Time is of the Essence: A Systematic Literature Review of Temporality in Information Systems Development Research

Journal:	*Information Technology & People*
Manuscript ID	ITP-11-2019-0597.R1
Manuscript Type:	Article
Keywords:	Information system development < Practice, Literature review < Methodology, Information system analysis and design < Information system development < Practice, IT project management < Information system development < Practice, IS professionals < People, IS academia

Time is of the Essence: A Systematic Literature Review of Temporality in Information Systems Development Research

Abstract:

Information Systems Development (ISD) is complexly characterised by time. ISD methods are considered an effective way for managing ISD projects in turbulent and time-sensitive environments. Yet, a comprehensive review of what is known about time in ISD is lacking. We address this gap by using a framework - which classifies time into three categories: conceptions of time, mapping activities to time, and actors relating to time. We conduct a systematic literature review which investigates time in ISD within the Senior Scholars' Basket, IT&P, and top two information systems conferences over the past 20 years. The search strategy resulted in 9850 studies of which 47 were identified as primary papers. The purpose of this paper is to identify, classify and analyse temporality in ISD literature. Our results reveal that ISD research is ill equipped for contemporary thinking around time. This systematic literature review (SLR) contributes to ISD by finding the following gaps in the literature: (1) clock time is dominant and all other types of time are under-researched; (2) contributions to mapping activities to time is lacking and existing studies focus on single ISD projects rather multiple complex ISD projects; (3) research on actors relating to time is lacking; (4) existing ISD studies which contribute to temporal characteristics are fragmented and lack integration with other categories of time; and (5) ISD methodology papers lack contributions to temporal characteristics and fail to acknowledge and contribute to time as a multifaced interrelated concept. We recommend that ISD researchers and practitioners pay due attention to the nuances and complexities of time when studying and using ISD methods. This work has developed the first SLR on temporality in ISD. This study provides a starting point for ISD researchers and ISD practitioners to test their commonly held temporal assumptions.

.

Keywords: Time, temporality, information systems development, systematic literature review.

1 Introduction

No matter the topic, or the context, time is always a prominent, multifaceted and complex concept (Ancona *et al.*, 2001). Information systems development (ISD) is no exception. In today's hypercompetitive environment, achieving faster time-to-market is hampered by asynchronous distributed teams and rapidly changing markets and requirements. ISD usually takes place in a relentlessly dynamic, high pressured, complex and unpredictable environment (Conboy, 2009; Kudaravalli *et al.*, 2017; Lee *et al.*, 2018). In such an environment, making decisions regarding time becomes even more critically important (Nandhakumar, 2002; Shmueli *et al.*,2016; Lee *et al.*, 2018).

Contemporary and emergent ISD literature is filled with temporal characteristics but neglect the complex and often subtle nature of time. Time as a construct is related to other constructs. For example, in ISD literature *pace* (Vidgen and Wang, 2009), *rhythm* (Sarker and Sahay, 2004), *velocity* (Power and Conboy, 2015), *speed* (Conboy, 2009), *just-in-time* (Lee, 1999), *on-time delivery* (Sarker *et al.*, 2009), *completion rates* (Yetton *et al.*, 2000), *lead time* (Patnayakuni and Ruppel, 2006), *time management* (Nandhakumar, 2002), *planning* (Shmueli *et al*., 2016), *time pressure* (Austin, 2001) *rapid change* (Ramesh *et al.*, 2010), *temporal dissonance* (Conway and Limayem, 2011), and *late deliveries* (Austin, 2001) are all illustrations of temporal terms in ISD literature.

Yet, those studying and experiencing ISD conceive time as clock time. This over-reliance on clock time overshadows ISD perspectives and theories. As a result, traditional time management techniques are ill prepared for ISD projects (Nandhakumar, 2002). This is illustrated by frequent late deliveries of ISD projects with continuous and problematic failure rates (Dwivedi *et al*., 2015; Wiener *et al.*, 2017). In contemporary and emergent ISD method literature, time has not been studied as comprehensively as it should have been. Yet, time is the single distinguishing factor between ISD methods to date (e.g., speed, sprints, daily stand ups, cycle time, lead time, velocity). Considering the importance of time in ISD and following numerous calls to research temporality within the context of ISD and under dynamic conditions, it has not been explored explicitly or sufficiently in information systems (IS) research (Lee and Liebenau 2000; Saunders and Kim 2007; Waller *et al.*, 2001).

Building on the comprehensive temporal framework proposed by Ancona *et al*., (2001), the aim of this research is to understand the various characteristics of temporality studied within the context of ISD. This study produces a systematic literature review (SLR) which provides an up-to-date analysis of temporality in ISD. This research contributes to research and practice by identifying any gaps, misconceptions or general conceptual issues in the application of temporal concepts to ISD to date. The paper describes the concept of temporality, the research approach to examining time in ISD literature, literature review findings, discussion, conclusions and future research.

2 Temporal complexity

Temporality refers to an individual's experience of time (Caldas and Berterö, 2012), which includes our relationship to time (Heidegger, 1927), and how we react to time (Fraisse, 1963). There have been explicit attempts to add to temporality theory within the past few decades (Ancona *et al*., 2001; Mosakowski and Earley, 2000; Orlikowski and Yates, 2002; Standifer and Bluedorn, 2006). However, there is a lack of an overarching temporal framework. There are several attempts to create an overarching theory on temporality, however no theory of temporality is universally accepted.

In organisational literature, several temporal frameworks have emerged over the last four decades, mostly within organisational research (e.g., Bluedorn and Denhardt, 1988, Ancona *et al*., 2001, Mosakowski and Earley, 2000, Orlikowski and Yates, 2002, Sonnentag, 2012). Scholars have used a range of temporal characteristics to describe temporality in organisations. There are frameworks (Bluedorn and Denhardt, 1988; Ancona *et al.*, 2001) which consider the full extent of time and all its complexity. These studies not only consider all temporal characteristics but also categorise them into an applicable structure. The Bluedorn and Denhardt (1988) framework classifies time into three categories: social time, mathematical time, and economic time. Ancona *et al*., (2001) classifies time into three interrelated categories: conceptions of time, socially constructed time, and actors relating to time. However, a concept analysis reveals that there are inconsistencies with the temporality literature that exists. There are inconsistent definitions and inconsistent use of temporal terms in these frameworks.

There are studies which examined temporal characteristics within a particular problem. These temporal characteristics vary. Temporality within organisational culture has been studied and the research found thirteen main temporal characteristics; time boundaries between work and non-work, sequencing of tasks, punctuality, allocation, awareness, synchronisation and coordination, variety versus routine, intra-organisational time boundaries, future orientation, schedules and deadlines, work pace, autonomy of time use, and quality versus speed (Schriber and Gutek, 1987). One study identified six temporal characteristics that can be used to evaluate the temporal effects of IS: duration, sequence, temporal location, deadline, cycle and rhythm (Lee and Liebenau, 2000). Another study examined temporality in organisations and found four temporal characteristics: sequential structure, duration, temporal location and rate of recurrence (Zerubavel, 1981). Ancona *et al*. (2001), Schriber and Gutek (1987), Lee and Liebenau (2000), and Zerubavel (1981) all examined temporality within an organisational context. Schriber and Gutek (1987), Lee and Liebenau (2000), and Zerubavel (1981) contributed to temporal characteristics. However, the framework by Ancona *et al*. (2001) is unique as it provides a holistic classification of temporal characteristics.

2.1 Classification of time

This study uses the Ancona *et al.* (2001) framework (Table 1) to firstly classify time and secondly to understand what ISD literature on time exists to date. Ancona *et al.* (2001) reviewed the literature surrounding temporality within the areas of organisational theory, sociology, social psychology, and anthropology and developed a framework to classify time. The framework was chosen because it is a well-regarded classification of time (Shen *et al.*, 2014). Shen *et al.* (2001) also chose it because it "synthesises a large swath of temporal concepts across diverse areas of temporal study and provides a common organising framework for these temporal constructs and variables". It is also an easily applied structure that can be used as a lens to examine literature (Shen *et al.*, 2014). Thus, it is suited to this research on ISD.

Category	**Subcategory**	**Sample Variables**
Conceptions of time	Types of time	Linear time, uniform time, cyclical time, subjective time, event time
	Socially constructed time	Work organisation (nine-to-five workdays, work time and family time), celebrations (Passover and/or Easter), time as a renewing cycle, time as linear continuity
Mapping activities to time	Single activity mapping (a)	Scheduling, rate of completion, duration
	Repeated activity mapping (aa)	Cycle, rhythm, frequency, interval
	Single activity transformation mapping (aa')	Life cycles, midpoint transitions, jolts, interrupts, deadline behaviour
	Multiple activity mapping (ab)	Relocation of activities, allocation of time, ordering, synchronisation
	Comparison and meshing of activity maps (ab) versus (aa)	Entrainment, patterning, temporal symmetry
Actors relating to time	Temporal perception	Experience of time, time passing, time dragging, experience of duration, experience of novelty
	Temporal personality	Temporal orientation, temporal style
Category spanning variables		Polychronic and monochronic time, banana time

Table 1. Classification of categories and subcategories, with sample variables (Ancona *et al.*, 2001)

2.1.1 Conception of time

The framework identifies three categories: conceptions of time, mapping activities to time and actors relating to time. Each classification of time is now discussed in turn. A conception of time can be created by an individual. For example, an employee in an organisation can conceptualise their own view of time (Medlin and Saren, 2012). There are different types of time such as linear time, uniform time and cyclical time. However, the most popular and widely cited types of time are clock time and event time (Mosakowski and Earley, 2000). Each society will conceptualise time differently. For example, some may use clock-based time whereas others may use event-based time (Mosakowski and Earley, 2000). Clock time versus event time can be associated with the Newton (1871) vs Einstein (1945) debate. Newton perceived time as absolute and Einstein perceived time as relative. Still, individuals can experience multiple types of time at once

(Ancona *et al*., 2001). Time is also revealed as a socially constructed phenomenon (Ancona *et al*., 2001; Saunders *et al*., 2004). Even within these groups, time can be used in a way which is appropriate to the subgroup (Ancona *et al.,* 2001). This means there can be different dimensions of time within a society (Saunders *et al*., 2004).

2.1.2 Mapping activities to time

The main aim of mapping activities to time is to get a valid analysis of what happens over time during an activity (Roe, 2008). This category explains that events and activities can be mapped to time. Mapping activities to time explains when an activity will begin, how long it may take and any fluctuations or patterns over the interval (Ancona *et al*., 2001). Single activity mapping maps a single activity to a time continuum (Ancona *et al*., 2001). Single activity mapping entails the examination of a single event which is not usually repeated once the activity has taken place. Repeated activity mapping has been researched far less than single activity mapping. Repeated activity mapping is where an activity is repeated on multiple occasions and is mapped to time. Single activity transformation mapping occurs when, during an activity, the old activity transforms into the new activity, changing the form of the activity (Ancona *et al.,* 2001). The single activity transformation mapping is catered for one single event. In multiple activity mapping, activities are examined in relation to each other. The primary concern for multiple activity mapping is allocating the correct amount of time towards the multiple activities (Ancona *et al*., 2001). Comparing multiple activity mapping is used to understand the differences and similarities in temporal characteristics. Not all activities have the same temporal characteristics.

2.1.3 Actors relating to time

Actors relating to time explain the actors which are involved in the previous two categories. Temporal perception variables are used to reveal how actors perceive and act with regard to the continuum of time. The actors may refer to the individual, team or the organisation (Ancona *et al*., 2001). The perception of time is different among the different cultures around the world (Mosakowski and Earley, 2000). Individuals also have their own temporal personality (e.g., when an individual will schedule his/her tasks). They will follow their own temporal personality while doing so (Avnet and Sellier, 2011). Although our perception of time is influenced by our culture, it is also formed by our own individual temporal personality. A temporal personality is unique to the distinctive individual, and the way in which an individual understands and experiences time will be exposed through their actions (Ancona *et al*., 2001).

2.2 Related literature

In the years prior to 2000, there have been a number of relevant time specific articles published. One paper assessed the relationship between improvisation and time in the organisation (Ciborra, 1999). Another

looked at the temporal pattern of technological adaptation in organisations (Tyre and Orlikowski, 1994). The next paper examined how information technology affects monochronicity, polychronicity and temporal symmetry (Lee, 1999). However, around the turn of the millennia, there was an increase in published papers on time and technology. Special issues were developed to attract more contributions to the field. In fact, the Information Society Journal contributed to the temporal impacts on individuals, organisations, and society (Lee and Whitley, 2002).

The first study in the special issue investigates the conflict between the emerging conception of time which are driven by globalisation and the conception of time which are driven by localised culture (Hongladarom, 2002). The second study reports an ethnographic study that investigates the ways in which time was experienced and managed in an information systems (IS) development project (Nandhakumar, 2002). The third study highlights the temporal effects in information and communication technology-enabled organisational change (Sawyer and Southwick, 2002). The fourth article examines time and space in mobile computing and telecommunications technologies (Green, 2002). The fifth article applies both space and time to understand the cyberspace field.

The increase in time related papers across the organisational and IS field was evident around the early 2000s. However, the insurge in time and technology related papers began to decrease towards the mid to late 2000s. For example, time papers published in journals such as the Information Technology & People saw an increase in the mid 2000s, but time specific papers were not published after this short period. For example, one paper tested the assumptions of the 24-hour workday during the dot-com bubble (Tapia, 2004). Another paper focused on the synchronicity in virtual teams (DeLuca and Valacich, 2006). However, in the years since these publications, time specific papers are rarely studied in Information Technology & People.

Although Information Technology & People is just one example, it's a common issue across IS and organisational research. That is, the 2000's saw an increase in interest in time related research over a short number of years. However, the papers were not published after this period. Instead, these journals defaulted back to referencing time as oversimplified clock-based measurement, where time is never the main focus of the study.

3 Review methodology

Firstly, the basis for any literature review is to identify the relevant literature within a field. Therefore, the researcher must understand and interpret the findings, while also examining, questioning, and critically assessing each study (Boell and Cezec-Kecmanovic, 2011). Secondly, when reviewing literature, researchers generally follow either a traditional literature review approach or a systematic literature review approach. Therefore, there are specific rationales for taking either option.

The advantage for following the traditional literature review is that the researcher has an opportunity to engage in the literature review process (Boell and Cezec-Kecmanovic, 2011). Through this level of interaction, interpretation and understanding develops (Okoli, 2015). Every literature review does not have to be carried out with the high level of rigor required of an SLR. A traditional literature review is most useful when the topic is new, where limited studies exist, and where the research question is broad. This type of literature review is also useful when a researcher does not need to create a literature review which is replicable and offers transparency for future researchers (Levy & Ellis, 2006).

The topic of a study also has an influence on the chosen literature review approach. Specifically, within ISD, time is oversimplified. Time is mentioned in most ISD studies, but it is rarely explicitly the main focus. If the authors chose the traditional literature review approach, the literature review would have limited the contributions of the study. The traditional literature review approach would have been limited to reviewing ISD studies which oversimplifies and misinterprets time. However, the SLR is an objective and structured review of these oversimplifications and misinterpretations. Thus, by choosing the SLR, it produces a review which contributes to how the ISD community views time and how the ISD community oversimplifies time in a structured and replicable way. Once there is an SLR published, then a traditional hermeneutic review could be valuable for future research.

Furthermore, time complexity included many temporal characteristics (speed, slow, interruptions, intervals, cycle, temporal perception, temporal personality etc). In fact, the Ancona *et al.*, (2001) framework defines time by using a total of 38-time characteristics. Therefore, the more hermeneutic approach of reading many potential papers and identifying the key concepts was unsuitable for our type of study. Instead, a systematic literature review was most valuable for the contribution to the future of research on time in ISD, IS and the broader organisational literature. Future researchers can read this study and unearth the exact steps taken and thus replicate these steps to other areas of IS. Whereas this level of replicability would not be possible in a traditional literature review.

Therefore, in conducting our literature review, we chose an efficient scientific method: a SLR. A SLR is a "means of identifying, evaluating and interpreting all available research relevant to a particular research question, or topic area, or phenomenon of interest" (Kitchenham, 2004:1). When following a traditional literature review, it does not mean that option is any less systematic (Boell and Cezec-Kecmanovic, 2011). However, the systematic literature approach was chosen as the review offers a high quality (Dybå and Dingsøyr, 2008), transparent and replicable review (Leidner and Kayworth, 2006). This method offers the capability of summarising a large quantity of research publications (Fink, 2005), for studies which aim to address a clearly formulated question (Petticrew and Roberts, 2006). Therefore, a SLR was chosen rather than a narrative literature review for four reasons: (1) our study aimed to answer a specific research question; (2) our area of study will generate a large amount of literature; (3) our intention was to systematically extract

relevant temporal references from the publications in a transparent form; (4) the rigour and replicability it offers leads to an unbiased scientific paper.

Within IS, SLRs have been published within the top journals (Grahlmann *et al.*, 2012; Lavranos *et al.*, 2015). However, not to a large extent. Two reasons for this neglect are that IS researchers remain unaware of the need for a rigorous SLR (Levy and Ellis, 2006) and that many are unsure about the methodology involved in conducting a SLR (Okoli, 2015).

We followed the SLR approach based on work by Kitchenham and Charters (2007), Levy and Ellis (2006), Okoli (2015) and Webster and Watson (2002). The foundation of our guide was taken from an IS guideline developed by Okoli (2015). However, we drew from similar work by Kitchenham and Charters (2007), Levy and Ellis (2006) and Webster and Watson (2002) to strengthen our scientific review.

3.1 Eight-step systematic literature review guideline

We followed an eight-step guideline which is required for the completion of a SLR. Although any of these steps can be followed by researchers who complete a narrative literature review, following all steps are essential to conduct a scientifically rigorous SLR (Okoli, 2015). In accordance with the systematic review guidelines (Okoli, 2015), we took the steps outlined in Figure 1.

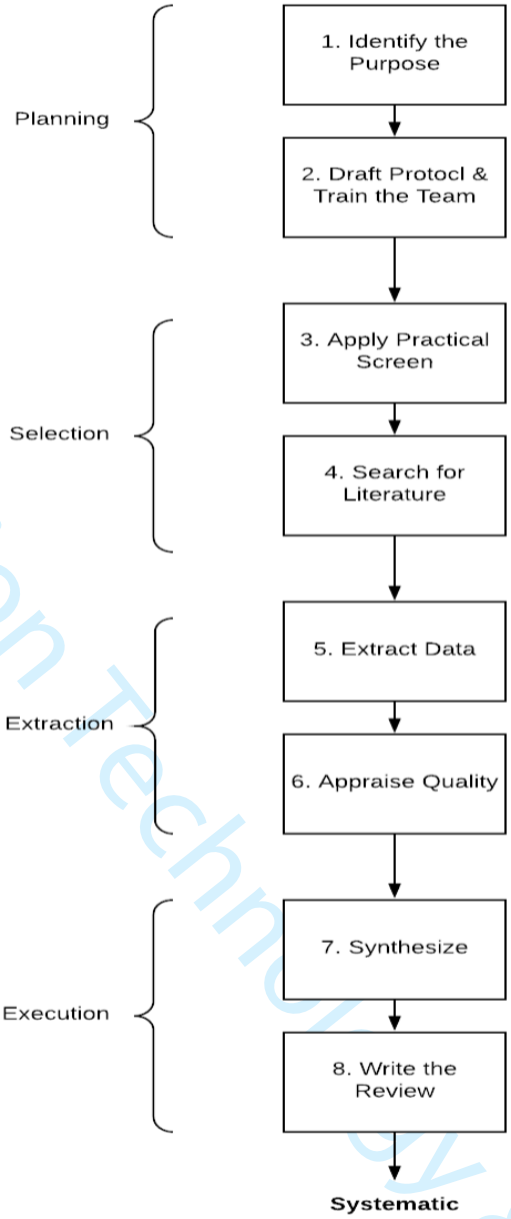

Figure 1. A systematic guide to literature review development (Okoli, 2015)

The objective of the review is to answer the research questions (Table 6). RQ1 is a comprehensive research question. We created five questions (RQ1.1 - RQ1.5) which are used to answer RQ1. RQ2 and RQ3 were created to provided rich data for the synthesis and discussion stage. In addition to enhancing findings on the complexity of time within ISD, the review also aims to contribute to conducting an IS SLR. A further contribution will be that of a study which conducts a SLR: (i) where the complexity and subtle nature of time is incorporated into a search strategy; (ii) to find relevant time papers; (iii) which are then systematically analysed based on a conceptual temporal framework.

The quality of a literature review is depended on the rigor of the search process (Vom Brocke *et al.*, 2009). Researchers should develop a search strategy in accordance with the research question. The goal of this step is to generate as many papers as possible which can answer the research questions (Kitchenham and Charters, 2007). When searching for the literature, a researcher begins by searching literature databases and electronic resources. Then a researcher conducts a keyword search to generate appropriate papers (Levy and Ellis, 2006).

A general approach of search string strategy is to base the search string on the research questions and include a list of synonyms, abbreviations, and alternative spellings (Kitchenham and Charters, 2004). Search terms may be a limitation of a study if articles use different terms for a research area (Gimenez and Tachizawa, 2012). Due to the multifaceted nature of the word *time* and the fact that many researchers may have used the term *time* in a multitude of ways, we needed a comprehensive strategy which included time synonyms and related terms. We also needed to consider the different variations researchers have used to talk about ISD. A keyword strategy (Table 2) was developed based on the temporal terms used in the Ancona *et al.* (2001) temporal framework. This framework provided a thorough and appropriate set of search strings which would structure our study. The search string was used following the boolean practice. A simple "OR" operator was used between keywords. The use of "*" after each word was implemented so the search would include multiple variations of the word.

Keyword Strategy
TOPIC: ((system* OR software*)) AND TOPIC: ((method* OR design* OR develop* OR practice* OR project* OR agile* OR scrum* OR "extreme programming" OR xp OR feature* OR crystal* OR lean* OR flow* OR team* OR technique* OR approach*)) AND TOPIC: ((tim* OR temporal* OR *cycl* OR schedul* OR rate* OR duration* OR rhythm* OR frequen* OR interval* OR jolt* OR interrupt* OR deadline* OR *sync* OR order* OR pattern* OR entrain* OR novel* OR "relocation of activities" OR "mid-point* transition*" OR "midpoint* transition*" OR clock* OR calendar* OR speed* OR slow* OR *prior* OR routine* OR fast* OR year* OR event* OR day* OR plan* OR monochronic* OR polychronic* OR pace* OR lag* OR urgen* OR sequen*))

Table 2. Keyword strategy

Once the literature databases have been confirmed, researchers should begin the literature search with leading journals. High quality papers which have led to major contributions are likely to be published within the top journals. Once the literature searches in leading journals has commenced, the leading conferences of a field should follow (Webster and Watson, 2002). The largest, most extensive and IS-specific databases were chosen. The keyword strategy was applied to the Association for Information Systems (AIS) '*Senior Scholars' Basket of Journals*', Information Technology & People (IT&P), and the top two IS conferences (Table 3). The search string used across these databases retrieved 9850 publications.

Conference/Journal	Acronym
European Journal of Information Systems	EJIS
Information Systems Journal	ISJ
Information Systems Research	ISR
Journal of the Association of Information Systems	JAIS
Journal of Information Technology	JIT
Journal of Management Information Systems	JMIS
Journal of Strategic Information Systems	JSIS
Management Information Systems Quarterly	MISQ
Information Technology & People	IT&P
International Conference on Information Systems	ICIS
European Conference on Information Systems	ECIS

Table 3. Association for information systems (AIS) senior scholars' basket of IS journals, IT&P, and top two IS conferences

High quality literature relating to the phenomenon under study can be found in digital libraries (Levy and Ellis, 2006). However, one problem with the multidisciplinary nature of IS is that literature is dispersed over hundreds of databases (Levy and Ellis, 2006). We used three databases to counteract this concern: (1) AIS, (2) SCOPUS, and (3) ISI Web of Science. These stored the journals and conference proceedings in which related to the ISD field. We used AIS as it uniquely provides papers from the leading IS conferences. We used Web of Science as it is the largest citation database which stores over 800 million references (Manikandan and Amsaveni, 2016). We used SCOPUS as it also claims to be the largest database for abstracts and citation (Kictenham and Charters, 2007). We manually searched Google Scholar to find papers which the other databases may have missed.

These databases were used to extract papers from the '*Senior Scholars' Basket of Journals*', IT&P and the top two leading IS conferences: the International Conference on Information Systems (ICIS) and the European Conference on Information System (ECIS). The '*Senior Scholars' Basket of Journals'* is the premium set of IS journals within the field. These are selected by senior scholars and consist of eight journals. They are commonly known as '*the basket of eight'* (Lowry *et al*., 2013). This basket includes the European Journal of Information Systems, Information Systems Journal, Information Systems Research, Journal of the Association of Information Systems, Journal of Information Technology, Journal of Management Information Systems, Journal of Strategic Information Systems, and Management Information Systems Quarterly. In addition, we added a journal outside the basket list; Information Technology & People. This journal is also highly ranked and has published ISD and SLR related content. Analysing a selection of the top journals can form an impression of the identity of the IS discipline (Goyal *et al.,* 2018). Therefore, these selected sources can be viewed as an appropriate representation but not exhaustive sample of the best research in temporality in ISD (Shen *et al.,* 2014).

A practical screening can be used to eliminate studies which fail to answer the research questions. SLRs need an inclusion and exclusion strategy (Kitchenham and Charters, 2004). While searching the literature

can generate a large number of papers, the use of an inclusion and exclusion strategy can eliminate unnecessary papers (Okoli, 2015).

No.	Inclusion Strategy
(1)	Each study should relate to one or more of our research questions
(2)	Each study should fall into the top eight IS journals, IT&P and the top two IS conferences
(3)	Each study should focus on temporality in ISD
(4)	Each study should be empirical, theoretical, conceptual, or experimental
(5)	Each study should be published between 2000 and 2020
(6)	If the study has been published in more than one journal or conference, the most recent version of the study is included

Table 4. Inclusion strategy

The inclusion (Table 4) and exclusion (Table 5) strategy was based on the research questions. Papers had to meet all the criteria and if not, were transferred into a subfolder for record purposes.

No.	Exclusion Strategy
(1)	Duplicate articles will be excluded
(2)	Papers not written in English will be excluded
(3)	Lesson learned, research in progress, editor's reports and experience reports will be excluded

Table 5. Exclusion strategy

Figure 2 explores the paper selection process. Once the identification of a search string was complete, pilot tests were carried out on the various databases. This meant refining the search strings for each database. However, the terms used to search the database remained constant. The lead author analysed the 9850 publications which were initially retrieved. In order to combat bias, a second reviewer was invited to analyse these same 9850 publications. For a paper to be included, the two reviewers had to be in agreement. Based on the removal of duplicate and non-scientific papers, 5652 papers were removed from initial results. This left 4198 papers, which were then analysed based on title and abstract. The title of each of the 4198 publications gave the reviewers an indication if it was outside the focus of the study. In this case, the publication would be excluded. However, there were many publications where the title was not clear if it was within the focus of the study. Therefore, the publication would remain until the titles, abstracts and keywords were examined. Based on the title, abstracts and keywords of each of the 4198 publications, 4037 papers were removed. In such cases where the abstract was still unclear, the publication would remain until the primary selection stage and the content of the full paper were examined. There were 161 full papers examined at the primary selection stage. Next, the reviewers separately scrutinised the 161 primary studies. An in-depth examination of each paper was conducted. This resulted in 114 further publications being excluded. There was a total of 47 primary studies remaining which are the basis for this SLR.

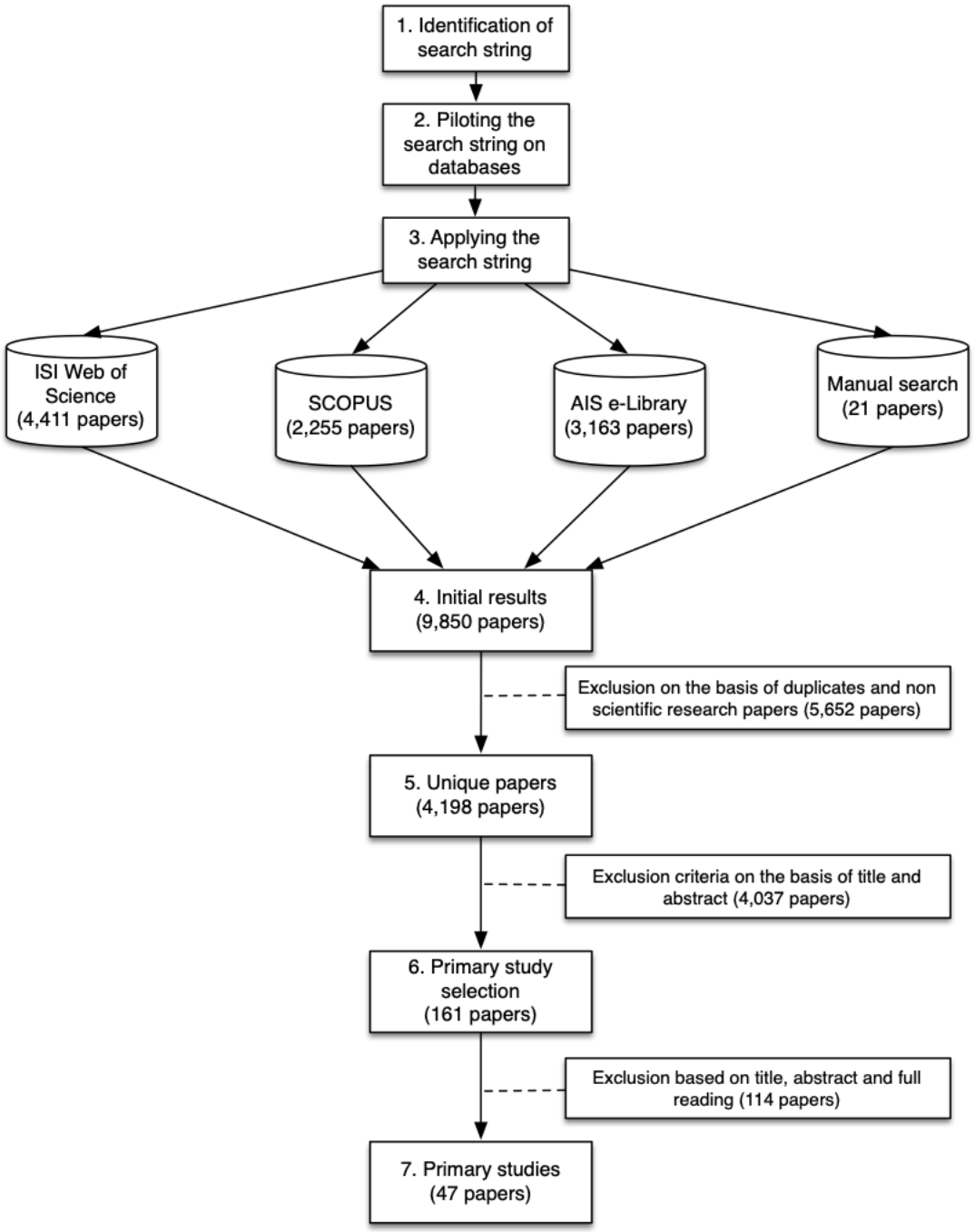

Figure 2. Paper selection process map

Once all possible papers are generated, the quality of the papers is assed (Okoli, 2015) in terms of overall quality and temporal specific quality. Papers which progressed through the practical screening were considered for the quality appraisal stage. The quality appraisal consisted of examining the strength of the papers' evidence. A lack of quality appraisals which were developed or used within IS literature meant that a comprehensive quality appraisal from software engineering was applied for this study. A quality appraisal, adapting the 11 factor criteria proposed by Dybå and Dingsøyr (2008), was applied to the 47 primary papers.

Each of the criteria was graded on a binary ('1' or '0') grade, in which '1' indicates 'yes' to the question, while '0' indicates 'no'. This quality appraisal was carried out by the lead author and an invited second reviewer. Any disagreements were resolved between the reviewers. The quality appraisal questions and primary studies (P) are listed in Appendix A, B and C.

As mentioned, all papers which successfully met the criteria of the practical screening are included in the final list of selected papers (Okoli, 2015). Data was extracted from these selected papers for the synthesis stage. The research questions should determine which data is extracted. Digital forms were used to keep a record of which studies answered the research questions (Okoli, 2015). The data extraction form (Table 6) was externally reviewed within the protocol to eliminate bias (Kitchenham and Charters, 2007). The extraction was employed to evaluate and develop richer data from each study.

Related RQ	Data Extraction
RQ1	What is the current state of temporality research in ISD?
RQ1.1	What number of academic studies on temporality in ISD has been published between 2000 and 2020?
RQ1.2	What are the publication channels used to publish studies on temporality in ISD?
RQ1.3	What data collection techniques have been used in studies on temporality in ISD?
RQ1.4	What kinds of contribution are provided by studies on temporality in ISD?
RQ1.5	What is the quality of the published paper?
RQ2	What characteristics of temporality is being studied in ISD research?
RQ3	What ISD methodology has been used in studies on temporality in ISD?

Table 6. Data extraction

4 Findings

This section provides the findings from the analysis of the 47 primary studies. The findings represent temporality research in ISD based on the following: (i) publication by years, (ii) publication channel, (iii) research methods used in primary studies, (iv) ISD contributions, (v) paper quality, (vi) temporal characteristics studied, and (vii) ISD methodology.

4.1 RQ1.1 Publication by years

The aim of this research question is to identify the number of academic papers which have studied temporality in ISD. Specifically, those studies published between the years 2000 and 2020 (Figure 3). The studies are categorised in three-year groups. Figure three reveals that on average publications on temporality in ISD has increased year on year. From 2000 to 2008, publications on temporality in ISD remained low. Specifically, there were 3 publications between 2000 and 2002. Publications then rose to 6 between 2003 and 2005 and 5 between 2006 and 2008. Over the next three years, between 2009 and 2011, there was a total of 11 publications during the period. Specifically, seven studies were published in 2009, making it the highest number of publications per annum. Between 2012 and 2014, there were 5 temporality in ISD publications. This increased to 8 publications between 2015 and 2017. Finally, the total publications between 2018 and 2020 were 9.

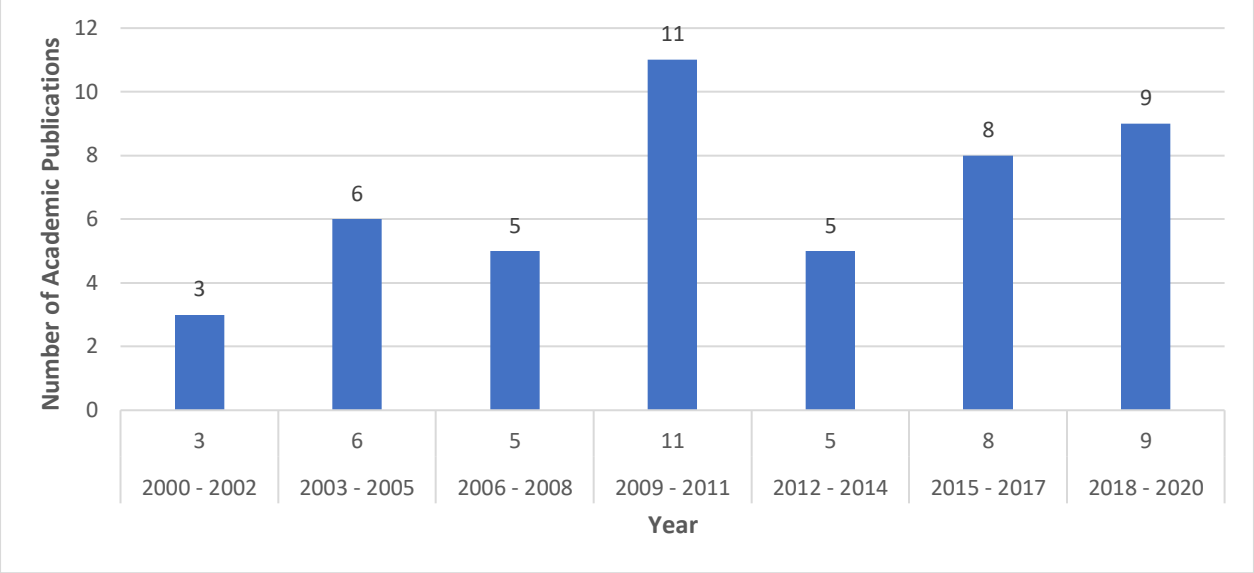

Figure 3. Publications by year

4.2 RQ1.2 Publication channel

The aim of this research question is to identify channels in which temporality in ISD is published. Table 7 shows that 34 of the primary papers were published in the AIS *senior scholars' basket of IS journals* and IT&P, while 13 were published in the top two IS conferences. The highest number of papers were published at ICIS. This conference published a total of eight studies over the 20-years period. The most popular journals were ISR and JMIS. These journals had six publications each during the same period. However, EJIS and JAIS were also popular at five publications each during the same period. IT&P had four publications. JSIS and JIT had the lowest number of publications at one each.

Channel	Title	Acronym	No. of Publications	Primary Study
Journal (n=8)	Management Information Systems Quarterly	MISQ	2	P37, P42
	Information Systems Research	ISR	6	P19, P20, P21, P22, P23, P24
	Journal of Management Information Systems	JMIS	6	P26, P27, P28, P29, P30, P31
	European Journal of Information Systems	EJIS	5	P4, P5, P6, P40, P41
	Journal of Strategic Information Systems	JSIS	1	P32
	Journal of Information Technology	JIT	1	P25
	Journal of the Association for Information Systems	JAIS	5	P33, P34, P35, P36, P43
	Information Systems Journal	ISJ	4	P15, P16, P17, P18
	Information Technology & People	IT&P	4	P44, P45, P46, P47
Conference (n=2)	International Conference on Information Systems	ICIS	8	P7, P8, P9, P10, P11, P12, P13, P14
	European Conference on Information Systems	ECIS	5	P1, P2, P3, P38, P39
Total			47	

Table 7. Publication channels

4.3 RQ1.3 Research methods used in primary studies

The aim of this research question is to identify the research methods and data collection techniques which were used to study temporality in ISD. As this research is concerned with the temporal input into the research process, insights can be drawn from the research methods used in each study. Whereby, this research study's the extent to which a temporal variable was present in the primary paper. There is often an assumption that time is simply and easily understood. However, the goal of this SLR is to understand the complexity of time within each primary paper and to understand the role temporal complexity played in the development process. While in certain instances, it was possible to determine the output of the dependent variable, this was only completed where possible.

Each study was either empirical, theoretical, conceptual, or experimental. Lesson learned, research in progress, editor's reports and experience reports were not included in these studies. A total of 19 primary papers adopted a quantitative method. A total of 20 primary papers adopted a qualitative method. A total of 8 primary papers adopted a mixed method approach.

Further analysis was conducted to determine the data collection techniques of the 47 primary papers. These are listed in Table 8. The survey techniques were used by two primary study papers to collect data. The simulation techniques were adopted by seven primary study papers to collect data. The experiments techniques were applied by five primary study papers to collect data. The use of secondary data was utilised by five primary study papers to collect data. Semi-structured interviews were incorporated by five primary study papers to collect data. An ethnography study was adopted by two primary study paper to collect data. The case study approach was used by eight primary study papers to collect data. The field study approach

was applied by two primary study papers to collect data. Conceptual approaches were used by two primary study papers. There was one study which utilised a hybrid approach to combine two qualitative data collection techniques. A mixed method approach was incorporated by seven primary study papers to collect data.

Method	Techniques	Primary Study
Quantitative	• Survey • Simulation • Experiment • Secondary data	P29, P34 P3, P4, P9, P20, P23, P26, P38 P17, P28, P30, P31, P36 P7, P8, P11, P13, P33
Qualitative	• Semi-structured Interviews • Ethnography • Case Study • Field study • Conceptual • Hybrid	P2, P6, P16, P39, P44 P5, P41 P10, P14, P18, P22, P25, P35, P45, P47 P27, P37 P1, P12 P15
Mixed Method	• Survey • Log Diaries • Semi-structured Interviews • Archival data • Observations • Linguistic analysis • Frequency analysis • Regressions	P19, P21, P24, P32, P40, P42, P43, P46

Table 8. Primary study research methods

Quantitative research methods were determined as the most popular. A total of 19 primary studies adopted the quantitative approach. Of which, a simulation technique is the most popular and is used by seven of the 47 studies. Qualitative research methods were adopted by a total of 20 primary studies, the case study technique was its most popular data collection technique, with a total of eight primary studies using this choice. Mixed method research methods were the least popular. A total of eight studies adopted the mixed method approach.

4.4 RQ1.4 Contributions of primary studies

The aim of this research question is to classify the contributions of temporality in ISD studies. The contributions are adapted from Shaw (2003) and Paternoster *et al*. (2014). The six contribution types are: (i) framework/method/technique, (ii) guidelines, (iii) lessons learned, (iv) model, (v) tool, and (vi) advice/implication. These are further explained in Table 9.

Title	Description
Framework/ Method/ Technique	The contribution of the study is a particular method, or technique, used to facilitate the construction and management of software and systems.
Guidelines	A list of advice or recommendations based on synthesis of the obtained research results.
Lessons Learned	The set of outcomes directly based on the research results obtained from the data analysis.
Model	The representation of an observed reality in concepts or related concepts after a conceptualisation process.
Tool	A technology, program, or application that is developed in order to support different aspects of software engineering.
Advice/Implication	A discursive and generic recommendation based on personal opinion.

Table 9. Contribution type (adapted from Shaw, 2003; Paternoster *et al.*, 2014)

The contribution types, method and data collection techniques of the 47 primary studies are listed in Table 10. The contribution type of the primary papers was categorised based on the contribution mentioned by the authors. In six papers there were more than one contribution type stated. A total of two primary studies made contributions in the form of a method. A total of three primary studies made contributions in the form of guidelines. A total of fifteen primary studies made contributions in the form of lessons learned. A total of 33 primary studies made contributions in the form of a model.

Primary Study	Contribution Types	Research Method	Data Collection Technique
P1	Model	Qualitative	Conceptual
P2	Lessons Learned	Qualitative	Interviews
P3	Model	Quantitative	Simulation
P4	Method	Quantitative	Simulation
P5	Guidelines	Qualitative	Ethnography
P6	Model	Qualitative	Interviews
P7	Lessons Learned	Quantitative	Secondary Data/ Survey
P8	Lessons Learned	Quantitative	Secondary Data
P9	Model	Quantitative	Simulation
P10	Model	Qualitative	Case Study
P11	Model	Quantitative	Secondary Data
P12	Model	Qualitative	Conceptual
P13	Model	Quantitative	Secondary Data
P14	Model and Lessons Learned	Qualitative	Multiple Case Studies
P15	Model	Qualitative	Hybrid/ Log Diaries and Interviews
P16	Method	Qualitative	Interview
P17	Lessons Learned	Quantitative	Experiment
P18	Model	Qualitative	Case Study
P19	Lessons Learned	Mixed Method	Interview/ Survey
P20	Model	Quantitative	Simulation
P21	Model	Mixed Method	Interview/ Survey
P22	Model	Qualitative	Case Study
P23	Model	Quantitative	Simulation
P24	Model	Mixed Method	Interview/ Survey
P25	Model	Qualitative	Case Study
P26	Model	Quantitative	Simulation
P27	Model	Qualitative	Field Study
P28	Model and Guidelines	Quantitative	Experiment
P29	Model	Quantitative	Survey
P30	Model	Quantitative	Experiment
P31	Model	Quantitative	Experiment
P32	Model	Mixed Method	Experiment/ Interview/ Observation/ Archival Data
P33	Model	Quantitative	Secondary Data
P34	Model	Quantitative	Survey
P35	Model and Lessons Learned	Qualitative	Case Study
P36	Model	Quantitative	Experiment
P37	Model	Qualitative	Field Study
P38	Model	Quantitative	Simulation
P39	Model and Guidelines	Qualitative	Interviews
P40	Lessons Learned	Mixed Method	Linguistic Analysis and Frequency Analysis
P41	Lessons Learned	Qualitative	Ethnography
P42	Model and Lessons Learned	Mixed Method	Interview, Correlations and Ordinal Regressions
P43	Model and Lessons Learned	Mixed Method	Case Study, Coding, Content & Sequence Analysis, Descriptive Statistics
P44	Lessons Learned	Qualitative	Interviews
P45	Lessons Learned	Qualitative	Case study
P46	Lessons Learned	Mixed Method	Content Analysis, Interviews, Archival Data
P47	Lessons Learned	Qualitative	Case Study

Table 10. Contributions, method and data collection techniques across studies

4.5 RQ1.5 Paper quality

This research question aims to explore the quality of papers published on temporality in ISD studies. This process involves examining the overall quality of the paper and the temporal specific quality of the paper. The aim is to establish and compare the general quality and the specific temporal quality of the 47 papers. The lead author and an external reviewer independently assessed the qualities of each of the 47 primary papers using the quality assessment criteria proposed by Dybå and Dingsøyr (2008). Both reviewers discussed the comparison and differences in scores until any disagreements were resolved. The quality assessment scores are presented in Figure 4.

For the first screening criterion, the examination of the overall quality of the paper revealed that all 47 papers scored full marks as the aims, context and research design were all clearly reported. However, when the temporal specific quality of the 47 papers were examined, the ratings were slightly lower. In fact, 42 papers clearly reported the temporal specific aims of the study. This meant, five out of the 47 papers did not provide a rationale for why time was undertaken as part of the study. Two of studies did not clearly report the temporal aims and objectives of the study. The remaining three studies used time as a measurement tool. Objective clock-based time is regularly used as a proxy for other concepts and thus rationales for the study of time can be simply explained or ignored completely. A main problem within time research is that time is a main factor in determining success (e.g., deadlines, 2-week sprints). However, researchers rarely study time explicitly. Therefore, while the remaining three studies used time as a measurement tool, they did not clearly state a rationale for why time was undertaken.

There was a further drop in ratings as only 40 papers clearly described the temporal context of the study. For the research design criterion, 43 out of the 47 papers appropriately aligned the research design to address the aims of the temporal research. The analysis of the overall quality of the paper revealed that three of the 47 papers were rated as 0 for recruitment sampling, not due to quality per se, but rather the studies were conceptual papers and recruitment sampling was not applicable. The analysis of the temporal specific quality showed that five of the 47 papers were rated as 0 for recruitment sampling. Of those, three were due to conceptual papers and two were due to an inadequate description of the methods used for identifying and recruiting the sample of the temporal research. The control groups used to compare treatments and temporal treatments were not a popular technique within the 47 papers. Hence, for both the overall quality and the temporal specific quality, 46 papers were rated 0. For the overall quality, the appropriate data collection methods were used and described in 46 out of 47 papers. Similar results were found when the temporal specific quality was examined as the data collection methods which addressed the temporal research issue was applied in 45 out of 47 papers. For the overall quality, the data analysis was sufficiently rigorous in all but two papers. Whereas, the appropriate methods for ensuring the temporal data was analysed and grounded

in the data was adequate in 43 out of the 47 papers. The regular reflection between the researcher and participants was deemed sufficient in 45 out of the 47 papers for the overall quality and 42 out of the 47 for the temporal specific quality assessment. The assessment of the overall quality of the paper indicated that only two papers did not convince the reviewers that the study provided clearly stated findings with credible results and justified conclusions. In comparison to the assessment of the temporal specific quality of the paper, five papers did not provide clearly stated temporal findings with credible results and justified conclusions. By assessing the overall quality of the paper and the temporal specific quality assessment, all studies were deemed to have provided value to research or practice.

Both parts of the quality assessment showed that most of the 47 papers were allocated high marks. This is a reflection of the high standard of journals and conferences in which this study based the SLR. The assessment of the overall quality of the paper exposed that four studies received at least two negative marks. These studies were all papers between 2000 and 2004. The temporal specific quality assessment revealed that most papers treated time to an adequate standard. However, 11 studies received more than three negative marks and four papers received more than five negative marks.

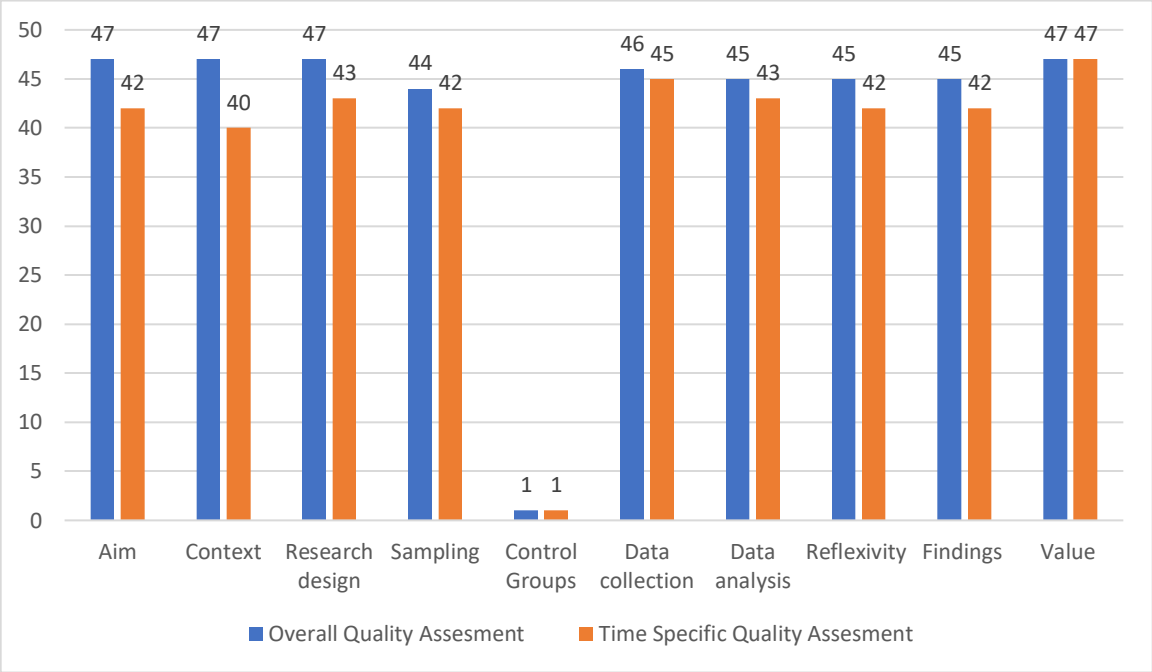

Figure 4. Quality assessment criteria

4.6 RQ2. Temporal characteristics studied

The aim of the research, using Ancona *et al.* (2001) as a lens, is to classify the temporal aspects of these papers so that the body of knowledge about temporality in ISD is examined. Each paper was classified based on the contribution to the temporal characteristics. Table 11 summarises the contribution of temporality in ISD studies.

Category	Subcategory	Temporal Characteristics	Primary Study Contribution
Conceptions of time	Types of time	Linear time, Uniform time Cyclical time	None found
		Clock time	P2, P5, P8, P9, P11, P14, P19, P21, P22, P24, P25, P27, P28, P30, P32, P33, P38, P44, P46
		Objective time	P2, P5, P8, P9, P11, P14, P19, P21, P22, P24, P25, P27, P28, P30, P32, P33, P38, P44, P46
		Subjective time	P14
		Event time	P14
	Socially constructed time	Work organisation	None found
		Celebrations	P5, P10, P14
		Time as a renewing cycle	Non found
		Time as linear continuity	None found
Mapping activities to time	Single activity mapping (a)	Scheduling	P29, P31, P40
		Rate of completion	P11, P16, P27, P28, P33
		Duration	P27
	Repeated activity mapping (aa)	Cycle	None found
		Rhythm	P5, P18, P48
		Frequency	P26, P28
		Interval	P9, P22, P26
	Single activity transformation mapping (aa')	Life cycle	P1, P25
		Midpoint transitions	P35
		Jolts	None found
		Interrupts	P14, P15
		Deadline behaviour	P14, P27
	Multiple activity mapping (ab)	Relocation of activities	P4, P5, P6, P34, P45
		Allocation of time	P17, P23, P42
		Ordering	P3, P5, P6
		Synchronisation	P2, P12, P14, P19, P21, P27, P28, P33, P38, P46
	Comparison and meshing of activity maps (ab) versus (aa)	Entrainment	P18
		Patterning	P9, P13, P15, P26, P28, P32, P33, P35, P43, P47
		Temporal symmetry	P7, P24, P28,
Actors relating to time	Temporal perception	Experience of time	P5, P8, P10, P12, P14, P20, P30, P36, P37, P39, P40, P41
	Temporal personality	Temporal orientation	P14
		Temporal style	P14

Table 11. Temporal characteristics studied

Table 11 summarises the contribution of each temporal characteristic to ISD. Papers which studied conceptions of time were reviewed by the subcategory of types of time and socially constructed time. Out of the 47 papers it was found that there was no contribution to the way in which we define or characterise the continuum of linear time, uniform time and cyclical time. However, many of the papers adopted the view that time is an objective clock-based concept which exists independently of actors. The papers made contributions to objective clock-based time in the form of real time (P2), clock time (P5, P14), cycle time (P8), time delay (P9), repair time (P11), time zone (P19, P24, P28, P33, P38, P44), work hours (P21, P46), and time (day, month, quarter) (P22, P25, P27, P30, P32). There was only one paper which contributed to the way in which we view subjective time and event time. This paper explored the challenge of an over-

reliance on subjective time and an under-reliance on objective time within flow ISD techniques. The paper also explored the challenge of mismatches between clock time and event time within flow ISD techniques (P14). It was found that three papers had contributed to how an organisational actor culturally created time. The temporal characteristic celebration was studied by three papers. The first paper investigated the cultural challenges which exist in globally distributed ISD. The paper found that the various festivals and holidays which exist in a globally distributed ISD team were not factored into performance expectations (P5). The second paper looked at the cultural effect on temporal separation within a globally distributed ISD team. Specifically, the paper examined the availability and unavailability of globally distributed ISD team members for synchronous interaction during the ISD project. The paper drew conclusions around the challenges of holiday unavailability and social unavailability (P10). The third paper drew a similar contribution by finding that socially created time had generated challenges for globally distributed ISD flow environments (P14). There were no contributions to how cultures or groups have culturally constructed a type of time in the form of a work organisation, time as a renewing cycle, or time as linear continuity.

The mapping of activities to time was the most frequent category in which ISD papers contributed. Single activity mapping included the temporal characteristics of scheduling, rate of completion and duration. A total of three papers contributed to scheduling. The first paper found that ISD projects with a higher amount of changes to people and scheduling goals are more likely to miss reaching intended schedules (P29). The next paper found that setting aggressive schedules can help limit the potential of ISD project escalation (P31). The third paper found that there is a relationship between budget or schedule overruns in IS projects and the abstraction of language usage (P40). A total of five papers contributed to the rate at which a task is completed. There is a paper which found large open source communities increases the speed of resolving a defect. The paper also found that adding new software developers to an open source community decreases the speed of resolving a defect (P11). The next paper examined short cycle time systems development. The paper identified five ISD practices which are distinguishable as a new form of short cycle systems development (P16). Another paper developed a conceptual framework of follow the sun (FTS) ISD. The paper identified a range of conditions which need to be present in order for FTS to improve ISD speed (P27). There is a paper which proposes that globally distributed ISD teams can achieve increased speed by managing the communication behaviours of team members. Specifically, in the form of deliberate interventions which control behaviours within time zones (P28). The next paper found that temporal dispersion has a direct relationship to ISD speed of open source projects (P33). Only one paper contributed to the amount of time spent to complete an activity. This paper contributed to ISD by proposing a model which incorporated the factors which affect duration in FTS. While only one paper contributed to duration, several papers included duration as a focus of their study. However, it was only used as a measurement and did not contribute to the way in which we describe, characterise or implement duration.

Repeated activity mapping included the temporal characteristics of cycle, rhythm, frequency and interval. Out of the 47 papers there was not any contribution to the cycle at which an activity is regularly repeated. There were two papers which contributed to rhythm. The first paper identified that globally distributed teams face challenges that are created by different biological and social rhythms. This is due to the various time zones which exist in the distributed environment. These impact on the productivity of the meetings which are close to the deadline (P5). The second paper contributed to ISD by finding that working rhythms are alternated due to routinised and improvised developer interactions (P18). There were two papers which contributed to the frequency. The first paper examined the frequency of users which modify, delete or create a particular database. The research suggests that virtual institutions can implement a channel-integration strategy only if their architectures support frequent realignments among channels (P26). The next paper found communication frequency and turn-taking have differentiated effects on the transmission of information (P28). There were three papers which contributed to the interval, which is the interval between repetitions of the activity (Ancona *et al.*, 2001). There is a paper which contributed to ISD by advancing a software reliability model which tested the assumptions of software fault intervals (P9). Another paper developed a framework for understanding and capturing spatiotemporal set-based constraints which includes a factor on time intervals (P22). The next paper provided a model that can help companies analyse the impact of software architectural choices. The study found that if interval times exceed more than 60 hours, then a functional integration strategy should be implemented (P26).

Single activity transformation mapping included the temporal characteristics of life cycle, midpoint transitions, jolts, interrupts and deadline behaviour. A total of two papers contributed to life cycle. The first paper developed a model which incorporates IS evaluation into the lifecycle of ISD (P1). The second paper developed a theory that explains how requirements evolve throughout the enterprise software life cycle (P25). Only one paper contributed to midpoint transition. This paper studied midpoint positions within an ISD project. The paper found that in the middle and later periods of the project, improvisation emerged more regularly and became more present in practice cycles (P35). There was no paper which made a contribution to the temporal characteristics jolt. A total of two papers made a contribution to interruption. There is a paper which found that technological impediments were disrupting the flow of work in ISD teams (P14). Another paper develops a taxonomy that classifies interruptions (P15). A total of two papers contributed to deadline behaviour. There is a paper which found that ISD teams would abandon the use of flow tools and practices when deadlines approach. This was due to the increased pace of work during this period (P14). Another paper found that time-boxing increases in FTS team member productivity as the deadline approaches (P27).

Multiple activity mapping included the temporal characteristics of relocation of activities, allocation of time, ordering and synchronisation. A total of five papers contributed to relocation of activities. There is a paper which provides a structured analysis of the benefits and assumptions of agile and plan based requirements

prioritisation methods (P4). There is a paper which provides strategies which assist globally distributed ISD teams when relocating their time (P5). Another paper provides a new value-based view of prioritisation techniques for requirements (P6). The next paper considered the impact of scheduled as well as unscheduled changes in resource allocation for an ISD project. The results show that the less testing resources remaining after reallocation, the firm is better off releasing the software earlier (P34). The final paper argues for a re-examination of the suitability of current planning practices in light of the complexity of developing electronic business systems (P45). A total of three papers contributed to allocation of time. The first paper found that the planning fallacy influences time underestimation of various software features (P17). The next paper found that the IS planning maturity is empirically and positively linked to both project success and project manager performance (P23). The final paper provides insights into how project planning and control mechanisms affect mutual understanding through their influence on sense giving and sensemaking (P42). A total of three papers contributed to ordering. There is a paper which proposed a model which incorporates private risks within project valuation for follow-up projects (P3). Another paper found that there was confusion caused by the jumbled sequence of chat messages between globally distributed ISD teams. The paper provides strategies of resolution in developing norms of messaging between the teams (P5). Another paper provides a new value-based view of prioritisation techniques for requirements (P6). A total of ten papers contributed to synchronisation. A paper found that synchronous communication was perceived to provide the instigator with more control (P2). Another paper contributes to ISD by creating a conceptual framework of organisational temporality. The framework includes a sub dimension on temporal coordination (P12). The next paper found that temporal personality led to a lack of synchronisation within an ISD team (P14). Another paper introduced a new form of coordination strategy which included a focus on time zone challenges (P19). A paper developed and empirically tested a relational model of coordination delay. The paper found that the use of synchronous web conferencing reduces coordination delays for team members in different cities with overlapping work hours (P21). Another paper found that understanding calendar efficiency, handoff efficiency, within-site coordination, and cross-site coordination is necessary for the evaluation in FTS development (P27). The next paper found that working across temporal distance improves development speed, but it creates coordination challenges and affects quality (P28). There is one paper which found that software complexity moderates the relation between temporal dispersion and software quality (P33). The next paper contributes to the management of the virtual teams by proving guidance on how to coordinate communications and what to focus the efforts on, given the different levels of project complexity (P38). The final paper studied temporal coordination through communication: using genres in a distributed software development start-up and found that structuring communication and work process is an important mechanism for the temporal coordination of dispersed activities (P46).

Comparison and meshing of activity included the temporal characteristics of entrainment, patterning, and temporal symmetry. Only one paper contributed to entrainment. This paper found that the process of games

development alternates between routinised and improvised practices, which sediment and flux the working rhythms (P18). A total of ten papers contributed to patterning. There is one paper which found that the pattern of variation during the testing of the delay with time can be related to the learning acquired by the testing team and the complexity of finding hidden software faults (P9). The next paper found that open source software development processes have disordered patterns in the initial stage of the projects, but gradually conform to multiple patterns (P13). Another paper examined interruptions added to the duration of a project and occurred through three interrelated patterns (P15). Another paper develops a mathematical model to evaluate time-related measures. The model is simulated to compare data accuracy and completeness in financial institutions characterised by different size and patterns of customers data (P26). The next paper proposes how to adjust team interaction patterns to achieve the desired performance goals (P28). There is one paper which found that distributed and co-located teams performing the same task differ in their patterns of communication and knowledge sharing, and in their performance (P32). Another paper found that managing the temporal work patterns of virtual teams for complex programs seems valuable (P33). The next paper found that the different forms of improvisation followed a pattern over the ISD project (P35). Another paper showed that the effect of method on software design activities is smaller than assumed and the impact of designer and project conditions on software processes and outcomes should thus not be understated (P43). The final paper found that a software development organisation increased their ability to learn broadly, deeply, and quickly by inventing, selecting and configuring learning routines (P47). A total of three papers contributed to temporal symmetry. A paper found that teams that experienced low temporal dispersion performed better than teams that experienced high temporal dispersion regardless of their nationality diversity (P7). There is a paper which highlights the negative implications of the lack of time zone overlaps between distributed members (P24). There is one paper which suggested that managers should adopt practices that discourage interactive communication to minimise turn taking during work time overlap windows and during task phases (P28).

Papers which studied actors relating to time were reviewed by the subcategory of temporal perception and temporal personality. Temporal perception includes the temporal characteristics of experience of time, time passing, time dragging, experience of duration and experience of novelty. A total of twelve papers contributed to experience of time. There is one paper which found that ISD teams faced problems arising from clock time differences and subjective interpretations. This paper also came up with strategies to resolve these issues (P5). The next paper developed an intuitive and effective measurement of time pressure in the context of software engineering management (P8). Another paper identified relevant cultural differences and multiple manifestations of cultural influence on temporal separation in globally distributed ISD (P10). There is a paper which contributes to ISD by creating a conceptual framework of organisational temporality. The framework includes a sub dimension on execution style (P12). A paper reveals that ISD teams face problems with different interpretations of time conceptions (P14). The next paper examined the effects of

time pressure on quality in software development (P20). There is a paper which found that anticipated guilt about launching the product as scheduled mediated the relationship between perspective-taking and de-escalation (P30). Another paper found that both fault responsibility and time urgency can have significant effects on an individual's willingness to report bad news in ISD project (P36). The next paper provides a new understanding as to how the nonhuman and human agencies involved in coordination are embedded in the past, present, and future (P37). The subsequent paper provides a number of differences between agile and sequential projects concerning time pressure (P39). The next paper provides a potential early warning signal for overruns in IS projects and propose that signals of the planning fallacy can be detected in a project's business case (P40). The final paper revealed that workplace play has multiple instrumental aspects which are related to the temporality, spatiality, materiality and sociality of IT work practices (P41).

Temporal personality includes the temporal characteristics of temporal orientation and temporal style. There was only one paper which contributed to temporal orientation, which refers to a broader, more complete set of characteristics that specify an actor's approach to time (Ancona *et al.*, 2001). This paper found that different time horizons emerged from the various team members and this caused issues to the flow of ISD work (P14). There was only one paper which contributed to temporal style. This paper found that there were temporal personality influences leading to a lack of synchronisation with ISD teams (P14).

4.7 RQ3. ISD methodology

The aim of this research question is to classify each of the 47 papers into an ISD methodology and the related temporal characteristics studied. Table 12 summarises the ISD methodology and temporal characteristics found in the temporality in ISD studies.

Primary Study	ISD Methodology	Temporal characteristic
P1	No specified method	Lifecycle
P2	No specified method	Clock and objective time, Synchronisation
P3	No specified method	Ordering
P4	Comparing of multiple methods (plan based and agile development)	Relocation of activities
P5	No specified method	Clock and objective time, celebrations, rhythm, ordering, experience of time
P6	No specified method	Relocation of activities, ordering
P7	No specified method	Temporal symmetry
P8	No specified method	Clock and objective time, experience of time
P9	No specified method	Clock and objective time, Interval, patterning
P10	No specified method	Celebrations, experience of time
P11	Open source software	Clock and objective time, rate of completion
P12	No specified method	Synchronization, experience of time
P13	Open source software	Patterning
P14	Flow	Clock, objective, subjective, and event time, interrupts, deadline behaviour, synchronisation, experience of time, temporal orientation, temporal style
P15	No specified method	Interrupts, patterning
P16	Agile	Rate of completion
P17	No specified method	Allocation of time
P18	No specified method	Rhythm, entrainment
P19	No specified method	Clock and objective time, synchronisation
P20	No specified method	Experience of time
P21	No specified method	Clock and objective time, synchronisation
P22	No specified method	Clock and objective time, interval
P23	No specified method	Allocation of time
P24	Agile	Clock and objective time, temporal symmetry
P25	No specified method	Clock and objective time, life cycle
P26	No specified method	Frequency, interval, patterning
P27	Agile	Clock and objective time, rate of completion, duration, deadline behaviour, synchronisation
P28	No specified method	Clock time, objective time, rate of completion, frequency, synchronisation, patterning, temporal symmetry
P29	No specified method	Scheduling
P30	No specified method	Clock and objective time, experience of time
P31	No specified method	Scheduling
P32	No specified method	Clock and objective time, patterning
P33	Open source software	Clock and objective time, rate of completion, synchronisation, patterning
P34	No specified method	Relocation of activities
P35	No specified method	Midpoint transitions, patterning
P36	No specified method	Experience of time
P37	No specified method	Experience of time
P38	No specified method	Clock and objective time, synchronisation
P39	Comparing of multiple methods (Sequential and agile development)	Experience of time
P40	Comparing of multiple methods (Hybrid/ Agile and waterfall)	Scheduling, experience of time
P41	No specified method	Experience of time
P42	Comparing of multiple methods (Agile and no specified method)	Allocation of time
P43	Comparing of multiple methods (Hybrid/ Agile and waterfall)	Patterning
P44	No specified method	Clock and objective time
P45	No specified method	Relocation of activities
P46	No specified method	Clock and objective time, Synchronisation
P47	Comparing of multiple methods	Patterning

	(Hybrid/ Agile and waterfall)	

Table 12. ISD methodology

Table 12 summarises the ISD methodology and the related temporal characteristics studied. The comparison of multiple methods was used by six papers. The first paper examined plan based and agile development methodology. This paper examined the relocation of activities (P4). The second paper explored sequential and agile development methodology. This paper studied the experience of time (P39). In the comparison of multiple methods, mapping activities to time and actors relating to time were used. However, there were no contributions to conceptions of time. The third paper evaluated a hybrid, agile and waterfall development methodology. This paper examined scheduling and experience of time (P40). The fourth paper assessed an agile and no specified method. The paper also examined the allocation of time (P42). The fifth paper evaluated a hybrid, agile and waterfall development methodology. The paper addressed patterning (P43). The sixth paper examined an ISD context involving hybrid, agile and waterfall development methodology. The paper also addressed patterning (P47).

The open source software methodology was studied in three papers. The first paper studied clock time, objective time, and rate of completion (P11). The second paper examined temporal patterning (P13). The third paper explored clock time, objective time, rate of completion, synchronisation, and patterning (P33). Although open source software was the most popular method chosen to study temporal characteristics, the studies were also limited to objective clock conceptions of time. While multiple activity mapping was studied in all papers, there was no paper which examined the actor's relationship to time.

The flow methodology was studied by only one paper. However, it encompasses all three categories of time, including clock time, objective time, subjective time, event time, interrupts, deadline behaviour, synchronisation, experience of time, temporal orientation, and temporal style (P14). This was the only ISD specific methodology paper which explored all three categories of time.

Agile as a single method was studied by two papers. The first paper studied clock time, objective time, and temporal symmetry (P24). The second studied clock time, objective time, rate of completion, duration, deadline behaviour, and synchronisation (P27). Agile methodology was similar to how the open source software methodology examined temporal characteristics. Conceptions of time were overshadowed by objective clock time. Mapping activities to time characteristics were prevalent in these studies. While the actor's relationship to time was not studied.

A total of 35 papers did not specify an ISD methodology. This reveals the major research gap within temporal ISD methodology papers. A further analysis showed that 24 of the 35 papers studied ISD projects generally (P1, P3, P6, P8, P9, P12, P17, P18, P19, P20, P22, P23, P25, P26, P29, P30, P31, P34, P35, P36, P37, P40, P42, P44). ISD projects generally incorporated all three categories of time. A total of eight of the 35 papers studied distributed teams (P2, P5, P7, P10, P21, P28, P32, P38). Distributed teams incorporated all three categories of time. Two papers studied individual team members (P15, P41). The first study

explores mapping activities to time and the second study explores actor's relationship to time. Similarly, only one paper studied co-located teams (P32). This study investigated conceptions of time and mapping activities to time.

5 Discussion

In this section, we summarise the SLR findings. Followed by theoretical contributions and implications for practice. We also discuss threats to validity and limitations.

5.1 Summary of findings

This study is a SLR that provides a comprehensive overview on temporality in ISD related papers. The search strategy resulted in 9850 studies of which 47 were identified as primary papers. To delve into the fundamental context of time and ISD studies, we classified and examined the articles based on publication by years, publication channel, research methods used in primary studies, ISD contributions, and paper quality. Our findings show that on average, temporality in ISD papers are on the rise each year. Our findings also show that the highest number of papers were published at ICIS. ICIS published more temporality in ISD papers than ECIS with eight and five publications respectfully. While ISR and JMIS published six temporality in ISD papers each. This makes them the most published temporality in ISD journals within the *senior scholars' basket of IS journals*. JSIS, and JIT published the least amount of temporality in ISD papers with one publication each. Our findings additionally show that qualitative research methods were more frequently used to study temporality in ISD. While quantitative methods were used slightly lower, this means that both methods were deemed a popular choice by researchers. A mixed method approach was used least by researchers. However, a mixed method approach was the most popular approach over the last two years of the review (2018-2020). Nonetheless, the study revealed a clear focus on simulation techniques and case study approaches as they were the most popular data collection technique used. While experiments techniques, use of secondary data and semi-structured interviews saw some regularity. Survey techniques, ethnography study, field study, conceptual approaches and hybrid approach were deemed least popular methods of data collection. Models were by far the most popular contribution type of the primary studies. Contributions in the form of methods, guidelines and lessons learned saw some frequency but were deemed least popular. There were no studies which contributed to tools or advice/implications. The paper quality of temporality in ISD literature was found to be of high quality. Although papers study time, some do not provide a rationale for why time was undertaken as part of the study. Instead, clock-based time is used as a measurement or time is the implicit focus of the study. Within such studies, it is often the time-based element that is the difference between success and failure. While researchers may not set out to study time, it becomes the dominant factor of the study. Furthermore, time is often the most important aspect of the research question, but many researchers do include time in the research question. When time is a part of the

research question, the researchers hold simple assumptions about time (e.g., faster is better). However, time is multifaced, social embedded and complex.

Next, we delved into a structured analysis of the temporal characteristics studied within ISD. Time in ISD studies to date have merely called for more comprehensive studies within the area, studied a singular temporal characteristic, or neglected other possible temporal relationships (Saunders and Kim 2007; Waller *et al.*, 2001; Lee and Liebenau 2000). A literature review based on time in IT meditated teams (Shen *et al.*, 2014) revealed some similar findings within their area of study, namely time is fragmented and lacks integration between categories, clock time dominates the literature, mapping activities to time focuses on singular projects and actor's relationship to time was neglected. Our findings show that many of the temporal characteristics of the Ancona *et al.* (2001) framework have been studied in the context of ISD. However, the research is fragmented and lacks integration between categories of time. From this analysis, some notable gaps emerged. There is a dominant objective clock-based view of time which exists in temporality ISD papers. The types of time subcategory were the most commonly studied. Specifically, clock and objective time are relied upon heavily. As clock time underlines these papers it means ISD literature does not address the full understanding of temporal complexity. The study of clock and objective time has served different functions, namely increased ISD delivery times and time zone challenges. However, these papers do not expand beyond the confines of clock time. Due to this singular coverage of clock time, other types of time are overlooked. Linear time, uniform time, cyclical time, subjective and event time, as additional perspectives were not widely used by researchers to gain a deeper and richer understanding of ISD. Researchers also overlooked the study of socially created time in making sense of ISD. ISD literature lacks the study of time as a social phenomenon. Specifically, ISD literature lacks the consideration that time is socially constructed and understood through human action, structured and enacted by different practices.

While many of the ISD literature mentions many of the temporal characteristics that Ancona *et al.* (2001) uses in the mapping activities to time, category and explicit contributions to these are minimal. This means that ISD literature is filled with temporal references but studies which contribute to these temporal characteristics remain insufficient. The papers make little contribution to scheduling and duration of a single activity and only touch on rate of completion. The papers do not contribute to cycle of a repeated activity and lightly touch on rhythm, frequency and interval. The papers do not contribute to the transformational jolt of a single activity and lightly touch on life cycle, midpoint transitions, interrupts and deadline behaviour. Contributions to synchronisation of multiple activity mapping saw regularity but relocation of activities, allocation of time, and ordering saw slight contributions. The papers made contributions to patterns between comparison and meshing of activities but saw minimum contributions to entrainment and temporal symmetry. We noticed that papers largely contribute to single ISD projects and rarely contribute to multiple ISD projects operating simultaneously. In reality, ISD environments are complex and consist of

multiple projects occurring instantaneously, which are often interwoven across multiple teams, locations and temporal conditions such as rate, pace and rhythm.

We noticed that the number of temporal perception publications have seen some uptake. However, there is a lack of research on both temporal perception and temporal personality. We concluded that the majority of temporal perception studies tended to focus only on time pressure in ISD projects and the differences in time perception between globally distributed teams. This means that temporal perception is studied in limiting areas and ignores many other possible areas of contribution within ISD. Furthermore, temporal personality is almost completely ignored in ISD literature. This indicates that the temporal personality research is in much need of attention. Also, as each category of the temporal complexity framework is interrelated, the study revealed that publications which focus on conception of time and mapping activities to time categories neglect the possible influences temporal perception and temporal personality may have on these studies.

We concluded that there is a significant gap of ISD methodology (such as agile, flow and open source) related papers which study temporal characteristics. Although many of the papers were ISD, they also did not specify a method (such as agile, flow and open source) in which was used to develop the IS. We noticed that the ISD methodology (such as agile, flow and open source) papers commonly mention and discuss temporal characteristics, but contributions to such are minimal. Interestingly, only twelve ISD methodology (such as agile, flow and open source) papers made a contribution to a temporal characteristic. Furthermore, these studies also lacked the integration between categories of time. Open source software methodology papers examined time in terms of conceptions of time and mapping activities to time but did not explore influences from actors relating to time. A flow technique paper was the only one which studies time in all three categories, including contributions to temporal personality. Agile methodology papers touched on conceptions of time, mapping activities to time and actors relating to time. However, this did not include contributions to temporal personality but rather temporal perception.

5.2 Theoretical contribution

Firstly, ISD is characterised by time with relentless focus on improving speed of development. ISD literature is filled with temporal characteristics. Yet, a comprehensive review of what is known about time in ISD is lacking. This work has developed the first SLR on time in ISD. It delivers an in-depth comprehensive examination of time within an ISD context. It provides a structured analysis of trends and gaps in the field. Secondly, it applies another application of the temporal complexity framework by Ancona *et al.* (2001) in an ISD context. This framework can be used by other IS researchers for SLR methodologies or indeed a more practical context. It exposes that time is indeed multi-layered and interrelated. Thirdly, this SLR tests the assumption about what we know about time in ISD literature. This SLR contributes to ISD by finding the following gaps in the literature: (1) clock time is dominant and all other types of time are under

researched; (2) contributions to mapping activities to time is lacking and existing studies focus on single ISD projects rather multiple complex ISD projects; (3) research on actors relating to time is lacking; (4) existing ISD studies which contribute to temporal characteristics are fragmented and lack integration with other categories of time; and (5) ISD methodology papers (such as agile, lean, flow) lack contributions to temporal characteristics and fail to acknowledge and contribute to time as a multifaced interrelated concept. As such, researchers and experts, for instance, may use the result of this study as an initial point for their research.

5.3 Implications for practice

This SLR has implications for designers and practitioners involved in designing or implementing ISD methodologies (such as agile, lean, flow). Firstly, the study shows that current consideration of time in ISD is inadequate. The study validates earlier calls for more research within the area. It indicates multiple areas where time is singularly focused, simplistic in its treatment and possible influences from actors is ignored. Secondly, a valuable starting point for practitioners may be to consider time as classified by Ancona *et al.* (2001). Practitioners which are using ISD methods rarely reflect on the possible impact that temporal characteristics such as temporal perception and temporal personality have on the ISD environment. ISD method practitioners can then reflect on their current assumptions about time at an individual, team or management level. ISD practices and tools can also be re-evaluated to test assumptions about time. Workshops and training could be given to ISD teams to critique these assumptions and provide an evaluation for ISD challenges caused by temporality influences. Recommendations could then be developed to improve ISD delivery efficiency. In addition, the lesser studied temporal characteristics could reveal the opening for new methods based on these characteristics. For example, event-based methods that can outperform existing ISD methods.

5.4 Validity threats and limitations of the study

There are a number of threats to the validity of this SLR, which is common within this type of study (Petersen *et al.*, 2015; Wohlin *et al.*, 2012). This section explores these threats to the validity and the limitations of the study. The validity framework by Wohlin *et al.* (2012) examines validity threats in terms of (i) construct validity, (ii) external validity, (iii) internal validity, and (iv) conclusion validity. *Construct validity* states that the author must attain the right measures for the concept under study (Petersen *et al.*, 2015; Wohlin *et al.*, 2012). To achieve this, the SLR followed a structured eight-step guideline which is required to conduct a scientifically rigorous SLR (Figure 1). Within the guidelines, steps included the paper selection process (Figure 2) which documents the process of filtering papers from the original 9850 to the 47 primary papers. To add to the mitigation of this threat, authors two and three had experience in systematic mapping studies and SLR's and thus provided regular feedback to strengthen construct validity of the process. *External validity* is concerned with generalisability of the study. That is, the extent to which the

study can be generalised to other areas outside of the context of this study (Petersen *et al.,* 2015; Wohlin *et al,* 2012). As this followed the thorough eight-step guideline by (Okoli, 2015), it attributed to mitigating the threats to validity. *Internal validity* is concerned with statistical causal relationships within the study. As the aim of the study was not to establish a statistical causal relationship, other mitigations were used to minimise threats to internal validity. This was carried out in the form of regular meetings with all authors to explore any possible bias within the SLR. *Conclusion validity* is concerned with the potential bias which may emerge in the interpretation of data. Strategies were used to reduce such threats: (i) three authors were involved in data extraction of the primary papers, (ii) the starting 9850 papers to the 47 primary papers was kept to provide a full 'audit trail', and (iii) conclusions drawn from analysis of the 47 primary papers involved all three authors.

Although this paper concentrated on mitigating threats to validity through the use of well-established strategies, the SLR has some limitations which needs to be mentioned. Firstly, a limitation of the study is that there is a risk of overlooking important contributions to time in ISD from papers outside of leading journals and conferences and non-IS outlets. In order to obtain a manageable number of articles, we chose an approach which would cater for the analysis of papers from a sample group of journals and conference proceedings known for their quality publications. Secondly, our focus is to utilise the full extent of temporality as defined by the Ancona *et al.* (2001) framework. This meant the search string was not compromised or limited. Instead, the search string included 37 time synonymies from the Ancona *et al.* (2001) framework. On the other hand, these search terms, though robust, have limitations. The concept of temporality is subtle and multifaced and we acknowledge that some papers which may be relevant might not mention words from our search string but may refer to temporality.

6 Conclusion and future research

Macro conditions (e.g., rapidly changing markets, policy changes) and micro conditions (e.g., regularly changing software requirements, change in organisational structure) all cause a turbulent ISD environment. The ISD teams in such an environment are often globally distributed and face regular synchronisation issues caused by a range of temporal complexities. In addition, management places increasing pressure to achieve a faster time-to-market. There are various ISD methods which are considered to be an effective way for managing ISD projects in tumultuous and time-sensitive environments. However, although ISD literature references and discusses time, a comprehensive review of what is known about time in ISD is lacking. Furthermore, the existing time discussions have over-relied on the simplistic clock-based view of time. Thus, time is conceived as one-dimensional and objective. A gap exists which conceives time as subtle, subjective, and socially embedded. This study answers the call from earlier researchers to study time in IS (e.g., Lee and Liebenau 2000; Waller *et al.,* 2001; Saunders and Kim 2007; O'Riordan *et al.,* 2013). This SLR examines the body of knowledge about time in ISD. This work has developed the first SLR on time in

ISD and provides a structured analysis of trends and gaps in the field. The study provides many new findings to the field of ISD through the utilisation of conceptions of time, mapping activities to time, and actors relating to time. This study provides a starting point for ISD researchers and ISD practitioners to test their commonly held temporal assumptions.

We found many gaps in which future researchers can focus. There is a gap in the contribution type of methods, guidelines and lessons learned, and advice/implications in which researchers make to the field. Studies, which consider time as more than just a singular focus of objective clock time, need to emerge. Linear time, uniform time, cyclical time, subjective time and event time are all types of time which ISD studies need to consider. Furthermore, research needs to explore how socially constructed time influences the ISD environment. Many of the ISD papers frequently refer to organising time. However, a lack of contributions to these mapping activities to time characteristics reveals a gap in the field. While temporal perception has seen an increase in coverage, it's still limited to time pressure in ISD projects and differing temporal perception between globally distributed teams. Temporal personality was only studied by one paper and thus reveals a gap in this area. Interestingly, contributions to time in ISD has been largely attributed to non-specified ISD methods. ISD methodology papers, such as agile, flow, and open source, need to study and make contributions to temporal characteristics. Thus, we make a call for future ISD studies to examine time as a broad and interrelated concept.

7 References

Ancona, D. G., Okhuysen, G. A., and Perlow, L. A. (2001), "Taking time to integrate temporal research", *Academy of Management Review*, Vol. 26 No. 4, pp. 512-529.

Antunes, V. and Moreira, J.P., (2011), "Approaches to developing integrated care in Europe: a systematic literature review", *Journal of Management & Marketing in Healthcare*, Vol. 4 No.2, pp.129-135.

Austin, R. D. (2001), "The effects of time pressure on quality in software development: an agency model", *Information Systems Research*, Vol. 12 No.2, pp. 195-207.

Avnet, T. and Sellier, A.L. (2011), "Clock time vs. event time: temporal culture or self-regulation?", *Journal of Experimental Social Psychology*, Vol. 47 No.3, pp.665-667.

Bartis, E., and Mitev, N. (2008), "A multiple narrative approach to information systems failure: a successful system that failed", *European Journal of Information Systems*, Vol. 17 No.2, pp. 112-124.

Baxter, P. and Jack, S., (2008), "Qualitative case study methodology: study design and implementation for novice researchers", *The Qualitative Report*, Vol. 13 No.4, pp.544-559.

Beraldi, S.D. and Abades, P.M., (2014), "Bibliographic study of bonding: caring for the mother-child attachment", *Revista de Enfermeria*, Vol. 37 No.1, pp.18-25.

Bluedorn, A. C., and Denhardt, R. B. (1988), "Time and organizations", *Journal of Management*, Vol. 14 No.2, pp. 299-320.

Boell, S.K. and Cecez-Kecmanovic, D., (2014), "A hermeneutic approach for conducting literature reviews and literature searches", *Communications of the Association for Information Systems*, Vol. 34, p.12.

Brady Germain, P., and Cummings, G.G., (2010), "The influence of nursing leadership on nurse performance: a systematic literature review", *Journal of Nursing Management*, Vol. 18 No.4, pp.425-439.

Caldas, C. P., and Berterö, C. (2012), "A concept analysis about temporality and its applicability in nursing care", *Nursing Forum: Wiley Online Library*, pp. 245-252.

Conboy, K. (2009), "Agility from first principles: reconstructing the concept of agility in information systems development", *Information Systems Research*, Vol. 20 No.3, pp.329-354.

Crossan, M.M. and Apaydin, M., (2010), "A multi-dimensional framework of organizational innovation: A systematic review of the literature", *Journal of Management Studies*, Vol. 47 No.6, pp.1154-1191.

Crossan, M., Cunha, M.P.E., Vera, D., and Cunha, J. (2005), "Time and organizational improvisation", *The Academy of Management Review*, pp. 129-145.

Ciborra, C.U., (1999). "Notes on improvisation and time in organizations", *Accounting, management and information technologies*, Vol. *9* No.2, pp.77-94.

DeLuca, D. and Valacich, J.S., (2006). "Virtual teams in and out of synchronicity", *Information Technology & People*. Vol. 19 No. 4, pp. 323-344.

Dingsøyr, T. and Lindsjørn, Y., (2013), "Team performance in agile development teams: Findings from 18 focus groups", *In International Conference on Agile Software Development*, pp. 46-60. *Springer, Berlin, Heidelberg.*

Durkheim, E. (1915), *The Elementary Forms of the Religious Life*, London: Allen & Unwin.

Dwivedi, Y.K., Wastell, D., Laumer, S., Henriksen, H.Z., Myers, M.D., Bunker, D., Elbanna, A., Ravishankar, M.N. and Srivastava, S.C., (2015), "Research on information systems failures and successes: Status update and future directions", *Information Systems Frontiers*, Vol. 17 No.1, pp.143-157.

Dybå, T. and Dingsøyr, T. (2008), "Empirical studies of agile software development: a systematic review", *Information and Software Technology*, Vol. 50 No.9, pp.833-859.

Einstein, A. (1945), "A generalization of the relativistic theory of gravitation", *Annals of Mathematics*, pp.578-584.

Einstein, A., (1905), On the special theory of relativity. *Annals of Physics*, Vol 17, pp.891-921.

Fink, A., (2005), *Conducting research literature reviews: From the internet to paper*, Sage.

Fitzgerald, B., Hartnett, G. and Conboy, K., (2006), "Customising agile methods to software practices at Intel Shannon", *European Journal of Information Systems*, Vol. 15 No.2, pp.200-213.

Fraisse, P. (1963), *The psychology of time*, New York: Harper.

Friedman, W. J. (1990), *About Time: Inventing the Fourth Dimension*, Cambridge, Mass.: MIT Press.

Garcia-Crespo, A., Colomo-Palacios, R., Soto-Acosta, P. and Ruano-Mayoral, M., (2010), "A qualitative study of hard decision making in managing global software development teams", *Information Systems Management*, Vol. 27 No.3, pp.247-252.

George, J. M., and Jones, G. R. (2000), "The role of time in theory and theory building" *Journal of Management*, Vol. 26 No.4, pp. 657-684.

Gimenez, C and Tachizawa, M. (2012), "Extending sustainability to suppliers: a systematic literature review", *Supply Chain Management: An International Journal*, Vol.17 No.5, pp. 531 – 543

Ginieis, M., Sánchez-Rebull, M.V. and Campa-Planas, F., (2012), "The academic journal literature on air transport: analysis using systematic literature review methodology", *Journal of Air Transport Management*, Vol. 19, pp.31-35.

Grahlmann, K.R., Helms, R.W., Hilhorst, C., Brinkkemper, S. and Van Amerongen, S., (2012), "Reviewing enterprise content management: a functional framework", *European Journal of Information Systems*, Vol. 21 No.3, pp.268-286.

Green, N., (2002). "On the move: Technology, mobility, and the mediation of social time and space", *The information society*, Vol. 18 No.4, pp.281-292.

Guerrier, Y., (2016), "Modern Day 'Schmidts': The legacy of taylorism in elite 'professional'roles". *Re-Tayloring Management: Scientific Management a Century On*, p.155.

Goyal, S., Ahuja, M. and Guan, J., (2018), "Information Systems Research Themes: A Seventeen-year Data-driven Temporal Analysis", *Communications of the Association for Information Systems*, Vol. 43 No.1, p.23.

Schriber, J. B., and Gutek, B. A. (1987), "Some time dimensions of work: Measurement of an underlying aspect of organization culture", *Journal of Applied Psychology*, Vol. 72 No.4, pp. 642.

Hawking, S, W. (1993), *A brief history of time: from the big bang to black holes*. New York: Bantam.

He, J., Butler, B.S. and King, W.R., (2007), "Team cognition: development and evolution in software project teams", *Journal of Management Information Systems*, Vol. 24 No.2, pp.261-292.

Heidegger, M. (1927), *Being and time*, Oxford: Blackwell Publishing.

Hongladarom, S., (2002). "The web of time and the dilemma of globalization", *The Information Society*, Vol 18 No.4, pp. 241-249.

Im, H.G., Yates, J. and Orlikowski, W., (2005). "Temporal coordination through communication: using genres in a virtual start-up organization", *Information Technology & People*, Vol. 18 No. 2, pp. 89-119.

Kamp, A., Lambrecht Lund, H. and Søndergaard Hvid, H. (2011), "Negotiating time, meaning and identity in boundaryless work", *Journal of Workplace Learning*, Vol. 23 No.4, pp.229-242.

Kavanagh, D., and Araujo, L. (1995), "Chronigami: folding and unfolding time", *Accounting, Management and Information Technologies*, Vol. 5 No.2, pp. 103-121.

Keil, M., Mann, J., and Rai, A. (2000), "Why software projects escalate: an empirical analysis and test of four theoretical models", *MIS Quarterly*, pp. 631-664.

Kitchenham, B., (2004), "Procedures for performing systematic reviews" . *Keele, UK, Keele University*, Vol. *33*, pp.1-26.

Kitchenham, B., Charters, S.M., (2007) "Guidelines for performing systematic literature reviews in software engineering", In *Technical report, Ver. 2.3 EBSE Technical Report. EBSE*. sn.

Kudaravalli, S., Faraj, S. and Johnson, S.L., (2017), "A configural approach to coordinating expertise in software development teams", *MIS Quarterly*, Vol. 41 No.1

Lavranos, C., Kostagiolas, P., Korfiatis, N. and Papadatos, J., (2015), "Information seeking for musical creativity: a systematic literature review", *Journal of the Association for Information Science and Technology*, Vol.67 No.9 ,pp. 2105-2117.

Lee, H., (1999), "Time and information technology: monochronicity, polychronicity and temporal symmetry", *European Journal of Information Systems*, Vol. 8 No.1, pp.16-26.

Lee, H., and Liebenau, J. (2000), "Temporal effects of information systems on business processes: focusing on the dimensions of temporality", *Accounting, Management and Information Technologies*, Vol. 10 No.3, pp. 157-185.

Lee, H.K., Lee, J.S. and Keil, M., (2018), "Using perspective-taking to de-escalate launch date commitment for products with known software defects", *Journal of Management Information Systems*, Vol. 35 No.4, pp.1251-1276.

Lee, H. and Whitley, E.A., (2002). "Time and information technology: Temporal impacts on individuals, organizations, and society". *The Information Society*, Vol. 18 No. 4, pp.235-240.

Leidner, D.E. and Kayworth, T., (2006), "A review of culture in information systems research: toward a theory of information technology culture conflict", *MIS Quarterly*, Vol. 30 No.2, pp.357-399.

Levy, Y. and Ellis, T.J., (2006), "A systems approach to conduct an effective literature review in support of information systems research", *Informing Science*, Vol. *9*.

Lowry, P.B., Gaskin, J., Humpherys, S.L., Moody, G.D., Galletta, D.F., Barlow, J.B. and Wilson, D.W., (2013), "Evaluating journal quality and the association for information systems senior scholars' journal basket via bibliometric measures: Do expert journal assessments add value?", *MIS Wuarterly*, pp.993-1012.

Maglyas, A., Nikula, U. and Smolander, K., (2011), "What do we know about software product management?-a systematic mapping study" . *In Software Product Management (IWSPM), 2011 Fifth International Workshop*, pp. 26-35. *IEEE*.

Maita, A.R.C., Martins, L.C., López Paz, C.R., Peres, S.M. and Fantinato, M., (2015), "Process mining through artificial neural networks and support vector machines: a systematic literature review", *Business Process Management Journal*, Vol. 21 No.6, pp.1391-1415.

Mainela, T., Puhakka, V. and Servais, P., (2014), "The concept of international opportunity in international entrepreneurship: a review and a research agenda", *International Journal of Management Reviews*, Vol. 16 No.1, pp.105-129.

Manikandan, M. and Amsaveni, N., (2016), "Management Information System research output: A scientometric study", *International Journal of Library & Information Science (IJLIS)*, Vol.5 No.1, pp.21-27.

McHugh, P. and Domegan, C., (2010), "Systematic reviews: their emerging role in the co-creation of social marketing value", *Regulation and Best Practices in Public and Nonprofit Marketing*, *59*.

Medlin, C. J., & Saren, M. (2012) "*Interaction: coherence to a future*", in M. S. Glynn, A. G. Woodside (Eds.), Business-to-Business Marketing Management, Strategies, Cases and Solutions, Vol. 18., Bingley UK: Emerald, pp. 173–188.

Mihalache, A., (2002). "The cyber space-time continuum: Meaning and metaphor", *The Information Society*, Vol. 18 No.4, pp.293-301.

Michon, J. A. and Jackson, J. L. (1985), *Time, mind, and behaviour*. Berlin: Springer-Verlag.

Mitchell, T. R., and James, L. R. (2001), "Building better theory: time and the specification of when things happen" *Academy of Management Review*, Vol. 26 No.4, pp. 530-547.

Mosakowski, E. and Earley, P.C. (2000), "A selective review of time assumptions in strategy research", *Academy of Management Review*, Vol. 25 No.4, pp.796-812.

Nandhakumar, J. (2002), "Managing time in a software factory: temporal and spatial organization of is development activities", *The Information Society*, Vol. 18 No.4, pp. 251-262.

Newton, S.I. (1871), Philosophiae Naturalis Principia Mathematica: Principia. Maclehose.

Norton, J.D. (2005), "*A conjecture on Einstein, the independent reality of spacetime coordinate systems and the disaster of 1913*" The Universe of General Relativity, pp. 67-102. Birkhäuser Boston.

O Riordan, N., Conboy, K. and Acton, T. (2013), "How soon is now? Theorising temporality in Information Systems research", *In International Conference on Information Systems (ICIS) 2013: Reshaping Society Through Information Systems Design, Milan, Italy, 15-18 December 2013.*

Okoli, C. (2015), "A guide to conducting a standalone systematic literature review", *Communications of the Association for Information Systems*, Vol 37, 43-52.

Orlikowski, W. J., and Yates, J. (2002), "It's about time: temporal structuring in organizations", *Organization Science*, Vol. 13 No.6, pp. 684-700.

Patnayakuni, R. and Ruppel, C.P., (2006), "Managing the complementarity of knowledge integration and process formalization for systems development performance", *Journal of the Association for Information Systems*, Vol. 7 No.8, p.21.

Pervan, G. (1998), "How chief executive officers in large organizations view the management of their information systems", *Journal of Information Technology*, Vol. 13 No.2, pp. 95-109.

Petticrew, M. and Roberts, H., (2006), "How to appraise the studies: an introduction to assessing study quality", *Systematic reviews in the social sciences: A practical guide*, pp.125-163.

Petersen, K., Vakkalanka, S. and Kuzniarz, L., (2015), "Guidelines for conducting systematic mapping studies in software engineering: an update", *Information and Software Technology*, Vol. 64, pp.1-18.

Paternoster, N., Giardino, C., Unterkalmsteiner, M., Gorschek, T. and Abrahamsson, P., (2014), "Software development in startup companies: a systematic mapping study", *Information and Software Technology*, Vol. *56* No.10, pp.1200-1218.

Polites, G.L., Roberts, N. and Thatcher, J., (2012), "Conceptualizing models using multidimensional constructs: a review and guidelines for their use", *European Journal of Information Systems*, Vol. 21 No.1, pp.22-48.

Power, K. and Conboy, K. (2015), A metric-based approach to managing architecture-related impediments in product development flow: an industry case study from Cisco. *In Proceedings of the Second International Workshop on Software Architecture and Metrics*, pp. 15-2. *IEEE Press.*

Ramesh, B., Cao, L. and Baskerville, R., (2010), "Agile requirements engineering practices and challenges: an empirical study", *Information Systems Journal*, Vol. 20 No.5, pp.449-480.

Roe, R. A. (2008), "16 perspectives on time and the chronometric study of what happens in organizations", *Time in Organizational Research, Vol.*3, p. 291.

Sarker, S. and Sahay, S., (2004), "Implications of space and time for distributed work: an interpretive study of US–Norwegian systems development teams", *European Journal of Information Systems*, Vol. 13 No.1, pp.3-20.

Sarker, S., Munson, C.L., Sarker, S. and Chakraborty, S., (2009), "Assessing the relative contribution of the facets of agility to distributed systems development success: an analytic hierarchy process approach", *European Journal of Information Systems*, Vol. 18 No.4, pp.285-299.

Saunders, C., and Kim, J. (2007), "Perspectives on time", *MIS Quarterly*, Vol. 31 No.4, p. 1.

Saunders, C., Slyke, C.V., and Vogel, D.R. (2004), "My time or yours? managing time visions in global virtual teams", *The Academy of Management Executive* (1993-2005), Vol. 18 No.1, pp. 19-31.

Sawyer, S. and Southwick, R., (2002). "Temporal issues in information and communication technology-enabled organizational change: Evidence from an enterprise systems implementation" *The Information Society*, Vol. 18 No.4, pp. 263-280.

M. Shaw, (2003) "Writing good software engineering research papers: minitutorial", *25th International Conference on Software Engineering*, pp. 726-736

Shen, Z., Lyytinen, K., and Yoo, Y. (2014), "Time and information technology in teams: a review of empirical research and future research directions" *European Journal of Information Systems*, Vol. 24 No.5, pp. 492-518.

Shmueli, O., Pliskin, N. and Fink, L., (2016), "Can the outside-view approach improve planning decisions in software development projects?", *Information Systems Journal*, Vol. 26 No.4, pp.395-418.

Singh, R., Keil, M., and Kasi, V. (2009), "Identifying and overcoming the challenges of implementing a project management office", *European Journal of Information Systems*, Vol. 18 No.5, pp. 409-427.

Sonnentag, S., (2012), "Time in organizational research: catching up on a long neglected topic in order to improve theory", *Organizational Psychology Review*, Vol. 2 No.4, pp.361-368.

Standifer, R. and Bluedorn, A., (2006), "Alliance management teams and entrainment: sharing temporal mental models", *Human Relations*, Vol. 59 No.7, pp.903-927.

Stewart, K.J. and Gosain, S., (2006), "The impact of ideology on effectiveness in open source software development teams", *MIS Quarterly*, pp.291-314.

Tapia, A.H., (2004). "The power of myth in the IT workplace: Creating a 24-hour workday during the dot-com bubble", *Information Technology & People*. Vol. 17 No. 3, pp. 303-326.

Taylor, F.W. (1911), The Principles of Scientific Management. New York and London: Harper & Brothers.

Tyre, M.J. and Orlikowski, W.J., (1994). "Windows of opportunity: Temporal patterns of technological adaptation in organizations", *Organization science*, Vol. *5* No.1, pp.98-118.

Vidgen, R. and Wang, X., (2009), "Coevolving systems and the organization of agile software development", *Information Systems Research*, Vol. 20 No.3, pp.355-376.

Vom Brocke, J., Simons, A., Niehaves, B., Riemer, K., Plattfaut, R. and Cleven, A., 2009, June. "Reconstructing the giant: on the importance of rigour in documenting the literature search process", In *ECIS*, Vol. 9, pp. 2206-2217

Waller, M. J., Conte, J. M., Gibson, C. B., and Carpenter, M. A. (2001), "The effect of individual perceptions of deadlines on team performance", *Academy of Management Review*, Vol. 26 No.4, pp. 586-600.

Wang, X., Conboy, K. and Cawley, O. (2012), ""Leagile" software development: an experience report analysis of the application of lean approaches in agile software development", *Journal of Systems and Software*, Vol. 85 No.6, pp.1287-1299.

Webster, J. and Watson, R.T., (2002), "Analyzing the past to prepare for the future: writing a literature review", *MIS Quarterly*, pp.xiii-xxiii.

Wiener, M., Cram, A. and Remus, U., (2017), "The view from the top–how senior executives exercise control over information systems projects to enhance performance", *In: The 25th European Conference on Information Systems (ECIS). Guimarães, Portugal.* 1423-1438.

Whittaker, B. (1999), "What went wrong? unsuccessful information technology projects", *Information Management & Computer Security*, Vol. 7 No.1, pp. 23-30.

Wohlin, C., Runeson, P., Höst, M., Ohlsson, M.C., Regnell, B. and Wesslén, A., (2012), "*Experimentation in software engineering",* Springer Science & Business Media.

Xia, W. and Lee, G., (2005), "Complexity of information systems development projects: conceptualization and measurement development", *Journal of Management Information Systems*, Vol. 22 No.1, pp.45-83.

Yang, H.D., Kang, H.R. and Mason, R.M., (2008), "An exploratory study on meta skills in software development teams: antecedent cooperation skills and personality for shared mental models", *European Journal of Information Systems*, Vol. 17 No.1, pp.47-61.

Yetton, P., Martin, A., Sharma, R. and Johnston, K., (2000), "A model of information systems development project performance", *Information Systems Journal*, Vol. 10 No.4, pp.263-289.

Yin, R. K. (2009), *"Case study research: design and methods",* 4. Udgave." Sage Publications.

Zaheer, S., Albert, S., and Zaheer, A. (1999), "Time scales and organizational theory", *Academy of Management Review*, Vol. 24 No.4, pp. 725-741.

Zerubavel, E., (1981), "*Hidden rhythms: schedules and calendars in social life",* University of Chicago Press. Chicago IL.

Appendix A: Primary papers

P1. Beynon-Davies, P., Owens, I. and Lloyd-Williams, M. (2000) 'Melding Information Systems Evaluation with the Information Systems Development Lifecycle', ECIS 2000 Proceedings.

P2. Aaltonen, A. and Eaton, B. D. (2009) 'Exploring the impact of real-time communication on media choice in the context of distributed work', ECIS 2008 Proceedings.

P3. Diepold, D., Ullrich, C., Wehrmann, A. and Zimmermann, S. (2009) 'A real options approach for valuating intertemporal interdependencies within a value-based IT portfolio management - A risk-return perspective', ECIS 2009 Proceedings.

P4. Port, D. and Bui, T. (2009) 'Simulating mixed agile and plan-based requirements prioritization strategies: proof-of-concept and practical implications', European Journal of Information Systems, 18(4), pp. 317-331.

P5. Sarker, S. and Sahay, S. (2004) 'Implications of space and time for distributed work: an interpretive study of US-Norwegian systems development teams', European Journal of Information Systems, 13(1), pp. 3-20.

P6. Tuunanen, T. and Kuo, I. T. (2015) 'The effect of culture on requirements: a value-based view of prioritization', European Journal of Information Systems, 24(3), pp. 295-313.

P7. Alfaro, I. (2010) 'Nationality Diversity and Performance in Global Software Development Teams: the Role of Temporal dispersion and Leadership'. ICIS 2010 Proceedings.

P8. Nan, N., Harter, D. and Thomas, T. (2003) 'The Impact of Schedule Pressure on Software Development: A Behavioral Perspective', ICIS 2003 Proceedings.

P9. Rahul, R. and Bagchi, A. (2006) 'Time Delay in Rectification of Faults in Software Projects', ICIS 2006 Proceedings.

P10. Huang, H. and Trauth, E. M. (2008) 'Cultural Influences on Temporal Separation and Coordination in Globally Distributed Software Development', ICIS 2008 Proceedings.

P11. van Liere, D. W. (2009) 'How Shallow is a Bug? Why Open Source Communities Shorten the Repair Time of Software Defects', ICIS 2009 Proceedings.

P12. Riordan, N., Conboy, K. and Acton, T. (2013) 'How soon is now? Theorizing Temporality in Information Systems Research', ICIS 2013 Proceedings.

P13. Li, X. and Zhou, F. (2017). The Relationship Between Process Variability and Structural Connectivity in Open Source Software Development. ICIS 2017 Proceedings.

P14. O'Connor, M., Dennehy, D. and Conboy, K. (2017). Examining the concept of temporality in Information System Development Flow. ICIS 2017 Proceedings.

P15. Addas, S. and Pinsonneault, A. (2015) 'The many faces of information technology interruptions: a taxonomy and preliminary investigation of their performance effects', Information Systems Journal, 25(3), pp. 231-273.

P16. Baskerville, R. and Pries-Heje, J. (2004) 'Short cycle time systems development', Information Systems Journal, 14(3), pp. 237-264.

P17. Shmueli, O., Pliskin, N. and Fink, L. (2016) 'Can the outside-view approach improve planning decisions in software development projects?', Information Systems Journal, 26(4), pp. 395-418.

P18. Stacey, P. and Nandhakumar, J. (2009) 'A temporal perspective of the computer game development process', Information Systems Journal, 19(5), pp. 479-497.

P19. Anderson, E. G., Chandrasekaran, A., Davis-Blake, A. and Parker, G. G. (2018) 'Managing Distributed Product Development Projects: Integration Strategies for Time-Zone and Language Barriers', Information Systems Research, 29(1), pp. 42-69.

P20. Austin, R. D. (2001) 'The effects of time pressure on quality in software development: An agency model', Information Systems Research, 12(2), pp. 195-207.

P21. Cummings, J. N., Espinosa, J. A. and Pickering, C. K. (2009) 'Crossing Spatial and Temporal Boundaries in Globally Distributed Projects: A Relational Model of Coordination Delay', Information Systems Research, 20(3), pp. 420-439.

P22. Currim, F. and Ram, S. (2012) 'Modeling Spatial and Temporal Set-Based Constraints During Conceptual Database Design', Information Systems Research, 23(1), pp. 109-128.

P23. Jiang, Z., Sarkar, S. and Jacob, V. S. (2012) 'Postrelease testing and software release policy for enterprise-level systems', Information Systems Research, 23(3 PART 1), pp. 635-657.

P24. Sarker, S., Ahuj, M. and Sarker, S. (2018) 'Work-life conflict of globally distributed software development personnel: An empirical investigation using Border Theory', Information Systems Research, 29(1), pp. 103-126.

P25. Schneider, S., Wollersheim, J., Krcmar, H. and Sunyaev, A. (2018) 'How do requirements evolve over time? A case study investigating the role of context and experiences in the evolution of enterprise software requirements', Journal of Information Technology, 33(2), pp. 151-170.

P26. Cappiello, C., Francalanci, C. and Pernici, B. (2003) 'Time-related factors of data quality in multichannel information systems', Journal of Management Information Systems, 20(3), pp. 71-91.

P27. Carmel, E., Espinosa, J. A. and Dubinsky, Y. (2010) '"Follow the Sun" Workflow in Global Software Development', Journal of Management Information Systems, 27(1), pp. 17-37.

P28. Espinosa, J. A., Nan, N. and Carmel, E. (2015) 'Temporal Distance, Communication Patterns, and Task Performance in Teams', Journal of Management Information Systems, 32(1), pp. 151-191.

P29. Gemino, A., Reich, B. H. and Sauer, C. (2007) 'A temporal model of information technology project performance', Journal of Management Information Systems, 24(3), pp. 9-44.

P30. Lee, H. K., Lee, J. S. and Keil, M. (2018) 'Using Perspective-Taking to De-escalate Launch Date Commitment for Products with Known Software Defects', Journal of Management Information Systems, 35(4), pp. 1251-1276.

P31. Lee, J., Keil, M. and Kasi, V. (2012) 'The effect of an initial budget and schedule goal on software project escalation', Journal of Management Information Systems, 29(1), pp. 53-78.

P32. Gupta, A., Mattarelli, E., Seshasai, S. and Broschak, J. (2009) 'Use of collaborative technologies and knowledge sharing in co-located and distributed teams: Towards the 24-h knowledge factory', Journal of Strategic Information Systems, 18(3), pp. 147-161.

P33. Colazo, J. A. and Fang, Y. (2010) 'Following the Sun: Temporal Dispersion and Performance in Open Source Software Project Teams', Journal of the Association for Information Systems, 11(11).

P34. Jiang, J. J., Klein, G. and Shepherd, M. (2001) 'The Materiality of Information System Planning Maturity to Project Performance', Journal of the Association for Information Systems, 2(1).

P35. Molnar, W., Nandhakumar, J. and Stacey, P. (2017) 'A Paradox of Progressive Saturation: The Changing Nature of Improvisation over Time in a Systems Development Project', Journal of the Association for Information Systems, 18(11)

P36. Park, C., Im, G. and Keil, M. (2008) 'Overcoming the Mum Effect in IT Project Reporting: Impacts of Fault Responsibility and Time Urgency', Journal of the Association for Information Systems, 9(7).

P37. Venters, W., Oborn, E. and Barrett, M. (2014) 'A trichordal temporal approach to digital coordination: the sociomaterial mangling of the cern grid', Mis Quarterly, 38(3), pp. 927-U393.

P38. Jiao, A., Egorova, K., Hahn, J. and Lee, G. (2016) 'The Effects of Spatial and Temporal Dispersion on Virtual Teams Performance', ECIS 2016 Proceedings.

P39. Süllwold, C., Basten, D. and Richter, J. (2018) 'Does the Approach Matter? A Qualitative Study on Differences Concerning Time Pressure in Agile and Sequential Information System Projects', ECIS 2018 Proceedings.

P40. Benschop, N., Hilhorst, C.A., Nuijten, A.L. and Keil, M., (2020). 'Detection of Early Warning Signals for Overruns in IS Projects: Linguistic Analysis of Business Case Language', European Journal of Information Systems, 29(2), pp.190-202.

P41. Chughtai, H., (2020). 'Instrumental Aspects of Play at Work In Information Technology Organisations', European Journal of Information Systems, pp.1-17.

P42. Jenkin, T.A., Chan, Y.E. and Sabherwal, R., (2019). 'Mutual Understanding in Information Systems Development: Changes Within and Across Projects', MIS Quarterly, 43(2).

P43. Thummadi, B.V. and Lyytinen, K., (2020). 'How Much Method-In-Use Matters? A Case Study of Agile And Waterfall Software Projects and Their Design Routine Variation', Journal of the Association for Information Systems, 21(4), p.7.

P44. Espinosa, J. A., DeLone, W., & Lee, G. (2006). 'Global Boundaries, Task Processes And IS Project Success: A Field Study'. Information Technology & People, 19(4), pp. 345-370.

P45. Finnegan, P., Galliers, R. D., & Powell, P. (2003). 'Applying Triple Loop Learning To Planning Electronic Trading Systems', Information Technology & People, 16(4), pp. 461-483.

P46. Im, H. G., Yates, J., & Orlikowski, W. (2005). 'Temporal Coordination Through Communication: Using Genres In A Virtual Start‐Up Organization', Information Technology & People, 18(2), pp. 89-119.

P47. Lyytinen, K., Rose, G., & Yoo, Y. (2010). 'Learning Routines And Disruptive Technological Change: Hyper‐Learning In Seven Software Development Organizations During Internet Adoption', Information Technology & People, 23(2), pp. 165-192.

Appendix B: Overall quality assessment criteria

Quality Criteria	Description
1. Is there a clear statement of the aims of the research?	The aims and objectives were clearly reported (including a rationale for why the study was undertaken).
2. Is there an adequate description of the context in which the research was carried out?	There was an adequate description of the context in which the research was carried out.
3. Was the research design appropriate to address the aims of the research?	The research design was appropriate to address the aims of the research.
4 Was the recruitment strategy appropriate to the aims of the research?	There was an adequate description of the sample used and the methods for identifying and recruiting the sample.
5. Was there a control group with which to compare treatments?	Any control groups were used to compare treatments.
6. Was the data collected in a way that addressed the research issue?	Appropriate data collection methods were used and described.
7. Was the data analysis sufficiently rigorous?	There was an adequate description of the methods used to analyse data and whether appropriate methods for ensuring the data analysis were grounded in the data.
8. Has the relationship between researcher and participants been considered to an adequate degree?	The relationship between the researcher and participants was considered to an adequate degree.
9. Is there a clear statement of findings?	The study provided clearly stated findings with credible results and justified conclusions.
10. Is the study of value for research or practice?	They provided value for research or practice.

Appendix C: Temporal specific quality assessment criteria

Quality Criteria	Description
1.Is there a clear statement of the aims of the temporal research?	The temporal aims and objectives were clearly reported (including a rationale for why time was undertaken as part of the study).
2. Is there an adequate description of the temporal context in which the research was carried out?	There was an adequate description of the temporal context in which the research was carried out.
3. Was the research design appropriate to address the aims of the temporal research?	The research design was appropriate to address the aims of the temporal research.
4. Was the recruitment strategy appropriate to the aims of the temporal research?	There was an adequate description of the methods used for identifying and recruiting the sample of the temporal research.
5. Was there a control group with which to compare temporal treatments?	Any control groups were used to compare temporal treatments.
6. Was the data collected in a way that addressed the temporal research issue?	Appropriate data collection methods were used and described which addressed the temporal research issue.
7. Was the temporal data analysis sufficiently rigorous?	There were appropriate methods for ensuring that the temporal data was analysed and grounded in the data.
8. Has the temporal relationship between researcher and participants been considered to an adequate degree?	The temporal relationship between the researcher and participants was considered to an adequate degree.
9. Is there a clear statement of findings on the temporal research?	The study provided clearly stated temporal findings with credible results and justified conclusions.
10. Is the study of value for temporal research or practice?	They provided value for temporal research or practice.