of information in the postwar period, the informational aspect once again becomes a challenge for society, and again technology proposes its solutions. This situation is presented in a kind of cycle, in which technology creates solutions to information problems which, in turn, generates new problems that are mitigated with new technological solutions.

No matter how fascinating computer science is, human beings still have an indispensable role in operating the technological tools and, of course, developing them. Behind the scenes of this dazzling spectacle is an immense contingent of knowledge workers: programmers, system analysts, database managers, graphic interface designers, and so on. The software industry, therefore, is rooted in these workers who make information and knowledge the 'raw material' for software development. Thus, it is urgent to verify how the relationship of these professionals with information is given, since it occupies central space in their activity.

3 USER STUDIES AND INFORMATION BEHAVIOR

The relationship of the individual or of a collectivity with information is named 'information behavior'. For Spink and Case (2012) information behavior refers to the purposeful search for information, the avoidance of information, the passive receipt of information, and unintentional situations such as encountering information. These authors show that information behavior is not restricted to the labor scope, but also occurs in several routine situations, such as, for example, the decision on the purchase of a certain product.

Wilson (1999) states that information behavior is the visible manifestation of the search for satisfaction of an information need. For this author, the information need ultimately seeks to satisfy basic underlying needs: physiological, affective and/or cognitive. In the scope of work, the most pressing need is the cognitive one as the individual perceives when he/she is faced with a situation in which his/her current knowledge is insufficient. Then, the process of searching for information begins, which is one of the information behavior manifestations.

It is important to consider information behavior - in addition to being an inextricable component of work, it can also be an ally of organizational success if well managed. Marchand, Kettinger, and Rollins (2001) analyzed a sample of twenty-two public and private companies from different countries and developed a concept for what could be universally considered to be 'good organizational performance', which is a perspective that goes beyond the simple financial aspect. For these authors, the good organizational performance is represented by the growth of the market share, financial growth, innovation in products and services, and the achievement of a higher level of good reputation by the company. The model is consistent as it infers that a company offering exactly the same product, with the same packaging over many years or even a company known to engage in unethical practices, can fatally lose their market share, jeopardizing financial gains. Moreover, according to these authors, superior performance is achieved through the efficient use of information, aligned with good information technology (IT) infrastructure, with information management practices and effective information behavior.

3.1 The Paradigms of User Studies

To better understand information behavior, one needs to contextualize it in the face of theoretical currents represented by the paradigms of user studies in information. Paradigms are perspectives, coherent sets of theories, methodologies, and concepts that serve as a guide for

the study of a given reality. Kuhn (1996, p. X) explains: "Attempting to discover the source of that difference led me to recognize the role in scientific research of what I have since called 'paradigms'. These I take to be universally recognize scientific achievements that for a time provide model problems and solutions to a community of practitioners

Capurro (2007) classifies IS paradigms in physical - considers information as a 'measurable thing'; cognitive - emphasizes knowledge as an entity, independent of the physical aspect, opening space for psychological approaches; and social - contextualizes information in collective values, such as culture and history. The physical paradigm is linked to a technocentric, statistical, information view, as the author states (2003). The cognitive and social aspects of information, therefore, do not receive great relevance from this perspective.

The cognitive paradigm requires a more consistent explanation. For the author, this paradigm can be explained by the popperian epistemology of the three worlds, specifically focused on world three.

[...] we may distinguish the following three worlds or universes: first, the world of physical objects or of physical states; secondly, the world of states of consciousness, or of mental states, or perhaps of behavioural dispositions to act; and thirdly, the world of objective contents of thought, especially of scientific and poetic thoughts and of works of art (Popper, 1985, p. 59).

Popper's third world allows to understand information and knowledge as realities endowed with their own existence, independent of their physical supports. In fact, Capurro (2007) relates this third world to the intellectual contents of written works, that is, the essence of thought, regardless of matter. According to this author, this perspective of information immateriality and of the knowledge permitted to consider them under the cognitive aspect.

Using Capurro's classification (2007), Araújo (2010) presents a classification of the paradigms of user studies: the traditional approach, related to the physical paradigm; the alternative approach, correlated to the cognitive paradigm; and the social paradigm, correlated to its namesake. According to Araújo (2010), the traditional approach understands information as having objective properties, aiming at the evaluation of information services. This approach, however, presented certain flaws. For Capurro (2007), the physical paradigm was aimed at the retrieval of scientific information, but did not contemplate the semantic aspects regarding the meaning, nor the pragmatic aspects regarding the effectiveness of information. Thus, the alternative approach addresses the flaws of the first approach, with a perspective centered on the human being as an individual.

For Rocha, Paula and Duarte (2016), in the 1970s, the alternative approach considered that the individual only incorporated information to fill knowledge gaps. According to these authors, they ignored the possibility of building knowledge in everyday life and the importance of the socio-cultural context. Capurro (2007) criticizes the isolationism of the cognitive paradigm, correlated to the alternative approach, in which the user is seen as absorbed in the intricacies of subjectivity itself in his/her relation to information.

The social paradigm appears later, with the purpose of filling the aforementioned needs. Within the scope of the alternative approach, however, efforts were made to break down strict cognitivism. The aforementioned authors mention Kuhlthau's Information Search Process (2005), which, in addition to considering cognition, also added the emotional factor to information seeking. Another example is Wilson's model (1999) which, although focusing on the individual, considers the demographic, social, and situational aspects of the person's relationship to information. Wilson's model (1999) is emblematic of this evolution towards an understanding of non-reductionist cognition, since it considers that searching behaviors and information use do not occur in a vacuum, but are contextualized in aspects of everyday life, work, economy, politics, among others. The focus of the model, however, remains on the individual.

As Capurro (2007) states, the social paradigm has emerged to effectively examine sociocultural aspects in user studies. Among the theories of this paradigm, one can identify some perspectives that recognize the duality of the relationship between the cognitive and the social, such as Savolainen's Everyday Information Seeking (ELIS) model, which deals with information behavior in everyday life. The assumptions of this model, according to the author (2005), are that the person seeks information to maintain the order of the structures of their way of life, and this way of life is defined from shared values and beliefs, constructed within the scope of the social and economic stratum the person is inserted. This idea is based on Bourdieu's (1984) observation that living standards, tastes, notions of what is acceptable and desirable to people, vary according to their social class. The tactics for maintaining the way of life using information, however, vary cognitively and psychologically.

According to Savolainen (2005), there are four lifestyle maintenance strategies: the positive cognitive, in which the person uses information effectively for problem solving; the negative cognitive, when the individual seeks and uses information in a systematic way, there is no expectation that problems are solved in an optimal way; the defensive affective approach in which there is an optimistic view on the resolution of problems, although avoiding situations that imply a risk of failure; and the pessimistic affective approach, in which the person does not believe in his/her own ability to solve problems using information and therefore does not engage in this quest. It is observed, however, that this model of information behavior gives more relevance to the preferences of information use in situations that occur in life outside the

work environment, not contemplating the specificities of the work setting.

Another two-dimensional perspective of user studies, coping with both cognitive and social, is Distributed Cognition Theory. Rocha, Paula and Duarte (2016) defend the Distributed Cognition Theory as a way of studying information behavior in a web of relations between people, environments and artifacts of knowledge. This is, therefore, another way of contextualizing the cognitive aspects that the authors situate, not in the alternative approach, but in the social paradigm.

Although there is a division between the social paradigm and the alternative approach, the reality of information seeking and use behaviors indicates that both individual cognitive needs and collective and social values influence this reality. Thus, Araújo (2010) also poses a distinct possibility for user studies: a hybrid approach, which considers both elements of the alternative and social approaches. In this perspective, it is coherent to reason that an alternative to mitigate the inherent gaps of each model can be found in a more holistic, multiperspective view, reached from the synthesis of the different paradigms. For Rocha, Paula and Duarte (2016), it is not possible to claim that one approach to user studies is better than the other, but that each perspective must be coherently used in each research context.

It is important to consider the human-centered perspective in relation to information, once, as previously mentioned, the machines - as they are not conscious - cannot truly benefit from the information and assimilate it in the way human beings do. Especially when one considers the organizational context, human beings are the real driving force behind the company's development, with creativity and decision-making power. In this context, it is argued that studies of information users should focus on human beings.

3.2 Models of Information Behavior

This subsection aims to briefly present two models of information behavior that highlights the human aspect. Spink and Case (2012) explain that models are simplified versions of reality, usually represented in the form of diagrams. The model, according to these authors, precedes the elaboration of a formal theory and has a more restricted scope of application than the theory. Thus, it is pertinent to briefly present one of several existing models of information behavior. The models to be discussed are Wilson's models of 1981 (Figure 1), 1996 (Figure 2) and 2006 (Figure 3). These models were selected primarily because they are widely used in IS and related areas and, secondly, because Wilson's work has evolved over the years and is emblematic of changes in trends in user studies, according to Spink and Case (2012).
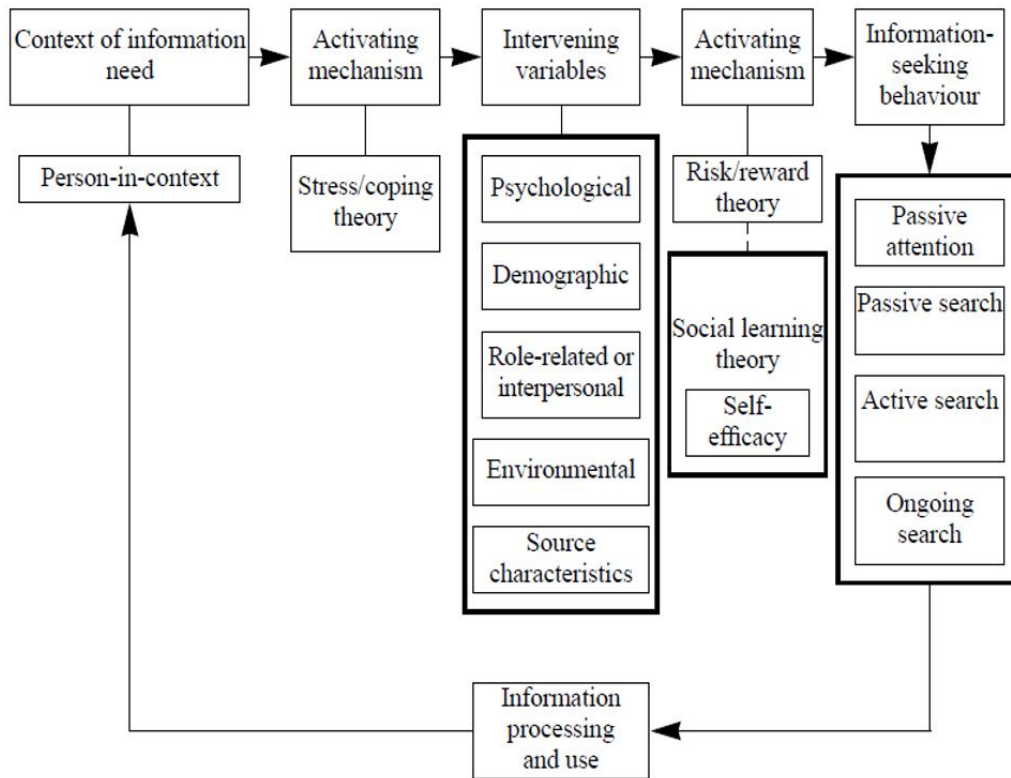
Figure 1. Wilson's Information Behavior Model, 1981.
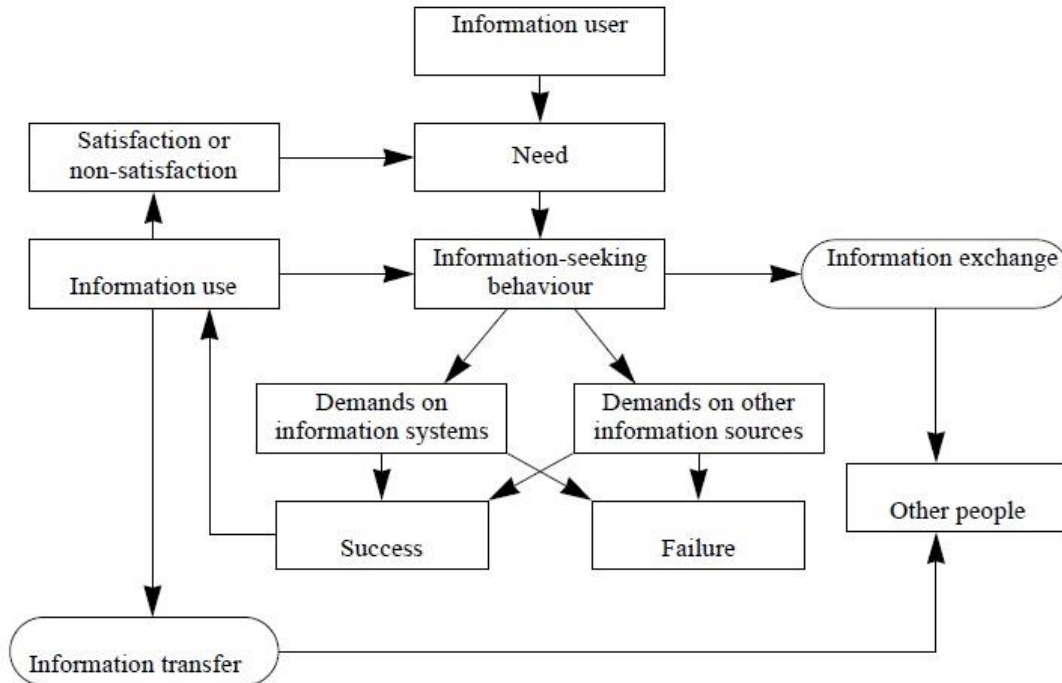
Source: Wilson (1999, p. 251).

Matta (2010) highlights some contributions by Wilson's 1981 Model of Information Behavior: the recognition that information need is secondary and related to more basic needs, such as physiological, affective and cognitive; the identification of barriers to the satisfaction of information need, from the user himself/herself, from the environment or his/her social context.

However, Wilson (1997) recognizes that his 1981 Model does nothing more than providing a map for understanding information-seeking behavior, disregarding any causal relationships involved in the information seeking and use, and fails to further explain the role of context in these two aspects. In this perspective, Wilson creates a new model (Figure 2), named the Complex Information Behavior Model, in 1996, solving previous problems and incorporating the mentioned barriers as intervening variables in the scope of information seeking.

**Figure 2.** Wilson's Information Behavior Model, 1996.

Source: Wilson (1997, p. 569).

Wilson's second model (Figure 2) incorporates several theories from different areas to explain each aspect of information behavior. According to the author, the following is highlighted in this model: The Stress and Confrontation Theory, which determines what needs will result in the search for information; the Theory of Risk and Reward, which explains the preference for certain sources of information; and the Self-Efficacy Theory, on the individual's level of confidence in his/her success in achieving satisfactory results with his/her information behavior.

Wilson's model reveals the possibilities for interdisciplinary relationships in IS, and how these contributions can enrich it. It is also observed that, even if this Model is human-centered, or cognitivist, it is not limited to a totally alienated view of information behavior. The fact that the model considers the user context, the roles he or she plays, and interpersonal relationships constitutes a kind of bridge to the social paradigm. Thus, a more holistic view of information behavior becomes possible.

The third of Wilson's Model (Figure 3) shows the environment as a determining and influencing factor of the individual's information behavior. It establishes a direct relation between the function and the role the organizational subject exerts in the work context to the psychological, affective and cognitive needs.

Figure 3. Wilson's Information Behavior Model, 2006.
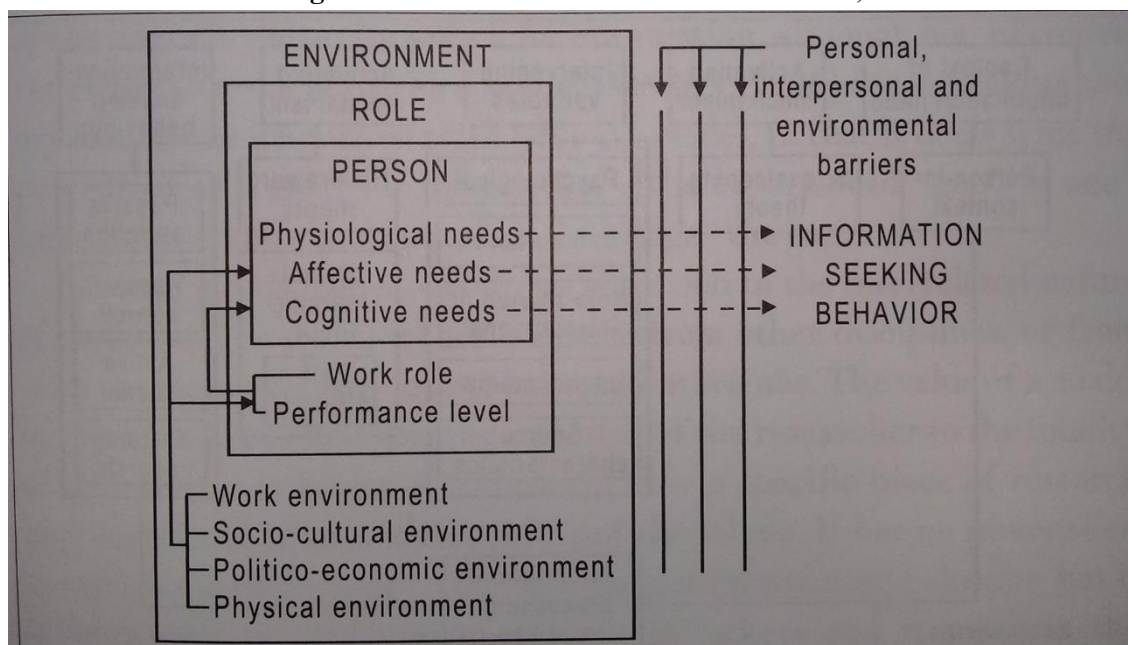
Source: Wilson (2006, p. 663).

Wilson (2006) explains that many factors, in addition to the existence of an information need, influence the information-seeking behavior, that is, having na information need is not enough to start the process, because environmental barriers can significantly affect the process.

As Savolainen's (2005) ELIS model, discussed in Section 3.1, reached a balance between cognitive and social, it is suggested that Wilson's model (1999) can be extended to contemplate the social aspects of the work environment in a more consistent way. This model is suggested to be used together with the analysis of the organizational culture. For Chiavenato (2003) organizational culture is a set of values and beliefs, the collectively accepted way of thinking and doing things in the organization.

Schein (2007) proposes a model of organizational culture analysis in three levels: the artifacts, which are the visible elements that represent this culture, such as the physical layout of the company, the way of dressing, the employees' language and so on; the coupled values, which are officially adopted values, and the shared tacit certainties, which are entrenched values and beliefs that are not explicit. For the author (2007), these shared tacit certainties are

the real essence of the organizational culture, which can be verified by contrasting the officially adopted values with the artifacts that denote the visible expression of the organization's true practices and values. Thus, having exposed some models and approaches for the analysis of information behavior, examining some evidence about the information behavior of software developers is relevant.

3.3 Software Developers' Information Needs and Organizational Culture

Developing software is a truly demanding activity in terms of information resources, constituting a context in which changes occur constantly and at an accelerated pace. Salovaara and Tuunainen (2013) argue that the constant technological evolution requires software development professionals to constantly update their knowledge, although, paradoxically, they are not given much space for this update within the companies they work. These authors (2013) state that most software companies adopt the so-called agile project management methodologies oriented to immediate results in which any practices that are not strictly necessary for project execution are understood as 'disturbances' in the workflow. Thus, even from the perspective of these authors, very little time is allocated for the information and knowledge construction and sharing within the software developers' teams.

Information, in the context of software development, is required for the execution of different types of tasks. Byström and Järvelin (1995) developed a useful task classification model based on the level they require decision-making, from the highly structured, which can be automated to the highly unstructured activities that require greater cognitive effort from the organizational subject.

> *Automatic information processing tasks* are *a priori* completely determinable so that, in principle, they could be automated [...]. *Normal information-processing tasks* are almost completely *a priori* determinable, but require some case-based arbitration concerning, for instance, the sufficiency of the information normally collected. [...] *Normal decision tasks* are still quite structured, but in them cased-based arbitration has a major role. Example: hiring an employee or evaluating student's term paper. In *known, genuine decision tasks* the type and structure of the result is *a priori* known, but permanent procedures for performing the tasks have not emerged yet. [...] *Genuine decision tasks* are unexpected, new, and unstructured. Thus, neither the result, the process, nor the information requirements can be characterized in advance (BYSTRÖM; JÄRVELIN, 1995, p.194-195).

The types of activities described above can also be used to analyze the software developers' work. Srivatsan et al. (2009) identified that 95% of programmers' work focuses on the categories 'normal information-processing tasks', 'normal decision tasks' and 'known, genuine decision tasks', and as the software project progresses, tasks will require a higher level

of decision-making. In this context, the choice for information sources is directly related to the level of challenge offered by the project. Moreover, according to the authors, routine projects present more 'normal information-processing tasks', for which people are more often used as information sources, whereas innovative projects present more 'known genuine decision-making tasks', for which the Internet is used as the information source.

However, Grzywaczewski et al. (2013) argue that the stressed use of the internet to solve programming problems is due in part to the unavailability of time and social barriers to communicate with fellow programmers. For the authors, programmers respond to this lack of communication using opportunistic programming practices, which would be na attempt to solve problems by try and error, by copying codes developed by others, available on the Internet. According to the authors, the solutions found through this practice are rarely documented to be used by others in the future, feeding a cycle of inadequate and inefficient programming practices. It is relevant, therefore, to understand how the professionals' attitudes to information can be modified, so that there is a more consistent communication flow among co-workers and more consistent programming practices.

Davenport and Prusak (1998) argue that the change in information behavior must be effected with a combined action on information behavior and information culture. For the authors, while the behavior refers to the individual, the information culture determines a group's values, beliefs and preferences about information, its sources and channels. Shared beliefs and values are precisely the basis of organizational culture, as defined by Chiavenato (2003). Thus, it is argued that the change in information culture occurs through the change in the perspective of the organizational culture regarding the relationship of people with information.

The processes of cultural change vary according to the maturity level of the company, and whether its founders, responsible for the creation and diffusion of culture, are still active. For Schein (2007), in new companies, which still have their founders present, the members embrace the culture with more conviction, by the influence of these founders. In this scenario, the author explains, cultural change can be carried out by placing in the lead individuals who, while embracing the core values of culture, have some distinct thoughts and attitudes that fit the desired cultural changes. These leaders will, therefore, be the drivers of change, being more readily accepted by the leaded ones and founders for agreeing to the basic principles of culture. In older companies, where culture is already established and founders are not present to promote it vigorously, more direct action can be taken. In this situation, says Schein (2007), the change can be made through educational actions that instruct the adoption of new practices, explicitly exposing the benefits of their adoption or the disadvantages of not doing so.

Having considered the behavioral and cultural aspects, it is necessary to understand exactly what the performed tasks are and the purpose programmers have to use the information

in a more specific way. This understanding allows to identify the information needs of professionals. Ko, Deline and Venolia (2007) identified some types of activities that motivate information seeking: writing programming codes; understanding and correcting program failures; understanding the causes of how a program executes; understanding the purpose and implications of code changes; keeping up to date on the work of colleagues and the evolution of the project. For these authors, co-workers are considered relevant information sources, and it is especially important for the programmer to keep up-to-date on the progress of the project, to understand the purpose of a code or the behavior of executing a program.

The role of the human being as an information source is reported by Nonaka and Takeuchi (1997), when they describe the socialization process that refers to knowledge transmission from experience or even tacitly, that is, from person to person. The authors argue that some aspects of this type of knowledge can be difficult to formalize, even though it is a strategic and valuable knowledge for the organization. It is evident, therefore, that both interpersonal communication and formal information sources are necessary for the work, according to the type and complexity of the activity to be carried out.

4 METHODOLOGICAL PROCEDURES

Initially, a bibliographic review was carried out aiming to build the theoretical basis of the work. In a multidisciplinary perspective, papers from the areas of Information Science, Economics, Philosophy and Computer Science were used. After the construction of the theoretical reference, data were collected about the scientific production on the information behavior of software developers. The survey on the theme was carried out in December 2018, in three databases: Library and Information Science Abstracts (LISA); Web of Science; and Reference Database of Journal Articles in Information Science (BRAPCI). LISA database, although focused on articles in IS, also covers the fields: Computer Science, Information Technology, Internet technologies, Artificial Intelligence, among others[1]. Web of Science, in turn, is a database of varied content, covering the most different categories of knowledge areas, such as: 'Computer Science, Information Systems', 'Information Science and Library Science', among others[2]. In this way, we sought to verify the number of articles on the theme within IS.

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[1] Available at: <https://www.proquest.com/products-services/lisa-set-c.html>. Access on: Dec 07, 2018.

[2] Available at: <http://images-webofknowledge.ez87.periodicos.capes.gov.br//WOKRS531OR13/help/pt_BR/WOS/hp_subject_category_terms_tasca.html>. Access on: Dec 07, 2018.

Both in LISA and Web of Science databases, the terms used for the search were: '((*"information behavior" OR "information behaviour") OR "user studies") AND ("software developer" OR "programmer")'*. The term for information behavior was used both in the American variant, information behavior, and in the British variant, information behaviour. The use of the expression user studies was aimed to increase the scope of the search, encompassing other perspectives about the subjects' relationship with information, in addition to the concept of information behavior. Both the term *software developer*, *desenvolvedor de software*, and the term *programmer*, or *programador*, were the two most common ways of referring to professionals who develop computer programs. The use of parentheses was necessary to guarantee the correct reading order of the query by the search system, and the consistency of the results, since the logical operator, *and*, takes precedence over the disjunction operator, *or*. (HASHIMOTO, MORIMOTO, 2010, CLARIVATE ANALYTICS, 2018). In this way, it was ensured that the instructions in the parentheses were first executed so that it would later merge with the operator *and*.

In BRAPCI database, the search *'("comportamento informacional" OR "estudos de usuários") AND ("desenvolvedor de software" OR "programador")'* presented inconsistent results, returning tens of thousands of records, whereas similar searches in LISA and Web of Science did not exceed the number of tens. To obtain more reliable results, four different searches were performed, combining the elements of the original research: *'"estudos de usuários" AND "programador"'; '"comportamento informacional" AND "programador"'; '"comportamento informacional" AND "desenvolvedor de software"'; '"estudos de usuários" AND "desenvolvedor de software"'*.

Initially, the results were computed by database, organized and displayed in tables. Due to the relatively small number of results returned in all the investigated databases, it was possible to analyze the abstracts of the articles to verify the topics, the perspectives and paradigms approached in relation to information behavior. The results of this last stage of analysis were categorized and organized in tables. Finally, the interpretation of the results was carried out using theoretical contributions of IS.

5 RESULTS AND DISCUSSION

This section presents the calculation of the number of papers addressing the information behavior of software developers or programmers. Three databases were used: LISA, Web of Science and BRAPCI. Table 1 shows the number of articles retrieved from the search with the terms '((*"information behavior" OR "information behaviour") OR "user studies") AND*

("software developer" OR "programmer")' in international databases, as well as the results from BRAPCI.

In BRAPCI, a distinct strategy was necessary, partitioning a greater search expression in four searches. When entering the search expression *'("comportamento informacional" OR "estudos de usuários") AND ("desenvolvedor de software" OR "programador")*', the number of retrieved results was very different from what was obtained from the international databases. While the search for similar content retrieved 48 records in LISA and eight in Web of Science, BRAPCI retrieved 20,462 records. To verify the results, four different searches were performed using the terms: *'"estudos de usuários" AND "programador"'; '"comportamento informacional" AND "programador"'; '"comportamento informacional" AND "desenvolvedor de software"'; '"estudos de usuários" AND "desenvolvedor de software"'.* All of the searches retrieved zero records. It is inferred that the inconsistencies in processing more complex searches by BRAPCI is due to its system's beta version, as informed, in red, in the header of its electronic page[3], that is, the system is in process and being improved.

Table 1. Papers on the information behavior of programmers in international databases.

Database	LISA
Search Terms	*(("information behavior" OR "information behaviour") OR "user studies") AND ("software developer" OR "programmer")*
Results	48
Database	**Web of Science**
Search Terms	*TS= (("information behavior" OR "information behaviour") OR "user studies") AND TS= ("software developer" OR "programmer")*
Results	8
Database	**BRAPCI**
Search Terms	*"estudos de usuários" AND "programador"*
Results	0
Search Terms	*"comportamento informacional" AND "programador"*
Results	0
Search Terms	*"estudos de usuários" AND "desenvolvedor de software"*
Results	0
Search Terms	*"comportamento informacional " AND "desenvolvedor de software"*
Results	0
Total number of results	**56**

Source: elaborated by the authors (2018).

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[3] Available at: <http://www.brapci.inf.br/index.php/res/>. Access on: Dec 07, 2018.

By reading the abstracts of the papers, we verified that, although the search terms were included in the abstracts, most papers were about aspects of elaborating and analyzing programming code, as well as computerized systems to support the daily tasks of libraries and/or their users. Table 2 shows the thematic categories addressed in the retrieved papers These articles were classified into two groups: those with a more humanistic approach and those with technology as the predominant subject.

Table 2. Themes addressed in the retrieved papers.

	Theme	Number of papers
Humanistic approach	Social aspects of knowledge construction	1
	History and evolution of IS and Librarianship	4
	Methodological approaches to IS	1
	Challenges information professionals face due to technological and economic changes	2
	Good practices for information services	1
	User studies and information behavior in libraries	5
	Information behavior of scholars in humanities	2
	Subtotal	**16**
	Theme	**Number of papers**
Technological Approach	Information-seeking behavior towards technological resources	2
	Computerized systems for libraries	10
	Documentary practices with digital resources	3
	Databases of scientific publications and patents	4
	Technology resources for education	1
	Aspects of software usability	3
	Aspects of elaboration and analysis of programming code	15
	Artificial intelligence and robotics in everyday life	2
	Subtotal	**40**
Total of results	56	

Source: elaborated by the authors (2018).

Of the total of 56 retrieved papers, two stood out as they considered aspects of information search and use by software development professionals in the work environment. The paper by Grzywaczewski et al. (2013), retrieved from Web of Science, brings discussion about the software developer's information acquisition, use, and sharing habits. The authors (2013) discuss the development of a recommendation system to assist programmers in finding information on software codes. According to Isinkaye, Folajimi and Ojokoh (2015), recommendation systems are those with the ability to predict which information will likely be

useful to a user according to their profile, making suggestions and allowing the system to autocomplete the search terms. Despite the technological approach, Grzywaczewski et al. (2013) identify that social barriers and deadlines hamper communication among software developers and force them to use the Internet as their major information source, which was previously discussed (Section 3.3).

It is important to highlight that Grzywaczewski et al. (2013) address aspects of the professionals' relationships with information without making explicit what approach or paradigm of user studies is considered in their study. This is possibly due to the fact that the study is centered in the development of a technological resource. The simple use of technological solutions to address gaps in information behavior and communication problems is challenged by Marchand, Kettinger and Rolins (2001), who claim that effective information behavior as well as effective information sharing demand favorable organizational culture.

The article by Sillito, Murphy and De Volder (2008) analyzes what questions programmers ask during the maintenance and adaptation of preexisting programming code and how they use automated analysis tools to respond to them, "[...] exploring similarities, connections, and differences among those questions" (Op. cit., p. 436). Although not explicitly mentioned in the paper, it is possible to reallized that the study adresses the information needs of programmers. These authors (2008), however, restricted their analysis to elements of the programming code as an information source, and omitted questions about how to approach the tasks, or the operation of code analysis tools. Also, no references to IS models or theories about user studies, information behavior, or related areas were found in the paper.

In addition, it was verified that several articles classified in the category ' Aspects of elaboration and analysis of programming code ', shown in Table 2, used the term user studies, but with a different concept from the one understood in IS. These user studies, in general, are experimental research aimed at verifying how subjects interact with technological tools, as evidenced by the example obtained from one of the retrieved papers:

> Our user study was aimed at evaluating the usefulness of Sniff to developers for real programming tasks [...] We designed four programming problems and assigned them to a set of users. [...] Each user was allowed to use Sniff for two of the four problems. Of the remaining two, they were allowed to use Prospector for one problem and Google Code Search Engine for the other. (CHATTERJEE; JUVEKAR; SEN, 2009, p. 394- 395).

It is also important to highlight that the retrieved articles mentioning the relationship of programmers with information at work in Web of Science are not under Information Science, but in Computer Science and Engineering. The results show a scarcity of studies focused on the study of information behavior in software development. This conclusion is in line with the observation by Spink and Case (2012), as they report that although studies on information

behavior in occupational categories constitute an increasingly expressive volume of work, most have focused specifically on some professions. These authors claim that these studies have concentrated more on the area of Health and on students in general, excluding several professional categories.

This investigation revealed that studies on programmers which do not consider purely technological solutions for the provision of necessary information to work, but considers humans, contextualized in their surrounding environment as protagonists in the search, valuation, acquisition, sharing and use of information and knowledge are limited. In this perspective, it is relevant to perceive the reality that technology alone cannot satisfy information needs in the work environment, since it is necessary to understand the kinds of required information, what they are used for, and the existing barriers to information acquisition. It is also important to recognize, as Wilson (1999) states, that not only documented information is relevant, but that people are important information sources. People are not only information sources, but creators and holders of knowledge accumulated along their work experience.

6 CONCLUSIONS

Because of the central role technology plays in contemporary society, it is important to consider the information needs of the professionals who create these technologies more carefully. As previously discussed, software developers are professionals who need to constantly acquire new information and knowledge to keep up with the changes taking place within their professional environment. However, the time they have to meet this need is scarce. The present research demonstrated that apparently few academic papers consider the information behavior of software developers. It is necessary to analyze their behavior in a holistic way, considering both the technology and the human factor, both the cognition and the collective context of the organizational culture. This balance between different perspectives seeks nothing more than to more faithfully represent the reality, which is multifaceted and complex.

Only by understanding the relationship of professionals with information can we improve it so that work can be carried out more smoothly, so that there are better and more innovative products and services. Even if these professionals are immersed in technology, they are human beings who work in structured organizations and that face challenges of competitiveness and survival in a very similar way to the others.

The discussions carried out in the present study were based exclusively on the theoretical framework, mostly in English language on information needs and behavior. Thus, it is necessary to collect empirical data on the reality of the information behavior of Brazilian programmers, as each country has its own peculiar socioeconomic realities which interferes in the way of living and in labor relations. It is suggested, as further research, a study on the information behavior of software developers in Brazil, conducting field surveys and interviews within the companies. In this way, good information practices and the problems faced by professionals in their relationship with information can be evidenced.

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