FIS 2010 Beijing, China

Exploring the Notion of Information: a Proposal for a Multifaced Understanding

Abstract: The notion of Information is one of the most essential that guides situations to flow in certain ways. Situations such as those of natural disasters, "the Haiti earthquake 2010"; the financial crisis, that of "Greece Crisis 2010"; or the environmental disasters, such as that of "oil slick in the Gulf of Mexico 2010", are just a few instances of constant growing empirical dilemmas in our global society, where information plays a central role. The meaning of what information is has clear implications on how we deal with it in our practical lives, which in turn may give rise to situations that we would prefer to be without. This way, the notion of information has evidently presented the need to question what it really means and how does it dominate the functioning of our global society. Thus, two questions emerge in this paper: *what definitions of the notion of information are presented in the literature?; and, what are the differences between these definitions?* To answer these questions, we have conducted a comprehensive literature survey of more than two hundred gathered publications. Detailed analyses of the content of these publications identified four forms of information notion definitions. The results show that these four forms present diverse and opposing views of the notion of information, labelled as the "quartet approach". These addressed different foci, contexts and challenges. In addition, we present an alternative, yet a novel understanding of the notion of information, associated with how information functions in our societies. This understanding is presented with a new perspective, intended to address significant needs of the information society.

Keywords: *information notion; information definition; information society; literature survey*

Miranda Kajtazi

School of Computer Science, Mathematics and Physics, Linnaues University, Sweden
Address: PG Vejdes Plats 6, DFM, SE-351 95
Växjö, Sweden.
email: miranda.kajtazi@lnu.se

Darek M. Haftor

Stockholm School of Business, Stockholm University, Sweden
Address: Stockholm University, School of Business, SE-106 91, Stockholm, Sweden
email: dh@fek.su.

About the first author of this paper:

Miranda KAJTAZI is a PhD candidate in Informatics, at the School of Computer Science, Physics and Mathematics, at Linnaeus University in Sweden. Her research interest concerns one of the most crucial resources of our human and social affairs: Information. Thus, Miranda explores the interplay of social dynamics and technology, by focusing at causes and consequences of information inadequacy in our global society.

1. Introduction

This paper presents some preliminary findings from an ongoing research into the notion of information. In this, a novel understanding of information is presented as associated with how information is functioning in our societies. Situations such as those of natural disasters, "the Haiti earthquake 2010"; the financial crisis, that of "Greece Crisis 2010"; or the environmental disasters, such as that of "oil slick in the Gulf of Mexico 2010", are just a few instances of constant growing empirical dilemmas in our global society, where information plays a central role. In these and many similar situations there seems to recur a pattern where there is a lack of needed information and/or there is an information overload.

Not surprisingly, various scholars have attentioned this central and crucial role of information in our human, industrial and social affairs. To mention two example instances only, the 1978 Noble Laureate Herbert Simon undertook an evolving approach to construct a new meaning of information, which has possible explanations for such situations as those mentioned above. For him, in one way, information is a complex form of human construct; hence, humans' particular reactions can depend largely on information that is available to them [1]. Similarly, another Noble Laureate of 2001, George Akerlof, predicted how information has become the main cause of some society failures, by attaching to his prediction the complexity of human behavior [2]. These and other explorations seem to point into the same directions: the meaning of what information is has clear implications on how we deal with it in our practical lives, which in turn may give rise to situations that we would prefer to be without – when a surgeon amputates the wrong leg of a patient, because the given information instructed so…

This way, the notion of information has evidently presented the need to question what it really means and how does it dominate the functioning of our global society. Subsequently, the key questions of investigation in this paper are as follows: *what definitions of the notion of information are presented in the literature?; and, what are the differences between these definitions?* To answer these questions, we have conducted a comprehensive literature review on the notion of "information". Results derived from this extensive literature, first present a historical development of many notions of information, mainly evolved during the last century. Hence, the literature shows that many notions of information have been proposed, such as information is an inward-forming [3] or information is an interpretation with some attached meaning [4, 5, 6, 7 & 8]; information is a fundamental reality [9, 10, 11]; information is physical [12, 13, 14]; or information is transmittable [15], among others. Second, the outcome from these analyses on these definitions, have led to a novel presentation of four identified forms (information is fundamental; meaningful; quantifiable; and, transmittable). We introduce a theoretical framework based on these four forms, which we label as the "quartet approach". This has led us to develop an alternative understanding of the notion of information. This study is intended to help a positive management of human, industrial and social affairs where and when information plays a crucial role.

This paper is structured in the following way: we first introduce the methodological considerations that have been applied to this research. Then we introduce a historical overview of the notion of information. This overview is followed by presenting the quartet approach. Afterwards, we continue with our proposed understanding of the notion of information. We continue to discuss the implications of this study to theory and practice.

2. Methodological Considerations

Two types of methodologies have been considered for this study. First we have conducted a comprehensive literature survey of more than two hundred gathered publications. These publications were retrieved from academic online database systems. The review of those publications was driven by the need to find explicit definitions of the notion of information. We have selected around fifty information definitions. The rest of the publications identified (dealt with referencing previous information definitions) have been useful for our analyses from broader perspectives to strengthen

our results.

Second, the analyses conducted on this comprehensive literature review was guided both by Heidegger's necessity of explicit interpretations of universal notions [16]; and, Husserl's system of propositions that are interlinked and have better overviews of different manifestations in the real world [17]. Those two, have driven phenomenological descriptions in our study.

There are, however, limitations in this study. The selection of publications was focused on retrieving literature published only during the last century. We consider that such a limitation has allowed us to derive novel results to better understand the role of information in the movements of the information society that emerged in the last century [18, 19].

3. A Historical Overview of the Notion of Information

The discussion about the notion of information has been present in all scientific disciplines. However, this literature survey identified those discussions as rather diverse and opposing [e.g. 3, 4, 15, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29]. Thus, information is viewed as an infinite of its characteristics, such as data to knowledge; signal to communication; symbol to meaning…[e.g. 3, 4, 7, 8, 15, 24 & 30]. Furthermore, these diversities have been used in different fundamental forms of information's very existence, namely: information is physical; biological; mechanical; social; digital…[e.g. 4, 6, 10, 24, 29, 31, 32, 33, 34]. Above all, information has long been understood as a universal notion [16], and it has been given freedom to be used without consensus in different scientific domains [e.g. 21, 35, 36, 37].

Moreover, we intend to systematically understand the diversities between information definitions that derive from two doctrines, which deal with the practice of the basic rule of defining information:

- the subjective orientation towards human communication of the meaning of information [6, 38, 39].
- the objective orientation towards external physical components of the universe that consist information [13, 14, 40].

Many scholars have devoted effort to distinguish between the two opposite doctrines of this fundamental rule of information. However, just a few analyses have met a logical picture of facts and a solid regularity to distinguish the two [10, 11, 24, 26, 29, 33 & 41].

Regardless of the growing research in this scientific dilemma, little work has been done on understanding the many differences on the notion of information definitions in detail. From previous contributions, we have noticed that they mostly concentrated on defining information through one of this tripartite: *philosophically* (through philosophy of information, the physical and the semantic nature of information) [6, 10, 27], *mathematically* (through information theory, the measurement and quantifiable information) [14, 15, 30, 40] or *more universally* (through the unified theory of information, the evolutionary information, the dependency on dissipative and living systems) [9, 11, 22]. In contrary, our quartet approach proposed here focuses on this tripartite. We use this tripartite in terms of both their objectivist and subjectivist practices. The rational of such analyses can help us to unify the diversity of information definitions.

4. The Quartet Approach

This study has identified four forms of our theoretical framework, the quartet approach. Those are: information is fundamental; information is meaningful: information is quantifiable; and, information is transmittable. This approach succeeded from the analyses on historical developments of the notion of information. All of the definitions that are used to build the quartet approach belong to the era of investigations from industrial revolution to information society [19]. This presents the era of immense research on bringing the meaning of fundamental notions of our existence, into discussions and debates.

Hence, we argue that the quartet approach has generated some interesting and useful results. The classification of definitions draws by depending on four initial accounted forms of information. All these definitions are based on philosophical implications of

the doctrines of objectivism and subjectivism. Thus, the following four forms of the notion of information are introduced:

—"Information is Fundamental". These definitions are primarily concerned with the concept of information as something being as equal as the basic substances or insubstances of the universe. (*Elaborated on section 4.1)*

—"Information is Meaningful". These definitions are primarily concerned with the knowledge and human capabilities, who are able to interpret and give meaning to something that is or becomes information. *(Elaborated on section 4.2)*

—"Information is Quantifiable". These definitions are not concerned whether information related to the fundamentals or its meaning given by human beings. These are only concerned with its definition in technical sphere; they are concerned to find technical possibilities to measure information. *(Elaborated on section 4.3)*.

—"Information is Transmittable". These definitions are only concerned with how information is transmittable, possibly in the same quantity, from one point to another. These definitions are much related to a composition of what would be "quantifiable information" and "communicated information to its destination", the latter in terms of human values. *(Elaborated on section 4.4)*.

There are several aspects that motivated us to build the theoretical framework of the quartet approach. First, information has become central not only in philosophy as a discipline, but also in all academic debates and industrial changes [10, 21]. These newly perceived performances, both in academia and industry, influence changes in information research. This can possibly help to reduce the complexity of many definitions of information. Thus, understanding how information definitions develop, and why information is reducible to specific forms, can help us to present explicit advices for designing a systemic approach on this matter.

Even more, many researchers have rather had a fascinating look into the notion of information. Their definitions have been exclusive for their environments and thoughts [e.g. 4, 9, 15, 20, 42, 43] among many others. Our focus is on classifying these different definitions of information, by restructuring the discussions that compelled no consensus. Other research has explored information that occurs as a companion entity for other essential concerns, in the context of calculations in mathematical theory [e.g. 15, 20, 25, 35, 40], semantic information [e.g. 21, 44, 45], information as a form: autopoietic and semiotic [e.g. 4, 24, 27, 31, 46, 47, 48], and information as meaning [e.g. 3, 7, 8, 49]. However, these are just to reference a few.

We use this diversification to distinguish our intention of presenting why there is a need to balance between these forms of information, and we argue that the application of each form in our current surroundings is useful, for what each signifies.

In reflection to the presented classification of definitions, we illustrate below a historical overview of the selected authors that have guided us to develop the quartet approach.

The basis of our inquiry to develop this approach is focused on the classifications as presented in Figure 1. The proposed classification has mostly developed on the basis of practices among scholars, who have been subject to diverse scientific influences on defining the notion of information.

We illustrate the application of those selected information definitions within this framework, by developing some theoretical understandings (context, challenges, dimensions). As a result of this development, the tendency has been to re-conceptualize the notion of information. For that, information has become significant for someone not only in its indefinite forms of definitions, but we consider that information as a notion has become more explicit to everyone in its quartet appearance. Finally, since we have tackled this dilemma at length, we argue that the quartet as our approach may possibly change the theoretical understanding (of being equivocal) of the notion of information.

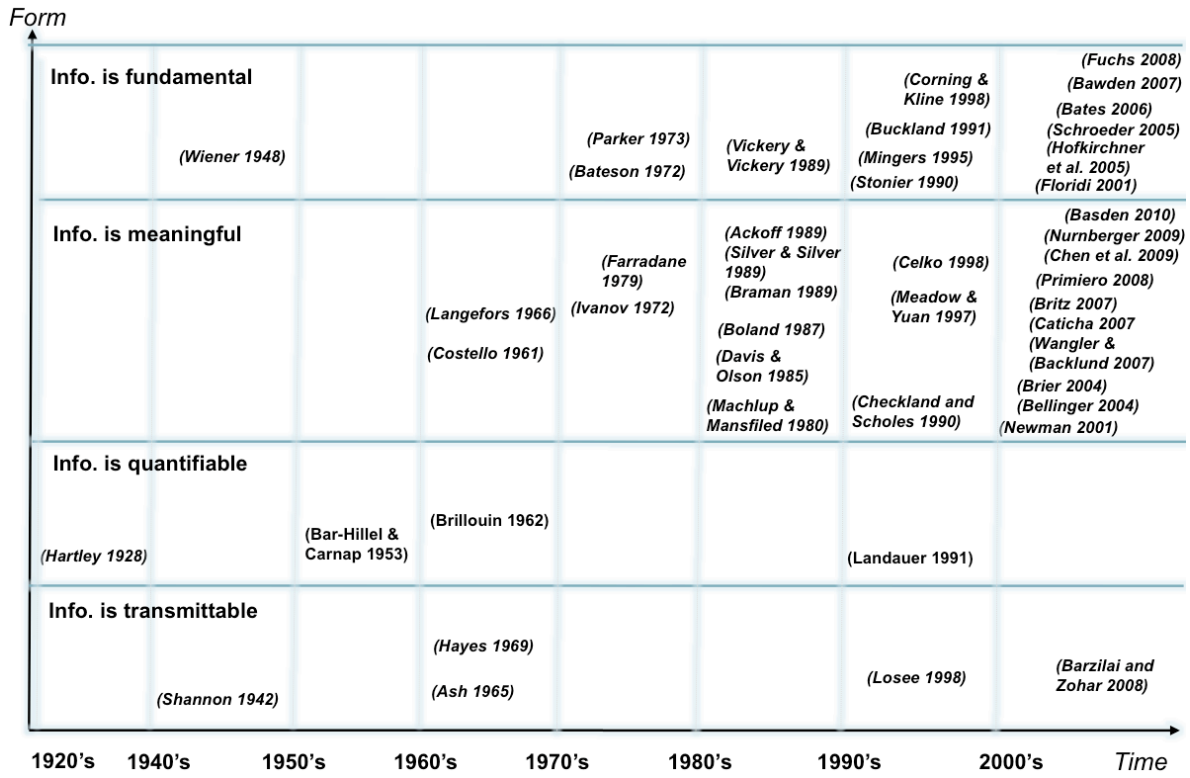

Figure 1: The presentation of the quartet approach: historical developments of the notion of information

The four next sub-sections present an overview of each of these identified forms. Due to limited space, we only mention some key selected definitions in each of these forms. To strengthen our overview, we also discuss more specifically one selected definition under each form. This way, we intend to clarify how such selected definitions are related to those four forms.

4.1 Information is Fundamental

This form presents the developments and understandings on the notion of information as being fundamental. Here, information is regarded as one of the essential elements that constitute our world [10, 50]. There are several independent approaches that tried to explain at least its participation as a constitutive element, so far, but not concisely its meaning. Some of these approaches stem from the inter-disciplinary influence. They define information in this context: "*information is a difference that makes a difference"* [4, p459]; *information is information, not matter and energy* [20, p 132]; "*information has arisen as a concept as fundamental and important as "being", "knowledge", "life", "intelligence", "meaning", or "good and evil"! all pivotal concepts with which it is interdependent* [51, p16]; "*information seems to be as fundamental building block of the universe as matter and energy"* [52, p86]; *Information is different from meaning. Information is an objective, although abstract, feature of the world in the same way as are physical objects and their properties* [6, p295]. These are just to mention a few.

Our implication to this identified form, classifies such definitions as the challenge of exploring information being fundamental, which stands independent of anything else that constitutes our world. Furthermore, for this form, information can be insubstantial, which defines the differences between the substances (the tangible) and the differences between the imperceptible (the intangible). Information can also be considered an independent complex element, for how it comes to existence, how it is interpreted by human context, or how it dissolves in the objective and subjective nature, and how it reoccurs.

In this regard, for us, one of the greatest definition of information as fundamental conceived in these analyses, has first been stated by Bateson [4, p459], for which he says information is a "*difference that makes a*

difference". This is possibly the most adequate definition, for one to understand the elementary meaning of what is information. However, the critical question then asks whether this definition is meaningful and elementary, and that in practice, this is the preparatory investigation for one to start thinking for what is deeply meant by the notion of information.

For Bateson, the infinity – of the differences, is what truly matters in whatever we experience in this world as information. It is "us – the living beings" and it is the "objects" – the physical entities, that for the way "we" or the "objects" continually transform (change through time), experience an infinite range of differences. This, according to Bateson [4] is a journey that is first made possible through hard-sciences. Indeed, this is the way in which the basis of our creation, the matter and energy, trigger every chance to experience a difference. Thus far, this has only illustrated the broad nature of Batesonian's philosophy of defining information. Our question "what is really meant by these differences of information" is yet to be explicated. For what is really meant with Batesonian's difference, he clearly points out that "we", or the "objects" exist around infinite differences, i.e. between the "object" and the moon, between "us" and the moon, between the "object" and the "us", and so on. Even more, for every "us" or for every "object" there are molecules, which have infinite differences between their current locations, past locations, or the locations in which "we" or the "objects" might be. This is so, that for every one of "us" there is a different way of perceiving information. In fact, very different of how for every "object" this is conceived. For "us", it can be from the inside, the sensory input from our mental abilities. It can also be from the outside, in the propagation of light and sound, the matter and energy. Be that as it may, this contrast is not absolute, points Bateson [4, p460]. As a matter of fact, this contrast must be mentioned and understood; otherwise it can lead one to problems. If this is necessary to be pronounced, then this is truly the greatest (yet too broad) meaning of the notion of information.

4.2 Information is Meaningful

This form of information, presents a growing scientific orientation in the last three decades. Information here, is defined as something that must be interpreted by human-beings. Many of the selected definitions derive from diverse areas of research, such as: personal worldviews, individual experiences; human knowing and human management; human social values, and the like. Hence, they define information as: "*Information equals data plus meaning* [7, p303]; Information is an inward-forming. It is the change in a person from an encounter with data. It is the change in the knowledge, beliefs, values or behavior of that person [3, p363]; Information is interpreted data, it is something we get to know, it is knowledge of some sort [8, p111]; "information is understood as potential until somebody interprets it" [32, p629]; information is data that are processed to be useful, providing answers to "who," "what," "where," and "when" questions [5, p5].

From our understandings, the developments in this area, suggest that there has been a broad view on defining information as meaningful (from social aspects to individual aspects), although, each of them stands critical towards human values, by putting the human understanding and human interpretation as the main source of creating information.

Every scientific discipline uses the concept of information in variety of contexts. A critical, yet an interesting debate on this pattern is introduced by Boland in 1987, on his determinate work to examine the most critical issues that concern information systems [3]. In particular, he focuses on the issue of how information has become a common dominator. For him, information is a notion, which is capable to bring together the basic elements of our existence, simply into a single framework of analysis. His concern, which is to investigate the use of the notion of information in variety of definitions, is more due to its use as a metaphor than of what information is in reality. In this aspect, he argues that there are some central information aspects of our social world. Boland's conception of information has been intruded by five most popular dictum fantasies of our time. He divided them on the basis of various research initiatives that took the responsibility to define information for their interests – the dictum. In spite of this investigation, for Boland,

each of them has failed to realize that the necessary condition of defining information is the interpretive system. In other words, it is the mental state of the human knower. His five identified fantasies were presented in sequence, and his intention was to highlight the focus of each: the removal of the human factor. It is through his accomplishments on research that he identified these fantasies. (i) information is structured data; (ii) an organization is information; (iii) information is power; (iv) information is intelligence; and, (v) information is perfectible.

In all these five forms, Boland intends to remain skeptical of how each utilizes information. He purposely refers to them as fantasies, or as imaginative devices that are not capable to describe the reality, but can only suggest a possibility. Though, his conception of fantasy is related to creativity versus delusion, composed of two faces: the productively imaginative face, and the self-deluding face [3, p367]. This idea of fantasies is primarily concerned with stressing the intention to remove the human aspect, together with the human action and human meaning. The sequential presentation of the five fantasies is designated to fail, argues Boland. Because information is *prima facie* a human element, he says. Thus, information for him is not structured data. It is not an object with potentials to design organizations. It is not an object that possesses intelligence, it doesn't give or bring power, and it is not perfectible [3, p370].

As a substitute of the five fantasies, for Boland information is an inward-forming. It can be a part of sense making for human beings, and their lived experiences, who are able to understand the world. Even if, in opposite, information could be regarded as an object that doesn't invoke the necessary meaning of a particular situation within our world, but, can in fact, delude our understandings.

4.3 Information is Quantifiable

This form is rather different from the first two. It is evident that the era when definitions and understandings of this form of the notion of information developed, present the era when technology started to flourish. The understanding of information in the form of being quantifiable comes from the Bell Systems Laboratory, primarily starting with Hartley's definition of the notion of information as "information is a measurable quantity [30, p536]. His influence has spread to his research stream, however, the use of the notion of information in his context has since been very weak, thus, their contribution today is re-interpreted as signals or digital inputs, rather than information. There are very few such definitions. Similar definitions put the role of information as something tangible, such as "information can have attached measure to it [44, p149] or, "information is physical" [40, p23].

In here, we purposely elaborate more on the definition first stated by Hartley in 1928, to gain a better insight to his view [30]. It is clear that he put effort on trying to attach quantity to information, in terms of the engineering aspect of electrical communications. His understanding of information came to mean something that appears in telegraphic or telephonic forms of communication. His interest was to explore system's capacity to transmit information, by simply adding some sort of measurable quantity. What is important in this understanding is that Hartley clearly states that information is an elastic term; therefore it is necessary to set up a specific meaning, which addresses his view. In this, Hartley's intention was to quantify the use of information as symbol representation, which for someone (here putting the human context) would mean something. He says: "in any given communication the sender mentally selects a particular symbol and by some bodily motion, as of his vocal mechanism, causes the attention of the receiver to be directed to that particular symbol [30, p536]. Further to this understanding, Hartley explores the human meaning aspects of information (here, he presents a well-elaborated example of how would someone interpret this sentence "apples are red"), for which he concludes that such an understanding would be of psychological factors. Thus, for him, it is desirable to eliminate such implications, while establishing a measure of information in terms of pure physical quantities.

4.4 Information is Transmittable

The last form of information identified in this

literature survey, presents the most debated research. This form also comes from the Bell Systems Laboratory, and it may be seen as advanced research of what Hartley and colleagues presented in their earlier work.

It starts from the pioneering work of Shannon and Weaver [53], since the 1940's, when Shannon first argued that "information is transmittable… the fundamental problem of communication is that of reproducing at one point, either exactly or approximately, a message selected at another point" [15, p379]. More on this, they introduce the notion of entropy in relation to the notion of information, but very vaguely defined. Ever since this contribution appeared, it has been regarded as the most controversial opinion to what the notion of information really stands.

Now this form might seem similar to the form of information being quantifiable. What differs this form from that of being quantifiable is the aspect of transmission of information with noisy communication, which would largely effect the final destination of information (in here, Shannon means the final input to a human being). For Hartley, this should rather be excluded, while for Shannon and Weaver, the transmission of information that conveys some message, may be of importance for humans. This is what they had in mind when they stated: "*the destination of information* transmission *can be a person* (who can suffer from noise) *or it can be a thing for whom the message is intended*. [15, p2].

Nevertheless, Shannon and Weaver have been unclear on why and how they put into the context the human understanding of transmitted information. Because for them, the semantic aspects remain irrelevant to engineering problems. Whereas, entropy is the fundament of information, defined via some mathematical theory of communication, primarily considering Boltzmann's meaning of entropy. This form of entropy, for Shannon, is put in terms of improbability to inspect noise in communication of information, implying disordered meaning to its final destination – *the human being*. In spite of this, Shannon states: "It is important to emphasize, at the start, that we are not concerned with the meaning or the truth of messages; semantics lies outside the scope of mathematical information theory [15, p. 2].

This controversy led to immense discussions and debates from trans-disciplinary views.

5. Introducing an alternative understanding of the notion of information

So, what is really information? Can we contextualize information as being fundamental? Is information really meaningful? Does it exist out-there, without attaching to it the human interpretation? Or is it necessary to bring a complete new reductionist approach, minimizing its role as being quantifiable or transmittable?

The preliminary results of this ongoing research have provided us with an alternative understanding of the notion of information. The diversity of definitions of the notion of information present information as a universal notion - that of Heidegger's understanding; and as a complex element – what Simon and Akerlof indicated [1, 2].

Accordingly, our understanding of the notion of information is rooted in the quartet approach. Moreover, we intend to present the need to give value to information, associated with how it dominates the functioning of our global society. Thus, we understand information as: "*representation of principles that guide humans' understanding to utilize its meaning in managing and/or communicating their needs in a particular situation at a particular moment in time*".
We argue that this understanding presents a new approach that explores how human interpretation has come to play critically in situations where information becomes the means of situation's output. The implication of this understanding is that information is an independent factor that plays a central role in the material world of our objective surroundings, as well as, in the mental world of our subjective nature.

6. Discussion

In this research, we have identified some of the most central definitions of the notion of information. Previous contributions have already given some

analyses, or some new ideas, and new definitions on the notion of information. However, this notion is still said to be an elusive concept [21, p351]; it is said to be the most powerful concept that, as an explicandum, it can be associated with several explanations [44, p9]; information is said to remain vague, while the confusion continues to reign [48, p33]; information is still a tricky concept [27, p3]; and, information is a popular term that has complicated its theoretical definitions [26, p1].

Indeed, these above mentioned views, present the only unified understanding of the notion of information, which in this context, they have consensus. Although, these references are just samples taken from the literature. Almost every contribution that has taken for granted the notion of information, introduces the reader to how this notion is thoughtfully regarded equivocal. Now this remains critical for this research. Yet, and apart of finding ourselves in that consensus, we have presented our view of the notion of information in the quartet of its forms. Furthermore, we have demonstrated the application of our theoretical framework, by introducing an alternative understanding of this notion. The latter is a proposal, which may not have precisely given a specific understanding of the notion of information - that would rather be an unfruitful reduction. This has rather given a generic understanding of the most basic information forms, "the quartet", which we brought together in the context of this understanding.

6.2 Implications for Theory and Practice

Our theoretical framework – the quartet approach can be used to further develop theoretical and meta-theoretical views, in regard to our analyses and results, together with all other developments in this area of research. We focused on previous contributions that have dealt with the notion of information explicitly. This, in response to our research questions, is theorizing about the role of the notion of information in its diversity. Subsequently, it requires specifying how information is understood. We have argued that our understanding of the nature of information helps to better specify the four forms of the quartet approach.

The quartet approach, and the new understanding of the notion of information also have important implications for its practice in information society. The results provide an analytical tool for human beings, who many times become the victims of unwanted causes and consequences of societal failures and fatalities. To follow up on one of our situations presented in the introduction, that with the recent financial crisis in Greece, information is regarded to be the source of generating such crisis. In our understanding, if information would have been utilized appropriately, and if information would be interpreted correctly for the needs of human beings, the bailout would be unnecessary to occur; especially, now in the time when the current global crisis are forming extreme depression in our economic and societal environments.

7. Summary

Information, understood as *representation of principles that guide humans' understanding to utilize its meaning in managing and/or communicating their needs in a particular situation at a particular moment in time* - shows its importance in empirical dilemmas, when societal failures or fatalities, caused by the lack of needed information lead to unwanted consequences: the Haiti earthquake 2010; Greece Crisis 2010"; or the oil slick in the Gulf of Mexico 2010. This paper presents a literature survey of academic research that explicitly address the need to understand and/or define the notion of information. The results show that the notion of information is highly diversified, ill-defined, and with no consensus, which presents a typical universal notion that is hard to understand. Thus, this paper intends to classify those definitions, by introducing four forms of the notion of information, labelled as the "quartet approach". Moreover, this classification introduces an alternative understanding of the notion of information, still in its infancy, but is regarded as highly relevant in empirical dilemmas. This calls for joining the efforts, aiming to shift the notion of information to a whole new perspective, by addressing significant needs of the information society.

References

[1] Simon HA. *The Sciences of the Artificial*. 2nd ed. Cambridge: MIT Press. 1996.

[2] Akerlof G. The Market for 'Lemons': Quality Uncertainty and the Market Mechanism. *Quarterly Journal of Economics, 1970; 84(3): 488-500*

[3] Boland RJ. *The In-formation of Information Systems*. In RJ Boland, RA Hirscheim (eds.) Critical Issues in Information Systems Research, 364-379. New York: John Wiley & Sons Ltd. 1987.

[4] Bateson G. Steps to an Ecology of Mind. New York: *Ballantine Books*. 1972.

[5] Ackoff RL (1989) From Data to Wisdom. *Journal of Applied Systems Analysis, 1989; 16: 3-9*

[6] Mingers JC. Information and meaning: foundations for an intersubjective account. *Information Systems Journal, 1995; 5: 285-306*

[7] Checkland P, Scholes J. *Soft systems methodology in action*. Chichester: John Wiley and Sons. 1990.

[8] Langefors B. *Essays on Infology – Summing up and Planning for the Future*. (Edited by Bo Dahlbom) Gothenburg Studies in Information Systems, Report 5, University of Göteborg. 1993.

[9] Fuchs Ch. Towards a Critical Theory of Information. In D Nafria, J María/Salto, A Franciso (eds.) Qué es Información? (What is Information?) Proceedings of the First International meeting of Experts in Infromation Theories. An Interdisciplinary Approach León: Universidad de León. 2008

[10] Floridi L. *Information - A Very Short Introduction.* Oxford: Oxford University Press. 2010.

[11] Hofkirchner W. *A Unified Theory of Information. An outline*. Creative Commons License. 2009.

[12] Stonier T. *Information and the Internal Structure of the Universe: An Exploration into Information Physics*. London: Springer. 1990.

[13] Stonier T. Information as a basic property of the universe. *Bio Systems, 1996; 38: 135-140*

[14] Brillouin, L. *Science and Information Theory*, 2ed ed. New York: Academic Press. 1962.

[15] Shannon CEA. Mathematical Theory of Communication. *Bell System Technical Journal, 1948; 27: 379–423 and 623–56*.

[16] Heidegger M. *Being and Time (DE: Sein und Zeit)*. London: Harper & Row. 1962, org. 1949.

[17] Husserl E. *Logical Investigations*. Vol 1. 2nd ed. (english). London: Routledge. 2001

[18] Castells M. *The rise of the network society*. Malden: Basil Blackwell. 1996.

[19] Castells M. *The Power of Identity: The Information Age: Economy, Society and Culture*. 2nd ed. Chichester: Wiley-Blackwell. 2010.

[20] Wiener N. Cybernetics or communication and control in the animal and the machine, 2nd ed. Cambridge: MIT Press. 1948.

[21] Floridi L. Is Information Meaningful Data? *Philosophy and Phenomenological Research, 2005; 70: 351-370*

[22] Hofkirchner W. (ed.). The quest for a unified theory of information. *Proceedings of the Second International Conference on the Foundations of Information Science*. Amsterdam: Gordon and Breach. 1999.

[23] Brier S. Cybersemiotics: a transdisciplinary framework for information studies. *BioSystems, 1998; 46: 185-191*

[24] Brier S. *Cybersemiotics. Why Information is not Enough!* Toronto/Buffalo/London: University of Toronto Press. 2008.

[25] Rapoport A. What is information? *Etc., 1953; 10: 247-260*

[26] Pervez A. Information as Form. *Journal of tripleC - Cognition, Communication, Co-operation, 2009; 7 (1): 1-11*

[27] Qvortrup L. The controversy over the concept of information. An overview and a selected and annotated bibliography. *Cybernetics & Human Knowing, 1993; 1(4): 3-24*

[28] Parker E. Information and Society. Proceedings of

a Conference on the Needs of Occupational, Ethnic, and other Groups in the United States, 9-50. USA: Library and Information Needs for the Nation. 1973.

[29] Bates MJ. Fundamental forms of information. *Journal of the American Society for Information Science and Technology, 2006; 57(8): 1033-45*

[30] Hartley RVL. (1928). Transmission of Information. *Bell System Technical Journal, 1928; 7: 335-363*

[31] Maturana HR, Varela FJ. *Autopoiesis and cognition*. Dordrecht, The Netherlands: Reidel. 1980.

[32] Brier S. Cybersemiotics and the Problems of the Information-Processing Paradigm as a Candidate for a Unified Science of Information Behind Library Information Science. *Library Trends, 2004; 52(3): 629-658*

[33] Brier S. Information and consciousness: A critique of the mechanistic concept of information. *Cybernetics and Human Knowing, 1992; 1(2/3): 1-24*

[34] Mingers J. Embodying information systems: the contribution of phenomenology. *Information and Organisation, 2001; 11: 103-128*

[35] MacKay DM. *Information, mechanism and meaning*. Cambridge, MA: MIT Press. 1969.

[36] Losee RM. A Discipline Independent Definition of Information. *Journal of the American Society for Information Science, 1998; 48(3): 254-269*

[37] Adams F. The Informational Turn in Philosophy. *Minds and Machines, 2003; 13(4): 471-501*

[38] Belkin NJ. Information concepts for information science. *Journal of Documentation, 1978; 34(1): 55-85*

[39] Luhmann N. Essays on Self-References. New York: Columbia University Press. 1990.

[40] Landauer R. Information Is Physical. *Physics Today, 1991; 44: 23-29*

[41] Capurro R, Hjørland B. The Concept of Information. In B. Cronin (ed.) *The Annual Review of Information Science and Technology, 2003; 37: 343-411*

[42] Israel D, Perry J. (1990). What is information? In P. Hanson (Ed.), Information, language and cognition (pp. 1-19). Vancouver, BC: University of British Columbia Press.

[43] Sebeok ThA, Danesi M. *The Forms of Meaning: Modeling Systems Theory and Semiotic Analysis*. Berlin: Mouton de Gruyter. 2000.

[44] Bar-Hillel Y, Carnap R. Semantic information. *British Journal of Science, 1953; 4: 147-157*

[45] Dretske FI. *Knowledge and the Flow of Information*. Oxford: Blackwell. 1981.

[46] Madden AD. Evolution and information. *Journal of Documentation, 2004; 60(1): 9-23*

[47] Peirce CS. Collected Papers vol. I-VIII. (eds.) Hartshorne and Weiss. Cambridge MA: Harvard University Press. 1931-1958.

[48] Britz JJ. *Definition of Information*. Research Report. South Africa: University of Pretoria Publishing. 2007.

[49] Bawden D. Information as self-organized complexity: a unifying viewpoint. *Proceedings of the Sixth International Conference on Conceptions of Library and Information Science—"Featuring the Future", 2007; 12(4)* http://informationr.net/ir/12-4/colis/colis31.html

[50] Floridi L. Two Approaches to the Philosophy of Information. *Minds and Machines, 2003; 13(4): 459-469*

[51] Floridi L. What Is the Philosophy of Information? *Metaphilosophy*; *2001*.

[52] Hofkirchner W, Fuchs CH, Klauninger B. *Informatinal Universe – A Praxo-Onto-Epistemological Approach*. In E Martikainen (ed.) Human Approaches to the Universe - interdisciplinary studies, 75-94. Finland: Bookstore Tiedekirja. 2005.

[53] Shannon C, Weaver W. *The mathematical theory of communication*. Illinois: The University of Illinois Press. 1949.