Using Fuzzy Logic in QCA for the Selection of Relevant IS Adoption Drivers in Emerging Economies

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ABSTRACT
This paper argues that typical adoption studies fail to capture the nuances and realities of emerging economies in Latin American (LAT) regions. Existing research has a long list of factors that are based on studies outside of the LAT region, which is a problem because there are almost no studies that capture the unique perspective of the LAT context. These issues, in turn, creates uncertainty because the context in LAT varies widely from the economies where most of these studies are conducted. To begin to address this problem, the authors used a Qualitative Comparative Analysis (QCA) using fuzzy logic to refine the selection of drivers obtained from earlier studies. The study revealed fourteen themes as being relevant candidate drivers for comparative future research purposes. It is argued that these results provide local stakeholders with a set of drivers relating to IS adoption within a specific context, namely in LAT economies and provide a contextual frame to develop more meaningful studies in LAT economies.

CCS Concepts
• **Computing methodologies→Vagueness and fuzzy logic.**

Keywords
Fuzzy logic; Qualitative Comparative Analysis; fsQCA; Information System Adoption; Latin America; Ecuador; Public Organization.

1. INTRODUCTION
Qualitative Comparative Analysis (QCA) is an analytic approach, complemented by a set of research tools that helps determine the necessary or sufficient conditions [1] to evaluate significantly varied outcomes of a selection process. This technique is also considered to be for to evaluating empirical analysis based on qualitative approaches [2]. In this instance, QCA is used to better explain and justify which of the large number of empirically refined themes obtained from a previous study should be selected as the most prominent candidate drivers affecting SISA in public organisation of emerging economies such as LAT regions.

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In this investigation, Public Ecuadorian Organizations (PEOs) are used as the case study of a LAT region for the analysis.

Some studies use two forms of QCA such as crisp-set (*cs*QCA) and fuzzy-set (*fs*QCA) rather than QCA in its multi-value form (*mv*QCA) to examine necessary and/or sufficient conditions to explore complex organizational parameters [3, 4] from a large set of variables. Other authors such as Servant and Jones [5] use other fuzzy logic techniques such as an automatic code-history-analysis. This approach that takes advantage of the fuzzy history graph to improve the accuracy of a fundamental task in code history analysis to identifying the revisions of a large set of code lines. Servant and Jones [5] argued that this technique provides higher accuracy than existing models to obtain fine-grained code history from extensive coding sets.

In an early three-stage process, a large set of candidates IS adoption drivers were initially identified from existing IS/IT adoption theories, local secondary data, and the opinion of local experts/practitioners. This set was obtained by using mixed-method analysis strategies. NVivo, which helps to make the data analysis process transparent and faster [6], was the research tool used to code and categorize the data. However, several of the identified themes were not dichotomous, imposing the need to choose *fs*/QCA to refine the set and to analyse causal relations. *fs*/QCA as a comparative analysis strategy that is applied to reveal patterns of association across the set of formed themes (each theme is considered a "Case"), and to provide support for the existence of causal relations between determined conditions in relation to the cases [2]. Based on the results, a fine-grained selection of the themes formed as candidate drivers of SISA was identified to be tested in different organizational LAT contexts. These factors can be anticipated for further studies. 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 answered.

2. APPLYING FUZZY QCA AS BRIDGING METHODOLOGY
2.1 Scoring in the analysis process
As part of a bridging process in a large mixed method study, *fs*/QCA is applied as a comparative analysis strategy revealing association patterns of formed themes (as cases) and bringing support to identify causal relations between determined conditions related to the cases [2]. Fuzzy-set scores used by QCA are applied to normalise 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 also Table 1, columns FrR of Stages 1, 2, 3).

According to Ragin [7], the fuzzy-set scores range from 0 to 1 and can describe different case conditions in a set (the 50 themes previously identified are considered as the 'cases' in the *fs*/QCA process). A set can be assumed as formalised representations of concepts. In this research, cases can be evaluated regarding their frequency of reference by relevance (as we named FrR) obtained by each identified theme. From each of them, the relationship significance extracted from Literature analysed 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 reach the saturation point [8, 9]. Then the FrR was calculated in each stage.

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

		Initial Study: Frequency of References Outcomes									*fs* QCA Result
		Stage 1			Stage 2			Stage 3 A+B			
Sec	Themes -candidate Drivers- (Caseid)	NR	NS	FrR	NR	NS	FrR	NR	NS	FrR	ST
1	Accessibility-Interconnectivity	2	2	0.0032	99	16	0.0739	184	44	0.1109	1
2	Age	7	7	0.0132	-	-	0	49	26	0.0131	
3	Attitude Towards Using-Intention to Use	28	19	0.0575	45	12	0.0536	105	38	0.039	0.67
4	Communication Channels	12	7	0.0211	5	3	0.004	53	25	0.0153	
5	Compatibility & Standardization	6	6	0.0141	33	9	0.0234	70	28	0.032	
6	Corruption	2	2	0.0055	3	2	0.0027	46	24	0.0137	
7	Cultural & Values Aspects	25	4	0.09	3	1	0.0027	54	32	0.0131	1
8	Defined Processes	1	1	0.0011	4	3	0.0023	46	29	0.017	
9	Economic Aspects	15	6	0.0399	3	2	0.0003	18	10	0.0012	
10	Education & Skills	16	10	0.0355	47	16	0.0278	103	41	0.0345	
11	Gender	6	6	0.0043	1	1	0.0009	5	4	0.0003	
12	Individual Income	3	3	0.0066	-	-	0	12	9	0.002	
13	Information Availability	-	-	0	93	15	0.0948	93	32	0.0434	1
14	Information Quality	6	6	0.0217	25	11	0.0303	44	27	0.0081	
15	Intellectual Property and Software Rights (*)	-	-	0	70	11	0.063	49	20	0.0203	0.67
16	Internet Facilities	5	5	0.0129	36	14	0.032	71	31	0.0245	
17	Job Relevance	6	6	0.0099	-	-	0	5	2	0.0006	
18	Labour Force	2	2	0.0052	-	-	0	24	16	0.0091	
19	Language	1	1	0.003	-	-	0	19	9	0.0017	
20	Leadership Continuity	-	-	0	-	-	0	26	13	0.014	
21	Loyalty	2	2	0.0069	-	-	0	1	1	0	
22	Market Environment	9	5	0.0218	5	3	0.0041	40	20	0.0092	
23	National Plan-ICT Inclusion	-	-	0	26	10	0.0259	24	12	0.0096	
24	National Telecommunication Environment	1	1	0.0013	4	1	0.0052	14	10	0.0021	
25	Nature of Development	4	3	0.0071	11	5	0.0122	106	29	0.0665	0.67
26	Net Benefits Perception	11	10	0.0428	21	11	0.0244	49	21	0.0259	0.67
27	Observability	3	3	0.006	-	-	0	-	-	0	
28	Organisational Aspects	12	8	0.0371	6	2	0.0063	3	3	0.0003	
29	Organisational Experience & Slack	15	7	0.0331	-	-	0	27	19	0.003	
30	Organisational Structure	4	4	0.0061	33	5	0.0298	4	3	0.0001	
31	Perceived Ease Of Use	21	15	0.0577	5	3	0.0061	57	26	0.0184	0.67
32	Perceived Usefulness	25	17	0.0778	52	13	0.0488	94	37	0.0436	0.67
33	Political Aspects	7	6	0.0138	7	4	0.0053	83	25	0.0271	
34	Population Changes	1	1	0.0019	-	-	0	1	1	0	
35	Regulation & Policies (*)	15	8	0.0346	129	19	0.1205	99	33	0.0429	1
36	Service Quality	4	4	0.0149	23	10	0.019	30	17	0.0099	
37	Subjective Norms & Motivation	18	11	0.0581	3	2	0.0023	84	31	0.0228	0.67
38	System Characteristics	9	6	0.0218	9	2	0.0123	33	16	0.0173	
39	System Development & Implementation	-	-	0	51	9	0.0545	53	23	0.0284	0.67
40	System Maintenance-Continuing Improvements	-	-	0	17	5	0.0122	34	20	0.0092	
41	System Obsolescence	-	-	0	2	2	0.0007	18	12	0.0042	
42	System Quality	4	4	0.01	32	7	0.0244	32	17	0.0059	
43	System Security Perception	7	4	0.0218	23	8	0.0282	115	30	0.0251	
44	Technology Costs & Budget	3	3	0.0073	27	8	0.031	116	36	0.0373	
45	Technology Infrastructure	10	6	0.0326	48	15	0.0429	72	26	0.0269	0.67
46	Technology Maturity & Awareness	6	3	0.0151	34	6	0.034	48	25	0.0154	
47	Timeframes	4	4	0.014	4	1	0.0042	68	33	0.0255	
48	Trust & Leadership Governance	5	3	0.013	25	12	0.0342	162	45	0.0554	0.67
49	Usage Behaviour and Use	20	15	0.0627	-	-	0	85	31	0.0445	0.67
50	User Satisfaction	10	8	0.0361	-	-	0	34	16	0.0099	
Sources analysed in each Stage			28			34			55		
Number of joint Themes refined			50			50			50		

Leyend: Number of References (NR); Number of Sources Analysed (NS); Frequency of References (FrR)

(*) last joined Themes by related mening and computed results

The three anchor points can define a set between the three stages: "High Level of References" (indicated by relationship score of 1), "No references" at all (relationship score of 0), and a crossover point (a probable relationship score of 0.5). However, between the extremes of full level of references and non-level of references, a set can have fine-grained relationship levels of references, ranging from four level sets (e.g., 0, 0.33, 0.67, and 1) to continuous sets (where the fuzzy score can take any value between zero and one). 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 Initial studies columns).

An fs/QCA applied score to standardize these ranges, used a more fine-grained relationship in which a fuzzy score can take any value between 0 and 1. Based on Legewie [1] and Ragin [7] suggestions, in this study, the cases are normalized in four-level sets 0, 0.33, 0.67, and 1. The FrR of each theme were obtained from the three stages of the initial study (see Table 1). These were used to measure the relevance of the selected themes in different sets of conditions. The normalized scores represented by the four fine-grained fuzzy scores are shown in 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 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 conditions or combinations of conditions in which all cases fit in a relation of necessity or sufficiency are rare. At least a few cases will usually differ from the general patterns. Therefore, it is necessary to evaluate how well the themes, as cases in different sets, fit a relation of necessity or sufficiency [1].

Furthermore, the outcome, evidencing computing consistency and resembling the idea of significance in statistical models, involves the degree measurement of necessity or sufficiency condition between causal conditions or 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 FUZZY LOGIC OF QCA APPLIED TO THE THEMES SELECTION AS CASES

3.1 The selection criteria for the fs/QCA outcomes

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

Case/s_ set of official representations of concepts used as part of a qualitative analytic technique ([11], [12], [13], [14], [15] as cited in Legewie [1]). In this study, the cases are the 50 themes obtained from three stages of the early study phase. Each theme is considered a case (named in the *fs*QCA software as "caseid").

Scoring Criteria_ the cases scoring 0.67 or 1 on the conditions, necessary or sufficient to the outcomes, are the themes recognised

as significant to all stages or in a stage [10]. The most prominent themes identified are selected for further analysis.

Necessity Condition_ is the condition of a determined set of themes (named as A-themes) necessary for the outcome Y (candidate drivers of SISA), if Y is not possible without the inclusion of A-themes. Therefore, in all the cases, outcome Y shares the presence of the A-themes' condition [1]. It is determined as the necessary condition to the outcomes or the necessity of determined outcomes [10].

Sufficiency Condition_ is the condition of a group of themes (A-themes) or the combination of other themes (X-themes) sufficient for the outcomes of Y (candidate drivers of SISA). Y will always rise if A-themes are present. However, other conditions, besides A-themes, may produce the outcome Y. These other conditions indicate that all cases in which A-themes are included share the occurrence of the outcome Y [1]. The definition of this statement is known as the sufficiency condition to the outcome [10].

INUS Condition_ is a single condition of Z-themes neither necessary nor sufficient by itself, but which can be part of the combination of one or more conditions that are sufficient for the outcome Y (candidate drivers of SISA) [1, 10].

Causal Recipes_ Causal Recipes are the conditions (using a set of theories or Boolean algebra) used to formally analyses to what degree some of these conditions, or a combination of them, are necessary or sufficient for the outcome [1, 10].

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

4. THE QCA PROCESS: DISCUSSION AND RESULTS

4.1 The fs/QCA analysis

Initially, we analysed the 50 identified themes as caseid to differentiate the Sufficiency, Necessity and possible Inus conditions. We used the fsQCA software to upload the spreadsheet with the original calculated FrR and to automatically convert the percentage to the proposed normalised fuzzy scores (see Table 2). The results obtained by computing all the causal recipes for the 50 themes, were stored in a new table (see Table 3). In this process, the different proposed recipes evidencing necessity or sufficiency aspects of the relationship were closely computed and examined.

During the *fs*/QCA process, the causal recipes, named Selected Themes with Higher Relevance (STHR), formulated as a combination of stages 1, 2 and 3 in the analysis process (see Table 3), were identified as the conditions that best suit the outcomes. These recipes accomplish the necessity of including Medium-high and High referenced themes obtained from the outcomes of Stage 3 (S3), which are also relevant emerging themes from Stage 2 (S2) and S3, and Stage 1 (S1) as it is shown in Figure 1.

Consequently, the level of references of 50 themes originally obtained, were normalized by using the *fs*/QCA score. From this process, six themes were identified as the most relevant (see Figure 1). At the same time, we identify which theme was the most significant to all stages in the study case (see the joining point in Figure 1). This was done by computing the LRAND recipe _Level of Reference joining the three themes_, used to measure the theme's reference level prominent to all the stages in the same proccess (see Table 3).

These themes achieved the necessary conditions determined by the Level of References of Necessary Themes LRTNS causal recipe with a narrow standard deviation of 0.1495882 (see

Table 4). Also, we identified the six themes in the STHR recipe (as higher selected themes of LRTNS) in which only a theme scoring 1 or 0.67 (using the *fs*/QCA scale) was computed, obtaining a very low standard deviation (9.93411E-09).

Table 3. Programming in fsQCA

Causal Recipes - Computed by Fs/QCA formula
(*) Necessity, Sufficient, or Inus condition
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

Table 4. Range to be used

	S1	S2	S3	LRT	LRTNS	STHR	THRS1	THRS2	THRS3	ST
Mean	0.33800	0.31840	0.36440	0.4584	0.34440	0.67000	0.75250	0.67000	0.67000	**0.75800**
Std. Dev.	0.19502	0.24048	0.16793	0.2118	**0.14959**	0.00000	0.14289	0.00000	no computed	**0.14593**
m	0	0	0	0.33	0	0.67	0.67	0.67	0.67	**0.67**
m	1	1	1	1	0.67	0.67	1	0.67	0.67	**1**
N Cases	50	50	50	50	50	6	4	3	2	**15**
Missing	0	0	0	0	0	44	46	47	48	**35**

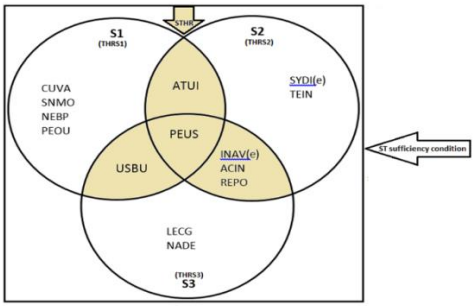

Figure 1. SISA in LAT selected themes structure.

4.2 The fs/QCA results

Even though STHR explains the necessary condition (Necessity condition) to identify the most relevant themes for combined stages, it does not consider the inclusion of all the possible themes that are highly significant to any specific stage. These incluisons are better explained in the Selected Themes (ST) recipe as a "Sufficiency condition" to answer the QCA research question (see Table 3). Initially, 15 themes emerged from the ST recipe application (Table 1, last column), which included the combination 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 number of themes as the LRT recipe which also allows identifying themes relevant to each of the stages at the same time, we choose to work with ST due to its lower standard deviation (0.14593) in relation to LRT (see

Table 4). ST also helps to identify more closely the significant relationship of the themes between the stages performed in the previous phases of this study.

From these evaluations, a preliminary result of 15 selected themes was obtained. Acronyms to identify each selected theme as driver of SISA were used, as it is shown in Table 5. Then, we closely re-examined the content, concept, meaning, and opinions obtained from the sources in relation to selected themes. Thus, we noted,

Table 5 fsQCA Scores of selected themes

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		4.9%
10	Perceived Ease of Use (PEOU)	**0.67**	0.33	0.33	0.33	0.67		4.9%
11	Technology Infrastructure (TEIN)	0.33	**0.67**	0.33	0.33	0.67		6.1%
12	Trust & Leadership Governance (TRLG	0.33	0.33	**0.67**	0.33	0.67		6.1%
13	Nature of Development (NADE)	0.33	0.33	**0.67**		0.67		5.1%
14	System Development & Implementation (SYDI)	0	**0.67**	0.33	0.33	0.67		4.9%
15	Intellectual Property and Software Rights (IPSR	0.67	0.33	0.67	0.33	0.67		Joined

from additional content analysis, that the themes named Intellectual Properties & Software Rights and Regulations & Policies (see Table 5) 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.

Furthermore, the decision to regroup these two themes was supported due to the fact that the fuzzy scores of Intellectual Properties & Software Rights (in the recipes LRTNS=0.33, ST=0.67) are lower than or equal to the Regulations & Policies score (in the recipes LRTNS=0.67, ST=0.67). Therefore, the Boolean operation of this union shows that the fuzzy scores of Regulations & Policies remain equal (LRTNS= 0.33 + 0.67 = 0.67 and ST = 0.67 + 0.67 = 0.67). Then, STHR=LRTNS conditioned by themes >= 0.67 presents the same result of Regulation & Policies before the combination of both (see Appendix I, Section 2). Consequently, the joining of the two last-mentioned themes reduced the themes selected to 14 (see Figure 1).

5. DISCUSSION OF THE OUTCOMES

5.1 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 and Figure 1). 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 recognised as "Inus conditions" accomplished (see Figure 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 organisations (see Table 5).

5.2 Grouping the results

To determine the nature of the themes and to better examine their influence as candidate drivers of SISA in LAT, we clustered them by related characteristics. The Control Characteristics group were determined based on existing literature and theories previously analysed. Thus, the selected themes were examined and reorganised into groups; related to Subjective Aspects, Technological Aspects, and Public Aspects. We kept consistent with the organisation undertaken in previous stages in which these themes were identified, or they emerged and were clustered according to their similarity.

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 Figure 2). Perceived Usefulness (named with the acronym PEUS) was the only theme evidencing high significance in the three previous stages (see also

Table 5 fsQCA Scores of selected themesTable 5. In *Technological Aspects*, four themes were selected from this group with a frequency of distribution of 36% over 100% (see Figure 2): 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 Figure 2). Regulations & Policies (named with the acronym REPO) was identified as highly significant in S2 and S3 but also mentioned in S1.

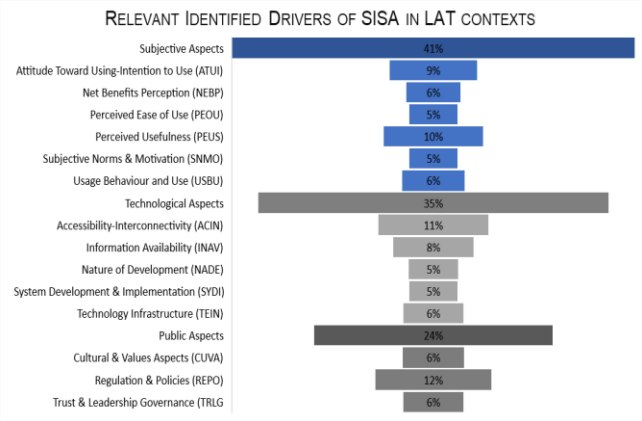

Figure 2. Funnel chart showing the frequency distribution of the selected drivers, clustered by similar characteristics

In the end, from these clustering process, we obtained an organisational structure to grouping the selected themes for further analysis of their relationship as drivers affecting SISA in PEOs (see Figure 2).

6. SUMMARY AND CONCLUSION

In this paper using a 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 named as fsQCA. 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 fsQCA 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 recognise 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 organisational contexts?".

To conclude, these results provide local stakeholders with a set of drivers relating to IS adoption within a specific context, namely in LAT regions. For future researchers, the findings will provide a contextual frame to develop future investigation to do comparative studies validating the selected drivers of IS.in in different organizations of LAT economies.

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8. REFERENCES

[1] Legewie, N.: 'An Introduction to Applied Data Analysis with Qualitative Comparative Analysis', in Editor (Ed.)^(Eds.): 'Book An Introduction to Applied Data Analysis with Qualitative Comparative Analysis' (2013, 2013-07-31 edn.), pp. 1-30

[2] Schneider, C.Q., and Wagemann, C.: 'Standards of Good Practice in Qualitative Comparative Analysis (QCA) and Fuzzy-Sets', Comparative Sociology, 2010, 9, (3), pp. 397-418

[3] Wagemann, C., Buche, J., and Siewert, M.B.: 'QCA and business research: Work in progress or a consolidated agenda?', Journal of Business Research, 2016, 69, (7), pp. 2531-2540

[4] Viswanathan, M., Bergen, M., Dutta, S., and Childers, T.: 'Does a single response category in a scale completely capture a response?', Psychology and Marketing, 1996, 13, (5), pp. 457-479

[5] Servant, F., and Jones, J.A.: 'Fuzzy fine-grained code-history analysis', in Editor (Ed.)^(Eds.): 'Book Fuzzy fine-grained code-history analysis' (IEEE Press, 2017, edn.), pp. 746-757

[6] Beekhuyzen, J., Nielsen, S., and von Hellens, L.: 'The Nvivo looking glass: Seeing the data through the analysis', in Editor (Ed.)^(Eds.): 'Book The Nvivo looking glass: Seeing the data through the analysis' (2010, edn.), pp.

[7] Ragin, C.C.: 'Redesigning social inquiry: Fuzzy sets and beyond' (University of Chicago Press, 2008. 2008)

[8] Creswell, J.W.: 'Qualitative inquiry & research design: Choosing among five approaches' (Sage, 2013. 2013)

[9] Charmaz, K., and Belgrave, L.: 'Qualitative interviewing and grounded theory analysis', The SAGE handbook of interview research: The complexity of the craft, 2012, 2, pp. 347-365

[10] Alcivar, N.I.S., Sanzogni, L., and Houghton, L.: 'Fuzzy QCA applicability for a refined selection of drivers affecting IS adoption: The case for Ecuador', in Editor (Ed.)^(Eds.): 'Book Fuzzy QCA applicability for a refined selection of drivers affecting IS adoption: The case for Ecuador' (IEEE, 2016, edn.), pp. 1-6

[11] Blatter, J.: 'Ontological and epistemological foundations of causal-process tracing: Configurational thinking and timing', ECPR Joint Sessions, Antwerpen, 2012, pp. 10-14

[12] George, A.L., and Bennett, A.: 'Case studies and theory development in the social sciences' (Mit Press, 2005. 2005)

[13] Gerring, J.: ‘Case study research: principles and practices’ (Cambridge University Press, 2006. 2006)

[14] Mahoney, J.: ‘The logic of process tracing tests in the social sciences’, Sociological Methods & Research, 2012, pp. 0049124112437709

[15] Strauss, A.L., and Corbin, J.M.: ‘Basics of qualitative research: techniques and procedures for developing grounded theory’ (Sage Publications, 1998. 1998)