THE USE OF OPEN, AXIAL AND SELECTIVE CODING TECHNIQUES: A LITERATURE ANALYSIS OF IS RESEARCH

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Abstract

Qualitative data analysis plays a critical role in academic research. Open, axial, and selective (OAS) coding techniques are widely associated with qualitative data analysis in information systems (IS) research. Therefore, this paper aims to examine the usage of OAS coding techniques and is based on reviewing and analyzing 96 published IS studies that have operationalized the techniques. This research follows the structural steps taken in content analysis in order to select, review and analyze relevant literature. The research is intended to contribute to the IS research community by classifying the papers analyzed against the different activities for operationalizing OAS coding. Our analysis shows that the use of coding by IS scholars has increased in recent years. However, we also find that there has been some vagueness in describing how the OAS coding techniques are executed within our highest quality IS research outputs.

Keywords: Open Coding, Axial Coding, Selective Coding, Data Analysis, Grounded Theory

1.0 Introduction

It is broadly appreciated that qualitative data refers to non-numeric data, where the focus on text (as qualitative data) rather than on numbers *"is the most important feature of qualitative analysis"* (Schutt, 2018, p.322). Such qualitative data opens up the opportunity for researchers to use any number of qualitative data analysis techniques available, as appropriate. However, irrespective of which approach is followed, qualitative data analysis will always involve a *"categorisation of data into concepts"* (c.f. Schutt, 2018, p.325) or a coding of the data. As Blair (2015, p.14) suggests *"in an attempt to help find meaning within qualitative data, researchers commonly start by coding their data"*. However, according to Elliott (2018, p.2850) even though *"coding is an almost universal process in qualitative research"*, it is a *"process which goes remarkably undocumented"* and as a result *"there is potential for considerable confusion regarding what coding actually is"*. Therefore, there is much to be decided on by the researcher when undertaking the art, science or indeed dance that is qualitative data analysis (Schutt, 2018), but it is also vitally important that the researcher appreciates that the rigor expected within a qualitative research study relies heavily on these data analysis decisions, and specifically those decisions made around coding. In fact, O'Reilly et al. (2012, p.251) when demystifying the grounded theory method makes reference to Locke (2001) who comments that *"the 'goodness of the fit' between the empirical observations and the conceptual categories they purport to indicate"* is the mark of the quality of the grounded theory.

As commented by O'Reilly et al. (2012) *"one of the most (if not the most) cited methods"* (p.256) of *"qualitative inquiry"* (p.247) is grounded theory. In reviewing the 40-year history of grounded theory methodological execution (and the variety from one study to another), O'Reilly et al. (2012) comment that the methodology is *"elusive and misunderstood by many"* (p.249) and *"it is particularly common to find GT [grounded theory] mentioned as the process used for research data analysis and coding"* (p.256). Of interest, O'Reilly et al. (2012, p.256) found that 83% of 126 articles returned from a search of grounded theory (using Business Source Premier) *"described the GT method as only a means by which to code and/or analyse data"* and they refer to these studies as adopting an "a la carte approach". Indeed, open, axial, and selective (OAS) coding techniques are widely associated with such qualitative data analysis in information systems (IS) research. Although there are a considerable number of publications that explain the use of these coding techniques (c.f. Webb and Mallon, 2007; Urquhart et al., 2010; Birks et al., 2013; Matavire and Brown, 2013; Seidel andUrquhart, 2013; Urquhart and Fernandez, 2013; Wolfswinkel et al., 2013), mainly in the context of the grounded theory method, few studies have focused on the analysis of how others have undertaken OAS coding in order to simplify its use, whether for neophyte or established researchers.

Thorne (2000, p.68) argues that *"unquestionably, data analysis is the most complex and mysterious of all of the phases of a qualitative project, and the one that receives the least thoughtful discussion in the literature"*. As stated by Given (2008, p. 186), *"for novice researchers, data analysis may seem like the most enigmatic and daunting aspect of qualitative research"*. Hence, when researchers decide to conduct data analysis using OAS coding techniques, they may be unsure about the procedure for operationalising these techniques. This unfortunate reality is captured by Thorne (2000, p.68) where they suggest that *"for readers of qualitative studies, the language of analysis can be confusing. It is sometimes difficult to know what the researchers actually did during this phase and to understand how their findings evolved out of the data that were collected or constructed. Furthermore, in describing their processes, some authors use language that accentuates this sense of mystery and magic. For example, they may claim that their conceptual categories "emerged" from the data – almost as if they left the raw data out overnight and awoke to find that the data analysis fairies had organised the data into a coherent new structure that explained*

everything!". Therefore, in this paper we will try to help researchers make sense of some of the assertions that are made about qualitative data analysis (and the coding of data using OAS coding techniques specifically) so that they can develop a critical eye for when an analytical claim is convincing and when it is not.

In this research paper we are intrigued to find out if studies published in our top IS journals (Senior Scholars Basket of Journals) that have used the OAS coding techniques in different contexts are adopting an *"a la carte approach"* (O'Reilly et al., 2012, p.256) or are *"cherry picking"* (Walsh et al., 2015, p.586) some aspects in their operationalisation of OAS coding. We are not assuming that there is a one-size-fits-all approach or a *"dogmatic and inflexible manner"* (Myers, 2009, p.111) required for qualitative data analysis (or OAS coding techniques specifically) but we do believe that we need to better understand the operationalisation patterns of OAS coding in research. The sense of *"fractional adaptation"* (O'Reilly et al., 2012, p.249) seems all too common and problematic where studies cite the use of the approach [grounded theory methodology in their case] but *"a substantial amount have merely applied particular pieces of the approach or adopted GT jargon"*. Therefore, while appreciating the *"designed-in flexibility of interpretive research"* (Gioia et al., 2012, pp.19-20) and that *"creativity is essential"* (Myers, 2009, p.111), we argue that flexibility and creativity are not acceptable excuses to justify taking an *"a la carte approach"* (O'Reilly et al., 2012, p.256) to the operationalisation of OAS coding. In short, the *"systematic, detailed analysis of the data"* (Myers, 2009, p.111) needs to be transparent. Therefore, the aim of reviewing and analyzing the studies is to answer the following question: *How have IS scholars operationalised OAS coding techniques?* Answering this question could help in forming an abstracted view of the techniques undertaken, as well as suggesting challenges to operationalising OAS techniques.

The remainder of this paper is organised as follows. It starts with an explanation of OAS coding proposed by Strauss and Corbin (1990) and concludes with a summary framework of these techniques. This is followed by the research method, whereby the research steps for content analysis are described and applied. Then, our findings are presented and the operationalisation of OAS coding technique patterns are captured in a conceptual model. The concluding remarks are presented in the final section.

2.0 Strauss and Corbin (1990, 1998, 2008): coding techniques

Coding is one of the techniques widely used in analysing qualitative data in the IS discipline (Tallon et al., 2013). OAS coding techniques were introduced by Strauss (1987) and developed over time by Strauss and Corbin (1990, 1998, 2008) as part of the Grounded Theory method (Seidel and Urquhart, 2013). In fact, O'Reilly et al. (2012, p.249) comment that the *"simultaneous coding and analysis of data"* highlights one of the five tenets of grounded theory.

The OAS coding techniques aim to generate concepts from field data (Walsham, 2006). According to Strauss and Corbin (1990, p. 57), coding *"represents the operations by which data are broken down, conceptualized, and put back together in new ways"*. Table 1 illustrates the definitions of open, axial, and selective coding according to Strauss and Corbin (1990).

Coding technique	Definition
Open coding	*"The process of breaking down, examining, comparing, conceptualizing, and categorizing data"* (p. 61).
Axial coding	*"A set of procedures whereby data are put back together in new ways after open coding, by making connections between categories. This is done by utilizing a coding paradigm involving conditions, context, action/interactional strategies and consequence"* (p. 96).
Selective coding	*"The process of selecting the core category, systematically relating it to other categories, validating those relationships, and filling in categories that need further refinement and development"* (p. 116).

Table 1 Open, axial, and selective coding definitions from Strauss and Corbin (1990).

Open coding is a process that aims to identify the concepts or key ideas that are hidden within data that are likely to be related to the phenomenon of interest (Bhattacherjee, 2012). Concepts and categories are generated in open coding (Glaser, 1992). Strauss and Corbin (1990) state that the concepts that appear to be similar are grouped together under a higher-order, more abstract concept called a category. When the categories are developed, their properties and the dimensions of these properties should also be identified (Strauss and Corbin, 1990).

Axial coding is best appreciated as the second reading of the data (Dezdar and Sulaiman, 2009). Therefore, the categories that emerged in open coding are refined in

order for them to be linked in the form of relationships. Importantly, axial coding is performed simultaneously with open coding (Strauss and Corbin, 1990; Dezdar and Sulaiman, 2009). Strauss and Corbin (1990) suggest that, in order to identify the relationship between categories, a paradigm model should be used that consists of the following elements: causal conditions, the phenomenon, the context, intervening conditions, action/interaction strategies, and consequences. Using this model enables the researcher to think systematically about the data in order to relate them (Strauss and Corbin, 1990). Developing a paradigm model goes beyond simply developing properties and dimensions, as in open coding, as the data are broken apart as concepts and become categories that have properties and dimensions; the intention is then to put the data back together in a relational form (Strauss and Corbin, 1990).

Selective coding aims to identify the core category which is the central phenomenon around which all the categories are integrated. In this technique, the analyst should be able to develop a clear story line about the area of study (Strauss and Corbin, 1990). Figure 1 presents a visual representation of an OAS coding framework that includes the coding activities within each of the coding techniques. The coding framework highlights an iterative process between the three coding techniques, which has been visualized by understanding the work of Strauss and Corbin (1990, 1998, 2008). Furthermore, the activities included within each OAS coding technique are also iterative in nature. For example, researchers can start discovering categories after labelling some of the concepts, although the activity of labelling concepts is also still in progress.

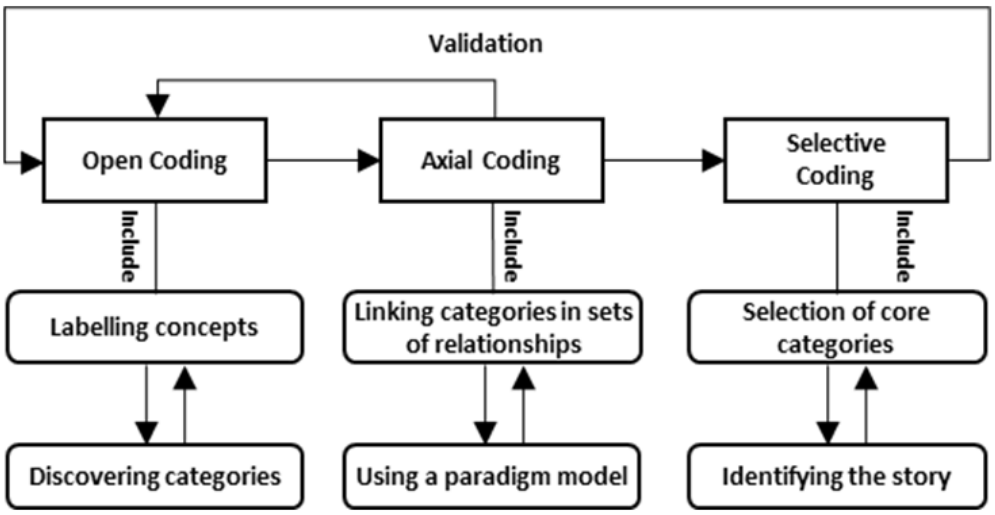

Figure 1 Coding framework (after Strauss and Corbin, 1990, 1998, 2008).

We now use this coding framework to structure the analysis of the 96 papers reviewed from our top IS journals as part of this literature analysis.

3.0 Research Approach

Given that the purpose of this study is to examine how IS scholars have operationalized OAS coding techniques, content analysis was deemed an appropriate analysis approach. Content analysis is a frequently used technique when analyzing texts (written or visual sources) especially where the meaning of the text is relatively straightforward and obvious (Myers, 2009). Content analysis requires the researcher to code the texts in a systematic way; therefore, through searching for 'structures and patterned regularities in the text' (c.f. Myers, 2009) the researcher applies a code to a unit of text that seeks to demonstrate the meaning of that text. Once coded, the resulting output can be both quantified and interpreted. Therefore, in effect, content analysis is best understood as "a quantitative method of analyzing the content of qualitative data" (Myers, 2009, p.172). Similar to Finney and Corbett (2007) this research adopted eight coding steps in order to conduct content analysis on a selection of scientific publications. These steps consist of data collection and coding procedures (see Table 2) which enable researchers to ensure clarity and transparency in the processes undertaken. These steps and the associated decisions are explained below.

Step	Description
Step 1: Decide the level of analysis	Researchers should decide what level of analysis should be conducted. The level of analysis can be a signal word, a set of words, phrases, or an entire document
Step 2: Decide how many concepts to code for	Researchers should decide whether to code text using a predefined set of concepts or develop a list of concepts incrementally during the process of coding
Step 3: Decide whether to code for the existence or frequency of a concept	After a certain number of concepts have emerged, researchers should decide whether to code the concepts for existence or frequency
Step 4: Decide on how you will distinguish between concepts	During this step, researchers should decide whether to code the concepts exactly as they appear, or if they can be coded in some altered or collapsed form
Step 5: Develop rules for coding your text	Researchers should define certain translation rules in order to ensure the consistency of the coding procedures
Step 6: Decide what to do with 'irrelevant' information	Researchers should determine what to do with information in the text that was not coded
Step 7: Coding the text	Researchers should start the coding procedure after the decision related to irrelevant information and should follow the translation rules identified in step 5
Step 8: Analyzing the results	After coding the data, researchers should decide how to review and present the results

Table 2 Eight steps taken in data collection and analysis (after Finney and Corbett, 2007).

Step 1: Decide the level of analysis

In this research, the level of analysis was considered to be the entire research paper to identify which of the papers had either used or explained OAS coding techniques in order to be included in the initial analysis. The focus was then on the research methodology section (and specifically the data analysis section) in order to examine the use of the coding techniques.

The data collection phase was initiated by collecting papers from the Senior Scholars' Basket of Journals. Our decision to use these eight journals of the AIS (association for information systems) to populate the dataset for this literature analysis is not unusual. The basket represents the highest quality research outputs in IS and "has often been used for citation or content analysis of IS research" (Prat et al., 2015, p.233). The papers were collected using the Google Scholar search engine. The Advanced function was applied for each journal. The keywords used here were 'open coding' OR 'axial coding' OR 'selective coding'. Hence, by using these keywords as our search terms, it could be guaranteed that every paper that had applied one of the coding techniques would appear in our search. The total number of results gained from all the journals searched was 335 papers.

The data analysis section in each paper was reviewed to identify the initial relevance of the paper. The related papers in this step are those that have applied at least one of the three coding techniques. As a result, 72 papers were excluded from the total of 335. Although one or more of the techniques were mentioned in these 66 papers, this was done in an unrelated context. For example, mentioning open coding as a term but not related to the data analysis. Table 3 illustrates the total number of excluded and included papers for each journal.

Journal	Excluded	Included
European Journal of Information Systems	27	59
Information Systems Journal	13	49
Information Systems Research	2	25
Journal of AIS	9	23
Journal of Information Technology	8	33
Journal of MIS	1	18
Journal of Strategic Information Systems	5	30
MIS Quarterly	7	26
Total	72	263

Table 3 Total number of excluded/included papers for each journal

Step 2: Decide how many concepts to code for

The papers were initially coded using the predefined concepts that are part of the coding framework (see Figure 1) and which were organized using a concept-centric matrix (c.f. Webster and Watson, 2002). This helped to appreciate what had been done in each paper. However, to understand how OAS coding techniques were operationalized in each paper, the researchers also decided to code concepts inductively that could simplify the use of coding analysis. Therefore, in this stage, all the concepts emerged incrementally through the processes of open coding.

Step 3: Decide whether to code for the existence or frequency of a concept

In this research, we decided to code for frequency rather than existence in order to gain a deeper insight into the concepts that emerged, as well as to avoid the uncommon use of the coding techniques.

Step 4: Decide on how you will distinguish between concepts

For this research, we decided to follow open coding analysis techniques suggested by Strauss and Corbin (1990), in which concepts that appear to be similar are grouped together under a higher-order, more abstract concept called a category.

Step 5: Develop rules for coding your text

The following translation rules were established and applied during our coding procedure:

- All papers were read the first time in order to code any relevant information about OAS coding.
- All the concepts that emerged from the papers were compared to identify similarities and differences in order for them to be labelled together in categories.
- Once all the papers had been coded, the researchers examined the categories that emerged as well as their properties within the actual text in order to ensure that they reflected the meaning of the text concerned.
- All the papers were coded within the coding framework (Figure 1) and organized using a concept-centric matrix.

Step 6: Decide what to do with 'irrelevant' information

The 263 papers included from step 1 underwent further review. We found that 42 of the 263 papers do not mention Strauss and Corbin (1990, 1998, 2008). Therefore, those 42 papers were considered irrelevant. The remaining 221 papers were classified into two categories: 1) those that used the coding techniques (209 papers); and 2) those that explained the coding techniques (12 papers: (Webb, Mallon 2007, Urquhart, Lehmann et al. 2010, Birks, Fernandez et al. 2013, Seidel, Urquhart 2013, Matavire, Brown 2013, Wolfswinkel, Furtmueller et al. 2013, Urquhart, Fernandez 2013, Berente, Seidel et al. 2019, Wiesche, Jurisch et al. 2017, Sarker, Xiao et al. 2018b, Sarker, Xiao et al. 2018a, Rivard, 2021). The 12 papers mainly explain the techniques within the context of the grounded theory approach. We also decided to exclude these papers as they do not use the techniques, and our focus is solely on those that have utilized the coding techniques in question. The remaining 209 papers, which used Strauss and Corbin's coding techniques, received in-depth analysis and were classified in order to direct our attention to answer our research questions of understanding how IS scholars have operationalized OAS coding techniques.

Step 7: Coding the text

We adopted the open coding technique from Strauss and Corbin (1990) for the content analysis. Open coding was used here to code any excerpt that explains the coding

procedure adopted in the paper. Open coding analysis is widely applied in conducting content analysis for a set of publications (e.g. Finney and Corbett, 2007; Goode and Gregor, 2009; Grahlmann et al., 2012).

Step 8: Analyzing the results

The analysis is presented under the findings and discussion sections. The findings section shows how IS scholars conduct coding techniques and includes some descriptive statistics about the papers analyzed. This is followed by the method the scholars used to operationalize the three coding techniques, concluding with the recommended list of papers and coding specifications that facilitate the conduct of the three coding techniques.

4.0 Findings

4.1 Initial paper classifications

Reviewing and analyzing the initial set of papers (209 selected papers) produced interesting findings. First, while the coding techniques proposed by Strauss and Corbin are still used by IS scholars in IS studies, not all of the papers operationalized all three coding techniques. Table 4 shows the classification of papers in terms of their use of OAS coding techniques. It can be seen that the first classification, 'OAS', has 96 papers that have used OAS coding techniques. We focus on these 96 papers for the remainder of the analysis reported in this paper (see the next section: Pursuing OAS classification).

Classification	Coding technique			Number of papers
	Open (O)	Axial (A)	Selective (S)	
OAS	Yes	Yes	Yes	96
OA	Yes	Yes	No	46
O	Yes	No	No	50
OS	Yes	No	Yes	10
A	No	Yes	No	7

Table 4 Classification of the techniques used in the 189 papers selected.

Figure 2 illustrates the yearly distribution of the papers included in Table 4 (209 papers) with the distinction of the first classification 'OAS'. It can be seen that the

overall number of papers that used the coding proposed by Strauss and Corbin has increased over time, which is an indication of the popularity and power of these techniques.

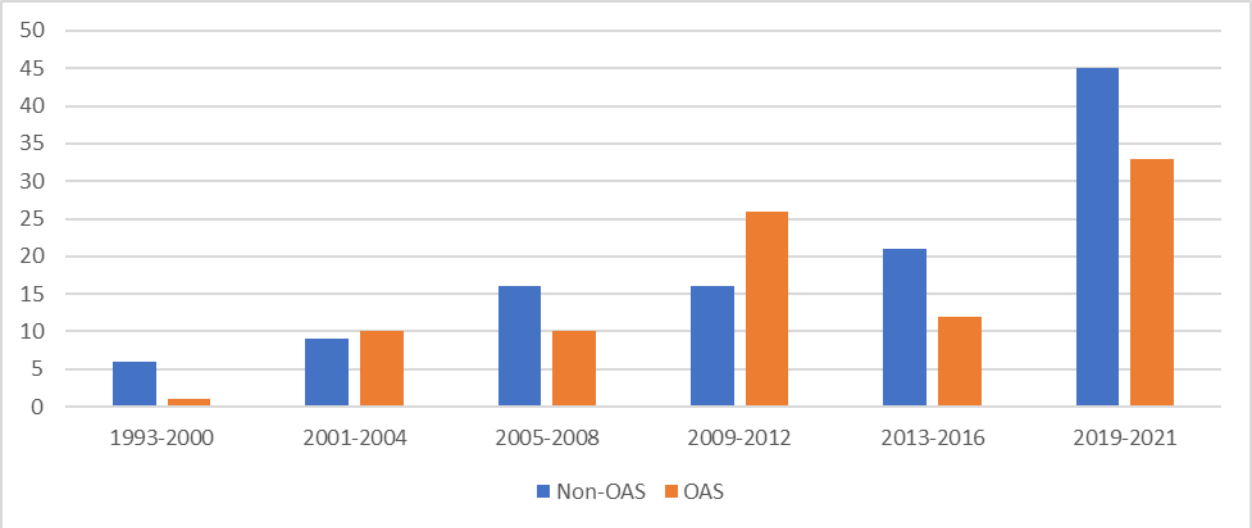

Figure 2 Papers that used one or more of the coding techniques, yearly distribution.

4.2 Pursuing OAS classification

Pursuing OAS classification considers the analysis of 96 papers in total (see Table 4). We analyzed these papers using a concept-centric matrix that consists of the data gathering techniques, where they were published, as well as an analysis of the context of the coding techniques, in which there are three possible values:

- Grounded theory (GT) approach: in which the main method followed is grounded theory and, therefore, grounded theory analysis techniques are used.
- Grounded theory (GT) analysis: in which there is no mention of the grounded theory approach or methodology. Grounded theory is only associated with the data analysis techniques.
- Other: in which there is no mention of the grounded theory approach or analysis and the approach to qualitative data analysis has simply been called ‘coding’.

The examination of the 96 papers enabled us to identify the type of data being analyzed using OAS coding. Table 5 illustrates the list of possible data gathering techniques and the percentages of the 96 papers that used them. In some cases, the papers reported using more than one data gathering technique.

Data gathering technique	Usage percentage	Examples
Interviews	87%	Pauleen, 2003; Goulielmos, 2004; Kirsch & Haney, 2006; Smolander et al., 2008; Chakraborty et al., 2010; O'Reilly & Finnegan, 2010; Gleasure, 2015
Documentation	44%	Ryan & Valverde, 2006; Keil et al., 2007; Goode & Gregor, 2009; Maldonado, 2010
Observations	23%	Huang et al., 2001; Vaast & Walsham, 2013

Table 5 Analysis of the data gathering techniques used in the 96 papers.

The majority of the 96 papers rely on interviews as the primary data gathering technique, while documentation is the second most commonly used technique. Many of the papers analyzed apply both interviews and observations and some include case documents. However, some papers rely solely on analyzing documents and are considered to be literature analyses (such as Goode and Gregor, 2009).

In terms of types of analysis, the 96 papers are distributed across the three types of data analysis context (see Figure 3). Most of the papers come under the GT approach. However, more than one-third refer to the coding techniques as GT analysis and apply them in different contexts. This is an indication of the use of the three coding techniques in a context of non-grounded theory research. In addition, there are 16 papers in which there is no mention of grounded theory, either in their approach or analysis, but which used the three coding techniques referred to by Strauss and Corbin (such as Maldonado, 2010 and Kane and Labianca, 2011).

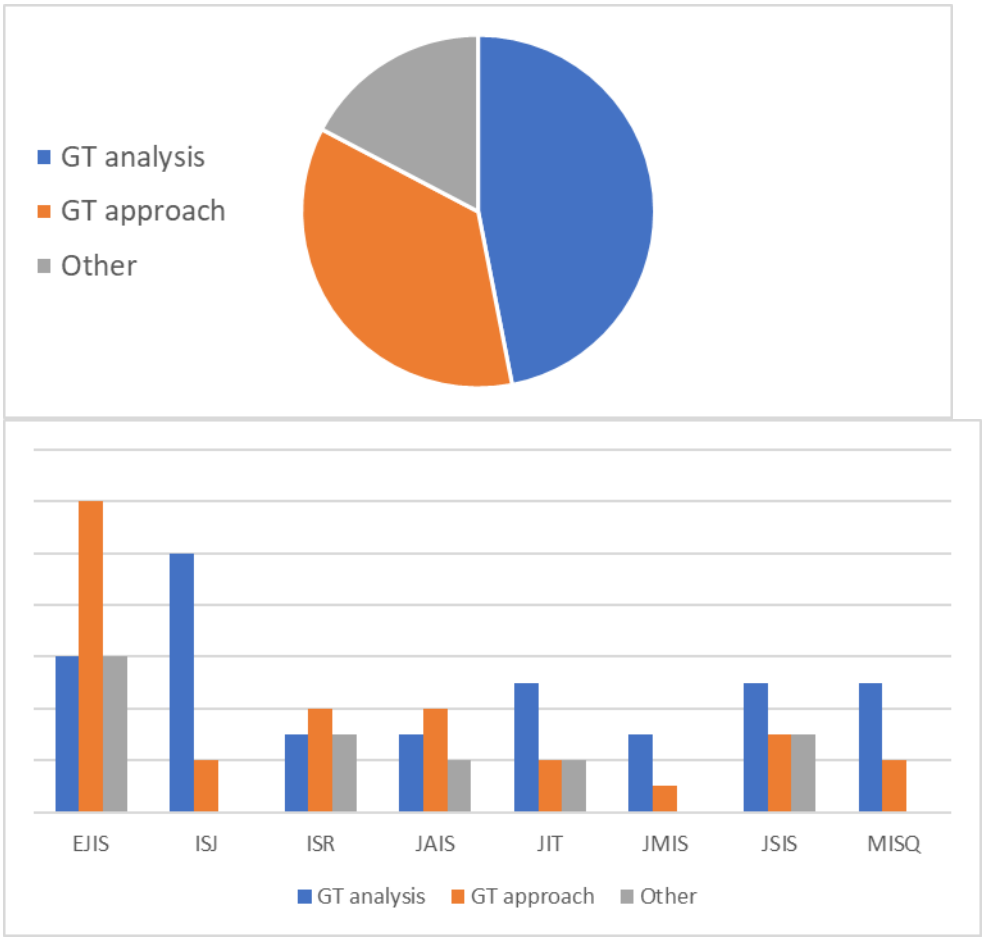

Figure 3 Context of the coding techniques.

Our findings show that the majority of the papers that used OAS coding did so in the context of a grounded theory approach. These papers explicitly follow the grounded theory approach which incorporate the three coding techniques and are aimed at building a theory, such as Galal (2001), Huang et al., (2001) and Day et al. (2009).

In addition, some papers did not follow a grounded theory approach or research methodology, although they used OAS coding and referred to them as grounded theory analysis. These papers mainly follow a theory building approach by referring to another method, such as case study research (c.f. Yin, 2003), building theory from case studies (c.f. Eisenhardt, 1985) or action research (c.f. Susman and Evered, 1978). Hence, OAS coding can be used in different contexts for research approaches that are aimed at theory building.

The final classification of the papers is ‘Other’. These papers in this classification used the OAS coding techniques. However, these papers do not mention grounded theory, either as an approach or a data analysis technique. It can be argued that some of these papers are aimed at empirically building a theory (such as Tan et al., 2015). However, there are some papers that have used the coding techniques in order to test a theory empirically, such as Maldonado (2010) and Chan et al. (2011). This indicates the power of using the coding techniques for non-theory-building research.

The following section presents a deeper analysis of how these papers operationalized open, axial and selective coding techniques.

4.3 Operationalizing OAS coding

Taking into consideration the 96 papers, we analyzed the research methodology section of each of the papers in depth. We did this in order to code all the concepts related to the three coding techniques to enable us to clarify how the coding was conducted within the respective studies. Initially, the 96 papers were coded according to the coding framework, which includes the three coding techniques and the activities involved (see Figure 1). We were able to classify the papers on a scale with (Explicit) material at one end and reference-only material (Hints) at the other end (c.f. Seidel and Urquhart, 2013). ‘Explicit’ material indicates papers that explicitly mention the three coding techniques as stated in the coding framework and fully explain the operationalizing processes, whereas ‘Hints’ indicates papers that only refer to the three coding techniques without specifying the processes or the activities involved.

Table 6 shows the classification of the 96 papers according to the coding framework (see Figure 1). The ten classifications presented in Table 6 reflect the ‘explicit’ (tick) and ‘hints’ (blank) coding of activities that we conducted. For example, a tick represents the fact that an activity is explicitly explained, whereas a blank represents the fact that an activity or coding technique is referred to (e.g. ‘following Strauss and Corbin’) but without providing specifics around the what or the how. A blank also represents a scenario where an activity is incorrectly associated with a coding technique. For example, the ‘discovering categories’ activity being associated with axial coding instead of the ‘linking categories in sets of relationships’ activity.

Classification Number		Reference	Number of papers	Open coding		Axial coding		Selective coding	
				Labelling concepts	Discovering categories	Linking categories in sets of relationships	Use paradigm model	Selection of core categories	Identifying the story
Explicit ——> Hints	1	(Work, 2002) (Baskerville & Pries-Heje, 2004) (J. C. Huang, Newell, & Pan, 2001) (Galal, 2001) (Day, Junglas, & Silva, 2009) (Palka, Pousttchi, & Wiedemann, 2009) (Maldonado, 2010) (Mueller, Mendling, & Bernroider, 2019) (Berente, Seidel, & Safadi, 2019)	**9**	√	√	√	√	√	√
	2	(Chang, Chen, Klein, & Jiang, 2011) (Goode & Gregor, 2009) (Mattarelli, Bertolotti, & Macrì, 2013) (Morgan, Feller, & Finnegan, 2013) (Ramesh, Cao, & Baskerville, 2010) (Keil, Im, & Mähring, 2007) (Clemmensen, 2012) (Kane & Labianca, 2011) (Walsh, Kefi, & Baskerville, 2010) (Xu & Ramesh, 2007) (Grace, Gleasure, Finnegan, & Butler, 2019) (Gleasure & Morgan, 2018) (Huber, Kude, & Dibbern, 2017) (Heeager, Eldridge, Toft, & Carugati, 2017) (W. D. Du & Mao, 2018) (Charki, Josserand, & Boukef, 2017) (J. Huang, Henfridsson, Liu, & Newell, 2017) (Moeini & Rivard, 2019a) (Van Looy, Poels, & Snoeck, 2017) (Moeini & Rivard, 2019b) (Xiao, Lindberg, Hansen, & Lyytinen, 2018) (Curto-Millet & Shaikh, 2017) (B. Tan, Tan, & Sun, 2018) (Walia, Zahedi, & Jain, 2018) (Boldosova, 2019) (Huber, Winkler, Dibbern, & Brown, 2020) (Hansen & Baroody, 2020) (Giddens, Petter, & Fullilove, 2021) (Cram, Proudfoot, & D'Arcy, 2021) (Renwick & Gleasure, 2021) (Xiao, Tan, Leong, & Tan, 2021) (Asatiani et al., 2021)	**32**	√	√	√		√	√
	3	(Williams & Karahanna, 2013) (Strong & Volkoff, 2010) (Zahedi & Bansal, 2011)	**3**	√		√	√	√	√
	4	(Feller, Finnegan, Fitzgerald, & Hayes, 2008) (O'reilly & Finnegan, 2010)	**2**	√	√	√	√		
	5	(Kock, 2001) (Gleasure, 2015) (Vaast & Walsham, 2013) (Goulielmos, 2004) (Berente & Yoo, 2012) (Strong et al., 2014) (Berente, Hansen, Pike, & Bateman, 2011) (P. Huang, Pan, & Ouyang, 2014) (Karoui, Dudezert, & Leidner, 2015) (Steffen, Gaskin, Meservy, Jenkins, & Wolman, 2019) (Parks, Xu, Chu, & Lowry, 2017) (Liu, Hull, & Hung, 2017) (Hur, Cousins, & Stahl, 2019)	**13**	√		√		√	√
	6	(Smolander, Rossi, & Purao, 2008) (Petrini & Pozzebon, 2009) (Bagayogo, Lapointe, & Bassellier, 2014) (Feller, Finnegan, Hayes, & O'Reilly, 2012) (L. J. Kirsch, 2004) (Ramesh, Cao, Kim, Mohan, & James, 2017) (Gleasure, Conboy, & Morgan, 2019) (F. T. Tan, Ondrus, Tan, & Oh, 2020)	**8**	√	√	√			
	7	(Berente, Gal, & Yoo, 2010) (Tallon, Ramirez, & Short, 2013) (Holmström & Sawyer, 2011) (Pauleen & Yoong, 2001) (Chan, Hackney, Pan, & Chou, 2011) (L. S. Kirsch, 1997) (B. Tan, Pan, Lu, & Huang, 2015) (L. J. Kirsch & Haney, 2006)	**8**	√				√	√
	8	(Pauleen, 2003) (Abraham, Boudreau, Junglas, & Watson, 2013)	**2**	√		√	√		
	9	(Lederman & Johnston, 2011) (Ransbotham & Mitra, 2009) (Leonardi, 2014) (Sarkar, Vance, Ramesh, Demestihas, & Wu, 2020) (F. T. C. Tan, Pan, & Zuo, 2019)	**5**	√		√			
	10	(Ryan & Valverde, 2006) (Jenkin & Chan, 2010) (Lindgren, Henfridsson, & Schultze, 2004) (T. Butler, 2011) (Vaast, 2007) (Chakraborty, Sarker, & Sarker, 2010) (Hackney, Jones, & Lösch, 2007) (Vannoy & Salam, 2010) (Matsuo, Wong, & Lai, 2008) (T. Butler & Murphy, 2008) (W. Du, Pan, Zhou, & Ouyang, 2018) (Rahrovani, 2020) (Oehlhorn, Maier, Laumer, & Weitzel, 2020) (Floetgen et al., 2021)	**14**						

Table 6 Classifications of the 96 papers by coding framework.

First off, from Table 6 we observed that there are a number of papers that do not specify any of the three coding techniques explicitly, having claimed to execute OAS coding (see classification 10), such as Lindgren et al. (2004), Ryan and Valverde (2006) and Jenkin and Chan (2010). These papers explicitly mention that they 'are following Strauss and Corbin's coding techniques', although there is no further explanation of how they used the coding. This is, therefore, considered an implicit (hints) use of coding techniques. Therefore, based on our observations, we refer to this concerning aspect of OAS coding execution as ***invisible theorisation***. Based on our observations these papers represent the least useful papers in order to demystify OAS coding and indeed mirror adopting a "language that accentuates this sense of mystery and magic" (Thorne, 2000, p.68) when it comes to the operationalisation of OAS coding. Perhaps references as opposed to detailed application of techniques (c.f. Rynes and Gephart, 2004) best defines this operationalization pattern.

From Table 6, it can be seen that 51 papers (see classifications 1,2,4, and 6) conduct open coding. The primary tasks being undertaken are 'labelling concepts' (labelling the concepts based on the data) and 'discovering categories' (discovering categories by comparing the concepts and creating an abstracted layer of similar concepts) in order for these categories to be used for axial coding, such as O'Reilly and Finnegan (2010) and Morgan et al. (2013). This can be considered the desired approach to open coding execution. We refer to this observed pattern as ***exemplar open coding execution***. However, even within this operationalization pattern, different terms are used to refer to concepts and categories. For example, one paper (Smolander et al., 2008) calls the concepts 'seed categories' and the categories 'super categories', which reflects the original meaning of the concepts and categories in open coding. In open coding, the concepts and categories emerge from the data. In terms of labelling concepts and categories, it is also recommended that these be taken from the actual terms in the data where possible (c.f. Petrini and Pozzebon, 2009; Strong and Volkoff, 2010), although predefined categories from the literature can also be used, as in Huang et al. (2014). Therefore, based on our observations, we refer to this concerning aspect of open coding execution as ***coding terminology fragmentation***. Unfortunately, this observation presents a known challenge within research. For example, Grix (2010, p.9) comments *"the lack of clarity and constancy of the social-*

research lexicon has led to a minefield of misused, abused and misunderstood terms and phrases" and this inevitable provides the researcher with a *"wide range of meanings and interpretations to the terminology of research"* (p.8). Indeed, Grix (2010, p.8) when commenting on key terms and their place in research suggest that *"an obvious and urgent need for agreement on the meaning of specific generic terms…..to prevent the confusion which surrounds many concepts"*.

From Table 6, we can also observe that 28 papers (see classifications 5,7,8, and 9) use open coding to only label concepts. The majority of these papers overlap between open and axial coding, with discovering categories considered in the axial coding technique. For example, Kirsch (1997), Holmström and Sawyer (2011) and Abraham et al. (2013) label concepts during open coding, then compare the concepts for similarities and differences in order to discover higher-level categories during the axial coding stage. The original open coding as presented by Strauss and Corbin considers this action to be part of the open coding stage. Therefore, we can see how the operationalisation causes confusion around coding. Therefore, based on our observations, we refer to this concerning aspect of OA coding execution as ***inter-technique activity bleeding***. Based on our observations such an OAS operationalization pattern mirrors a sense of *"fractional adaptation"* (O'Reilly et al., 2012, p.249) where the researchers have *"merely applied particular pieces of the approach or adopted [the] jargon"* (p.249).

In terms of axial coding, our analysis shows 16 papers (see classifications 1,3,4, and 8) are considered to demonstrate the desired operationalisation of axial coding (again referred to as ***exemplar axial coding execution***), as they are 'linking categories in sets of relationships' as well as 'using a paradigm model' as their main focus in axial coding. However, we observed that, in the axial coding stage, the majority of the papers consider that the linking of categories in sets of relationships is the main action that should be conducted, without specifying the paradigm model, such as Goulielmos (2004), Berente and Yoo (2012) and Strong et al. (2014). As a result, these papers have perhaps lost the advantages and the flavor of axial coding because they did not use a paradigm model. Therefore, based on our observations, we refer to this concerning aspect of axial coding execution as ***coding paradigm model exclusion***. It is worth mentioning that this operationalisation pattern aligns with what O'Reilly et

al. (2012, p.256) have termed an *"interesting conundrum"* (in their reflection on grounded theory practices) where they comment that *"many of the researchers who have used GT in a select or a la carte manner offer their research results as theoretical outputs"*. Put simply, this suggests that the theoretical outputs are challenged due to such a piecemeal approach to data analysis (axial coding in this case). Indeed, it would seem that "the 'goodness of the fit' between the empirical observations and the conceptual categories they purport to indicate" (O'Reilly et al., 2012, p.251) is somewhat diminished where a paradigm model is not used. Indeed, Galal (2001, p.5) sum this situation up nicely, stating that *"the quality and validity of a theory cannot be divorced from the way it is generated"*.

In terms of using a paradigm model, the majority of the papers do not mention a paradigm model at all. In fact, our analysis reveals that only 16 papers mention a paradigm model (forming relationships between categories), It is important to mention the significance of this observation at this point. The output of step six of our research approach was 209 papers that all claimed to follow Strauss and Corbin (thereafter 96 of these papers claimed the use of OAS coding techniques). However, the main distinction between Strauss and Corbin (1990) and Glaser (1992) in terms of coding techniques is the use of a paradigm model, or not. For Strauss and Corbin, axial coding means using a paradigm model; an argument which is also made by (Seidel and Urquhart, 2013). Indeed, Day et al. (2009, p.642) sum up their position on using the paradigm model as follows "*knowing that some researchers have criticized the coding paradigm due to its tendency to force data into a pre-fabricated form, we made certain to apply it as a guide instead of as a dogmatic principle by closely concentrating on emerging themes*".

In axial coding, the categories that result from open coding are compared for similarities and differences in order to make causal relationships between them. Here, we found many of the researchers misunderstand this kind of activity by only re-grouping categories at a higher level, whereas they should be related to causal relationships. In many cases, it requires the researcher to return to the original text (the data collected) of the categories and the associated concepts in order to understand the actual relationships. Therefore, we argue that having a paradigm model helps to operationalize the right approach to axial coding (see Figure 4, an example of

the relationships between the elements of the paradigm model). In fact, not being able to visualize what constitutes the workings of a paradigm model might also explain why it is not that prominent a feature of axial coding in the papers reviewed. In addition, our analysis also reveals that not all of a paradigm model's elements need to be used during axial coding. For example, Chakraborty et al. (2010) and Williams and Karahanna (2013) use elements of their 'own paradigm model', whereas, in contrast, Day et al. (2009) and Strong and Volkoff (2010) use the same elements of the original paradigm model as prescribed by Strauss and Corbin (1990).

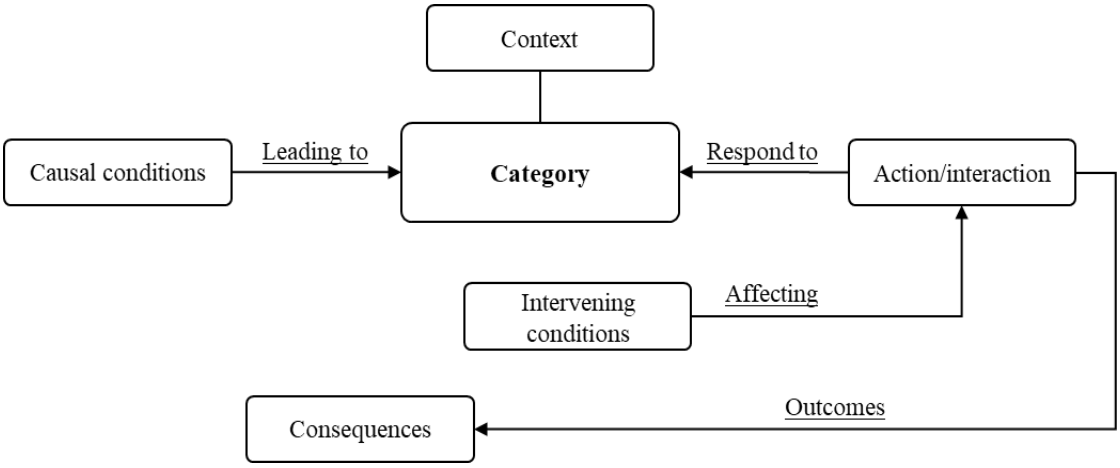

Figure 4 Example of the relationships between the paradigm model's elements.

In terms of their use of selective coding, the majority of the papers (65) (see classifications 1,2,3,5, and 7) undertake the selection of core categories and identify a story as stated in the coding framework, such as Keil et al. (2007), Day et al. (2009) and Morgan et al. (2013), which can be considered as desired execution of selective coding (again referred to as ***exemplar selective coding execution***). However, some of the papers, such as Feller et al. (2008) and O'Reilly and Finnegan (2010), conduct selective coding simply by re-doing axial coding and identifying causal relationships between categories. As a result, these papers that have claimed selective coding (see classification 4), do not in fact do it; as a result, the activities under selective coding are left blank in Table 6. Others, such as Kirsch (2004), re-do open coding by generating categories or comparing them in terms of similarities and differences. Therefore, based on our observations, we refer to this concerning aspect of selective coding execution as ***prior technique activity repetition***. This operationalization pattern reflects the example provided by Grix (2010, p.9) where he suggests "*consider*

a would-be bricklayer who does not know the difference between a trowel, a spirit level and a chisel. These are the basic tools of his trade without which no wall can be built. Each tool has a specific purpose and, if it were used wrongly (or in the wrong order), for example, taking a chisel to lay bricks, the results would be disastrous".

To provide a summary of our analysis and establish the "so what" of our observed patterns (a critical element of our theorizing efforts) we present a conceptual model of OAS coding operationalization (see Figure 5). This model provides a visual representation of our sense making and showcases our "thinking about the data theoretically, not just methodologically" (Gioia et al., 2012, p.21). By presenting the conceptual model we are strengthening the contributions and providing an "opportunity to speculate" (Gioia et al., 2012, p.25) where further exploration of OAS coding may add value, beyond this study. Our stated proposition is as follows: exemplar OAS coding execution is impacted by the concerning aspect of OAS coding within and across OAS coding phases. For example, coding terminology fragmentation is a concerning aspect in opening coding execution.

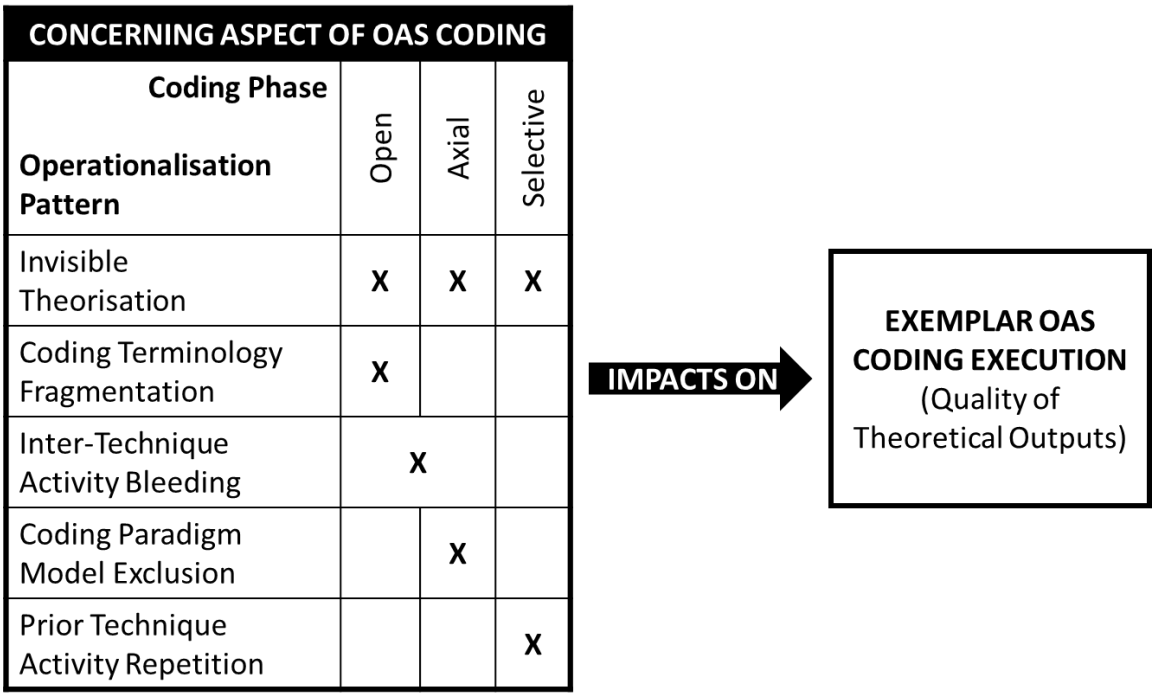

Figure 5 Conceptual Model of OAS Coding Operationalisation.

5.0 Discussion and Contribution

In this section, we discuss the findings from our analysis of 96 coded papers in order to clarify some of the confusion that exists regarding the use of OAS coding. We argue that this confusion is not helpful for established or neophyte researchers. Initially, we found that the use of OAS coding is increasing within IS academic publications. However, we observe different patterns and flexibility in the use of open, axial and selective coding. Our analysis also indicates that these coding techniques can be useful for a variety of research activities and can readily be adapted to answer specific questions. From our point of view, these differences are driven by the nature of the research strategy; however, it can also be considered a misunderstanding of how to operationalize the OAS coding techniques themselves. However, some of the papers are explicit and comprehensive in explaining the process of operationalizing the OAS coding of their data. We argue that these papers (row 1 of Table 6) represent a "recommended reading list" of OAS coding exemplars for established and neophyte IS researchers.

We observe that many of the coded papers have not explained how they used the coding techniques, which creates more confusion for researchers. Reflecting back to Thorne (2000) and embracing the prescriptions of Gioia et al. (2012) it can be argued that visual aids (such as a data structure or indeed a paradigm model, as in this case) are not being used extensively enough (as part of the presentation of OAS coding in our highest quality IS research outputs) in order to bring clarity and not confusion to guide both established and neophyte researchers in their efforts. In fact, Gioia et al. (2012) state the necessity of having a data structure as part of any qualitative data analysis effort. The data structure ensures that researchers configure their data *"into a sensible visual aid"* while also providing *"a graphic representation of how [the research] progressed from raw data to terms and themes"* (Gioia et al., 2012, p.20). Furthermore, Gioia et al. (2012) argue that *"constructing a data structure compels us to begin thinking about the data theoretically, not just methodologically"* (pp.20-21). Therefore, the data structure provides a view of the rigor of the qualitative research which is *"necessary for journal publication"* (Gioia et al., 2012, p.21).

In summary, borrowing the language of Gioia et al. (2012), it can be argued that a data structure is an output of the researcher's progression from 1st-order categories (akin to open and axial coding) to 2nd-order themes, their interconnectedness, and aggregate dimensions (akin to selective coding). The data structure facilitates the telling of an informative *"story on the basis of transparent evidence"* (Gioia et al., 2012, p.23), for example, the use of informants quotes that *"align with the exemplars shown in the data structure figure"* (Gioia et al., 2012, p.23). In essence *"the reader should be able to see the data-to-theory connections in the form of linkages among the quotes in text, the 1st-order codes in the data structure, and their connection to the emergent 2nd-order concepts/themes and dimensions"* (Gioia et al., 2012, p.23). As an example, one of the OAS coding exemplars identified in this study (Day et al., 2009) really reflects this progression. In fact, such an approach to reporting the OAS coding efforts is a direct challenge to the invisible theorisation observed in classification 10 (the 'hints' papers).

6.0 Concluding remarks

According to Rowe (2014) there is a need within the IS community to publish more literature reviews. He argues that *"literature reviews can be highly valuable"* and *"every researcher looks for [a literature review] when starting a research study" (*Rowe, 2014, p.242). So, where the main goal of a literature review is *"to classify what has been produced by the literature"* (Rowe, 2014, p.243) we believe that we have achieved this for OAS coding techniques and mapped the territory (see Table 6). In fact, this paper is the first paper to do a comprehensive longitudinal analysis of OAS coding within our top IS journals (Senior Scholars Basket of Journals).

Rowe (2014, p.246) suggests that *"the quality of a literature review depends on its systematicity, since systematicity implies reproducibility through documenting the search process and potentially indicates comprehensiveness"*. This research study identified and analyzed 96 published IS studies that have operationalized OAS coding techniques. Using a systematic approach, through the eight coding steps of content analysis, the selection process yielded 335 publications that were subjected to selection and exclusion criteria, which led to the exclusion of 72. Following a more in-depth review of the remaining 263 publications, 96 were found to serve the

research purpose explicitly. These 96 publications were analyzed using an open coding analysis technique to conduct an in-depth content analysis of the OAS coding techniques mentioned in these publications. Therefore, we believe that we have achieved the systematicity required to ensure the reproducibility of our work by others.

As stated in the introduction of this paper, the motivation for producing this paper is to find out if studies published in our top IS journals (Senior Scholars Basket of Journals) that have used the OAS coding techniques in different contexts are adopting an *"a la carte approach"* (O'Reilly et al., 2012, p.256) or are *"cherry picking"* (Walsh et al., 2015, p.586) some aspects in their operationalisation of OAS coding. In short, we can get a sense of clarity or confusion from our observations. Interestingly, our analysis clearly shows that the descriptions of the three coding techniques (open, axial and selective) used by IS scholars have been rather vague. We observed many overlapping activities between the three coding techniques; for example, some papers conducted axial coding with open coding activities. The majority of the papers also missed the core value of the paradigm model during axial coding (which is in itself a useful visual aid). Our analysis also confirms that there is uncertainty within the research community with regard to the operationalization of open, axial and selective coding techniques. No doubt this uncertainty causes confusion for both established and neophyte researchers.

As stated in the introduction of this paper, we want to help researchers make sense of some of the assertions that are made about qualitative data analysis (and the coding of data using OAS coding techniques specifically) so that they can develop a critical eye for when an analytical claim is convincing and when it is not. As an example, the papers (recommended reading) listed in row 1 of Table 6 (e.g. Work 2002, Baskerville and Pries-Heje, 2004, Huang et al., 2001, Galal, 2001, Day et al., 2009, Palka, et al., 2009, Maldonado, 2010, Mueller et al., 2019, Berente et al., 2019) are explicit and comprehensive in the way they conduct the open, axial and selective coding techniques in different research contexts. In fact, we suggest that this list of papers is intended to act as a recommended reading list (the must reads) for established and neophyte researchers looking to execute a qualitative data analysis strategy. In fact, we can go one step further and recommend that all research methods

modules, associated with graduate research programmes, incorporate these seven papers as part of their reading lists. Indeed, a further invaluable teaching and learning exercise would be for researchers to compare the papers classified in row 1 of Table 6 with those classified in row 10; thereby creating a compare and contrast of the 'explicit' and the 'hints' approaches used to narrate the operationalisation of OAS coding techniques.

We recognize that this review may generate more questions than it answers, however, we believe that in doing so it will further advance the understanding of OAS coding complexities for IS researchers and beyond. In short, we hope that it encourages others to do further theorizing around the status quo of OAS coding. Embracing the advice of Webster and Watson (2002) we will conclude this paper by signalling our belief that we have addressed the contributions (what's new?), impact (so what?), logic (why so?) and thoroughness (well done?) expected from a review article and hopefully it represents a "benchmark for others".

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