

Applying QCA with Fuzzy Logic to Generate 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 many studies conducted outside the Latin American (LAT) nations. These investigations fail to appropriate the context of IS adoption in LAT. This fail is mainly due to the geographical scope of existing studies. Those aimed at North America for example, are out of context regarding a diverse technological approach when applied to LAT. Further, uncertainty and an inability to predict outcomes of technology adoption, create variances in results because the local contexts are not considered. The reasons for this are unclear from existing studies. To detailed explore this problem further, a Qualitative Comparative Analysis (QCA) was applied to LAT economies, expecting 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 study purposes. The drivers provide LAT stakeholders, as well as 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. Particularly in LAT economies where a scarcity of related technological studies is evident [1, 2]. The extraction of adoption factors from large sets of variables or extensive coding sets remains problematic given the pluralistic nature of adoption contexts. Single response categories (scales) might not completely capture perceptions [3, 4] related to the multifaceted technology adoption problem being studied in the 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 [5] for adoption IS in LAT regions. Servant and Jones [6] for example, use fuzzy logic in historical analysis to improve revisions of larger code sets accurately. These authors also argued that a fuzzy technique is more precise than other methods, because it enables researchers to reduce large coding sets to more concisely defined ones.

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 different outcomes of a selection process [5]. This technique is also useful for evaluating empirical analyses based on qualitative approaches [7]. 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 are Public Ecuadorean Organizations (PEOs). Studies often refer to different forms of QCA like crisp-set (csQCA) or fuzzy-set (fs/QCA) as opposed to multi-value form (mvQCA) to study necessary and/or sufficient conditions in data that have a complex set of variables and parameters [3, 4]. Servant and Jones [6], for example, use automatic code-history-analysis with a fuzzy history graph to expand the accuracy of a code history analysis, expecting to simplify the revision 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 [6].

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.

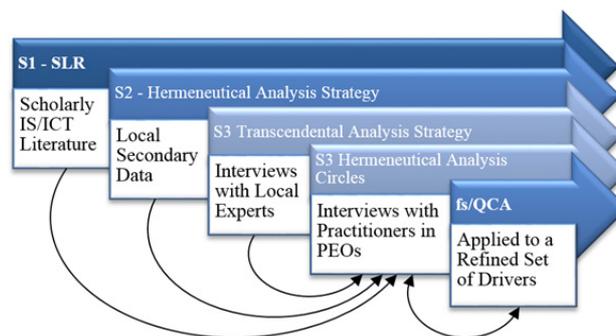


Fig. 1. The early three stages process of the bridged with fs/QCA

To provide a foundation for the analysis, a Systematic Literature Review was conducted. Primary data were collected using qualitative coding and NVivo (see Fig 1). To the data collection follows established principles of coding and data collection which is transparent, faster, and enables the researcher to categorize, classify and store data much more effectively [8]. The identified set of drivers also referred to as themes or candidate drivers, were not dichotomous imposing the need to use fs/QCA to refine the set and to perform causal relations analysis. The 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 concerning the cases [7]. It is relevant to this study because it is a useful methodology for examining the underpinning theoretical concerns of existing models.

Therefore, the research question, "Which themes identified from existing IS/IT adoption theories, local secondary data, and local experts/practitioners' opinions, are the most prominent candidate drivers affecting SISA in LAT organizational contexts?" was expertly researched and justified. The results demonstrated a fine-grained categorization of themes and sets of similar characteristics could 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 extensive mixed method study, guided by a pluralistic methodology from a pragmatic point of view [9-11], 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 [7]. 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 [12], 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 from a set of drivers, are considered as the 'cases.' It is assumed that a set is a structured conceptual framework. In this research, cases are 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 [13, 14]. Then the FrR was calculated in each stage (See Table 1 Section 1).

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

Sec	Themes -candidate Drivers- (CaseId)	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										
		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													

Legend: Number of References (NR), Frequency of References (FrR)
 (*) Last jointed Themes by related mening and computed

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 various 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 vary in the degree of relevance for a complete set [12] (see Table 1, Section 1 columns).

Based on Legewie [5] and Ragin [12] suggestion, an fs/QCA applied a 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). Table 2 (below) shows how the ranges are used. The scores were normalized and given a relevant fuzzy score.

Table 2. Normalized scores [15]

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 [12] states that combinations of conditions in which all cases are considered to relate regarding sufficiency and necessity are extremely rare. It is normal to expect that cases should differ somewhat from expected generalized patterns. For reasons of fit, therefore, it is essential to assess how strong cases match in different sets [5].

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 [12].

3 The Refined Themes Selection Using fs/QCA

3.1 Criteria for selecting the fs/QCA results

Definitions stated concerning QCA were mostly textually taken from our previous published partial results Solorzano et al. [15], which helps to better explain terminologies for the fs/QCA process and fs/QCA software application used. The definitions used are determined as follows.

Case/s: the set(s) representing official concepts, used as part of a the qualitative analysis, as previously discussed ([16], [17], [18], [19], [20] as cited in Legewie [5]). 50 themes emerged from the first part of the research. Each theme is called a case (referred to as "case ID" in the software used).

Scoring criteria: The cases that scored between 0.67 or 1 for each of the conditions namely, necessity or sufficiency, were considered relevant to the study. The

themes that obtained the highest frequency were selected for further analysis. These themes are also considered to be significant to all stages or within a stage themselves [15].

Necessity condition: Is applied to a determined set of themes (labeled A-themes) essential for outcome Y (referring to the candidate drivers of SISA), if Y is not achievable without the inclusion of A-themes. In all of the cases, outcome Y links the presence of the A-themes' condition [5]. The themes accomplishing this condition are determined as necessary for the results. These are identified as the “necessity condition” of determined outcomes [15].

Sufficiency condition: Defines a cluster of themes (A-themes) or the grouping of other themes (X-themes) enough for achieving Y (candidate drivers of SISA). Y will continually increase because of A-themes' presence. Other conditions, besides A-themes, can influence Y's outcomes. Such conditions indicate a causal relationship between A-Themes and outcome Y [5]. This condition is referred to as the “sufficiency condition” for the result [15].

INUS condition: Is a single condition of Z-themes. In itself, not necessary or sufficient but can group with other conditions sufficient for the outcome Y (candidate drivers of SISA) [5, 15].

Causal recipes: Are conditions that use Boolean algebra to formally analyze to what degree condition(s) are necessary or sufficient for an outcome [5, 15].

Table 3 shows the formulas for the Causal Recipes used and computed in the fs/QCA software. 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

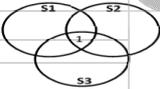
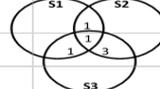
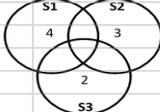
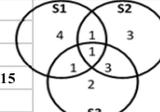
Fs/QCA software was used to differentiate the Sufficiency, Necessity and possible Inus conditions, for the initially 50 identified themes. The spreadsheet with the original calculated FrR was uploaded to automatically convert the frequencies to the proposed normalized fuzzy scores (see Table 2). The results obtained by computing all the causal recipes for the 50 themes concerning 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 carefully 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 the 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).

In 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 the last figure on Table 3

and the joining point in Fig 2). It 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 recipe 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. Causal Recipes for the initial themes set identified 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) LRTNS3 = 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>=0.67 s3>=0.67) *Sufficiency	

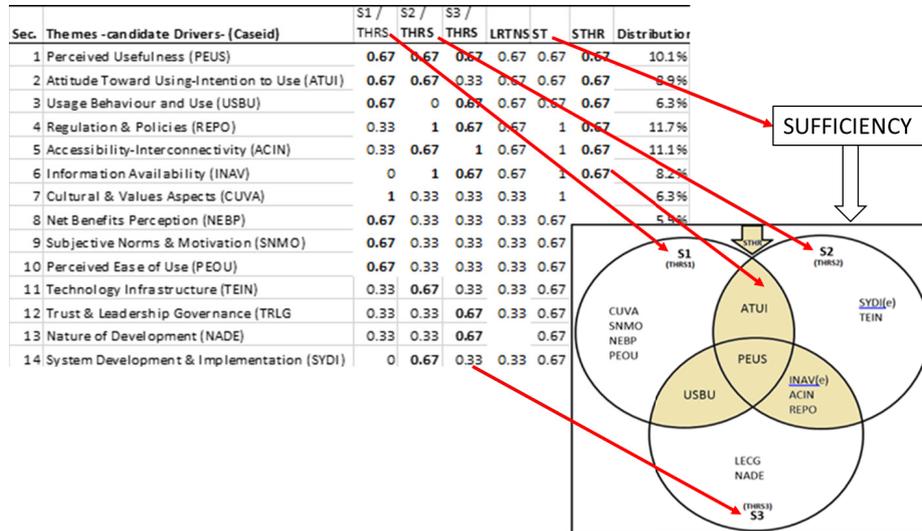


Fig. 2. Structure of selected themes as candidate SISA in LAT drivers

The 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). These themes in the STHR recipe (as higher selected themes of LRTNS) scoring 1 or 0.67 (using the *fs*/QCA scale) were analyzed, resulting in a low standard deviation (9.93411E-09).

Table 4. The initial themes set identified 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
lrtllocal	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

While the STHR explains the necessary condition (Necessity condition) to identify the critical themes for combined stages, it does not reflect the themes determined as highly significant at any specific stage. Such inclusions are better explained in the Selected Themes (ST) recipe as a “Sufficiency condition” which gives 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 amalgamation 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 same 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) concerning LRT (see Table 4). ST also reinforces the significance of the connection between the themes and the stages of previous phases of this research.

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 a 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. In the end, six 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 [Field]). 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 utmost 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	<i>fs</i> QCA	Frequency
Themes -candidate Drivers- (Caseid)	Result (ST)	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 Table 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). Emerging means that these themes do not have been 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.

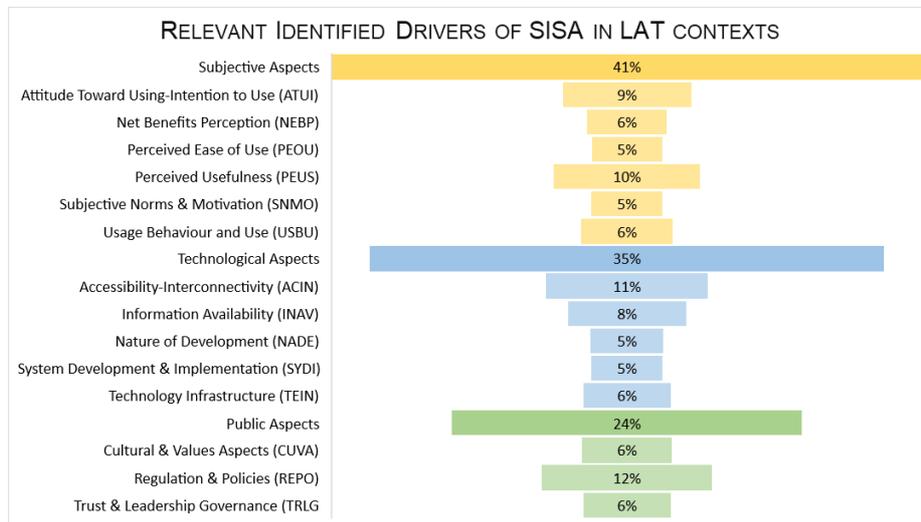


Fig. 3. SISA in LAT selected themes structure

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 made by using existing software packages. This approach helps to avoid ambiguities which are challenging 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. Mainly these were tested by accomplishing sufficiency conditions as drivers of adoption in PEOs. The possibility that the selected candidate drivers can be tested in other LAT contexts was anticipated. However further investigation should be done to check these assumptions further.

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. To start with the inquiry is important because the primary 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 were 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 of 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 entirely different, the results will continue to be less significant or even worse altogether 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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