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Popperian Falsifiability on Enterprise Architecture Is Suitable from a Scientific Standpoint?

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Abstract

Enterprise architecture (EA) is defined as a high-level strategic modeling, which has been shaped to help managers deal with the complexity of the business environment. Just as many areas of knowledge have been the focus of researchers on what regards testing and verifying them as scientific or not, EA is the focus for the analysis conducted in this study. Among the many scientific demarcation criteria are the philosopher Karl Popper's ideas, which only consider as scientific theories that can be properly tested and are falsifiable. This study aims to analyze how studies related to EA, considering Popper's scientific demarcation criteria, contribute to the acknowledgement of EA as suitable from a scientific standpoint. In an extensive literature review, EA studies that focused on business management in international databases were sought after. The results, when analyzed under the rules that guide the methods used on EA studies, lead to the inference that despite having made great progress, EA still has a long way to go on the search for expansion and maturity of the analyzed criteria.

Keywords: popperian falsifiability, enterprise architecture, business architecture, information architecture, demarcation criteria, scientificity

1. Introduction

The Enterprise Architecture is identified with potential for integration between Information Technology (IT) and business processes for its holistic nature, able to promote to the design, development and implementation of integrated systems of people and their skills, materials and equipment. EA covers an approach that incorporates the knowledge of Systems Engineering and Business Process Reengineering (Lilles et al., 1996) and promotes re-setting of organizations to better promote its mission and operationalize its strategic guidelines (Tribolet, 2005). EA may serve many goals in addition to providing an adequate solution for the comprehension and investigation of relations and processes between the organizations that develop strategy plans and IT (Mamaghani, Madani, & Sharifi, 2012). By providing generalist views and wide encompassing rules, it aims at achieving, in a coherent and organized way, the objectives related to the organizational processes, structures, information and technology supply (Ross, Weill, & Robertson, 2006; Tamm, Seddon, Shanks, & Reynolds, 2011; Senff, Carvalho, Veiga, Duclós, & Pancote, 2015; Veiga et al., 2015; AWagter, Van den Berg, Luijpers, & Steenbergen, 2005).

The definition of EA is the representation of a high level view of the company's business, processes and IT systems, in a way such systems and processes are shared by different sectors of the company. It establishes itself between IT and the formulation of the business strategy (Tamm et al., 2011). These authors have studied the benefits EA may provide to an organization, with a careful literature review, and have stated that EA provides its benefits through its impact on the facilitators; they have also conducted a thorough discussion on possible paths for future research, pertaining critical importance to their study (Tamm et al., 2011).

Studies investigating EA present a few fundamental problems. According to Lange, Mendling and Recker (2012) as well as Tamm et al. (2011), there is a lack of explanative theory on the field of EA, and many of the papers

focus on the creation of a framework, but neglect important facts such as the benefits that may be perceived EA. Another fact is the lack of empirical research, specifically quantitative studies aimed at how EA may offer benefits (Bradley, Pratt, Byrd, Outlay, & Wynn, 2012; Niemi, 2006; Tamm et al., 2011). The result is a scarcity of clear, explicit theory on how EA accrues value to the organizations.

Based on the literature, this research intends to analyze academic studies regarding EA, from a scientific scientific standpoint, and how studies related to this theme are evolving on this field. This paper aims at fulfilling gaps which may exist when analyzing whether EA may be characterized as a consolidated area on the literature, contributing to the advance of this science and on the construction of frameworks that help managers deal with their challenges. To attain such purpose, the present paper is divided in 5 sections. On the next section the concepts regarding Enterprise Architecture, Scientific demarcation and its criteria are presented. Section 3 describes the methodological procedures, and section 4 describes Data analysis. The work is rounded out on section 5 with a conclusion regarding the limitations and suggestions for future research.

The classification of science is discussed by several authors and faces different concepts; one of the authors that heavily influenced the way to conceptualize, define and even see an area as scientific was Karl Raimund Popper (1902-1994). This author has a number of published papers (Popper, 1968, 1972, 1994, 2002, 2004), being frequently quoted and sometimes even criticized on the literature. His criteria for scientific demarcation are falsifiability or refutability. Popper (1972) states that "we have to propose theories boldly, try to refute them and then tentatively accept them if we fail". Criticizing and falsifying a theory consist of formulating it and attempting to prove its veracity as well as that of the scientific knowledge presented, possibly replacing these for new theories which shall also be tested and criticized, but may be closer to the truth.

This study is based on business-oriented EA, having as a goal to analyze the rules which guide the methods utilized in EA studies, according to Popper's demarcation criteria and define whether they contribute for the acceptance of EA as a scientific theory. It aims at answering the question: Do the rules that guide the methods utilized on Enterprise Architecture studies, according to Popper's demarcation criteria, contribute to the acknowledgement of EA as suitable from a scientific standpoint?

2. Conceptual Basis

2.1 Enterprise Architecture

The term "Enterprise Architecture" (EA) encompasses plans for the development of IT scenarios in organizations. It brings some of the main assumptions proposed by Zachman (1987) and Pereira and Souza (2004), and extends itself towards a more approximate trend of the business process at the expense of the focus on technology. EA makes use of high-level logical views in order to facilitate the interaction of non-centralized information, aiming at eliminating redundancies (Zachman, 1987).

Pereira and Souza (2004) proposed an EA method for an organization based on a model proposed by Sowa and Zachman (1992), which defines several artifacts for each cell; such method defines a sequence for filling up the cells in a top-down order, making use of an incremental approach. They presented an instrument developed with the intent of supporting the model proposed by Zachman. Such tool: 1) acts as an information repository for its own concepts, 2) produces the intended artifacts representing each content, 3) allows for multidimensional analysis between the elements concerning the perspectives and 4) assesses integrity, dependence and alignment level of businesses and information systems. The authors concluded that effective implementation is a challenge for organizations.

According to the same authors, EA contributes in a significant way to the management of the information system; they also state that Zachman's proposed method presents difficulties on instancing the cells (Pereira & Souza, 2004). With such proposal one is able to perform EA in an easy, intelligent and effective way, but during the execution of their work, the existence of a new concept for the Zachman framework was confirmed, thus designat in it as an anchor point and allowing the apprehension of the existence of semantic relation between cells on any of the tool's perspectives.

The need for the development of EA emerges with the increase in complexity of the information systems implantation process (Zachman, 1987). Due to this, logical constructs would be necessary in order to define and control interfaces and the integration of the organizational system's components. Its proposal, according to Bradley et al. (2012), direct the alignment of information systems, organizational processes and company strategy; it would also be the organizational logic for IT infrastructure and business processes. Currently EA is defined as a technique or high-level strategic modelling, its purpose being helping managers deal with the complexity of the company environment (Lankhorst, 2009). Ross, Weill & Robertson (2006) point out that EA

may be characterized as a form of logical organization for business processes and IT infrastructure, reflecting the integration and standardization needs of the company's operational model.

EA considers the organization as whole instead of focusing on a given section, individual component and/or projects of such (Zheng & Zheng, 2013). It possesses several detail levels and representations which allow the alignment of these with business processes, making it possible for stakeholders to visualize all of the organization's information and scenarios (Bischof et al., 2015; Niemann, Miede, Wolfgang, Repp & Steinmetz, 2010); it also includes the integrated form of the organizations' structure and its processes, applications, systems and techniques (Lankhorst, 2009; Iyer & Gottlieb, 2004).

Tamm et al. (2011) place that many are the positive results that come from proper EA utilization. These results show up as higher rates for organizational alignment, enhanced decision making process, expense reduction and performance increase. It may thus configure itself and an important tool for the promotion of alignment between business and IT (Strnadl, 2006). Ross, Weill & Robertson (2006) stress that its essential elements are based on the creation of an execution basis wich results from careful selection of IT processes which have to be standardized and integrated.

EA also creates, through its usage, a group of descriptive and relevant representations, which are utilized to describe the organization and may also serve the establishment of organizational changes (Zachman, 1987). Furthermore, it must be updated during its utilization, as well as used for the identification of problems during process execution (Anaya & Ortiz, 2005; Hjort-Madsen, 2006). It may also be used to support the development of information systems and reengineering (Zachman, 1987).

2.2 Scientific Demarcation and Its Criteria

Popper questions the classification of theories as scientific in his work "Conjectures and Refutations" in 1972. In this study, Popper reformulated some considerations on the criteria for scientific demarcation, among which are there: i) the theory that cannot suffer refutation is not scientific; ii) every attempt to test a theory is in effect an attempt to refute it; iii) the confirming evidence should not be considered if doesn't come from a genuine theory test; iv) some theories passive of testing, when falsified, may still be valid if some auxiliary *ad hoc* assumption is added to it, or if the theory is reinterpreted *ad hoc*, preventing it from actual refutation (Popper, 1972). No theory can be considered true for there is no absolute truth, and so the scientist must opt for the theory that has been tested the most times and resisted such testing (Popper, 1972).

To describe this philosophy, Popper (1968) utilized the term "critical rationalism" as a way to demonstrate his contempt for classical empiricism. Concerning the approach on knowledge, Popper (1968) states that such is objective. Objective knowledge would be the expansion of knowledge through repetitive problem solving. He observes still that on the course of scientific development, researchers are subject to error and passive of committing mistakes.

The criteria for scientific demarcation were reinforced by Popper (2004), who presents some proposals in his "theses". He begins, the first and second theses, with reflection on knowledge and ignorance; much is known, but the more one knows the more new, unsolved problems come up, such idea being related with the third thesis, "knowing" and "not knowing", with which he concludes nothing is known (Popper, 2004); on he goes to the fourth thesis, which states that knowledge comes from problems; that is to say, "there is no new knowledge without problems; there are also no problems without knowledge". (Popper, 2004)

The sixth thesis proposes that the social science method consists in experimenting possible solutions for the problems. The objectivity of science is on the objectivity of the critical method; no theory is ineligible for criticism. It brings as its central ideas: i) the social science method consists in experimenting possible solutions for certain problems, problems which begin and come up during investigation; ii) these solutions are proposed and criticized, and if a theory cannot withstand criticism it is then not considered scientific, but if it does there may then be an attempt for refutation; iii) if the solution resists the criticism it is temporarily accepted until it undergoes falsification once again.

By the end of such theses, Popper (2004) concludes that theories can never be justified in a rational way, but even so they may be criticized rationally and distinguished from worse theories. Popper stresses that proposals and theories, in order to be considered scientific, must be falsifiable. No theory is ready and finished, but rather finds itself in constant process of testing and refutation, being currently and temporarily corroborated but passive of refutation through further study at any given moment. In his book "The Logic of Scientific Discovery", Popper (1968) presented falsifiability, testability and refutability as criteria used to justify the classification of theories as scientific. That is to say, instead of confirming a theory by its data, the ideal would be to propose its

falsification, testing it through the observation and experimenting. The essential elements proposed by Popper (1968) for the testing of theories are presented briefly on Table 1.

Table 1. Theory testing according to Popper

Type of test	Description
Internal testing	Seek coherence in the conclusions made from the title
Form Testing	Testing to classify a theory as empiric, scientific or merely a tautology
Innovation testing	Examining whether the theory really is new or is already contained within preexisting ones.
Empirical testing	Examining of the applicability of the conclusions produced from this new theory.

Source: Adapted from Popper (1968)

Popper states that in order to be considered scientific, it is necessary for a theory to be tested, not only with a replicated model, but also through criticism, furthermore, every sort of testing is an attempt to refute a theory (Popper, 1972). In addition, it is also stated that knowledge comes from problems; that the social sciences method consists in experimenting solutions for a given problem; that the formulation of hypotheses ought to be supported by theory and not merely conjectured (Popper, 2004). It is also proposed that solutions encountered via research be subject to criticism from different researchers, their limitations explained with clarity and that further studies on it be suggested.

In his work "The Structure of Scientific Revolutions", Kuhn (1975) claims that in order to create and validate some form of science, it is necessary that theories, data and paradigms be interconnected; according to the author, science evolves in stages. Normal science can be conceptualized as "research firmly based on one or more past scientific accomplishments. Such are acknowledged for some time by a specific scientific community as the basis for the community's future practice" (Kuhn, 1975).

The goal of normal science does not consist in discovering substantial new things of critical importance; the results obtained contribute to increase the outreach and accuracy with which a paradigm can be explained (Kuhn, 1975). When the currently in effect rules fail, an anomaly emerges and science undergoes a period searching for new theories. The emergence of new theories is preceded by a period of imbalance, for it demands the deconstruction of paradigms and alterations on the problems and techniques of normal science; such period is called extraordinary science, on which a change of paradigms takes place and new theories are assimilated. Such changes demand in turn the destruction of previous paradigms and consequently cause conflicts between discordant schools of thought (Kuhn, 1975). Only after periods like these, so called crises, does the normal science takes place once again, now bearing a new set paradigms and theories.

The scientific research programs are presented by Lakatos and Musgrave (1970); to them, a research program is what Kuhn conceives as paradigms. They furthermore suggest that science progresses by means of these programs, which possess an irrefutable core—negative heuristics. Positive heuristics represent a protective ring around this core, "consisting in a set of suggestions or partially articulated evidence of how to change and develop the 'refutable variants' of a research program, as well as how to modify and sophisticate the 'refutable' belt itself" (Lakatos & Musgrave, 1970, p. 165). Any anomaly that occurs and tries to modify the core of the program does not actually modify it, but rather creates a new research program. The discovery of an anomaly or inconsistency does not interrupt the development of a program (Lakatos & Musgrave, 1970).

3. Methodological Procedures

With the intent of verifying whether studies regarding EA facilitate its acknowledgement as a consolidated theory, a bibliometric study was conducted with the objective of elaborating a quantitative and qualitative analysis of the scientific production regarding EA (Cooper & Lindsay, 1998). With such analysis, it is also possible to verify the importance of the theory for academic research, which may define new directions and research strategies for future research (Melo & Andreassi, 2010). For the data analysis, descriptive statistics with frequency analysis and content analysis was conducted, aiming at analyzing studies in an extensive, deep way based on scientific demarcation criteria, also analyzing the evolution of an area and the corroboration that propels it.

To obtain a solid base on a number of works, a literature research on EA was conducted, and the following

databases were consulted: *Google Scholar*, AIS Electronic Library, IEEE, ACM and SCOPUS; other databases were not accessed due to lack of access. Following the guidelines of Simon, Fischbach & Schoder (2013), the databases were sought for papers contemplating the terms *enterprise architecture, business architecture* and *process architecture* on the title, abstract and keywords.

The studies analyzed were all published in-between 2004 and 2015, comprising a total of 129 papers located and accessed so that they could be downloaded and analyzed. For the validation of the separation of the studies that mention EA in terms of business, they were forwarded to a group of 13 specialists who then separated those pertaining the focal area of the study from those that do not and only concern Information technology (IT). After this validation a total of 58 papers remained, which were once again analyzed, this time under the light of the criteria for scientific demarcation.

To analyze the scientific evolution of EA, the papers were analyzed according to the criteria proposed by Popper (2004), albeit without referring to the author. The focus of this analysis was structural, verifying the papers' methodological rigor based on the criteria for scientific evolution. The indicators utilized for scientific demarcation are displayed on Table 2.

Table 2. Indicators for scientific demarcation criteria

Objective	Dimension	Indicators
Popper's scientific criteria	Research outlining	Offering scientific problems
		Presenting problems related to theories
		Experimenting solutions for the problems
		Present hypotheses/assumptions
		Relating hypotheses/assumptions with theory
	Research operationalization	Testing the theories
		Describing the method in detail
		Defining the theoretical structure
	Post-research	Facilitating criticism towards the study

Fonte: Adapted from Popper (1968)

Some studies presented implicit information; such is the case for hypotheses in quantitative studies and assumptions in qualitative ones. To better define its existence, studies that presented such implicit information were put to the test using face-to-face validation; this method is sensible to the discrepancies between meanings presumed by the investigators and those acknowledged by the target population (Kirk & Miller, 1985). The papers were analyzed by pairs of doctorate students from an Administration program, providing thus a higher degree of reliability for the information obtained.

4. Data Analysis

Popper (1972) claims it is essential to differentiate the scientific meaning from the social meaning of research. While in science it is sought to demonstrate facts, a scientific law does not determine the way something happens, and instead describes how it happens. Society establishes a conduct to be followed and a social law doesn't describe a fact which took place but rather defines the way things should happen on given circumstances.

The goal of scientific work is to delimitate scientific laws adopting a method, testing, collecting and registering the results while expecting other researchers to do the same so that a certain theory may be corroborated. A scientific law (or theory) is only valid when it undergoes and resists being tested by the scientific community; such is the method which Popper (1968) calls deductive reasoning test.

The focus of this study consists on analyzing the structure of the studies in conformity with Popper's criteria for scientific demarcation. The viability of the theme or aspects related to its or the methods' choice was not pondered. Table 3 shows an increase in the number of the studies analyzed throughout the period; in the first year (2004), only three papers were found, but in 2014 eight studies were analyzed an in the last year (2015) there were but two studies available. It is worth noting that in the the year of 2015 some papers had yet to be published by the time data was gathered, and it may thus be possible that other works regarding the subject have come up.

Table 3. Analyzed papers, ordered by year, classification and structure

Year	Quantity	Qualitative	Quantitative	Qualitative and Quantitative	Well defined structure
2004	2	1	-	1	1
2005	1	-	1	-	1
2006	7	5	-	2	4
2007	3	3	-	-	1
2008	2	2	-	-	2
2010	11	10	-	1	4
2011	9	8	1	-	7
2012	6	5	1	-	3
2013	6	3	3	-	5
2014	8	6	1	1	5
2015	3	2	1	-	2

Source: Search data

Table 3 shows there was an evolution in the number of studies analyzed. From the total published and analyzed papers, 3.44% were from 2004, but 18.96% were from 2010. 5.17% of the papers were from 2015. In almost all years there is a prevalence of qualitative studies, being such numerically superior to quantitative ones. In 2011, 10 out of the 11 published works were qualitative and the other was simultaneously quantitative and qualitative. In 2014, 6 out of 8 published works are qualitative, while one of the remaining is quantitative and the other employs both.

Studies of qualitative nature are based on the interpreting of facts; it is not necessary to validate research or make it generalized in other contexts, but rather to propose an explanation of how facts occur in a specific context. The number of studies classified according to Popper's demarcation criteria may be related to the subjective character of these investigations and the recent history of usage of such on organizational studies. One of the inferences that can be made regarding results related to Popper's demarcation criteria is that the qualitative area presents concrete data and information to the tests that studies of this nature seek to explore. Consequently, there is a greater concern with the detailed description of the studied cases.

Due to the increase in yearly publications and in order to better present the evolution of the area from a scientific standpoint, the results are analyzed in percentile form, comparing papers that present scientificity criteria and the total number of papers from the corresponding year. Considering Popper's demarcation criteria on what concerns his fourth thesis, which claims that all knowledge comes from problems, and that the solving of such comes from the attempt which consists in the trial and error method. In Table 4, the studies that presented a research problem, mention any theory, and presented actual solutions for the problems proposed are evidenced.

Table 4. Hypotheses and research problems (%)

Year	Quantity	Hypotheses	Hypothesis is related to theory	Problems	Problem is related to theory	Solutions for the problem were experimented
2004	2	-	-	50.00	50.00	50.00
2005	1	100.00	100.00	100.00	100.00	100.00
2006	7	28.57	28.57	71.43	42.86	71.43
2007	3	33.33	33.33	33.33	33.33	33.33
2008	2	50.00	50.00	100.00	50.00	100.00
2010	11	18.18	18.18	27.27	27.27	27.27
2011	9	33.33	33.33	66.67	66.67	55.56

2012	6	33.33	16.67	66.67	50.00	66.67
2013	6	16.67	50.00	83.33	83.33	83.33
2014	8	50.00	50.00	75.00	62.50	62.50
2015	3	33.33	33.33	66.67	66.67	66.67

Source: Search data

When analyzing the studies according to publication year, it was noticed that in 2004 none of the two analyzed articles presented a hypothesis, but they did present theory-based problems and a criticism-friendly positioning. In the following years, though hypotheses were present there was no sensible usage increase in some authors. Another criterion analyzed was the research problem and its relation to theory; such criterion's prevalence increased from 50% in 2004 to 83.33% and 62.50% in 2013 and 2014 respectively. The studies that furthermore presented solutions for the problems proposed also increased in number, from 50% in 2004 to 62.50% in 2014. The results are in conformity with Popper's sixth thesis (2004) in which the author claims the social sciences method experiments with possible solutions for the problems, behavior which presented an increase in the number of EA studies. Considering the number of published articles, it went from 2 in 2004, to 5 in 2014. This evolution takes place from 2011 on; in such year, half of the published papers presented theory-based problems as well as solutions for these.

Many of the studies, though presenting their hypotheses/problems with a certain amount of methodological rigor, fail to match the requirements proposed by Popper for form tests. These tests consist in knowing if the theory is a real theory or just a tautology. What is stated on many works is that the theory relies on rhetoric, redundant terms or texts which repeat (and thus respond to themselves) the same idea, making it impossible for the theory to be tested by Popper's deductive method.

This type of enunciation allows the deriving of some singular enunciations from others (Popper, 1968). It allows thus to infer that a tautological theory does not present elements that allow their classification as scientific; it in turn may not arbitrarily alter in insignificant ways enunciations already tested, thus being exposed to the risk of relying on common sense and not providing and explanation on how and why such a theory was developed.

Popper's (2004) sixth thesis states that science is in the objectivity of the critical method and that no theory is immune from criticism. If a theory is not open to criticism it may not be considered scientific. EA studies analyzed present an increase in compliance with these requisites on Table 5.

Table 5. Method, theory and openness to criticism (%)

Year	**Quantity**	**Well detailed method**	**Was the theory tested?**	**Is the solution open to criticism?**
2004	2	50.00	50.00	-
2005	1	100.00	100.00	100.00
2006	7	28.57	42.86	71.43
2007	3	33.33	33.33	33.33
2008	2	50.00	50.00	50.00
2010	11	9.09	27.27	36.36
2011	9	55.56	33.33	33.33
2012	6	50.00	50.00	66.67
2013	6	50.00	66.67	83.33
2014	8	50.00	37.50	37.50
2015	3	33.33	33.33	33.33

Source: Search data

When comparing the amount of studies published in each year and whether these have a well described

methodology, Table 5 shows that papers presented a well described methodology. The results go against that on years 2007, with only 33.33% of the articles presenting good methodology, and in 2010, in which only one out of 11 methodologies was properly described. A well-described methodology is that which makes clear the way in which the study was conducted, its characteristics and whether it is possible to replicate it using the method presented.

Studies were also analyzed on whether they tested any theory and if such was corroborated. It was verified that there was not any evolution on such field compared to the amount of papers published and analyzed. The percentage was the same throughout the years, but the number of papers published increased. By the end of his theses, Popper (2004) states that theories can never be justified in a rational way, but can nevertheless be rationally criticized and distinguished from worse ones. Unlike what Popper (2004) says, results indicate that there was no increase on what concerns the utilization of theories.

The studies that welcome criticism, when compared to the total studies on all years, were more prevalent on the years 2012—66.67%; and 2013—83.33%. These studies presented a more criticism- and replication-friendly positioning in order to9 corroborate or refute the results. Popper (1972) adds that no theory may be considered as true, for there is no absolute theory, and it is thus necessary to opt for those which resisted testing the most.

5. Final Considerations

This study aimed at analyzing the ways in which papers regarding business-oriented EA present scientifical evidence, according to Popper's scientific demarcation criteria, of the evolution of the studies in this area. It was verified that, according to these, it is possible to infer that this area, though newly born, presents evolution on the following criteria: i) presenting problems that need resolution, relating these to existing theory and presenting solutions for them; ii) presenting and relating the hypotheses or assumptions to existing theory test the theory. Some criteria present no actual evolution; studies consistently present a well-detailed methodology, though no evolution was observed when compared to the increase in number of papers in the area.

Throughout the period of analysis, studies became increasingly open to criticism, further testing theories and not only replicating them, in compliance with Popper's falsifiability principle. Despite the great evolution presented, studies still have a long way to go in the search for enhancement of the analyzed criteria and the consolidation of this area. Considerations on scientific evolution of an area require a process involving the action of researchers in the production and dissemination of knowledge through research networks. Further study may help in the acknowledgement and consolidation of the area, making use of different sources and throughout a longer period of time, as well as referring to demarcation criteria from other authors.

Through results and evidences found in the analysis, it is inferred that this study has attained its goal by analyzing the rules which dictate the methodologies utilized on EA studies, according to Popper's demarcation criteria, and that contribute for the consolidation of EA as a field of study in evolution from a scientific standpoint. For professionals and academics this study presents a qualitative foundation which presents the evolution of EA studies and its consolidation as science. For new studies, it presents the evolution of an area that has been studied by several authors.

Its contribution in a general way relies on the fact that it presents the evolution of an area that emerged from IT and went into business, being studied by researchers and utilized by entrepreneurs to better manage their businesses. This study contributes to the fulfillment of the gaps identified by Lange, Mendling & Recker (2012) and Tamm et al. (2011), which identified a need for explanative theory in the field of EA, and that many of the papers published focus on creating a framework but neglect important facts like benefits that can be perceived by EA. The study also corroborates with Bradley et al. (2012), Niemi (2006), Tamm et al. (2011) who identified a lack of empirical research, specifically qualitative studies focused on the means by which EA can be beneficial.

Its limitation relies on only analyzing a period of 10 years and having specific search criteria. The results are limited to the research criteria utilized, and may thus not be generalized to longer periods or other scientific demarcation criteria. Another limitation is in working within a limited time frame, from 2004 to 2015. This implies that there may be studies before and after the time frame or even on other research databases which are potentially important to the area.

The authors suggest deepening the study by referencing other authors which present scientificity criteria; analyzing business-oriented EA studies under a different light and broadening the study base in quantity and duration. It is also suggested to analyze the evolution from a scientific standpoint of IT-oriented EA studies, comparing the results with the ones presented on this study.

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