Applying QCA with Fuzzy Logic to create a refined set of factors for Information Systems Adoption:

The Case of Public Ecuadorian Organization, an example of IS adoption in Emerging Economies

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Abstract— Information Systems (IS) research continues to contribute to a long list of technology adoption factors from research studies conducted outside the Latin American (henceforth LAT) nations. These studies fail to appropriate the context of IS adoption in LAT. This is mainly because the context of existing studies, namely those aimed at North America for example, do not have the same technological facilities that LAT nations do. This greatly inhibits the ability of these studies to be applied to the LAT context. Further, uncertainty and an inability to predict outcomes of technology adoption creates variances in results due to the fact that context is not considered. The reasons for this are unclear from existing studies. To explore this problem further, a Qualitative Comparative Analysis (QCA) was applied to LAT economies to assess a refined set of drivers from existing technology adoption studies. A Fuzzy Logic process was used to refine these drivers. The research found that fourteen themes are candidates for future research purposes. The drivers provide LAT stakeholders, as well actors from other emerging economies, with a contextual frame that can be the basis for adopting technology more meaningfully within these nations.

Keywords— Fuzzy-logic; Qualitative-Comparative-Analysis; *fs*/QCA; Information-System Adoption; Latin-America; Ecuador; Public Organization

1 Introduction

Predicting IS adoption outcomes in public organizations is challenging. The extraction of adoption factors from large sets of variables or from extensive coding sets remains problematic given the pluralistic nature of adoption contexts. Single response categories (scales) might not completely capture perceptions [1, 2] related to the com-

plex technology adoption problem being studied (local context). To this end, a Qualitative Comparative Analysis (QCA), applying fuzzy logic techniques, is used as a qualitative-quantitative bridging methodology to analyze predetermined sets of responses by examining necessary and/or sufficient related conditions [3] for adoption in LAT regions. Servant and Jones [4] for example, use fuzzy logic in historical analysis to improve accurate revisions of larger code sets. Servant and Jones [5] argued that this technique is more precise because it enables researchers to use coding sets to define more specific coding history for larger coding sets.
QCA using fuzzy-set, complemented by a set of research tools, is an analytic approach that helps determine the necessary or sufficient conditions to evaluate significantly varied outcomes of a selection process [3]. This technique is also useful for evaluating empirical analyses based on qualitative approaches [5]. QCA is used in this way to validate which of a large number of empirically refined factors obtained from a previous study should be selected as the most relevant for LAT nations. The unit of analysis in this study is PEOs (Public Ecuadorian Organizations). Studies often refer to different forms of QCA like crisp-set (*cs*QCA) or fuzzy-set (*fs*/QCA) as opposed to multi-value form (*mv*QCA) in order to study necessary and/or sufficient conditions in data that has a complex set of variables and parameters [1, 2]. Servant and Jones [4], for example, use automatic code-history-analysis with a fuzzy history graph to expand the accuracy of a code history analysis too simply the process of larger code line sets. These authors argue that this process is more accurate and consistent when attempting to determine finer coding grades in larger code sets [5].

In an early three-stage process, large sets of candidates IS adoption drivers were initially identified from hundreds of variables, factors, constructs, determinants, and categories proposed in existing IS/IT adoption theories, local secondary data, and the opinion of local experts/practitioners (see Fig. 1). Even though a significant number of drivers were reduced to a more refined set using mixed-method analysis strategies, the obtained list remained excessively large to meet the requirement of this analysis. That is, to work towards a set of refined drivers suitable for future research towards a solution of complex adoption problems in LAT.

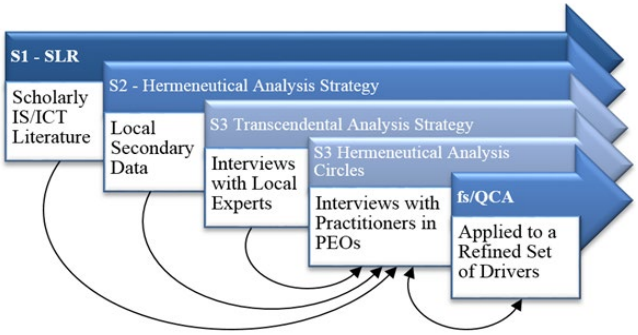


Fig. 1 The early three stages study process bridged with *fs*/QCA

To provide a foundation for the analysis a Systematic Literature Review was conducted. Primary data was then collected using qualitative coding and NVivo (see Fig. 1). This follows established principles of coding and data collection [6] which is transparent, faster and enables the research to categorize, classify and store data much more effectively. The identifies set of drivers, also referred to as themes or candidate drivers, were not dichotomous imposing the need to select *fs*/QCA to refine the set and to perform causal relations analysis. *fs/*QCA as a comparative analysis strategy was conducted to show associated patterning in the set of candidate factors in which each one-was considered a "Case". Also, *fs/*QCA provides support for the existence of causal relations between determined conditions in relation to the cases [5]. It is relevant to this study because it is a useful methodology for examining underpinning theoretical concerns of existing models.
Therefore, the research question, "Which themes identified from existing IS/IT adoption theories, local secondary data, local experts/practitioners' opinion, are the most prominent candidate drivers affecting SISA in LAT organizational contexts?" was effectively researched and justified. The results demonstrated a fine-grained categorization of themes and sets of similar characteristics that were to be explored in different LAT organizational contexts. These drivers can be anticipated for further IS adoption studies. The aim, therefore, is to produce a set of themes that other researchers can apply to similar local contexts to better understand the complexity of adoption in emerging economies.

2 Applying fuzzy QCA as a bridging methodology

2.1 The Scoring processes

In this large mixed method study, *fs*/QCA was applied as a bridging process of a comparative analysis strategy for revealing association patterns of formed themes (as cases) and bringing support to identify causal relations between determined conditions related to the cases [5]. Fuzzy-set scores used by QCA are applied to normalize the Frequency of reference by Relevance (FrR) relationship of the 50 themes identified from the outcomes in three previous stages of this study (see Table 1). The FrR calculated ranges from 0.0000 to 0.1205 over 50 themes as the Maximum level of FrR per stage (see Table 1, columns FrR of Stages 1, Stage 2 and Stage 3).

According to Ragin [7], the fuzzy-set scores can be ranged from 0 to 1 to describe different case conditions in a set. In the *fs*/QCA process of this study, the 50 themes previously identified are considered as the 'cases'. It is assumed that a set is a structured conceptual framework. In this research, cases can be evaluated regarding FrR, obtained by each identified theme.

From each of them, the relationship significance extracted from Literature analyzed of existing IS/IT adoption theories (Stage 1), local secondary data (Stage 2), local experts and practitioners' opinion transcripts (Stage 3) were qualitatively evaluated to saturation point [8, 9]. Then the FrR was calculated in each stage (See Table 1 Section 1).

The three anchor points can define a set between the three stages: “High Level of References” (indicated by relationship scored 1), “No references” at all (relationship scored 0), and a crossover point (a probable relationship scored 0.5). However, between the extremes of the full level of references and non-level of references, a set can have fine-grained relationship levels of references, where the fuzzy score can take any value between zero and one, for example, ranging from four level sets (0, 0.33, 0.67, and 1). Cases on different sides of the crossover point per stage can be qualitatively different, while cases differing from the FrR in the set on the same stage of the crossover point may differ in the degree of relevance for a complete set [7] (see Table 1, Section 1 columns).

Table 1. The initial set of themes as possible SISA drivers

Section 1: Outcomes of Previous study phase Mix-Method										Section 2: Outcomes of Bridging *fs*/QCA Strategy									
		Stage 1			Stage 2			Stage 3 A+B			fsQCA computed Result Summary by Case								
Sec	Themes -candidate Drivers- (Caseid)	NR	NS	FrR	NR	NS	FrR	NR	NS	FrR	Cases:	S1	S2	S3	LRT	LRTNS	STHR	THRS1	THRS2	THRS3	ST
1	Accessibility-Interconnectivity	2	2	0.0032	99	16	0.0739	184	44	0.1109		0.33	0.67	1	**1**	**0.67**	**0.67**				**1**
2	Age	7	7	0.0132	-	-	-	49	26	0.0131		0.33	0	0.33	0.33	0.33					
3	Attitude Towards Using-Intention to Use	28	19	0.0575	45	12	0.0536	105	38	0.0390		0.67	0.67	0.33	**0.67**	**0.67**	**0.67**				**0.67**
4	Communication Channels	12	7	0.0211	5	3	0.0040	53	25	0.0153		0.33	0.33	0.33	0.33	0.33					
5	Compatibility & Standardization	6	6	0.0141	33	9	0.0234	70	28	0.0320		0.33	0.33	0.33	0.33	0.33					
6	Corruption	2	2	0.0055	3	2	0.0027	46	24	0.0137		0.33	0.33	0.33	0.33	0.33					
7	Cultural & Values Aspects	25	4	0.0900	3	1	0.0027	54	32	0.0131		1	0.33	0.33	**1**	0.33		1			**1**
8	Defined Processes	1	1	0.0011	4	3	0.0023	46	29	0.0170		0.33	0.33	0.33	0.33	0.33					
9	Economic Aspects	15	6	0.0399	3	2	0.0003	18	10	0.0012		0.33	0.33	0.33	0.33	0.33					
10	Education & Skills	16	10	0.0355	47	16	0.0278	103	41	0.0345		0.33	0.33	0.33	0.33	0.33					
11	Gender	6	6	0.0043	1	1	0.0009	5	4	0.0003		0.33	0.33	0.33	0.33	0.33					
12	Individual Income	3	3	0.0066	-	-	-	12	9	0.0020		0.33	0	0.33	0.33	0.33					
13	Information Availability	-	-	-	93	15	0.0948	93	32	0.0434		0	1	0.67	**1**	**0.67**	**0.67**				**1**
14	Information Quality	6	6	0.0217	25	11	0.0303	44	27	0.0081		0.33	0.33	0.33	0.33	0.33					
15	Intellectual Property and Software Rights (*)	-	-	-	70	11	0.0630	49	20	0.0203		0	0.67	0.33	**0.67**	0.33			0.67		**0.67**
16	Internet Facilities	5	5	0.0129	36	14	0.0320	71	31	0.0245		0.33	0.33	0.33	0.33	0.33					
17	Job Relevance	6	6	0.0099	-	-	-	5	2	0.0006		0.33	0	0.33	0.33	0.33					
18	Labour Force	2	2	0.0052	-	-	-	24	16	0.0091		0.33	0	0.33	0.33	0.33					
19	Language	1	1	0.0030	-	-	-	19	9	0.0017		0.33	0	0.33	0.33	0.33					
20	Leadership Continuity	-	-	-	-	-	-	26	13	0.0140		0	0	0.33	0.33	0					
21	Loyalty	2	2	0.0069	-	-	-	1	1	-		0.33	0	0	0.33	0					
22	Market Environment	9	5	0.0218	5	3	0.0041	40	20	0.0092		0.33	0.33	0.33	0.33	0.33					
23	National Plan-ICT Inclusion	-	-	-	26	10	0.0259	24	12	0.0096		0	0.33	0.33	0.33	0.33					
24	National Telecommunication Environment	1	1	0.0013	4	1	0.0052	14	10	0.0021		0.33	0.33	0.33	0.33	0.33					
25	Nature of Development	4	3	0.0071	11	5	0.0122	106	29	0.0665		0.33	0.33	0.67	**0.67**	0.33				0.67	**0.67**
26	Net Benefits Perception	11	10	0.0428	21	11	0.0244	49	21	0.0259		0.67	0.33	0.33	**0.67**	0.33		0.67			**0.67**
27	Observability	3	3	0.0060	-	-	-	-	-	-		0.33	0	0	0.33	0					
28	Organisational Aspects	12	8	0.0371	6	2	0.0063	3	3	0.0003		0.33	0.33	0.33	0.33	0.33					
29	Organisational Experience & Slack	15	7	0.0331	-	-	-	27	19	0.0030		0.33	0	0.33	0.33	0.33					
30	Organisational Structure	4	4	0.0061	33	5	0.0298	4	3	0.0001		0.33	0.33	0.33	0.33	0.33					
31	Perceived Ease Of Use	21	15	0.0577	5	3	0.0061	57	26	0.0184		0.67	0.33	0.33	**0.67**	0.33		0.67			**0.67**
32	Perceived Usefulness	25	17	0.0778	52	13	0.0488	94	37	0.0436		0.67	0.67	0.67	**0.67**	**0.67**	**0.67**				**0.67**
33	Political Aspects	7	6	0.0138	7	4	0.0053	83	25	0.0271		0.33	0.33	0.33	0.33	0.33					
34	Population Changes	1	1	0.0019	-	-	-	1	1	-		0.33	0	0	**0.33**	0					
35	Regulation & Policies (*)	15	8	0.0346	129	19	0.1205	99	33	0.0429		0.33	1	0.67	**1**	**0.67**	**0.67**				**1**
36	Service Quality	4	4	0.0149	23	10	0.0190	30	17	0.0099		0.33	0.33	0.33	0.33	0.33					
37	Subjective Norms & Motivation	18	11	0.0581	3	2	0.0023	84	31	0.0228		0.67	0.33	0.33	**0.67**	0.33		0.67			**0.67**
38	System Characteristics	9	6	0.0218	9	2	0.0123	33	16	0.0173		0.33	0.33	0.33	0.33	0.33					
39	System Development & Implementation System Maintenance-Continuing	-	-	-	51	9	0.0545	53	23	0.0284		0	0.67	0.33	**0.67**	0.33			0.67		**0.67**
40	Improvements	-	-	-	17	5	0.0122	34	20	0.0092		0	0.33	0.33	0.33	0.33					
41	System Obsolescence	-	-	-	2	2	0.0007	18	12	0.0042		0	0.33	0.33	0.33	0.33					
42	System Quality	4	4	0.0100	32	7	0.0244	32	17	0.0059		0.33	0.33	0.33	0.33	0.33					
43	System Security Perception	7	4	0.0218	23	8	0.0282	115	30	0.0251		0.33	0.33	0.33	0.33	0.33					
44	Technology Costs & Budget	3	3	0.0073	27	8	0.0310	116	36	0.0373		0.33	0.33	0.33	0.33	0.33					
45	Technology Infrastructure	10	6	0.0326	48	15	0.0429	72	26	0.0269		0.33	0.67	0.33	**0.67**	0.33			0.67		**0.67**
46	Technology Maturity & Awareness	6	3	0.0151	34	6	0.0340	48	25	0.0154		0.33	0.33	0.33	0.33	0.33					
47	Timeframes	4	4	0.0140	4	1	0.0042	68	33	0.0255		0.33	0.33	0.33	0.33	0.33					
48	Trust & Leadership Governance	5	3	0.0130	25	12	0.0342	162	45	0.0554		0.33	0.33	0.67	**0.67**	0.33				0.67	**0.67**
49	Usage Behaviour and Use	20	15	0.0627	-	-	-	85	31	0.0445		0.67	0	0.67	**0.67**	**0.67**	**0.67**				**0.67**
50	User Satisfaction	10	8	0.0361	-	-	-	34	16	0.0099		0.33	0	0.33	0.33	0.33					
	Sources analysed in each Stage (NS)		28			34			55												
	Number of joint Themes refined		50			50			50												
	Leyend: Number of References (NR), Frequency of References (FrR) (*) last joined Themes by related mening and computed																				

Based on Legewie [3] and Ragin [7] suggestion an fs/QCA applied score to standardize ranges can take any value between 0 and 1. Thus, for a more fine-grained relationship, the cases can be normalized in four-level sets 0, 0.33, 0.67, and 1, in relation with FrR of each theme, obtained from the three stages of the initial study (see Table 1). The table below demonstrates how the ranges were utilized. The scores were normalized and given a relevant fuzzy score (see Table 2).

Table 2. Normalized scores [10]

FrR Range obtained from NVivo	*fs*/QCA Score	Measure
0	0	No References
0.001 to 0.0402	0.33	Low-Medium Level of References
0.0403 to 0.0803	0.67	Medium-High Level of References
0.0804 to 0.1205	1	High Level of References

2.2 The consistency of the fuzzy score range

To justify the sensitivity of the cutoff point, the researchers discussed consistency and the coverage of the fuzzy score range. For example, Ragin [7] states that combinations of conditions in which all cases are considered to relate in terms of sufficiency and necessity are extremely rare. It is normal to expect that cases should differ somewhat from expected generalized patterns. For this reasons of fit therefore, it's important to asses how well cases match in different sets [3].

Furthermore, the outcome, evidencing computing consistency and resembling the idea of significance in statistical models, involves a degree of measurement of the necessity or sufficiency condition. In turn this demonstrates causal conditions through the combination of conditions. Thus, the *fs*/QCA software computes consistency of the fuzzy scores ranges used. The value range "0" indicates no consistency and "1" indicates perfect consistency, providing a measure of empirical relevance. This range of measurements is analogous to the variance contribution of a variable in a statistical model [7].

3 The refined themes selection using *fs*/QCA

3.1 Criteria for selecting the *fs/*QCA results

Definitions stated in relation to QCA were mostly textually taken from our previous published partial results Solorzano et al. [10], which helps to better explain terminologies for the *fs*/QCA process and *fs*/QCA software application used. The definitions used are expressed as follows:

Case/s_ set of are used as part of a qualitative analysis discussed previously ([11], [12], [13], [14], [15] as cited in Legewie [3]). 50 themes emerged from the first part of the research. Each theme is called a case (in the software used, "caseID").

The cases that were scored (Scoring Criteria-) between 0.67 or 1 for each of the condition, necessary or sufficiency conditions were considered as relevant to the study. The themes that scored the highest, making them the most prominent, were selected for further analysis. These themes are also considered to be significant to all stages or within a stage themselves [10].

A Necessity Condition_ is for a set of themes (labelled A-themes) determined for the result Y (referring to the candidate drivers of SISA), if Y is not probable without the addition of A-themes. In all of the cases, result Y links the presence of the A-themes' condition [3]. It is determined as the necessary condition to the outcomes or the necessity of determined outcomes [10].

Sufficiency Condition_ is the allocated for a cluster of themes (A-themes) or the grouping of other themes (X-themes) satisfactory for the results of Y (candidate drivers of SISA). Y will continually increase as a consequence of A-themes being present. Other conditions can influence the result. Such conditions indicate a causal relationship between A-Themes and Y Themes.[3]. The is referred to as "the sufficiency condition for the outcome [10]."

INUS Condition_ is a single condition of Z-themes. These are considered to be not necessary or sufficient, but part of the grouping of conditions that are sufficient for the result Y (candidate drivers of SISA) [3, 10].

Causal Recipes_ are the conditions that use Boolean algebra to formally analyze these conditions, or a grouping of them, that are necessary or sufficient for the result [3, 10].

The formulas for the Causal Recipes used and computed in the *fs/*QCA software are presented in Table 3. The intention is to cover Sufficiency, Necessity and Inus conditions that can be obtained.

4 Discussion and results

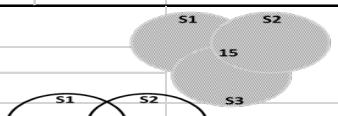
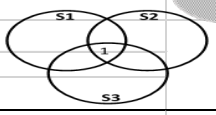
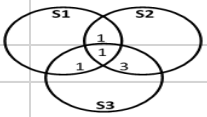
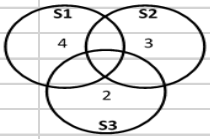
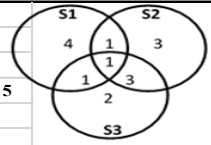
4.1 The *fs*/QCA computerized process and analysis

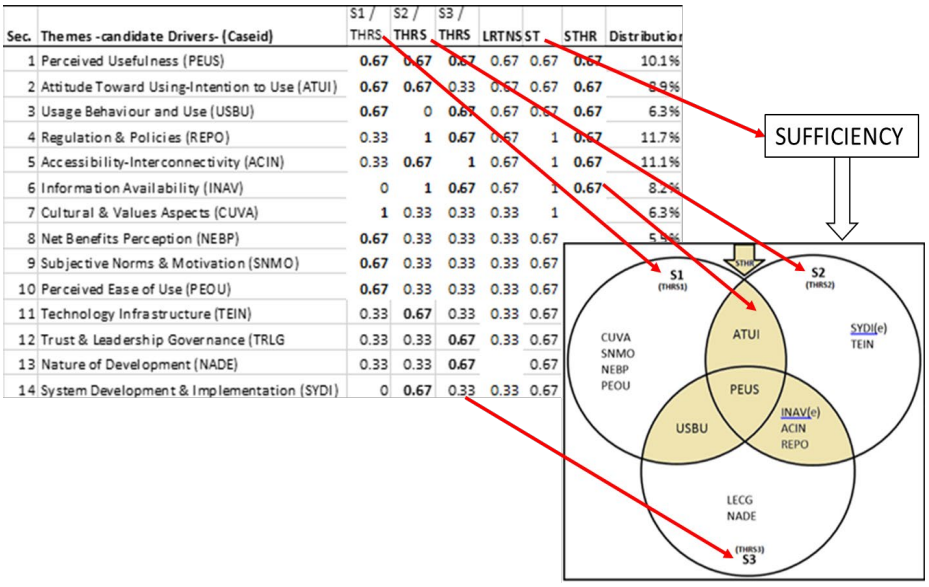
*Fs/*QCA software was used to differentiate the Sufficiency, Necessity and possible Inus conditions, for the initially 50 identified themes. The spreadsheet with the original calculated FrR was uploaded to automatically convert the frequencies to the proposed normalized fuzzy scores (see Table 2). The results obtained by computing all the causal recipes for the 50 themes in relation to the three previous stage processes, were stored in a different table (see Table 1 Section 2). Different proposed recipes, evidencing necessity or sufficiency aspects of the relationship, were calculated and closely examined.

During the *fs/*QCA process the causal recipe, named 'Selected Themes with Higher Relevance' (STHR), formulated as a combination of stages 1, 2, and 3 in the analysis process (see Table 3), was identified as the conditions that gained the best result through fit. This recipe accomplishes the necessity of including Medium-high and High themes obtained as outcomes of Stage 3 (S3), which are also emergent themes from Stage 2 (S2) and S3, and Stage 1 (S1) (see Fig. 2).

At the end, six themes were obtained as the most relevant. The most significant theme to all stages in the study case was also identified (see Last figure Table 3 and the joining point in Fig. 2). This was done by computing the 'Level of Reference joining the three themes' (LRAND) recipe, applying a simple logic of _AND_ combination of S1, S2, and S3. This was used to measure the theme's reference level as part of the stage in the overall process (see the formula in Table 3).

Table 3. The initial set of themes as possible SISA drivers

Causal Recipes - Computed by Fs/QCA formula (*) Necessity, Sufficient, or Inus condition	Relationship between stages
LRT = S1 + S2 + S3 = **15** (Level of references of all themes) compute: lrt = fuzzyor(s1,s2,s3) *Sufficiency	
LRAND = S1 x S2 x S3 = **1** (Level of Reference joining the three themes) compute: lrtand = fuzzyand(s1,s2,s3) *INUS	
LRTLOCAL = S2 + S3 = **11** (Level of References Local Sources Themes) compute: lrtlocal = fuzzyor(s2,s3) *INUS	
EMERGE = S3 + S2 If S1 = 0 (Emerging Themes) EMERGE = **3** compute: emerge = fuzzyor(s2,s3) if (s1==0) *INUS	
S1S2 = S1 x S2 = **1** (Stage1 and Stage2 Themes) compute: s1s2 = fuzzyand(s1,s2) *INUS	
S1S3 = S1 x S3 = **2** (Stage1 and Stage3 Themes) compute: s1s3 = fuzzyand(s1,s3) *INUS	
S2S3 = S2 x S3 = **4** (Stage2 and Stage3 Themes) compute: s2s3 = fuzzyand(s2,s3) *INUS	
LRTNS3 = (S3 x S1) + (S3 x S2) (Level of Referenced Themes in relation to S3) LRTSN3 = S3 (S1 + S2) = **5** compute: lrtns3 = fuzzyor(s1s3,s2s3) *INUS	
LRTNS = (S3 x S1) + (S3 x S2) + (S1 x S2) = **6** (Level of References of Necessary Themes) compute: lrtns = fuzzyor(s1s2,s1s3,s2s3) *Necessity	
Computing only highly relevant themes for the combination of the three stages. Then,STHR = LRTNS (conditioned) (Selected Themes with Higher Relevance) STHR = (S3 x S1) + (S3 x S2) + (S1 x S2) if LRTNS >= 0.67 compute: sthr = fuzzyor(s1s2,s1s3,s2s3) if (lrtns>=0.67) (Themes with Higher Relevance only to S1) THRS1 = LRT If (LRTNS < 0.67 and S1 >= 0.67) = **4** (Themes with Higher Relevance only to Stage 2) THRS2 = LRT If (LRTNS < 0.67 and S2 >= 0.67) = **3** (Themes with Higher Relevance only to Stage 3) THRS3 = LRT If (LRTNS < 0.67 and S3 > =0.67) = **2** *INUS (4 + 3 + 2 = 9)	
Determining relevant themes particularly per each stage compute: thrs1 = lrt if (lrtns<0.67&&s1>=0.67) compute: thrs2 = lrt if (lrtns<0.67&&s2>=0.67) compute: thrs3 = lrt if (lrtns<0.67&&s3>=0.67)	
Computing all relevant themes, per stage or for more than two of the three stages ST = STHR OR THRS1 OR THRS2 OR THRS3 (Selected Themes) Same as ST = LRTNS OR LRT (conditioned) **ST = LRTNS + LRT if (LRTNS >= 0.67 or (S1 >= 0.67 or S2 >= 0.67 or S3 > =0.67)) = 15** compute: st = fuzzyor(lrtns,lrt) if (lrtns>=0.67||(s1>=0.67||s2>=0.673||s3>=0.67)) *Sufficiency	



Sec.	Themes -candidate Drivers- (Caseid)	S1 / THRS	S2 / THRS	S3 / THRS	LRTNS	ST	STHR	Distributior
1	Perceived Usefulness (PEUS)	**0.67**	**0.67**	**0.67**	0.67	0.67	**0.67**	10.1%
2	Attitude Toward Using-Intention to Use (ATUI)	**0.67**	**0.67**	0.33	0.67	0.67	**0.67**	8.9%
3	Usage Behaviour and Use (USBU)	**0.67**	0	**0.67**	0.67	0.67	**0.67**	6.3%
4	Regulation & Policies (REPO)	0.33	**1**	**0.67**	0.67	1	**0.67**	11.7%
5	Accessibility-Interconnectivity (ACIN)	0.33	**0.67**	**1**	0.67	1	**0.67**	11.1%
6	Information Availability (INAV)	0	**1**	**0.67**	0.67	1	**0.67**	8.2%
7	Cultural & Values Aspects (CUVA)	**1**	0.33	0.33	0.33	1		6.3%
8	Net Benefits Perception (NEBP)	**0.67**	0.33	0.33	0.33	0.67		5.5%
9	Subjective Norms & Motivation (SNMO)	**0.67**	0.33	0.33	0.33	0.67		
10	Perceived Ease of Use (PEOU)	**0.67**	0.33	0.33	0.33	0.67		
11	Technology Infrastructure (TEIN)	0.33	**0.67**	0.33	0.33	0.67		
12	Trust & Leadership Governance (TRLG	0.33	0.33	**0.67**	0.33	0.67		
13	Nature of Development (NADE)	0.33	0.33	**0.67**		0.67		
14	System Development & Implementation (SYDI)	0	**0.67**	0.33	0.33	0.67		

Fig. 2. SISA in LAT selected themes structure

These six themes achieved the necessary conditions by the Level of References of Necessary themes LRTNS causal recipe, with a standard deviation of 0.1495882 (see Table 4). The six themes in the STHR recipe (as higher selected themes of LRTNS) scoring 1 or 0.67 (using the *fs*/QCA scale) were analysed, which resulted in a low standard deviation (9.93411E-09).

Table 4. The initial set of themes as possible SISA drivers

Variable	Mean	Std. Dev.	Minimum	Maximum	N Cases	Missing
s1	0.338	0.1950179	0	1	50	0
s2	0.3184	0.2404775	0	1	50	0
s3	0.3644	0.1679305	0	1	50	0
lrt	0.4584	0.2117958	0.33	1	50	0
lrtand	0.218	0.1702116	0	0.67	50	0
lrtlocal	0.4048	0.2153345	0	1	50	0
emerge	0.522857	0.244874	0.33	1	7	43
s1s2	0.2248	0.181000	0	0.67	50	0
s1s3	0.2776	0.1538124	0	0.67	50	0
s2s3	0.278	0.1807761	0	0.67	50	0
lrtns3	0.3376	0.1421768	0	0.67	50	0
lrtns	0.3444	0.1495882	0	0.67	50	0
sthr	0.67	9.93411E-09	0.67	0.67	**6**	44
sthrs1	0.7525	0.1428942	0.67	1	4	46
sthrs2	0.67	9.93411E-09	0.67	0.67	3	47
sthrs3	0.67	not computed	0.67	0.67	2	48
st	**0.758**	**0.1459315**	**0.67**	**1**	**14**	**36**

4.2 The *fs*/QCA results

Whilst the STHR explains the necessary condition (Necessity condition) to identify the key themes for combined stages, it doesn't reflect the possible themes that are determined as highly significant at any specific stage. Such inclusions are better explained in the Selected Themes (ST) recipe as a "Sufficiency condition" as a response to the QCA research question (see Table 3). Initially, 15 themes emerged from the ST recipe application (Table 1, last column), which included the grouping of the "Necessity condition" in STHR, and the "Inus conditions" of THRS1, THRS2, and THRS3 (see Table 3). Even though the ST recipe outcomes include the identical quantity of themes as the LRT recipe which also allows identifying themes relevant to each of the stages at the same time, ST was singled out due to a lower standard deviation (0.14593) in relation to LRT (see Table 4). ST also benefits to recognize the significant connection between the themes and the stages of previous phases of this research project.

From the computing results, 15 selected themes were obtained. Acronyms to identify each selected theme also were used (see Table 1 section 2). However, the content, concept, meaning, and opinions obtained from the sources in relation to selected themes were closely re-examined. Thus, it was, from the additional content analysis, that the themes named Intellectual Properties & Software Rights and Regulations & Policies are both defined as rules of law related to IS/ICT in the context of the current research. Therefore, they were regrouped within one theme as Regulations & Policies without affecting the results of the recipes ST and STHR (see Table embedded in Fig. 2). In the end, a final selection of 14 Themes as drivers of SISA in PEOs remains.

5 Discussion of the outcomes

5.1 The relationship relevance among the selected themes

The 14 themes obtained with the higher level of relevance from the *fs*/QCA technique and their relationship within the three stages, were determined as a "Sufficiency condition" to answer the research question. As a result, six of the themes selected by the acronyms —ACIN, REPO, INAV, PEUS, ATUI, and USBU —were identified as the most relevant themes, determined as the "Necessity condition" for SISA outcomes (see Fig. 2). From the selected themes, PEUS was determined as the principal driver mentioned by all the sources. Finally, eight remaining themes—CUVA, NADE, TRLG, TEIN, NEBP, PEOU, SNMO, and SYDI— were identified as highly important, but only in one of the three stages at a time. These were recognized as "Inus conditions" accomplished (see Fig. 1).

The obtained results were then anticipated as the sufficiency condition, represented by the ST recipe, and confirmed with the STHR recipe. The 14 themes obtained are then proposed as the most prominent candidate drivers of SISA in public LAT organizational contexts (see table embedded in Fig. 2).

5.2 Clustering the themes for results

To explore these themes further and to examine their influence as candidate drivers of SISA in LAT, we clustered them through related characteristics. The Control Characteristics group were determined based on existing literature and theories previously analyzed. Thus, the selected themes were examined and reorganized into groups; related to Subjective Aspects, Technological Aspects, and Public Aspects. We kept consistent with the organization undertaken in previous stages in which these themes were identified, or they emerged and were clustered according to their similarity (see Table 5).

Table 5. The selected themes as SISA drivers clustered by categories

Distribution by Categorie Themes -candidate Drivers- (Caseid)	*fs* QCA Result (ST)	Frequency Distribution
Subjective Aspects		41%
Attitude Toward Using-Intention to Use (ATUI)	0.67	9%
Net Benefits Perception (NEBP)	0.67	6%
Perceived Ease of Use (PEOU)	0.67	5%
Perceived Usefulness (PEUS)	0.67	10%
Subjective Norms & Motivation (SNMO)	0.67	5%
Usage Behaviour and Use (USBU)	0.67	6%
Technological Aspects		35%
Accessibility-Interconnectivity (ACIN)	1	11%
Information Availability (INAV)	1	8%
Nature of Development (NADE)	0.67	5%
System Development & Implementation (SYDI)	0.67	5%
Technology Infrastructure (TEIN)	0.67	6%
Public Aspects		24%
Cultural & Values Aspects (CUVA)	1	6%
Regulation & Policies (REPO)	1	12%
Trust & Leadership Governance (TRLG	0.67	6%

In the group containing themes with characteristics related to *Subjective Aspects*, six of them were identified as highly significant based on the *fs*/QCA process. This group was determined with a distribution of 41% over the 100% calculated from the set of drivers selected (see Table 5 and Fig. 3). Perceived Usefulness (named with the acronym PEUS) was the only theme evidencing high significance in the three previous stages of the current study (see also Fig. 2). In *Technological Aspects,* four themes were selected from this group with a frequency of distribution of 36% over 100% (see Fig. 3): In this group, we highlight that INAV and SYDI, are emerging themes from local sources (identified in S2 and S3). This means that these themes were not previously proposed as drivers of IS adoption in the review of existing theories. In *Public Aspects*

cluster, three themes were identified as relevant with 24% over 100% (see Fig. 3). Regulations & Policies (named with the acronym REPO) was identified as highly significant in S2 and S3 but also mentioned in S1.

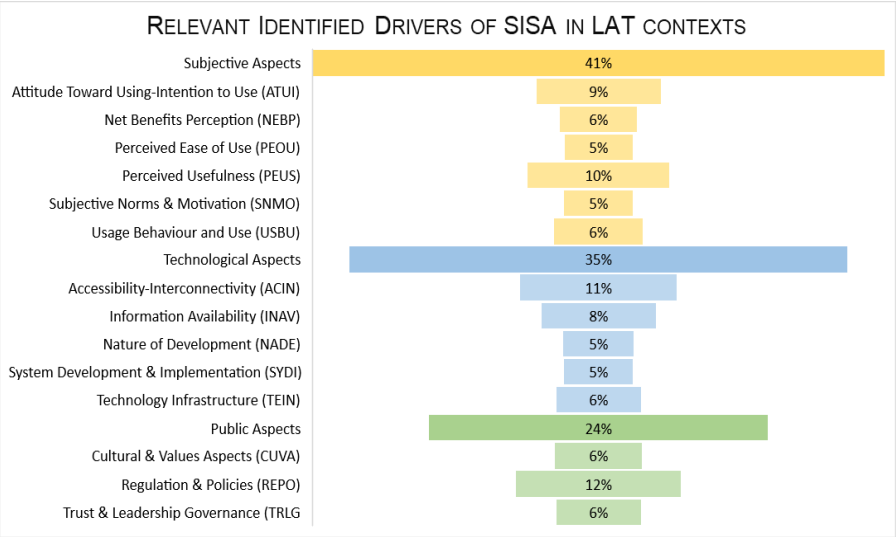


Fig. 3. SISA in LAT selected themes structure

In the end, from these clustering process, we obtained an organizational structure to grouping the selected themes for further analysis of their relationship as drivers affecting SISA in PEOs (see Table 5 Fig. 3).

6 Summary and conclusion

In this paper using an *fs*/QCA case study to identify the candidate drivers of adoption in PEOs, we aim to explain the applicability of *fs*/QCA in IS adoption studies. To this end, we apply fuzzy logic techniques to refine a set of identified drivers of adoption. The application of fuzzy logic in the selection process was done by using existing software packages. This approach helps to avoid ambiguities which are difficult to overcome in qualitative studies and provides clear and measurable outcomes. As a result, the application of QCA process using *fs*/QCA to compute and normalize earlier outcomes, lead to the selection of 14 themes representing the candidate drivers of SISA in LAT regions. Particularly these were tested by accomplishing sufficiency conditions as drivers of adoption in PEOs. We anticipated the possibility that the selected candidate drivers can be tested in other LAT contexts. However further investigation should be done to further test these assumptions.

The results recognize the criteria used to select the relevance of the drivers chosen. The selection of relevant drivers includes the accomplishment of Inus, Necessity, and

Sufficiency conditions enclosing the three previous stages of early phases of the current study. In the end, the process of using fuzzy logic on QCA involves the identification of relevant drivers from existing studies, local secondary data from LAT, and local primary data from PEOs. Therefore, we answered the stated research question "Which themes identified from existing IS/IT adoption theories, local secondary data, local experts/practitioners' opinion, are the candidate drivers affecting SISA in LAT organizational contexts?".

Future researchers should begin with the question of context as this study has. This is because the main drivers point toward a different contextual frame than the one that dominates most adoption literature. That is, while traditional literature looks at the conditions from a traditionally highly developed technical culture (Silicon Valley or North American government institutions for example) most of the world is still developing their systems and challenges to adoption are very, very different for these nations. Future research should seek to explore the contextual variables that emerging through analysis of both the local context and the traditional adoption models. A failure to do that will result in there being no real understanding to what the barriers to adoption are in emerging technological economies like Ecuador. Further, if researchers continue to apply models that were designed to measure adoption in economies that are completely different, the results will continue to be less significant or even worse completely spurious.

In conclusion, this study provides LAT stakeholders with a set of drivers that can be used to understand IS adoption within a specific context, namely in LAT regions. For future researchers, the findings will provide a conceptual context to explore future investigation to do comparative studies validating the selected drivers of IS in different organizations of LAT economies.

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