Is Action Research the Path to a Solid Research Culture in IS/SE for Costa Rica?

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Abstract
In Latin America there is a visible evidence of lack of research initiatives and a strong disassociation between Academia and Industry in the areas of Information Systems and Software Engineering. Despite the potential of Latin America, such situations hinder the opportunity to build up the required knowledge in order to participate competitively in the international market, holding back the possibility of a technology-based economy in these countries. We propose action research as a flexible and plausible research schema for bridging the gaps between Academia and Industry in Latin America. Action research can be seen as a plausible approach for promoting a research culture in Latin America (more specifically in the Costa Rican perspective), considering the current needs of the Industry and the current situation in the Academia for performing research in Information Systems and Software Engineering.

Keywords: Research Methods, Action Research, Information Systems, Software Engineering, Costa Rica, Latin America
1. Introduction
In Latin America in general, there seems to be a deep separation between researchers and practitioners, and a deep abyss in terms of research between Academia and local Industry. Science and technology and their natural relation to research, development and innovation are far from mature in Latin America [64]. In Costa Rica, independently of its inherent quality, Information Systems and Software Engineering (IS/SE) research has been, so far, isolated, poorly funded, weakly connected to local industry, and (with just some very noticeable exceptions) underappreciated by the authorities [17, 30, 31, 45, 46].

In this paper, we propose that, in a country like Costa Rica, Action Research (AR) can be the bridge that joins both sides of the chasm and promote a stronger research culture in IS/SE. We believe that AR can be successful in countries where industry is reluctant to sponsor research due to some misconceptions around the term “research” (which can be misunderstood as “too theoretical” and “of no practical use”).

For starters, there should be a natural bond between AR and research in IS/SE. In almost every IS/SE project of practical relevancy, it is possible to establish a mutual learning relationship for both Academia and Industry. The company learns about the findings provided by the researcher during the process, whereas, at the same time, the researcher learns and publishes about the problem area and the difficulties in applying a recommended technique in a practical situation, which, in turn, opens new research areas of academic interest.

Therefore, we conjecture that a good understanding and application of the paradigms and practices of AR applied to IS/SE by part of both Academia and Industry\(^1\) should bring significant quantitative and qualitative benefits for both players in Costa Rica. For the happiness of “pure” researchers, more publications, more theses, more theoretical results and of course better funding are possible under this strategy, while, at the same time, Industry would benefit from sound solutions to their practical problems.

We intend through this article to provide an overview of this methodology, pointing out its potential benefits and challenges; and describe the essentials of what we consider as needed in order to implement it in a Latin American context (more specifically Costa Rica).

This paper offers eight sections. Section 2 mentions some aspects of the current situation been faced in Latin-American countries regarding the prevalent research culture within the educational institutions and academia in general, as well as the status of the collaboration between Industry and Academia. Section 3 is focused on the Costa Rican context. Section 4 explains some background about AR. The combination of AR and IS/SE research is explored in Section 5. Section 6 discusses some interesting issues of applying AR to IS/SE, including the main challenges of such approach. In Section 7, we sketch a possible Plan of Action for creating the conditions that allow the flourishing of AR as a mean to a real research culture in IS/SE in Costa Rica. The paper is concluded in Section 8.

2. Research in Latin American: A Brief Context
Latin America (LA) is a region of cultural and ethnic diversity that exhibits profound social and economic inequalities where wealth distribution is not homogeneous [64]. Countries like South Korea and Taiwan, now considered as fully developed knowledge-based economies, had similar conditions to those in LA less than three decades ago, while our economies have not found yet the key to ignite a fully competitive technological market. Governments have become aware of the importance of technology advancement and funding, but still more efforts on this line are needed, as well as a better understanding of the role of national innovation systems.

Science and Technology (S&T) and their natural relation with research, development and innovation are far from mature in LA [64]. Even if most countries have established institutions dedicated to track their status in Research and Development (R&D), a solid system of innovation is still absent. Regional organizations as RICYT [58] maintain indicators related to R&D, and to S&T production up to 2004. An extensive work in [64] discusses the state of S&T in Latin America and the Caribbean, focusing on the interplay between social conditions and R&D outcomes (publications, papers, patents). During the last 20 years, LA countries have had a highly centralized power structure and an extensive bureaucratic frame. Lack of an appropriate infrastructure at all levels is also typical in most of the countries [55].

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1. Obviously, the initial effort must come from Academia.
According to [64], a strong indicator of the commitment of a nation towards a knowledge-based society is financial support to S&T activities. All countries in LA invested $15 billion on S&T during 2000 [58], with $11 billion used in R&D. In comparison, Canada amounts $12 billion for R&D alone that same year, an amount above all the funds available in LA. Countries like Mexico, Chile, Argentina and Brazil are the top investors, where Brazil has shown a consistent growth during the last decade [58]. Another measure in R&D systems is diversity of funding sources. In LA, government predominates over any other source by amounting 57% of R&D funds in average, contrary to what happens in developed countries where industry investments reach 60% to 70% of available sources. Most of research work is done in public university systems with low or inexistent binds with industry. This has prevented the formation of strong collaboration links and financial support, as well as limited the ability of finding opportunities and common goals. Industry shares in R&D amount at most 32% of funding sources in the region. International experience of countries like Ireland shows that the transition to a knowledge-based economy is strongly coupled to a increase in private R&D investment over time [64]. Human resources in S&T sectors are unevenly distributed in Academia and Industry. Few researchers join industry preferring to stay in universities or public research institutions. Research positions share a common problem in the region in terms of dedication, due to lack of full-time positions. In terms of qualification, LA has improved its amount of Ph.Ds but even so, it falls short for strong world-class R&D development in comparison with countries like Finland [30], apart from isolated individual efforts. The final outcomes of scientific and technological processes are publications and patents. LA does not have a complete, reliable and integrated database of publications, and most of them are scattered in different areas (medicine, biology, etc.) [64]. The amount of publications indexed in SCI (Science Citation Index) and other worldwide scientific reference databases show that the contribution from LA to global scientific knowledge is only 2% to 3% [58]. In terms of quality, LA accounts only for 1% of world-wide citations, less than half of the total contribution of the region. Patenting new products is infrequent in LA. Even if non-local patents in the region have almost tripled, local patents only have increased in a 2.5% at most [58]. Also, patenting rates are much lower that publication rates; a tendency that shows patenting has not yet become an important consideration in local research. Brazil has the highest patenting rate, with 5.3 patents per 100.000 inhabitants (113 patents in 2000), while Asian countries such as Taiwan produced 5806 patents in 2000.

When it comes to S&T activities in the areas of Information Technologies, Brazil and Chile have taken the lead in LA. A study published in 2005, which used a methodology from the National Survey of Information Technology of U.S.A., suggested that there is only a three-year gap between U.S.A. and Brazil universities in the area of Information Technologies [42]. Chile has the highest per-capita level of published Information Technologies scientific papers in Latin America [5, 54]. However, despite the strong potential of these countries, there is still a large lack of strong technological environment or conditions to promote a significant competitive software industry [41].

3. Costa Rica and IS/SE Research

Costa Rica is rated among the most developed countries in LA just below Mexico and Brazil in some indicators and near the top 4 for all of them [58]. Statistics from 2004 indicate that there are 338 researchers per million inhabitants and 1128 official research projects [46]. In the case of Computer Science, the number drops to 27 official researchers. Most Costa Rican researchers are not in full-time positions, sharing time with teaching. Research funds mostly come from government and public universities, and a quite modest budget comes from industry [17]. More than 50% of local industry dedicate less than US$5000 to R&D. This is a major problem, because human resources with research oriented degrees do not feel compelled to leave public or university positions even for short periods of time. Collaboration between Academia and Industry in the knowledge level is weak: statistics in [17] show that Academia was placed as the 6th most relevant expert source of information. Only 20% of companies have established some sort of agreement or relationship with other partners different from Industry, and from those only 14% have established links with Academia. Human resources for research are scarce in Costa Rica. In Computer Science and related areas, there are probably no more than 50 Ph.Ds (at most 30 of these Ph.Ds are registered) [45]. Industry employees mostly undergraduate students (41%), few masters (13%) and even less Ph.Ds (1%) [17]. The Costa Rican Advisory Commission for Advanced Technology found in 2003 that most companies are not satisfied with mathematical and scientific skills of most graduates [45]. Evidence points out that more intensive research degrees and doctorates are needed. Costa Rican government has already realized that it lacks a consistent innovation system [29]. There are efforts on implementing a sound national strategy for innovation and the XXI Century Strategy (Estrategia Siglo XXI) has gathered the most prominent scientists and actors in local S&T activities in order to devise a consistent path to a knowledge based economy in 2050. Through a series of technical reports [29, 30, 31], weaknesses, risks and opportunities in S&T have been clearly identified. Most of the areas considered to be relevant (data mining, bioinformatics, nanotechnology, information sciences) require full-time research positions and a critical mass of Ph.Ds.
The current CS curricula in Costa Rica point out the importance of student’s industry experience. For instance, it is a graduation requirement for students from the Costa Rica Institute of Technology to do a one-semester internship in a working environment. But the approach followed has been centered only in a sort of training for preparing the students for the industry, leaving aside the “research process” erroneously perceived as “too formal or stiff” by many practitioners. This can be reflected in many of the final graduation reports in the bachelor level which do not encompass a proper research framework, even lacking of clear research questions or problem formulations.

In Costa Rica, many practitioners often see research as a sort of burden without any practical results. The strong positivistic influence in the area of IS/SE and its close relative CE (Computer Engineering) and the historical dissociation between the research communities and the software companies could explain the absence of interest from practitioners in participating or investing in research projects. This situation has had the sad effect of wasting most of the knowledge that could have been drawn from all these practical experiences. As a result, in general, the students end up only as consultants for the companies where they are performing the project. Since there is a lack of research guidance or research framework, no relevant learning (nor publications) for the research community can be drawn from the process.

4. Action Research
The term Action Research was coined by the social psychologist and educator Kurt Lewin in the 1940s (while working at the Research Center for Group Dynamics of the University of Michigan) to describe work that did not separate the research from the action needed to solve the problem [27, 39, 40, 41, 44]. Lewin’s process was cyclical involving a “non-linear pattern of planning, acting, observing, and reflecting on the changes in the social situations” [49]. Initially, the concept was clearly associated to educational issues. According to [27] “By the 1970s, we saw again the emergence of action research. Education practitioners questioned the applicability of scientific research designs and methodologies as a means to solve education issues. The results of many of these federally funded projects were seen as theoretical, not grounded in practice”. In other research methods, specially from a sociological point of view, the researcher seeks to study a particular phenomena but not to change it. On the other hand, AR is concerned with studying a process and simultaneously creating organizational change [4]. De Villiers [22] by citing [23], describes AR as a methodology that aims to bridge the gap between research and practice by encompassing action outcomes and research outcomes. Zuber-Skerrit [68] appoints AR as appropriate for inquiry into educational technology and for investigating the introduction of technologies into organizations. During the last decades, the definition of AR has been applied to fields different from education creating different forms of AR [6, 8, 10], but keeping the main spirit of Lewin’s proposal. All they have in common the practical collaboration between researchers and industry practitioners, in order to solve a problem and striving to improve their strategies, practices, and accumulate knowledge of the environments within which they practice [57]. Some authors even call AR the industry-as-laboratory approach [53]. In a simpler definition, Advison et al. understand AR as a research method that solves immediate practical problems while expanding scientific knowledge [2]. Reason and Bradbury indicate that, under AR, the knowledge is built from reflection over their practices: “Action Research is not only a research that describes how humans and organizations behave in the outside world but also a change mechanism that helps human and organizations reflect on and change their own systems” [57]. Gilmore et al. in [32] point out the importance of mutual collaboration towards reaching a dual goal: “Action Research aims to contribute both to the practical concerns of people in an immediate problematic situation and to further the goals of social science simultaneously. Thus, there is a dual commitment in Action Research to study a system and concurrently to collaborate with members of the system in changing it in what is together regarded as a desirable direction. Accomplishing this twin goal requires the active collaboration of researcher and client, and thus it stresses the importance of co-learning as a primary aspect of the research process”.

Provoking change is a fundamental characteristic of AR, and precisely because of this, AR has been accepted as a valid research method in applied fields such as organization development and education [18, 25, 63]. According to [11, 23, 24] AR is an agent of change through being:

- **Cyclic**: as iterative steps recur in a longitudinal time frame, generating knowledge to inform further action.
- **Participative**: as clients, end users and researcher collaborate in partnership as co-researchers or as practitioner and researchers examine their own work. Stakeholders are full participants in the research process or even serve both as subject and researcher.
- **Qualitative**: operating more via verbal aspects than by numbers.
- **Reflective**: since critical reflection on the process and outcomes is vital to each cycle, and this reflection is used in designing subsequent steps and events.
• **Responsive**: as it reacts and adapts flexibly to the findings from each previous cycle.

Figure 1, adapted from [27], shows the main stages of the so called **AR Cycle**. Kemis also presents a similar diagram in [34]. One of the main differences between **AR** and “classical” research becomes evident on the step of “Identify the Problem”: under **AR** a research problem is preferable if it is something over which the researcher can have influence. Similarly, the required **AR** step “Act on Evidence” asks that the researcher designs a plan of action that generates a change and that the researcher studies that provoked change [27].

![Figure 1. Action Research Cycle [27]](image)

Avison in [3] presents a series of arguments in favor of **AR**:

- The high involvement of the researcher with the research subjects allows for access to rich and in-depth research data.
- Since the topic of the research is partly selected by the client (e.g., a company in a specific industry), its findings are likely to be of high relevance to at least a section of the practitioner community (e.g., the immediate research client and other companies in the same industry).
- The real world orientation of the approach offers a singular opportunity to recruit part-time doctoral students who hold positions in organizations facing a problem whose solution can lead to relevant research findings.
- The problem-solving orientation of the research increases chances of obtaining research funding.

Potts in [53] also recognizes several advantages of **AR**:

- The definition of the problem comes from a detailed understanding of the environment (in this case, the context),
- Less emphasis on a separate technology-transfer phase where results are applied to practical problems, and
- Feedback shapes later investigations and becomes increasingly problem-focused.

### 5. Action Research and IS/SE

Many authors have complained that the gap between **IS/SE** research and the practice of the discipline must be reduced [67]. In this Section, we want to address the feasibility of conducting **AR** in projects focused on the areas of **IS/SE**. We claim that **AR** could be of advantage for promoting **IS/SE** research practice in countries, like Costa Rica, where the industry is reluctant to sponsor research due to some misconceptions around the term “research” and where there is no a strong research culture. In every **IS/SE** relevant project, it is possible to establish a mutual learning relationship. The immediate problem for a certain company can be linked to open research problems in the area.

**AR** combined with **IS/SE** is mainly considered a european stream despite the fact that **AR** has its roots in U.S.A. social science research [39, 40, 41]. This can be seen from the amount of **AR** studies that come from european researchers. For example, the *Multiview Contingent Systems Development Framework* [1], *Soft Systems Methodology* [19], and *Effective Technical and Human Implementation of Computer-based Systems (ETHICS)* [47, 48]. In contrast to the predominant logical positivistic research approach in U.S.A., **IS/SE** research in Europe has a strong interpretivistic approach, which is evident in the publications related to **IS/SE** in the past 10 years [26].
Baskerville in [9], citing [12, 61], notes that AR operates with a different epistemology than traditional science (does the knowledge obtained through AR actually qualify as science? [56]). Continuing with [9], it is realized that AR is intervening social systems, and since IS/SE can be understood in so many aspects as a social science the link is almost obvious. One of the first works to explore this connection was ETHICS [47, 48]. Checkland used AR in connection to systems analysis to develop the approach of soft systems, where he argues that systems analysts need to apply their craft to problems that are not well defined [19]. Lau [37] states that AR can address complex real-life problems and the immediate concerns of practitioners. Wood-harper in [66] introduced AR to the IS community as a research methodology. Other research methodologies like Grounded Theory and Development Research that are related somehow to AR are mentioned by [68] in terms of their roles and applicability in the IS/SE domain.

It would not be strange (even though we cannot affirm this with certainty) that the U.S.A. research tradition has influenced to some extent the educational programs and the research approaches used in Latin America, explaining the relatively shortage of IS/SE research under the AR paradigm in LA. Walsham et al. performed a study of papers dealing with IS/SE research in developing countries which revealed the lack of AR projects in such countries [65]. A study reporting on a Telecentres project in Latin America mentions a participatory AR project lead by Mexico’s Centro de Comunicación Comunitaria in order to work on the “Internet in My Public Library” program to integrate three Telecentre modules with existing libraries [33]. Another example of AR conducted with a Brazilian company is described in [28].

Many companies in Latin America are currently in a crucial growing stage where they are trying to define future steps as an organization in order to reach different markets in software production [17]. The problem of developing software systems in this context involves different and interesting challenges. In particular, there is a wide diversity of sectors addressed by these companies (e.g., e-commerce, financial systems, embedded solutions, etc.). Subcategories of AR like “Contextual Action Research”, referred also as action learning, proposed by Trist [62], can provide interesting insights on these different sectors, since it is domain-based, and it tries to involve all affected parties and stakeholders. Mathiassen [43] suggests AR as a means to understand, interpret and propose changes to the practice of IS/SE. This aspect can enable researchers to achieve a better understanding of the needs of practitioners and even of complete sectors of the industry. Avison [2] states: “Failure to include human factors may explain some of the dissatisfaction with conventional information systems development methodologies: they do not address real organizations”, and stresses the need of AR, where the emphasis is more on what practitioners “actually do”. When using AR, there is a big support from the practitioner’s side, where the usage of SE terminologies are quickly adopted by the members of the organization and an active engagement can be perceived.

In most AR situations, a researcher’s role consists mainly in facilitating dialogue and promoting reflective analysis among the participants, providing them with periodic reports, and writing a final report when the researcher’s involvement has ended [32]. Now, during an IS/SE project under AR, the roles of the researcher could be:

- **Planner/Leader:** In terms of the development of the software, the planning and execution of the activities could be the primarily role.
- **Designer:** The researcher could work as the Software designer in the project
- **Observer/Reporter:** This role is necessary in order to collect and document the outcomes and knowledge acquired from the practice, as stated in the AR framework.

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<th>Table 1: Differences between AR and Consulting (from [9])</th>
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<td><strong>Action Research</strong></td>
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<td><strong>Foundation for Recommendations</strong></td>
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Recently, criticisms to traditional approaches to IS/SE have been raised, pointing out flaws in the “research-then-transfer” approach which often fails to address significant problems within the field [17]. The “industry-as-laboratory” approach has become popular since it enables focusing on practice rather than only principles. However, AR must be
are mainly related to changes in higher education strategies, promotion of partnerships between industry-academia and the numerous studies that support and criticize this approach [1, 3, 5, 6, 8, 10, 13, 15, 16, 22, 23, 26, 28, 35, 36, 37, 38, 51, 53, 59, 65, 67].

For more details about the interesting relationships between AR and research in IS/SE we invite our readers to check out the numerous studies that support and criticize this approach [1, 3, 5, 6, 8, 10, 13, 15, 16, 22, 23, 26, 28, 35, 36, 37, 38, 51, 53, 59, 65, 67].

6. Discussion
This section confers briefly different aspects that need to be considered when attempting to implement AR. These aspects are mainly related to changes in higher education strategies, promotion of partnerships between industry-academia and evaluation of possible challenges that AR could bring due to its inherent characteristics as due to the characteristics of Latin American context.

6.1 AR in Higher Education
Some examples of IS/SE related education that have used AR successfully in their curricula are reported in [60] where students undertake research in multinational organizations doing analysis of problems and development aligned with collective reflection based on their findings. A post-doctorate program which makes active use of AR is described in [15]. There have been examples of successful AR projects in South Africa, involving an IT Department of a Bank working together with an IT department of an Institute of Technology [51, 52].

A framework that supports the practice of AR throughout the educational program should be formulated. In this process, the educators and researchers play an intrinsic role in the process of proposing the actual framework and providing guidance to the students in their research activities. Avison [2] points out the lack of detailed guidelines for novice researchers and practitioners to understand and undertake AR studies and suggests the use of the framework described by Lau in [37] which can be seen as a sort of foundation on which the pedagogy of AR in IS/SE development can be refined and debated. Avison remarks that still this framework needs to be supplemented through a broad set of criteria which will enable to design, conduct, present and evaluate AR.

6.2 Promoting Academia-Industry Partnership
This requires a framework supported by a fully dedicated group of professors, researchers, students, and members of the academic community. It also means that the personnel must be acquainted with research process and have publication goals. There is a need of more formal spaces where Industry and Academia can collaborate jointly. Examples of possible approaches can be seen in [21, 36]. An example of a successful partnership/project schema between Industry and Academia can be seen in [35], which describes the working schema of “Guidant Program”, a research lab project run by the Embry-Riddle Aeronautical University and an industry partner. The project strives on fostering student’s professional development, driving the faculty development through the creation of a body of knowledge in the practical application of S&T to their domain area, and contributing to the profession by means of publications of research findings.

6.3 Possible Challenges
One of the biggest challenges in AR (as pointed out by Mathiassen [43]) is to establish a functional relationship between the research (researchers need to adopt flexible approaches as practice change) and the practitioners (who need to be available and engage in critical reflections of their practices). This difficulty can be manifested by the tight schedule of the members and difficulty to reach them due to the company’s plans. Systematic data collection is sometimes difficult due to the emerging nature of the findings [43]. If the nature of the relationships is sporadic, partnerships can be difficult to manage in an academic setting (i.e. from [35] “…when the department had available resources, our industry partners did not have an appropriate project or available funds. When our industry partners had a prospective project, the faculty had already been assigned to other academic responsibilities…”). The social-cultural aspects of Latin America can present a challenge for participative methods as AR. Previous publications suggest that AR is less feasible in centralistic environments (one interesting example is presented in [14] where it is concluded that participation in Cuba is restricted by political and organizational constraints). In Costa Rica, we should consider these aspects as possible limiting factors when undertaking a participatory research approach where organizational schemas play an intrinsic role and moreover if they happen to have a centralistic nature. Avison [2] mentions that another potential challenge is to establish a mutually
acceptable ethical framework, denoting that AR won’t succeed where there is a conflict between researchers and practitioners or among practitioners themselves. This relates somehow with Kock [35] who states: “Whatever the case, the IS action researcher serves two different ‘masters’, namely the research client and the research community as a whole. The needs of these two masters are usually entirely different and sometimes conflict with each other.” Avison also presents in [3] a list of potential disadvantages of using AR for IS/SE:

- If the researcher does not have close ties with at least one organization, it is often hard to gain access to a site where the researcher can act as an agent of change.
- The amount of time that has to be committed by the researcher is very large compared to other research approaches.
- If the research is funded by an organization, conflicts of interest may detract from the credibility of reported findings.
- The high involvement of the researcher with the study subjects can influence their perceptions and actions and therefore bias research findings.
- Research projects may take too long to be completed, which may hinder the adoption of the research approach by doctoral students, particularly in programs that follow the American model.
- In spite of their likely relevance to practitioners, it is hard to publish research results in top IS/SE journals.

In addition, most of the difficulties mentioned in Section 5 apply to the Costa Rican context, from the organizational access issues to the time constraints of the researchers.

Rose [59] recalls the importance of the conceptualization of the research activity in terms of the methodology which can be justified, expressed and opened up to challenge. Without such a clear understanding, the research is flawed from the beginning. Although this aspect is basically present in most of the other research paradigms in SE, there is still a challenge especially from the teachers and lead researchers to guide novice researchers through this conceptualization process. This needs to be aligned with the organizational needs and level of access of the Industry partners. Yet, as mentioned in [38], AR epistemological basis as a research paradigm is open to questioning due to the different types and emphases of AR. Lau concludes that it is necessary for the researcher to distinguish the type of AR used and its historical context from which the purpose, focus, theory and methods of the study are based. This aspect should be addressed by the researchers in the specific context of Latin America.

7. Suggested Plan of Action
As far as this research has shown, there are important questions that remain open before any implementation of AR models in Costa Rica or Latin America for sustainable IS/SE research which is the aim of our proposal. The first of them is the lack of specialized statistics on regional software research projects, patents and publications (you cannot manage, nor improve by that matter, that which you cannot measure). A second issue is the generation and strengthening of what we may call a knowledge production culture or research culture within our academic environments, permeating to industry relations and encouraging at the same time foundations for basic research on a healthy interplay (we are far away from “publish or perish”). Last, but not least, a way must be found to transcend from proposals in AR to actual implementations, focusing on the relationship between Industry and Academia and their mutual understanding.

Currently, it is difficult to find a convenient, organized and specialized database of research projects, patents and most important, publications in IS/SE or Computer Science in general for Latin America. Unpublished work is invisible and nonexistent knowledge, but even worse, published work acquires a similar status when it cannot be used, assessed or even found. AR relies on information about the evolution of the nearby social and economic system, but without adequate information the AR cycle would be interrupted from the very beginning. Any AR implementation attempt should have a parallel initiative for recording the results of research activities including at the very least: status of research projects, derived publications, citations to those publications, and derived patents.

The second point is about how research is perceived and the steps towards a research culture within Latin America academia itself. Difficulties in finding appropriate data indicate immaturity by themselves; if such activities were common, information needs around publishing data would be already solved for every area such as IS/SE in non-painstaking ways. University systems are not enforcing mechanisms to track the state of research adequately, or even reinforcing research appropriately as an important transversal topic within the Computer Science, Computer Engineering and Software Engineering curricula. A revision of curricula in the light of the social role of computing and AR is required in order to guarantee a sustained increase in human resources, as well as give thrust to more and more exhaustive research
degrees in the region.

Finally, we need a success case that intersects Academia's research abilities with Industry potential to inject resources. The absence of examples limits the possibility of mutual trust. We suggest that a common language between Academia and Industry should be worked out from the beginning in order to clarify objectives, motivations and most important of all, expectations. The third task derived from this article is the design of an approach mechanism to industry needs from the IS/SE community in the sense of collaboration, not only as a producer-consumer relation around human resources.

Thus, we propose the following steps (some of them could be implemented in parallel) toward the establishing of an active research culture in IS/SE through AR in Costa Rican Academia:

1. Create real incentives to the publishing of peer-reviewed scientific papers (either by monetary incentives, or through the establishment of a publish-or-perish regime).
2. Create an effective record of the research activity in the area (research projects, published papers, citations, patents, etc.). Define metrics of success.
3. Divulge the principles and practice of AR among our academic communities (anthologies of related papers, conferences, seminars, injection of its ideas in the curricula, etc.).
5. Define the rules of cooperation between Academia and Industry (funding, non-disclosure-agreements, patent ownership, permissions for publication, etc.).
6. Focus initially on small projects that can be solved using AR. The measure of success must be both the satisfaction of the clients and the publication of scientific papers.
7. In the spirit of AR, evaluate the results and iterate.

8. Conclusions
In its purest form, scientists do research to learn new things, or as Richard Feynman used to say we do research because of “the pleasure of finding things out”. Problems are researched and (sometimes) solved because they are interesting (even useful), and because once the research has been published, the human race will have a new knowledge that did not have before. Universities and higher education institutions should satisfy three clear mandates: teaching, researching and giving back to our societies. Alas, the tendency on the past years demonstrates that the focus has been solely and heavily on the first one. In order to have a steady production of scientific research coming from the IS/SE area many bridges must be built. In this paper, we have suggested AR as the bridge that could join both sides of the chasm. We have presented cases in other contexts where AR has been successful. Suggestions mentioned in this work towards applying AR in Latin American (more specifically in Costa Rica) stand as the first step. We aimed to provide the overview of the methodology and underpin the essentials of what is needed in order to make it a reality. There is still much more work left concerning to how to actually apply it and understand the adjustments and steps required throughout the process, as well as the implications of those on the educational models. But if we take into account the potential benefits of this schema, surely the effort will be paid off.

We would like to conclude with some remarks from Avison and De Villiers respectively which we believe are strongly linked to the spirit of this study: “No other research approach has the power to add to the body of knowledge and deal with the practical concerns of people in such a positive manner”[2]. “If thorough descriptions of the AR process are given and the above implications addressed, then AR will be regarded as not only an acceptable scientific research approach, but a preferable approach in which to conduct research in an ever-changing society” [15].

References


