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What can move non-IS developers towards open and collaborative development initiatives?

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Abstract. *Information systems (IS) have been developed to meet the increasingly complex demands of organisations and society, with a growing understanding of the need for multidisciplinary competencies. It is critical that IS development specialists work with users to conceive and build IS, especially in open and collaborative innovation initiatives. Making these initiatives accessible to non-IS developers can be an opportunity to provide solutions best suited to meet the needs of an application context and more appropriate to the expectations of their target audience. However, non-IS developers are generally unwilling to participate in initiatives for IS development, even open and collaborative ones, due to their lack of technological skills. Our research objective is to identify factors that can influence them to participate, having the Theory of Planned Behaviour as our theoretical basis. We conducted a qualitative interview-based and interpretative study of five open and collaborative development initiatives in Brazilian universities. Results show that the main (beliefs and cognitive) factors influencing non-IS developers to engage are: being able to create useful solutions to the community; professional growth; receiving help from mentors; achieving goals; receiving support from colleagues; availability of tools to facilitate software development; and experiencing new IS development opportunities. These results support organisations to establish guidelines to engage non-IS developers in open and collaborative development initiatives, improving multidisciplinarity and open innovation.*

Keywords*. Open Innovation, Open and Collaborative Development, Engagement, Theory of Planned Behaviour.*

1. Introduction

Information systems (IS) have been increasingly adopted in the most varied contexts, and developed to meet the increasingly complex demands of organisations and society of the open-world [Baresi et al., 2006; Huizingh, 2011; Agrifloglio et al., 2020]. The progressive need for multidisciplinary competencies [Hacklin and Wallin, 2013;

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Ryymin et al., 2020] and the recognition of design practices [Brown and Wyatt, 2010; Auernhammer, 2020] are keys to providing effective services. They have motivated the endeavour of having together both specialists and users into the task of conceiving and building innovation, including IS solutions [Morrongiello et al., 2017; Schöfer et al., 2018; Kummitha, 2019].

Open Innovation (Chesbrough et al., 2014) is a contemporary approach to boost knowledge exchange among organisations and between organisations, clients and society. Universities have increasingly taken part in open innovation ecosystems to carry on education, research, technology development and social impact projects [Olsson et al., 2020]. They are expected to be environments where creativity, knowledge and multidisciplinarity would frequently take place and have been the scenario of open and collaborative development initiatives (e.g., hackathons and living labs). In open and collaborative initiatives, multidisciplinarity is usually a concern. There is an expectation of attracting individuals with the most varied profiles, interested in participating in these initiatives. However, open and collaborative development initiatives have predominantly attracted IS development participants [Porras et al. 2019; Sadowski, 2017], as it is the case in the Brazilian context [Rodrigues, 2019; Araujo and Silva, 2018].

The understanding that non-IS developers, particularly users, are essential to IS development is already shared by IS development approaches in organisations as well as by innovation management literature, following the increasing adoption of participatory approaches such as agile development [Beck et al., 2001] and design thinking [Vianna et al., 2012]. However, user/customer engagement is still a challenge in IS development [Signoretti et al., 2019] and in innovation activities [Leonidou et al., 2020]. Therefore, this research follows the understanding that the lack of participation by non-IS developers can limit the potential for multidisciplinarity and innovation, which are fundamental for creating effective solutions to the challenges that arise in open and collaborative development initiatives.

The main goal of our research is to identify factors that can influence the intention of non-IS developers to participate in open and collaborative development initiatives. We consider non-IS developers as anyone who has never programmed or who, at some point in their life, has had contact with programming but does not recognise him/herself as being able to develop IS.

We performed a qualitative and interpretative study to identify these factors. In the study, we interviewed participants from five open and collaborative development initiatives in Brazilian universities. To conduct the interviews, we followed the Underlying Discourse Unveiling Method (UDUM) [Nicolaci-da-Costa et al., 2009], which is a research method that guides the data collection obtained in interviews following a model that simulates everyday conversations in informal contexts. Based on the content of the interviews, we extracted and organised the beliefs and attitudes that drove non-IS developers to participate in open and collaborative development. We used the Theory of Planned Behaviour (TPB) [Ajzen, 1991] as our theoretical guidance. TPB is an approach to predict and explain human behaviour in specific contexts, based on empirical evidence, and it states that an individual's intention to perform a behaviour is based on beliefs that imply cognitive factors that make him/her willing to perform a certain attitude.

The findings are that the non-IS developers are highly motivated to participate in open and collaborative development initiatives to create useful solutions, experience new IS development opportunities and have professional growth. For the IS development, they expect to find help from mentors, get support from colleagues and have tools available to facilitate software development. In this scenario, they believe they can create a prototype. Understanding these factors makes it possible to suggest strategies for improving non-IS developers' engagement in open innovation initiatives and, consequently, make these initiatives more multidisciplinary, promoting solutions with greater innovative potential or more appropriate to the reality of the end IS users.

The remaining of this article is organised as follows: Section 2 presents the research context, explaining our understanding of open and collaborative information systems development initiatives; Section 3 discusses related work; Section 4 details the theoretical research background — Theory of Planned Behaviour; Section 5 describes the case studies design and the interview method — the Underlying Discourse Unveiling Method; in Section 6 we present the case studies results and findings; and, finally, in Section 7 we present the research conclusions.

2. Open and Collaborative Information Systems Development

We understand open and collaborative IS development as a way for creating IS in an increasingly complex, multidisciplinary and changing world [Siqueira et al., 2017; Araujo, 2017], reinforced by the growing demands on organisational [Tidd et al., 2005] and social innovation [Murray et al., 2010]. In this research, we define open and collaborative IS development as a process of creating an IS in which any interested individual can participate in this creation and that, during this process, there is a sharing of individual efforts in teams to achieve the desired results [Bekkers and Tummers, 2018; Meirelles et al., 2018; Linåker and Runeson, 2020].

Gacek and Arief (2004) characterise the open-source software (OSS) movement as publishing freely a source code to be edited by anyone who wants to actively contribute to the development of a software, directly interfering with its characteristics. We bring this characteristic to open and collaborative IS development, focusing on the participation of any interested individual. However, we do not consider the OSS movement as a complete open and collaborative IS development initiative because OSS is a movement with a format dedicated primarily to experts in IS development. Also, open and collaborative development initiatives have an appeal in creating IS-based innovations, whereas the OSS movement focuses on developing software [Zhang et al., 2017; Fu et al., 2017; Horta et al., 2018].

Baldwin and Hippel (2011) explained that the open collaborative innovation proposal is to promote the participation of people who want to share the work of generating the design of an innovation, openly revealing the results of their collective design efforts for use by others. Then, individual efforts must be shared in teams to achieve the desired results in an open and collaborative IS development.

Hilgers and Ihl (2010) stated that when there is an empowerment movement for several contributors, extrapolating organisational boundaries to create solutions together with collaborative development efforts, the individual's role in society is reformulated and makes this perhaps the most democratic ideas, where individuals can play a vital role in shaping the world in which they live. Analogously, we seek to reinforce the

meaning of open and collaborative IS development that we bring to this research, in which an IS can better meet the needs of a community when users themselves are free to jointly mature their goals, and they can build the artefact that will support the achievement of these goals.

This research focuses on specific open and collaborative development models (see Table I), namely: hackathons, code camps and living labs. These models are those where the participation of non-IS developers are usually and mostly welcome and expected, and are the models which are present in the case studies we will describe later in this article.

The word **hackathon** combines the words "hack" and "marathon", where the hack is used to explore and investigate the possibilities of creation through programming [Briscoe and Mulligan, 2014]. Pogačara and Žižek (2016) explain that the term "hacking" has been applied to subjects not only associated with computers, but with creative thinking and "out of the box" exploration for improvement. A hackathon is typically a short initiative (about two days), with a very focused development objective/challenge where participants - usually programmers and others involved in software development - collaborate to create prototypes for solving/facing the problem/challenge, the best solutions being awarded [Almirall et al., 2014; Briscoe and Mulligan, 2014].

The term **code camp** refers to the act of building programs (coding) in a short time (camp). It is an intensive, social and cooperative approach to collaborative learning of programming techniques, in which knowledge and skills are generated from experiences [Alaoutinen et al., 2012]. In a code camp, a programming challenge is solved by a small group of participants who need to learn the skills necessary to complete the task [Porras et al., 2007]. Groups are encouraged to interact, promoting mutual help, as well as there is an incentive to creativity, with a limited set of technologies to be used.

A **living lab** is an arena of co-creation involving multiple actors (e.g., users, developers, and researchers) in an innovation process towards designing and experimenting with new solutions in specific contexts [Almirall and Wareham, 2008; Dell'Era and Landoni, 2014]. Living labs organise participants to contribute to ideation, providing integration and support to new skills development and designing user-centred products and services, promoting user participation through feedback and reputation mechanisms [Almirall and Wareham, 2008].

Hackathons have been mainly used for business and social technology innovation; code camps tend to be used as programming and software engineering skills development, and living labs have proved to be initiatives to innovate in the design of products and services which require high levels of user acceptance. However, they all promote engagement and collaboration as a key to creativity and innovation for building technological artefacts [Briscoe and Mulligan, 2014; Alaoutinen et al., 2012; Almirall and Wareham, 2008]. Additionally, there is usually an expectation of attracting individuals with different backgrounds and profiles, including future innovation users.

In this research, we do not aim to carry out an exhaustive bibliographic research in order to identify all open and collaborative IS development existing models. Thus, hackathon, code camp and living lab are the models that we mention here because they are the models we found within the bibliographic we used for this research, as well as

the models corresponding to the case studies we explored. Likewise, we consider these three models as adequate examples for understanding open and collaborative IS development.

Table I. Comparison of open and collaborative development models (by the authors)

		hackathon	code camp	living lab
differences	length	short	short	long
	objective	create innovations	learning software development techniques	experience innovations intensely in real situations
	how to organise the participants	in groups	in groups	mutual cooperation without groups
similarities	interaction between participants	yes	yes	yes
	software is developed	yes	yes	yes
	open call for broad participation	yes	yes	yes

3. Related Work: Non-IS developers Engagement

In this section, we present some works found in the literature that demonstrate an effort to make open and collaborative development initiatives closer to the reality of non-IS developers.

Karlsen and Lovlie (2017) analysed the difficulties in having a hackathon as a way to facilitate multidisciplinary learning and innovation among filmmakers, programmers and designers. The authors reported that many participants were frustrated by not knowing how to program, and being demanded to have “something digital” as a result. The authors suggest that if the objective of an open and collaborative development initiative is to facilitate digital creation for participants without

programming skills, the organisers should provide tools for non-IS developers to facilitate digital creation and collective learning.

Zapico et al. (2013) reported on five open and collaborative development initiatives to promote sustainability (Green Hackathons) where developers, researchers, environmentalists and citizens worked on creating innovative software solutions. The authors reported that most participants worked in groups formed before or during the initiative, but some participants worked alone on their projects or decided to act helping different groups. Participants that were non-IS developers looked for programmers to support the implementation of their ideas. The authors suggested strategies to increase non-IS developers participation: integration of technical and non-technical skills in the teams, providing specialised technical or non-technical "consultants" and more support for those who do not have technical skills.

Simonofski et al. (2020) studied previous work about motivators to participate in hackathons. They collected data about the participants' (both IS specialists or not) motivators and demotivators in a hackathon in a Belgium university, through a questionnaire and in-depth interviews. As a result, the authors listed 26 motivating factors. They highlighted as the main motivators: fun, opportunity to learn, influence from others, the hackathon theme, proximity to the hackathon location, the opportunity to test their development skills, the conviviality, the rewards, the opportunity to work on new projects, prestige, convincing communication by the organisers, and the opportunity to meet sponsors and the professional recognition.

These works describe important findings concerning the observation of participants' behaviour and their perception about the experience of taking part in an open and collaborative development setting. They also propose recommendations on how to enable the participation of non-IS developers in these initiatives. However, in the case of the works of Zapico et al. (2013) and Karlsen and Løvlie (2017), the recommendations are based only on the authors' feelings, without a formal survey to capture the participants' motivations. In the case of the Simonofski et al. (2020) work, the focus is not exclusive about the non-IS developers, having the results influenced by the experts in IS development too. Additionally, these related works were set only in hackathons, which made us question whether the motivations raised and proposed recommendations could also be valid in other types of events.

We conducted case studies focusing specifically on non-IS developers, considering different models of open and collaborative development, and using a theoretical framework to identify and organise observed motivational factors. So, our research contributes to the understanding of the reasons why a non-IS developer decides or feels motivated to engage in an open and collaborative IS development initiative, as well as the factors which may influence the intention of non-IS developers to take part in these initiatives, having the Theory of Planned Behaviour as theoretical frame.

4. Theoretical research background

As a part of our research to understand factors that can influence the intention of non-IS developers to participate in open and collaborative development initiatives, we used the Theory of Planned Behaviour (TPB) [Ajzen, 1991] as a guide to discovering the beliefs and cognitive factors that lead non-IS developers to participate in IS development, although they are not normally familiar within this environment. Researchers often use the TPB as an approach to predict and explain human behaviour in specific contexts, based on empirical evidence. Therefore, TPB suits well to our research as our research aim to explain non-IS developers' willingness to take part in these initiatives (explain human behaviour) in Brazilian university initiatives (specific context), and we need to obtain data from observation and interviews in real open and collaborative development initiatives (empirical evidence).

Ajzen (1991) stated that an individual's intention to perform a behaviour is based on beliefs that imply cognitive factors that make people willing to perform a certain attitude. TPB affirms that the intention to behave is influenced by (i) **attitudes** motivated by *behavioural beliefs*, (ii) **subjective norms** motivated by *normative beliefs*, and (iii) **perceived behavioural controls** motivated by *control beliefs* (Figure 1) [Ajzen, 1991; Steinmetz et al., 2016].

Behavioural beliefs deal with the consequences that someone believes will occur due to a certain behaviour. Then, a personal assessment is made about which attitudes will be carried out for or against the behaviour [Ajzen, 2002]. In our research, knowing the behavioural beliefs and attitudes that drive non-IS developers to participate in an open and collaborative development may be an opportunity to find ways to boost the attitudes of non-IS developers and extract the best from them, or even clarify any mistaken beliefs.

Normative beliefs are related to the individual expectation of how social reactions will be, especially family and friends, about the shown behaviour. It is associated with social pressure for approval [Ajzen, 1991; Ajzen, 2008]. Consequently, normative beliefs define the subjective norm, which is the perception of social pressure to have, or not, a certain behaviour [Ajzen, 2008; Verbeke and Vackier, 2005]. In our research, knowing the normative beliefs and subjective norms that influenced non-IS developers to participate in an open and collaborative development is useful to understand how much and what kind of support is needed to turn them interested to participate. It also provides the understanding of what can be replicated to other individuals who do not have the same support, and the evaluation of a way to address discouragements that individuals may have received.

Control beliefs are factors that may turn a behaviour performance to be possible or impossible, and they are related to the presence or absence of resources and opportunities which allow the behaviour to be performed [Ajzen, 2008; Ajzen, 2002]. The perceived behavioural control is the perception of how easy or difficult it is to control the factors that enable or hinder the realisation of the behaviour [Ajzen, 1991; Han et al., 2010]. In our research, knowing the control beliefs and the perceived

behavioural control which allow non-IS developers to participate in open and collaborative development is useful to understand how an open and collaborative development initiative can provide resources to give participants more confidence that they will be able to carry out their projects and objectives.

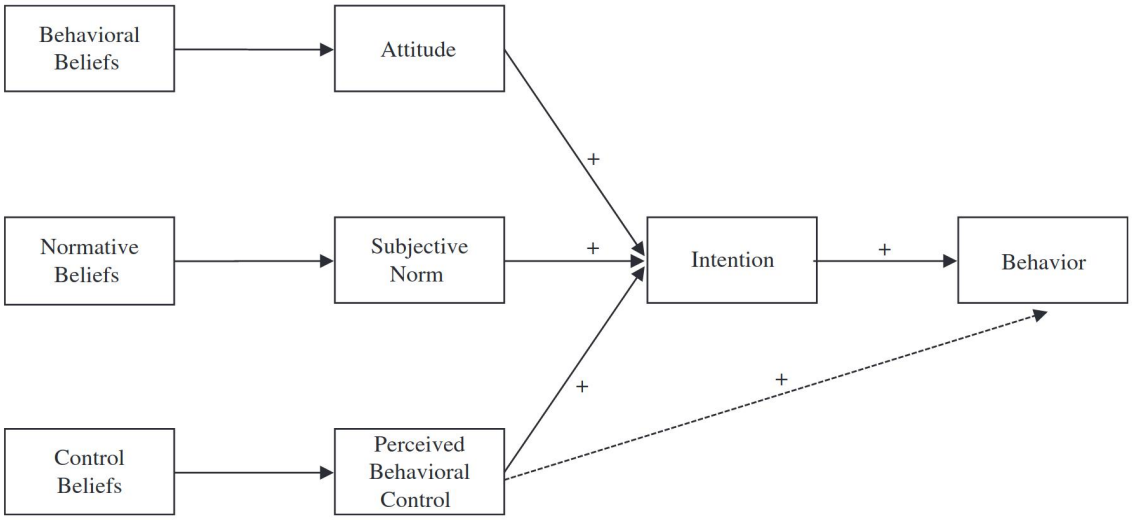

Figure 1. Theory of Planned Behaviour model (adapted from Steinmetz et al., 2016)

5. Case studies design

We conducted multiple case studies with multiple units of analysis [Yin, 2014], i.e., distinct case studies with a similar design in the same context or domain, with opportunities for complementary results. We studied five open and collaborative development environments in four different universities, conducted in different places, at different points in time and with no participants in common.

5.1 Context and units of analysis

The main objective of the five initiatives was the construction of IS-based solutions for different problems, and the IS artefact was the main expected outcome. All these initiatives allowed and stimulated the participation of non-IS developers and explicitly encouraged the creation of teams. Public calls for participation, disseminated through social media and websites, intended to stimulate the participation of non-IS developers, highlighting they were welcome. Participants voluntarily engaged into the initiatives and, except for Development Academy, there was no previous participants' selection. All participants needed to do was to register themselves or their team in the initiative. Table 2 summarises the characteristics of the five cases studied in the research.

We considered three hackathons: the hack@UNIRIO and two UNIGRANRIO hackathons. The hack@UNIRIO was a hackathon conducted with our participation in the organising team at a public university in Rio de Janeiro, Brazil. In order to make the initiative accessible to non-IS developers, we strengthened the dissemination of the idea that anyone interested in the event could participate, regardless of having or not

knowledge in IS, included the MIT App Inventor[1] as a diversifier and provided a specialised MIT App Inventor mentor. The hack@UNIRIO theme "supporting university-society initiatives" was previously known since the initiative was announced, and all participants, organisers and guests jointly discussed which issues on the initiative's theme they would like to address and what solutions could be created.

The organisers of UNIGRANRIO hackathons, conducted at a private university in Rio de Janeiro, Brazil, invited us to visit them. They also provided specialised IS mentors in their events. The 2018 and 2019 UNIGRANRIO hackathons, their respective themes "public health" and "public security" were released on the eve of the initiative's start, and the candidates needed to form teams and submit their ideas to the organising committee that approved which teams could participate in the hackathon.

We also created the Present Society as a combination of a hackathon (the participants worked in a short period, discussing the issues about the initiative's theme and creating the corresponding solutions), code camp (the participants learned to use the MIT App Inventor to create their prototypes) and living lab (prevailed the cooperation between participants with a spirit of mutual help and the proposals that would best serve real situations). It was conducted at a public university in a municipality in the metropolitan region of Rio de Janeiro. In order to make the initiative accessible to non-IS developers, we disseminated the idea that anyone interested in the event could participate, specially those who did not know how to develop IS; we included the MIT App Inventor as the tool to learn, and provided a specialised MIT App Inventor mentor.

Finally, we also had the opportunity to contact participants from the Development Academy, a training program (which we will keep details confidential at the request of the organisers) in a private university in São Paulo, Brazil, which brought together more characteristics of a code camp, where participants were submitted to continuous IS development challenges in several application domains for almost one year. The Academy used Challenge Based Learning[2] to promote innovation without a competitive scenario, but by creating challenges to motivate participants to excel and achieve their goals. Also, in order to make the initiative accessible to non-IS developers, they disseminated the idea that non-IS developers interested in the academy could participate, and provided specialised IS developers mentors.

Table 2. Units of analysis (by the authors)

	hack@UNIRIO	UNIGRANRIO hackathon	UNIGRANRIO hackathon	Development Academy	Present Society
year	2018	2018	2019	2019	2019
duration	3 days	2 days	2 days	24 months	3 days

[1] http://appinventor.mit.edu/explore/about-us.html

[2] http://challengebasedlearning.org/about

focus	create IS innovations	create IS innovations	create IS innovations	-create IS innovations -learn IS development for mobile apps	-create IS innovations -learn IS development for mobile apps
participants organisation	in groups	in groups	in groups	mutual cooperation without groups	mutual cooperation without groups
theme	supporting university - society initiatives	public health	public security	several domains	supporting university - society initiatives
university	public	private	private	private	public

Once the related works considered one (Karlsen and Lovlie, 2017; Simononfski et al., 2020) to five (Zapico et al., 2013) initiatives, in this work we also considered five open and collaborative development initiatives. We were involved in the organising group of the initiatives (hack@UNIRIO and Present Society) or were allowed by the organisers to contact the participants (UNIGRANRIO hackathons and Development Academy). Although there are several university hackathons in Brazil, to the best of our knowledge there is no other work that considers different open and collaborative IS development initiatives. The five cases we studied provide a broad spectrum of different characteristics of open and collaborative development models described in section 2 (i.e., hackathon, code camp and living lab).

5.2. Data Collection and Analysis

To carry out the interviews, we used the Underlying Discourse Unveiling Method (UDUM) [Nicolaci-da-Costa et al., 2009], which proposes data collection through interviews grounded by everyday conversations in informal contexts. To guarantee this informality, UDUM adopts procedures such as: using a script of questions that do not sound artificial; respect the flow of the interviewee's reasoning through a flexible application of the script; and conduct interviews in informal contexts in which respondents feel at ease. UDUM comprises five phases, illustrated in Figure 2 and described as follows.

Figure 2. Phases of the UDUM (adapted from Nicolaci-da-Costa et al., 2009)

Sample selection: Qualitative research may be laborious and time-consuming. Therefore, UDUM suggests the thoughtful selection of a few participants to interview. A homogeneity of participants' characteristics is required, which can be common experiences or common personal attributes, according to the research objectives. In this research, we selected participants, from the abovementioned open development initiatives, who had never programmed or had contact with programming and did not recognise themselves as being able to develop IS. These restrictions assure the homogeneity of the participants' characteristics. The selected sample comprised a total of 15 subjects: two participants from hack@UNIRIO, two participants from 2018 UNIGRANRIO Hackathon, three participants from 2019 UNIGRANRIO Hackathon, five participants from the Development Academy and three from the Present Society. In the case of the UNIGRANRIO hackathons and the Development Academy, we asked the organisers of the events to nominate the participants who were non-IS developers to be interviewed. In the case of the hack@UNIRIO and the Present Society, we directly contacted the non-IS developers to identify which ones could participate in the interviews. Table 3 summarises the interviewees' profiles.

Script elaboration: UDUM suggests the interview script should be structured with the flexibility to inspire natural conversations, and it must contain open questions that are adaptable to the context of the interviews and allow any type of response, including opinions, reflections, feelings etc. In this research, the interview script included open questions concerning: interviewees' personal and professional profile; previous experience with system developing/programming and several questions related to the interviewees' perception of each TPB dimension before, during and after the initiative. The script used to extract the interpretations from the participants' statements is in the Appendix A.

Interviews: According to UDUM, participants are interviewed, and interviews may be recorded based on a consent agreement. In this research, we scheduled the interviews in advance and conducted them face-to-face or through telephone. We recorded the interviews under participants' agreement (the consentment term is in the Appendix B), but the recordings of the interviews are not available to download due to the confidentiality agreement. We conducted all the interviews after the events, except those regarding the participants from the Development Academy, whose interviews we conducted during the event.

Transcription: We manually transcribed the interviews to text format, anonymised the data, and the transcriptions of this research are accessible at Silva (2020).

Analysis: Following UDUM, interviews content is analysed to identify patterns and recurring aspects in participants' discourse. Two types of analysis are performed (i) the intra-participant analysis to evaluate individual responses, comparing the testimonies, searching for inconsistencies, contradictions, new concepts, etc.; and (ii) inter-participant analysis to evaluate the responses of the whole group, looking for recurrences that may reflect values of the context to which the participants belong. For

this research, we followed an interpretative approach for analysing our data [Walsham, 2006], which understands that our knowledge of reality, including the domain of human action, is a social construction by human actors, and studies are done in the field, investigating people in their social contexts. The interpretation was conducted based on the interviews, adopting a reflexive approach. We first carried out the intra-participant analyses, where it was possible to understand from each interviewee their particular beliefs and factors that led them to act in an environment that they usually do not have familiarity with, which is IS development. Then, we performed the inter-participant analysis, considering the collection of interviews, in order to identify within the group of the interviewees what factors based on TPB determined their participation in the open and collaborative development initiatives. We focus here on the inter-participant analysis to expose the consolidated results and not overextend this article, as it combines all intra-participant analyses. The detailed intra-participant analyses can be accessed at Silva (2020).

Table 3. Interviewees' profile (by the authors)

participant	initiative	scholarity	occupation area	knowledge about IS
A	hack@UNIRIO	undergraduate	Law	never programmed
B	Present Society	attending master's degree	Telecommunications	have had contact with programming, but do not recognise himself able to develop IS
C	Development Academy	undergraduate	Math	have had contact with programming, but do not recognise himself able to develop IS
D	Present Society	undergraduate	Management	never programmed
E	Development Academy	undergraduate	Psychology	never programmed
F	Development Academy	undergraduate	Publicity	never programmed

G	Development Academy	undergraduate	Electrical Engineering	have had contact with programming, but do not recognise himself able to develop IS
H	hack@UNIRIO	undergraduate	Public Management	never programmed
I	Development Academy	undergraduate	Accounting	never programmed
J	Present Society	attending master's degree	Arts	never programmed
K	UNIGRANRIO hackathons	undergraduate	Social Service	never programmed
L	UNIGRANRIO hackathons	undergraduate	Biology	never programmed
M	UNIGRANRIO hackathons	undergraduate	Civil Engineering	never programmed
N	UNIGRANRIO hackathons	undergraduate	Civil Engineering	never programmed
O	UNIGRANRIO hackathons	undergraduate	Army	never programmed

*Note: No interviewee has had previous experience in open and collaborative development initiatives.

6. Findings

In this section, we present our main findings, organised by the TPB dimensions. A diagram summarising the factors that determined the participation of non-IS developers in open and collaborative IS development initiatives, according to TPB, is depicted in Figure 3. The transcripts' excerpts in this section represent only selected examples of the responses to show the idea of the collected interviews.

6.1. Behavioural Beliefs

Participants mentioned[3] as one important belief that by participating in the initiative, they could contribute to **creating useful solutions to society**. Participants' intention is highly related to their perception of the applicability of what they will develop:

> *"I decided to participate in this initiative, first due to its scope, which was to meet society's demands, to develop a solution in response to a community's*

[3] All transcriptions are presented according to our free translation from Portuguese.

> *demand. I thought that it was essential. It is one of the university roles. Second, in my master's degree, I am studying this same theme."*
>
> participant 'B'[4], from Present Society

> *"What made me participate in this initiative was my motivation to create things for everyday life."*
>
> participant 'C', from *Development Academy*

They reinforced the applicability of their ideas through different perspectives ("something big and meaningful", "a problem that happens a lot", "the usefulness of an app", "help many people", "life quality", "downloaded from the app store", "astonishment", support gender vulnerability, "impact" and "accessibility").

The interviewees also mentioned the importance of the initiative **to address a theme that they feel interested in**, which they have an affinity with:

> *"If I had an opportunity to participate in another initiative before, I don't know if I would participate if the theme were another. Because what exactly caught my attention at this particular initiative was the possibility of everyone being able to create, even if not working in the programming area, and also being able to create something to solve day-to-day problems. You see a practical application, something that is real.*
>
> *I think that if there were more things like this (the initiative), people would not have this view that it is a separate, special, difficult thing, and would be more interested [in participating] as well."*
>
> participant 'D', from Present Society

They also perceived **innovation and change** as important aspects, and that the development initiatives "work to stimulate creativity", motivate to "create other innovations", are a "new style of knowledge, thinking of new forms of social resolutions", give "an opportunity to make a complex idea more concrete", and support that "in a short time you have to materialise the idea":

> *"During the initiative, I saw that development is something bigger. It also works to stimulate creativity to develop new tools. Tools that will be practical, that someone really needs."*
>
> participant 'C', from *Development Academy*

They also mentioned curiosity of **being part of an unprecedented experience**, an opportunity for overcoming challenges, of practising an out of the routine activity and an inquiry attitude about how an open and collaborative development initiative could enable non-IS developers to develop IS in a short time:

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[4] The real names of the participants were hidden due to the confidentiality agreement accepted by the interviewees.

"I decided to participate in the initiative because I like challenges, so it would be a great challenge for me. ... it is something completely different for me."

participant 'E', from *Development Academy*

The fact that the interviewees had none or low previous experience with programming made them declare themselves aware that they do not know how to conduct an IS development work:

"Even when I was an intern at a project, where I lived with programmers, and they were constantly talking about programming, I saw people working with software development, but I never worked on creating programs and understood nothing of the terms they used. And I was not interested in programming because it involved mathematics."

participant 'F', from *Development Academy*

"Before the initiative, I didn't believe I could develop software because I thought it was a very complicated thing, and I had the idea that I needed to spend several hours to be able to create a small program."

participant 'G', from *Development Academy*

Participants **lack confidence in their ability to develop applications**. They considered participating in the initiative as craziness, liable to be embarrassed in the presence of other more experienced participants. Because they do not know precisely how to act at the initiative, some asked themselves *"will I be able to do all this?"*:

"When my friend talked about the initiative, I thought it was crazy because it didn't involve our area, and I would be ashamed. But after I read about this type of initiative, I understood the importance of developing programming, technology, for the whole society."

participant 'H', from hack@UNIRIO

"One of the thoughts I had when I entered the initiative was "will I be able to do all this?", Because I didn't even know what I was going to do. So, the doubt hit very hard. But knowing that there would be other people with other backgrounds who also knew nothing, helped me a lot to have confidence."

participant 'I', from *Development Academy*

Regardless of this lack of confidence, **they held in high esteem both the technology companies that have a good work environment and people who have and implement good technology ideas**, which encouraged them to take advantage of the initiative as **a way of materialising their ideas**:

"I decided to participate in the initiative because I always wanted to make the application I proposed, but I always considered myself unable to do it. As people were not available to me, I always put the idea aside. When I felt a little more

capable, then I decided to act and make it happen, which is what is happening now."

participant 'J', from Present Society

"Even before the initiative, I didn't believe I could develop software. I saw so many people creating apps, making good ideas come true, and I thought 'I want to create apps too and materialise my ideas, I want to be a part of that'."

participant 'F', from *Development Academy*

They highlighted their interest in an initiative in which it could be possible **to improve their knowledge and their professional curriculum**, even when they were not sure of the details of how the initiative would proceed:

"*Before the initiative, I went to an interview, and on the occasion the interviewer commented on the importance of knowing how to program to be able to perform the job tasks. So, having knowledge about technology to solve problems, improve your work, is fundamental. Then, I went to the initiative with that line of thought."*

participant 'H', from hack@UNIRIO

Finally, they reported the possibility of **winning awards** or money from the initiative:

"What made me participate in this initiative were new experiences. The challenge of doing something I had never done before. And a little insistence from my friend. And the awards. Being awarded is good."

participant 'H', from *hack@UNIRIO*

6.2. Attitudes

The interviewees reported behavioural beliefs that were key to make them develop the attitude of staying in the initiative. The belief that **the knowledge acquired, or deepened, from the IS development practice could be useful for their lifetime** made them **confident of achieving their goals**. They assumed that the **development of an IS could be possible** for anyone willing to dedicate some effort to the subject, without necessarily becoming an expert in IS development. However, they also realised **the importance of using the knowledge they previously had from their areas of expertise**:

"I never thought I'd do something with programming, and knowing how it is done. At the same time is scary because I have a lot to learn, but on the other hand, it is good because it is a lifelong learning experience."

participant 'I', from *Development Academy*

"Participating in the initiative was an awakening that "you can do it". It doesn't necessarily have to be your area. Your ideas are not that crazy. It was an awakening of possibilities for me that I couldn't see."

participant ‘K’, from UNIGRANRIO *hackathons*

Believing that taking part in the initiative would be a challenging and novel experience, participants declared that **teamwork**, a **clear understanding of the process** during the initiative, and **an intense focus on finding solutions**, were relevant factors for making them stay:

> *“At the beginning, the group motivated me not to leave. I thought about leaving because I didn’t know what I was doing there. As nobody was prepared, I thought about giving up. But my girlfriend talked to me and convinced me to at least demonstrate that we participated and tried to create something… But after I realised that the process started to work, I saw that something could be achieved, even if it was the worst application of the initiative. But then I could say that I participated and did something. Watching the prototype taking shape, I saw that everything would be fine, in the sense of delivering some application.”*

participant ‘L’, from UNIGRANRIO *hackathons*

> *“What kept me going was the understanding of how the initiative would proceed. Everything that was presented was understandable. And as it was understandable, I was able to follow. And that was encouraging me to stay.”*

participant ‘J’, from Present Society

6.3. Normative Beliefs

The normative beliefs highlighted by the interviewees demonstrate a dilemma. **They receive encouragement from friends, family, colleagues or teachers**. The interviewees attended invitations from dates and colleagues to participate together in the initiatives, combining profiles to create a team. However, they also faced scepticism from other friends:

> *“At first, I wasn’t going to participate in this initiative... It was my girlfriend who came up with the idea and asked me to participate, mainly because I am from the biological area and we believe that this knowledge could collaborate in creating a solution for the health area. Everything was thought of from the idea of my girlfriend.”*

participant ‘L’, from UNIGRANRIO *hackathons*

> *“Before the initiative, when they were aware that I intended to develop software, people did not speak, but I had the feeling that they were thinking “You? Are you sure?” in a way they didn’t believe. My parents encouraged me and said that the future belongs to those who know how to do programming.”*

participant ‘E’, from *Development Academy*

They also considered teachers and university employees suggestions that participating in the initiatives would be a good professional experience. However, some teachers questioned whether it was really useful to participate in these initiatives,

demonstrating unfamiliarity with these initiatives and thinking that programming could not contribute to their areas of activity:

> *"At the time of registration for the initiative, I even asked some teachers what they thought about it. They said that although programming is not essential knowledge for my area, it can be useful in the future. So I thought about trying and adding this knowledge to the curriculum."*
>
> participant 'G', from *Development Academy*

Interestingly, the same actors identified as motivators are also a source of scepticism. For example, professionally or in their former education, most of the interviewees had never received any kind of incentive to create IS:

> *"Before the initiative, I received no support or incentive to develop software. I never got close to that. In fact, in life, I only met one ICT person, which reinforced my idea that only ICT people who made software."*
>
> participant 'D', from Present Society

> *"Before the initiative, I had an incentive to develop software by observing technology companies, to learn about different work environments, in which it is not being in the cubicle all day in front of the computer. It is more collaborative, which encouraged me to glimpse the area and pursue it. ... But colleagues and teachers in my field do not show an incentive."*
>
> participant 'G', from *Development Academy*

Other reactions were apathy, misunderstanding of what was involved, or rejection of the interviewee's decision to participate in the initiative:

> *"Before the initiative, people were apathetic when they heard that I intended to develop software. ... And already during the initiative I even commented that I would be developing software, but people didn't believe, they didn't care about what I'm going to do. But I've lived with it for so long that I don't even care about it anymore."*
>
> participant 'J', from *Present Society*

Finally, some interviewees considered the statement of **professionals in their areas, saying that knowing how to program can be a differential in the curriculum**.

6.4. Subjective Norms

Normative beliefs reinforced subjective norms of needing **mutual collaboration among participants** in order to succeed:

> *"The collaborative atmosphere of the initiative encourages me a lot, which makes me go further and try harder. And also my family encourages me now when they see that it is something I am enjoying doing."*

participant ‘G’, from *Development Academy*

Help from the mentors, knowledge exchange among participants with different skills (regardless of whether they are programmers or not) as well as **incentives from the colleagues** to not give up were decisive for the interviewees to achieve their goals and overcome their lack of confidence:

> *“During the initiative, I got much incentive to use the development and design tools. Mentors gave a lot of ideas and information, which encouraged me a lot. ... College colleagues are more supportive of the experience, and initiative colleagues praise and say I have a lot of potential.”*

participant ‘E’, from *Development Academy*

> *“Before the initiative, people called me crazy, saying that there is no way to reconcile programming with my area of education. But I was able to demonstrate that it does, and we worked a lot with it at the initiative. ... And there, at the initiative, because we have people outside the Information Technology area who think differently, I can work more and more with innovations.”*

participant ‘C’, from *Development Academy*

The interviewees who decided to comment about their performance at the initiatives with college colleagues, friends and relatives, received **positive reactions** of astonishment, encouragement, congratulations and pride, even when the person did not understand the initiative scope completely. Some interviewees additionally received invitations to develop applications**:**

> *“As I published images of my participation on social networks, I received many congratulations on these publications. ... However, my impression is that people congratulated without understanding what the initiative was about. It was because of the image of me speaking in front of the public and receiving an award.”*

participant ‘A’, from hack@UNIRIO

> *“During the initiative, people’s reaction to knowing that I was developing software first was a surprise, and my parents were proud. And now, orders for software creation are coming in.”*

participant ‘E’, from *Development Academy*

However, scepticism and dilemma persisted, and participants both seemed to **overcome negative comments** with confidence and pride as well as a feeling of discredit or lack of maturity of their final product:

> *“After the initiative, when I arrived with a prototype of my idea, there were reactions of surprise. For me, these reactions are natural, because I have lived with it for so long that I incorporated it into my life. I am not surprised by people’s reaction. No one ever believed in me, only myself.”*

participant ‘J’, from Present Society

“When people heard that I intended to participate in the initiative, they generally thought it was a crazy idea, due to the perception that professionals in my area work in cubicles, and that programming is another area that has nothing to do with it. College colleagues also said that investing in programming would not help much in my field of education… As I think the opinion of my family members is more important, and the experience at the initiative is being positively different from what I imagined, I don’t care about these negative opinions... I am the only woman in my college course, so I already live with a certain prejudice. So one more doesn’t make much of a difference. I have to keep doing what I think is good for my career.”

participant ‘G’, from *Development Academy*

Nevertheless, the interviewees believe that their experiences at the initiatives **can positively influence those who do not know how to develop an IS**:

“People have to believe in themselves, that they can do it. Just study and dedicate yourself. ... My case was persistence in wanting to do it. I don’t think I have the talent for programming, but at the initiative, with an appropriate tool, I managed to do it.

Thus, it is enough for the person to try, see if they can and seek knowledge. That’s the message I have for those who don’t know how to program. In everything that the person focuses on, it is possible to really achieve.”

participant ‘H’, from hack@UNIRIO

“My participation shows that no matter how different your area is, you always have something to contribute.”

participant ‘F’, from *Development Academy*

6.5. Control Beliefs

Most interviewees believed that **developing an IS would be a complex task** and that they would **take part in activities in which they were more confident**, such as visual design or presenting their ideas:

“During the initiative, what kept my belief that I could develop software was my perseverance and also because I had nothing to lose. ... As my area is not computer science, I went intending to demonstrate an idea in the form of slides for people to understand. But I ended up programming because of the tool presented, and started to develop the application. ... Mentors’ support also contributed.”

participant ‘A’, from hack@UNIRIO

Some interviewees thought that the initiatives would be like a traditional expositive class, but the majority reported that **they did not imagine how they would act with IS development** at the initiatives:

> *"Before my participation, I imagined that my performance would be totally different from the way it was. ... I thought it would be like a traditional methodology in the classroom, and when we got there, we saw how different and cool it is."*
>
> participant 'I', from *Development Academy*

They also believed **there would be computers for everyone and dedicated mentors to help** the development of prototypes:

> *"Of the difficulties encountered, the first was not sleeping and not being able to leave the initiative. Another was the low availability of computers, and I had to look for information by cell phone, which was difficult."*
>
> participant 'M', from *UNIGRANRIO hackathons*

> *"We came prepared to stay at the initiative but also prepared to leave. When we asked if there would be someone supporting us, since we knew nothing about programming, the organisers replied that there would be mentors guiding, indicating a tool, allowing at least one layout, a drawing of the application we could demonstrate. Then we decided to stay at the initiative."*
>
> participant 'K', from UNIGRANRIO *hackathons*

6.6. Perceived Behavioural Controls

Guidance from mentors and help from other participants with development or domain experience was an important perceived behavioural control reported in the study. The interviewees emphasised the **importance of mentors in indicating IS development techniques and tools** suitable for the initiatives' purpose and the programming level of the initiative participants:

> *"We take advantage of the knowledge of teammates by directing each one to their best area. I had the patience to make phone calls to get new content to be included in the app. The other colleague already had information about obstetric violence, and we used that information. The biology student was used to explain the importance of prenatal care and medical care, in addition to being responsible for the development of the prototype. And the other participant who had more free time, we used to look for other pending information."*
>
> participant 'K', from UNIGRANRIO *hackathons*

> *"In the early hours, I didn't know what I was doing. I watched some video lessons about programming but didn't know what I was doing. So I was desperate and I got the feeling that I was at the initiative for nothing, and I wouldn't be able to*

deliver anything and become the mockery of the initiative. It was in a ten-minute conversation with the mentor that he gave guidance on what we could do."

participant 'L', from UNIGRANRIO *hackathons*

However, the interviewees considered suitable the role of the mentors when they suggested functionalities to the prototypes, but they should **not interfere directly with programming or doing the visual design**:

"Because the environment of the initiative is a place ... to create technology, when the mentors, who are the people with experience, came with information like "this is not going to work", it made my suggestions be cut. ... I don't see it as a negative thing, I see it as a welcome help, but my decision making took a long time before the information from these specialised people arrived."

participant 'K', from UNIGRANRIO *hackathons*

"I really liked the final product because it was our way. If a mentor had stayed with us to give an opinion on the layout, it would not have been the same. ... But it was our way because it was simple, with the characteristics of people who don't know how to program and tried to do it. It was simple and objective."

participant 'N', from UNIGRANRIO *hackathons*

The **use of end-user development tools** (like the MIT App Inventor and the Ionic Creator[5]) was also an important element for the interviewees to be able to create their prototypes:

"A mentor gave tips on how to create the prototype and indicated the use of the Ionic Creator, advised to look for classes about the tool on YouTube, but did not teach how to use it or what it was specifically about….I did not use all the resources of Ionic Creator, but I used a good part of them. Everything I needed from the tool was available."

participant 'L', from UNIGRANRIO *hackathons*

"The experience in developing software was challenging. I thought it would be more complex, but we used tools for beginners, allowing us to develop something. I managed to create a lot more than I thought I could."

participant 'H', from hack@UNIRIO

Interviewees also perceived a **growing acquisition of knowledge and confidence in the application development process**:

"I liked the dynamics. For me, it worked better than if on the first day I had presented the development tool and only the next day was the discussion of ideas. I think that thinking about ideas and then learning to develop is much better.

[5] http://ionicframework.com/creator

Because when you go to work on the tool, you already have an idea of what you would like to do with it."

participant 'D', from Present Society

"I was very unsure. Although I believed in myself a lot, I was very insecure when I found out I wouldn't have a programmer at my disposal and because I had no idea what I was doing. I was out of my comfort zone. ... But things started to happen. And when I started to see the application with a little more shape, I started to believe more….For a moment I thought about going home, but I thought better of it and decided to do my best."

participant 'A', from hack@UNIRIO

The Interviewees pointed out other aspects which brought them some burden: going to the initiative location, the scarcity of time (for reconciling private obligations and the time available for the initiatives) and the need for more dedication to complete the prototypes with all the desired functionalities.

6.7. Intention

About the intention, we can see that all interviewees had the **intention to participate in open and collaborative development initiatives**. Thus, all the factors that influenced the interviewees found in this research are reliable to the real intention of non-IS developers to participate in open and collaborative development initiatives.

Furthermore, as a way of identifying whether the experience also aroused a feeling of wanting to participate in future initiatives, we took advantage of the moment of the interviews to reap that future intention. In this aspect, the interviewees demonstrated an interest to produce new ideas, to participate in other open and collaborative development initiatives or to study more about IS development, but without becoming an expert in the area:

"I am motivated to create other innovations with the resources used in this initiative. And I think I would participate in other initiatives like this."

participant 'M', from UNIGRANRIO *hackathons*

"I don't intend to specialise in software development. I intend to make partnerships to create possible new software and would look for designers and programmers."

participant 'A', from hack@UNIRIO

Indeed, after the experience, some interviewees improved their prototypes or acted in other initiatives as a mentor:

"I even used the software I created the day after the initiative to see how it was. I only adjusted a small part. Then I didn't use it anymore, but it's still on my computer."

participant 'H', from hack@UNIRIO

"I feel motivated to create other innovations with the resources used in this initiative. And in the second edition of the initiative I really enjoyed participating as a mentor, I was a co-participant.

I think my work impacted the institution as an example for students of other courses ... This was propagated to students saying that it is possible. When I won the first edition of the initiative, in addition to making me a mentor in the second edition of the initiative, it also influenced me to be classified in a selection of scholarships in Spain."

participant 'K', from UNIGRANRIO *hackathons*

There was also a statement that an interviewee was invited to participate in projects that involved IS development:

"I feel motivated to create other innovations. Even because there is a project here at the university to create an atlas of zoology, and as the professor of that project knew that I won the initiative, he invited me to create an application for this atlas. So I told him that I need a little more study to mature the idea. People believe me, because I won the initiative, which influences me to want to learn a little more about the programming area. To continue the area and maybe create another application later."

participant 'L', from UNIGRANRIO *hackathons*

Finally, the interviewees demonstrated an awareness that IS specialists should be responsible for developing professionals IS:

"I am an amateur programmer, and I had only a short programming basis. If I ever need to create a program, I believe that this experience may help me… But programming is not my area, it is not in my interest, and I think it should be done by professionals."

participant 'A', from hack@UNIRIO

"I intend to make partnerships to create new software, because you can't do a good project alone. I would like to work with people who are more focused than me, because I am from a creative area, I "travel" sometimes, and need to keep my foot on the floor… I would also look for good programmers and also people with ideas completely different from mine."

participant 'F', from *Development Academy*

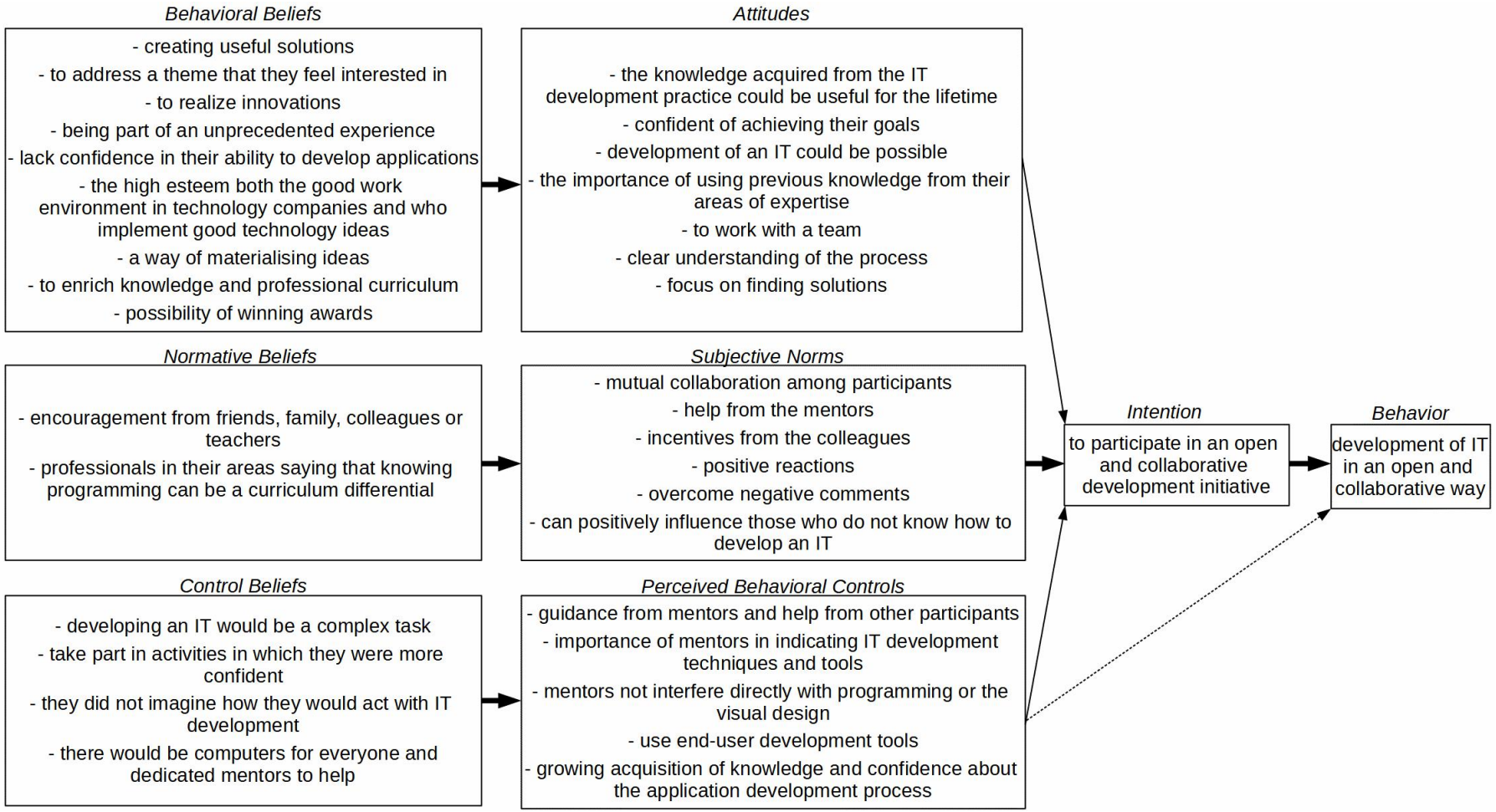

Figure 3. Factors that determined the participation of non-IS developers in open and collaborative IS development initiatives, according to TPB (by the authors)

7. Conclusions

This research article describes qualitative and interpretative case studies conducted to identify the aspects that can influence the intention of non-IS developers to participate in open and collaborative IS development.

7.1. Contributions

Our findings show that participants are motivated by a combination of professional (IS development and application, professional contacts) and personal (challenge, learning and curiosity) aspects. Additionally, they report being more confident when the initiatives provide human (mentoring and teamwork) or technology support (high-level development tools) and feel discouraged when people near them question their purpose and abilities to take part in these initiatives. These findings are very close to those reported by Simonofski *et al.* (2020) in Belgian universities, which may indicate common aspects around the globe. However, our study presents more details on the subjective perspective involved in the non-IS developers' participation and the specificities of the different cases of open and collaborative IS development initiatives.

Open and collaborative design and development of IS is considered as one of the great IS research challenges of the IS research community in Brazil [Siqueira et al., 2017; Araujo, 2017]. The present research contributes to facing this challenge by describing ways to motivate multidisciplinarity and innovation through open and collaborative projects. Our results contribute to the understanding of non-IS developers' attitudes, allowing future similar initiatives to be more attractive to their public and enhance participation. Furthermore, our results may also help improve multidisciplinarity in innovation settings in organisations, by inspiring ways to motivate or avoid demotivation of non-IS developers to engage in IS innovation initiatives.

We organise information from interpretive qualitative case studies that explain the factors that can influence the intention of a group, i.e., non-IS developers, to participate in open and collaborative development initiatives. We also showed the applicability of the UDUM method in the interviews that allowed us to add new knowledge to the IT area. In the case of the TPB, we demonstrate how the theory collaborated in producing a model (Figure 3) to understand which factors influence non-IS developers to be willing to participate in open and collaborative development initiatives.

This research provides some recommendations for future open and collaborative IS development initiatives to be more attractive to non-IS developers. The first recommendation is the choice of relevant themes to lead to the development of solutions that positively impact a community. In addition to the social benefit, participants see it as an opportunity to show their knowledge, beliefs and ideas. The second recommendation is to make available, in an accessible way, as much information about the event. Information is a tool that encourages participants to face events with more confidence and awareness of what they are doing. The third recommendation is the

availability of an end-user development tool that facilitates the construction of prototypes by the participants. The fourth recommendation is the guidance of mentors so that the participants feel safe and supported to begin to develop their prototypes. The final recommendation is to make open and collaborative IS development initiatives as welcoming as possible. These recommendations are essential for the participants to overcome any difficulties due to lack of technical knowledge in IS development and so that any lack of stimuli become insignificant.

7.2. Validity of the study and its findings

Our case studies are valid according to the following criteria [Yin, 2014]: i) construction validity: we conducted the studies collecting multiple sources of evidence - participants from different institutions at different points in time - with interviews based on TPB dimensions; ii) internal validity: the case studies had an exploratory nature, and analysis of causal relationships among variables were not expected in this research; iii) external validity: the design of these case studies can be replicated to any open and collaborative IS development initiatives in universities and results can be compared using the TPB model; iv) reliability: all case studies can be classified as open and collaborative IS development environments, the same models and methods were applied, and results were interpreted as an attempt to generalisation.

7.3. Limitations

All cases studied were carried out in university environments, and they may not be generalised to open and collaborative development initiatives carried out in other contexts. In all the studied initiatives, participants developed mobile applications. We cannot say the respondents' answers would be the same if other kinds of information systems (desktop, web-based etc.) had been required. Finally, the studies lack longitudinal observation, i.e., whether the interviewees did engage in other IS development activities afterwards. It remains open whether the interviewees' statement of future intention to participate in other initiatives is materialised.

7.4. Future work

As future work, we suggest conducting new case studies and observing results considering different profiles (gender, age, economic and social levels) and contexts other than universities, specifically open and collaborative development initiatives organised by enterprises.

Another possible future work may be investigating people who had not participated in open and collaborative development initiatives to verify whether the factors match those from non-IS developers who participated. The report of this other audience, with an opposite experience, can bring complementary knowledge to the ones found here and show new strategies for the events.

Acknowledgement

<<omitted>>

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Appendix A - Interview Script

1. General Questions
   - 1.1. Age
   - 1.2. Genre
   - 1.3. Ethnicity
   - 1.4. Education
   - 1.5. Income
   - 1.6. Occupation area

2. Identify the level of knowledge in software development
   - 2.1. Before the event, what was your knowledge, even if only theoretical, about software development?
   - 2.2. What knowledge did you acquire during the event?
   - 2.3. Today, after the event, how do you perceive your knowledge about programming?
   - 2.4. Before the event, how did you perceive your ability to create software?
   - 2.5. During the event, how was your perception of being able to create software?
   - 2.6. Today, after the event, how is your ability to create software?
   - 2.7. Before the event, had you already participated in any software development activity, or collaborative software development event? If so, what was created, what was your performance, and what were the resources used?
   - 2.8. After the event, did you participate in some other activity, or software development collaborative event? If so, what was created, how was your performance, and what resources were used?

3. Attitude
   - 3.1. Why did you decide to participate in the event?
   - 3.2. Before the event, what made you believe you could develop software?
   - 3.3. During the event, what kept your belief that you could develop software?
   - 3.4. Now, after the event, what makes you believe you can create software?
   - 3.5. Before the event, what motivated you to create software?
   - 3.6. During the event, what kept you motivated to create software?
   - 3.7. Now, after the event, what are the current motivations for creating software?

4. Subjective Standards
   - 4.1. Before the event, what support or incentives did you receive to develop software?
   - 4.2. During the event, what support or incentives did you receive to develop software?
   - 4.3. Now, after the event, what support or incentives do you receive to develop software?

4.4. Before the event, what was the reaction of people when they knew you intended to develop software?
4.5. During the event, what was the reaction of people when they knew you were developing software?
4.6. Now, after the event, what is the reaction of people when they know that you developed a software?
4.7. How did people react when they used the software you created?
4.8. How do you believe that your experience will influence those who don't know how to develop software?

5. Perceived Behavioral Control
   5.1. Before your participation, how did you imagine your performance would be?
   5.2. During the event, how did you evaluate your performance?
   5.3. Today, how do you evaluate your performance?
   5.4. Before the event, what difficulties did you encounter and how did you face them?
   5.5. During the event, what difficulties did you encounter and how did you face them?
   5.6. Now, after the event, what difficulties do you face and how do you face them?
   5.7. Do you think you achieved the desired goal with your software?

6. Intention
   6.1. How do you intend to use this new knowledge in the future?
   6.2. Do you intend to improve your software development skills? If so, how?
   6.3. Do you believe you will create new software yourself? If so, with or without the resources learned during the event?
   6.4. Do you intend to make future partnerships to create new software? If so, which profiles would you look for and why?

Appendix B - Consentment Term

FREE AND INFORMED CONSENT FORM

TITLE OF THE RESEARCH: Motivation and empowerment of non-IS developers in open and collaborative innovation initiatives.

STUDY OBJECTIVE: To identify the factors that motivate and empower non-IS developers to participate in open and collaborative innovation initiatives.

BENEFITS: The research will help to identify factors that empower and motivate non-IS developers, enabling the proposition of actions that increase the participation of non-IS developers in open and collaborative innovation initiatives.

INTERVIEW RECORD: All conversation during interviews will be recorded.

CONFIDENTIALITY: The interviewee's name will not appear on the interview record, as well as on any form to be filled in by us. No publication departing from the interview will reveal the names of research participants.

DATA ANALYSIS: The analysis of the present study will be part of the master's thesis text of the student Thiago Andrade Marques da Silva, under the guidance of Prof. Sean Siqueira, carried out through the Postgraduate Program in Informatics at the Federal University of the State of Rio de Janeiro, and occasional scientific publications. Extracts from the interviews may be published both in the dissertation and in publications, without mentioning the name of the interlocutor.

CLARIFICATIONS: Investigators are available to answer questions from the respondent. If necessary, contact Thiago Andrade Marques da Silva at thiago.marques@uniriotec.br, or Prof. Sean Siqueira at sean@uniriotec.br.

I read, understood and agreed with this interview.

I confirm that I have received a copy of this Consent Form and I give my free and voluntary consent to participate in this study.

_____, _____ of _____ of _____.

Participant's Legible Name:_____

Participant Signature: _____

Signed Researcher: _____