Design of a Technology Adoption Model through a Systemic Inquiry

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ABSTRACT

The Laboratorio de Investigación e Innovación Tecnológica (LIIT) at the Universidad Estatal a Distancia (UNED), the costa rican distance education university, is a World Bank and governmental funded technological research and innovation laboratory started in 2014. Currently, the laboratory faces technology adoption issues as a result of the acquisition of a new computing infrastructure.

Technology adoption models focus on determining the variables that influence the behavior of adoption. From a systems thinking perspective, those approaches do not capture complexities that emerge from the human relationships involved during adoption. To do so, the case of interest is viewed as a wicked problem with several stakeholders and loosely defined boundaries, thus allowing the enactment of a systemic inquiry as an innovative way to design a technological adoption model that contributes to the resolution of the issue perceived as problematic.

A reproducible and systematic methodology is proposed, and the corresponding results are presented. The main outcome consists of an activity model. This device serves as a guide for purposeful action towards adoption of the new platform, i.e. as a technological adoption model. Potentialities and limitations of the enacted systemic inquiry are discussed and paths for further development are presented.

Keywords: Technology adoption, systemic inquiry, wicked problems.

1. INTRODUCTION

Situation of interest
The Laboratorio de Investigación e Innovación Tecnológica (LIIT) at the Universidad Estatal a Distancia (UNED), the costa rican distance education university, is a World Bank and governmental funded technological research and innovation laboratory founded in 2014 [1].

The adoption of a new technological platform at LIIT represents the situation of interest to explore. The task of adopting LIIT's new computing infrastructure unfolds itself as a complex issue, with no definite boundaries to formalize the problem, several stakeholders involved in the decision-making process and uncertainty about the outcomes of possible solutions.

Technology adoption models
Several models to explain the adoption of technology have been developed from a variety of perspectives in the academic community. Some of them have privileged the individual level of study, arguing that individual perceptions towards innovative technology determine its adoption, while others have considered organizational settings and environment to be more relevant [2].

The most referenced model in the field is the Unified Theory of Acceptance and Use of Technology (UTAUT), which resulted from the review, comparison and synthesis of eight previously validated models of technology adoption, which had intention and/or usage as the key dependent variable in common [3].

UTAUT has been empirically tested with the same data used for the previously identified models and cross-validated in other scenarios. As a result, a set of five direct determinant variables (performance expectancy, effort expectancy, social influence, facilitating conditions) and four moderators (gender, age, experience, voluntariness of use) were taking into account for the model [3].

Although UTAUT has been updated since its original proposal to deal with the complex and uncertain situations that involve technology adoption nowadays [4], for the purposes of the situation of interest, it is considered that the model lacks the capability of dealing with multiple stakeholders views and the uncertainty present in technology adoption processes.

Proposed approach
In order to study the situation of interest, a Systemic Inquiry (SI) is proposed, i.e a learning process that is enacted with stakeholders of a situation that is experienced as problematic [5].

Similar to a case study, i.e an inquiry that relies on multiple sources of data as a means to understand and to give an answer to a question given in a real-life situation [6], SI considers multiple perspectives and sources of knowledge, but it can be distinguished from it and other forms of inquiry in that emphasis is given to systems thinking traditions and the opportunity to create new social technologies or institutional devices that help dealing with complex situations [5].

Furthermore, the situation of interest is viewed as a wicked problem, which is a concept first introduced by Rittel & Webber [7] to address issues of urban planning and, in general, to reflect on the difficulties faced with systems-engineering-like (linear and analytical) problem solving approaches when facing social issues. They defined those problems as wicked not in the sense of evil, but to point out that they might be devious and can, for better or worse, have unintended consequences. Furthermore, wicked problems are not considered "problems" in the traditional scientific sense because they lack well defined, formal problem statements that help reduce the issue to possible solutions to those statements. On the contrary, wicked problems are dealt with re-solutions, i.e. actions that help changing their nature in the hope of improving the situation, but without any guarantee that the outcome will do so. Depending on the situation, re-solutions to wicked problems can lead to more complex instead [7].

Although the concept of wicked problems might be considered a relatively old approach, its application is still valid today. According to Ritchey [8], one can still argue that complex social

situations, such as technology adoption, are still being "solved" by linear methods as if they were engineering problems. Moreover, the notion of wicked problem has been adopted in political circles as a discursive and rhetoric resource, without really taking its implications into account [9]. This scenario makes it very appropriate to use the concept to deal with technology adoption (TA) in the case of study.

A SI opens opportunities to systematically explore the case and involve the stakeholders in the development of an innovative TA model that deals with the recognized complexity. Furthermore, the proposed approach aims at finding purposeful actions to resolve the issue of interest [5]. Rather than a unique solution to the problematical situation, SI offers possible resolutions for purposeful action, making it a feasible approach to tackle wicked problems [7].

According to Checkland and Poulter (2010), a SI comprises two main processes:

1) **Structured exploration of the situation of concern:** Implies, at least, exploring the situation's current context, appreciating its multiple stakeholder perspectives and generating questions of purpose that help distinguish the what, how and why the situation is perceived as problematical. Systems thinking and practice tools, such as spray diagrams, rich pictures as well as activity models, are used during these processes to help stakeholders make sense of the perceived problematic situation and to unfold possible accommodations that fulfill their requirements.

2) **Take action to change the situation:** Facilitate purposeful action that can be seen by stakeholders as desirable and culturally feasible is the ultimate goal of a SI. Actions to be taken to change the situation in the desired direction are agreed among stakeholders for future monitoring and evaluation. This will result in a new situation that can again be subject of SI.

Both processes are detailed in the methods section. The rest of the paper includes a results section that presents the products of the enacted SI, followed by a set of conclusions about the SI as well as future directions of further research are proposed.

2. METHODS

The SI consisted of two processes, first a structured exploration of the issue of interest and then a process of facilitating actions to resolve the situation at stake. Both are described as follows.

Structured exploration of the situation

To deploy the structured exploration of the situation, several meetings were conducted to unfold the issues perceived as problematic and to start purposeful dialogue through systems thinking devices that serve as models of the situation in order to find feasible actions to take, and in this case to design the desired TA model.

There were five weekly sessions held and each session took at most two hours long, which was the timeframe most stakeholders could invest given their obligations. Among stakeholders were: researchers, students, representatives of the technological department of the university and authorities that were interested in the issue.

Sessions were conducted as follows:

1) Session 1: An introductory session with all stakeholders. Basic systems thinking concepts and tools as well as relevant TA models were presented, so that a common ground was developed for further systemic inquiring. Moreover, the concepts of wicked problems and SI were explained. Moreover, the proposed methodology was presented and some questions regarding possible issues of TA at LIIT were conducted as a means to explore initial stakeholders concerns and perceived boundaries.

2) Session 2: This session was devoted to spray diagramming. Spray diagrams reveal the connections between concepts relevant for a situation of interest. They are normally used as reflection tools to help structuring the situation before going deeper into questions regarding stakeholders and boundaries (The Open University, 2017). The tool was presented, and examples were given to participants for orientation purposes. Based on the examples shared, participants were asked to draw their first spray diagrams focusing on issues such as: actors involved, possible concerns and relevant expectations about the situation that they found important to include.

3) Session 3: In this session all participants explained their spray diagrams to their colleagues. Once all of them were shown, discussion started around similarities and particularities from each case. After that, participants were engaged in the development of a unifying spray diagram that contained all their respective concerns. The resulting spray diagram is shown in the next section.

4) Session 4: The next meeting focused on expressing the situation and the first ideas for the desired technology adoption model as a rich picture, i.e. graphical devices employed during a SI to capture main stakeholders, viewpoints, processes, issues (both current and potential) and any other relevant aspect that helps to understand the problematical situation. These pictures not only offer the possibility to capture knowledge graphically but can be enriched as the problematic situation is examined. Examples of rich pictures were presented, and participants were asked to develop their own. As this turned out to take longer than expected, participants were given the chance to work by themselves on the task after the session.

5) Session 5: The fifth session served as a discussion session about the resulting rich pictures. Participants presented and explained their rich picture. Discussion about commonalities and differences took longer this time, as participants found conflicting issues among their rich pictures. Following Checkland and Poulter [10], to promote possible accommodations, participants were asked to collaboratively draw a rich picture that expressed all their concerns. The result is shown in the results section.

Facilitating action to change the situation

The last step was implemented through two sessions described as follows:

1) **Session 1:** In this case, given the resulting rich picture, participants were asked to draw an activity model of purposeful actions that could solve the issues expressed. To

do so, examples of activity models were shown, and participants started drawing theirs. It is important to mention that activity models are diagrams that represent purposeful action as a system. This graphical representation contains a logically linked set of activities that are monitored against some measurement of performance. The idea is that the model serves as a device to monitor and control the actions to be taken in a situation of interest [10].

2) **Session 2**: This session served as a validation space. Participants presented their proposed activity models and discussion towards a unified activity model that could serve as a TA model was enacted. The practice took longer than expected, so participants were asked to finish the model collaboratively at some moment after the session. Before the end of the meeting, a dialogue time was given to, following Checkland and Poulter [10], monitor the whole SI. Participants expressed their views so far and gave their input about their experience at that point.

3. RESULTS

First data regarding the structured exploration of the situation is revealed and then the output representing the desired course of action and thus the technology acceptance model is given.

Spray diagram

The following spray diagram reveals the participants' concerns communicated in relation to relevant issues associated with the adoption of the new technological platform at LIIT.

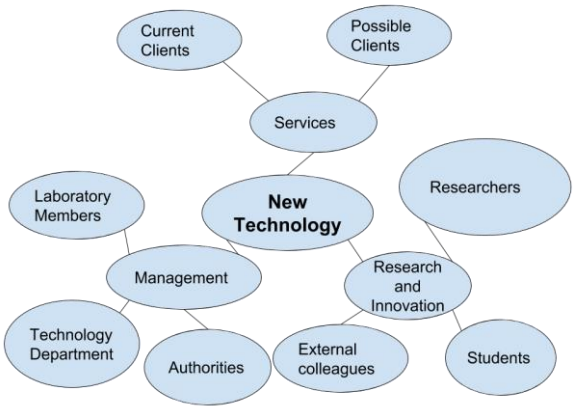

Figure 1. Resulting Spray Diagram

The expectations made explicit through the spray diagram are: issues regarding new possible services to develop with the platform, possible complexities deploying the new technology for research and innovation activities at the laboratory and the difficulties that might arise as far as management is concerned. Relevant actors for each issue are also represented in the diagram.

Rich picture

The rich picture presented in Figure 2 was collaboratively designed during the sessions and represents the concerns of all stakeholders involved. It is presented as it was drawn by the participants as a means to evidence the process of collectively drawing purposeful actions This result is an accommodation of the situation all participants agreed with [10].

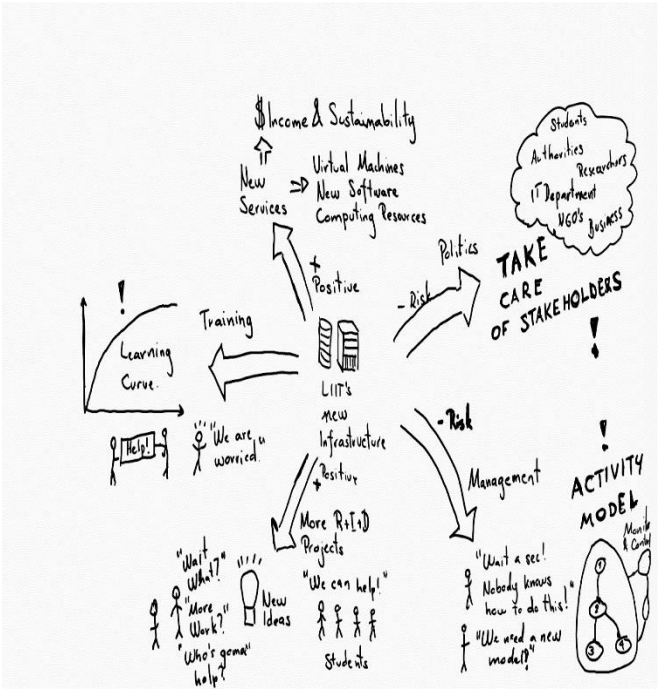

Figure 2. Resulting Rich Picture

Going clockwise, the first point to mention is that awareness was raised about stakeholders involved and affected by the TA process, for instance, students, authorities, researchers, IT Department, NGO's and business agencies collaborating with LIIT. It is worth pointing out that they are perceived as important political actors that deserve care and attention. Not doing so, would be riskful for LIIT's sustainability.

Then management issues emerged as important, the perception transmitted is that there there is a lack of knowledge as far as management of the platform is concerned, thus the need of a model was evident for the participants.

Furthermore research and innovation activities are expected to grow, new ideas and projects should be fostered with help of the platform, assistant students and LIIT's researchers. Although this is perceived as a positive situation, the main concern is excessive workload coming from the new technology. The rich picture also describes an urgent need for training given the possibly steep learning curve associated with the adoption of the new technology.

Finally, according to the picture, there is a chance to develop new services that might contribute to increase income for the laboratory and contribute towards future sustainability. Several are services are mentioned and overall this was perceived as positive by the participants.

Activity model

The activity model shown in Figure 3 resumes the concerted purposeful actions agreed by the stakeholders to adopt the new technology [10].

The following purposeful actions were agreed:

1) **Training:** The first step agreed was to provide training for stakeholders involved.

2) **Services design:** New services need to be designed to add value to the technology.

3) **Marketing:** It is important to let possible users know about the existence of the new technology and services.

4) **Management design:** Management activities needs to adapt to the new technology. Strategies to do so are going to be developed at infrastructure, project and service levels.

5) **Research and innovation activities:** As these area is expected to increase, it was considered important to put it in the model because it can directly affect the adoption of the new technology.

6) **Monitor and Control:** Monitor and control activities were included. The adoption will be a constantly changing process to which adaptation will be needed and therefore these two activities are required.

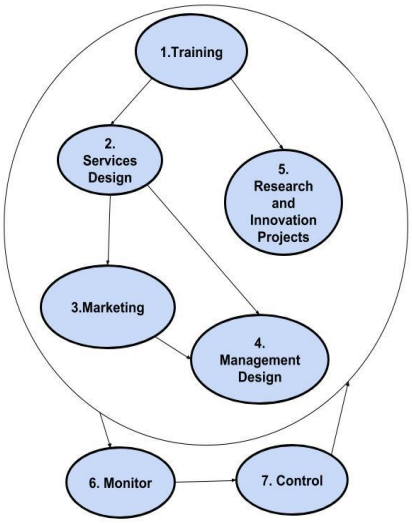

Fig 3. Resulting Activity Model

Next, discussion and conclusions about the obtained results are presented.

4. DISCUSSION

Although the aim has been accomplished through the enactment of a SI and the resulting activity model serves as a technology adoption model to deal with the situation of interest, it is important to recognize the complexity of the issue at hand. The process has not come to a definite solution, rather it has reached a point from which another inquiry can start over again, i.e. a re-solution [8]. This is coherent with the positions expressed by Ison [5] and Checkland & Poulter [10], and demonstrates the wickedness of the situation of interest, in the sense that once actions to improve the issue are taken, possibly a new wicked problem will emerge.

As far as the methodology is concerned, the SI demonstrates a systematically designed process that can be reproduced in other contexts where TA is experienced as a wicked problem. It is important to recognize that LIIT's environment is unique to the situation of interest [7], but this does not exclude the possibility to reproduce the methodology under different situations. The focus of the SI is not to provide a definite TA model that deals with all possible cases, but rather to facilitate the orchestration of purposeful actions that are culturally and politically feasible [10].

It is also important to discuss possible paths for future work. Three aspects come to mind:

1) **The possibility of including quantitative methods during the SI:** From a more traditional technological management perspective, it would be desirable for the model to include quantitative data as a tool to consider during the SI [4]. Typical variables such as costs and human resources needed to deploy the technology adoption model could be taken into consideration and could help to foster more SI efforts in the future.

2) **Development of systemic capabilities at LIIT:** An important part of the inquiry was the time dedicated to the introduction of systems concepts. Without that investment from the facilitator, the SI could not have been possible. A minimum background is required for participants to fully understand the SI. According to Reynolds et al. [11], a capability building framework is in need in the systems thinking academic community, as a means to facilitate the spread and use of systems tools.

3) **Systemic Validation**: SI validation remains a difficult task. Although monitor and control activities were included in the resulting TA model, the question remains of how to validate the SI through system thinking tools. According to Collins et al. [12] 'end of project' evaluation does not suffice for SI initiatives, research towards systemic validation is much needed. Furthermore, for the situation of interest, it is important to explore possible validation alternatives that help improve the effectiveness of future SI initiatives.

It is worth mentioning that there is value added to the development of TA models because the SI promoted a social learning system [13]. There was concerted dialog among participants, which allowed for appreciation of different and possibly conflicting perspectives and needs in order to contribute to possible re-solutions.

5. CONCLUSIONS

The enacted SI has demonstrated an innovative and viable way to tackle technology adoption as a wicked problem. This novel view took into consideration multiple stakeholders and sought accommodations among them in order to enable purposeful action, i.e. value was added through social learning.

This is not to say that traditional TA models, such as UTAUT, cannot describe TA processes, but the enacted SI certainly brings out the question of how such models can address complexities that arise in today's changing and complex techno and sociological environments.

Finally, the enacted SI serves as an example that can promote innovative uses or adaptations in other contexts. It is expected that the research contributes to the spreading of ideas such as wicked problems and systems thinking among institutions

willing to experiment with innovative approaches for technology adoption studies.

6. ACKNOWLEDGEMENTS

The author would like to thank all the actors that participated voluntarily during the systemic inquiry and UNED for supporting the initiative.

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