Flow in Information Systems Research: Review, Integrative Theoretical Framework, and Future Directions

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Abstract. As information systems (IS) are increasingly able to create highly engaging and interactive experiences, the phenomenon of *flow* is considered a promising vehicle to understand pre-adoptive and post-adoptive IS user behavior. However, despite a strong interest of researchers and practitioners in flow, the reliability, validity, hypothesized relationships, and measurement of flow constructs in current IS literature remain challenging. By reviewing extant literature in top IS outlets, this paper develops an integrative theoretical framework of flow antecedents, flow constructs, and flow consequences within IS research. In doing so, we identify and discuss four major flow streams in IS research and indicate future research directions.

Keywords: Flow theory, flow measurement, flow streams, human-computer interaction, integrative theoretical framework

1 Introduction

In today's digital economy, information systems (IS) are both, a significant investment for companies and an integral part of employees' daily work [1]. Due to technological developments, such as multi-media-rich user interfaces (UIs), IS are able to create highly engaging and interactive experiences [1]. More specifically, the design and implementation of IS plays an important role in whether or not users have holistic experiences such as "flow" when interacting with technology. Moreover, in today's technology landscape, most work-related tasks are at least to some extent IT-mediated. Hence, studying how flow affects pre-adoptive as well as post-adoptive IS use has been acknowledged of theoretical and practical significance [1–3]. Thereby, flow is adopted from the reference discipline of psychology and refers to "the holistic sensation that people feel when they act with total involvement" [4, p. 36].

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However, despite the intense usage of flow-related constructs within IS research, its reliability and validity still remains low [5–9]. Novak and colleagues identified 13 different flow constructs with an average usage rate of only four per study [5]. Conceptually, the inconsistencies also concern the hypothesized relationship between flow and other constructs [8]. Finneran and Zhang [7] concluded that the "diverse flow models demonstrate the different understandings of antecedents, flow experiences, and consequences" [7, p. 98]. Moreover, most flow constructs used by IS researchers only partially overlap with the constructs and measurements suggested by the reference discipline of psychology [4, 10, 11]. In summary, it can be concluded that current IS research summarizes the usage of flow within its discipline as "too broad and ill-defined due to the numerous ways it has been operationalized, tested, and applied." [12, p. 227]

In this paper, we review 43 articles in top IS outlets pursuing the following research question: *What is the state-of-the-art in flow research within top IS outlets?* Our SLR builds upon existing reviews [6, 8, 13] and extends these studies in several ways. We complement the literature-based discussions on flow by Finneran and Zhang [6] and Siekpe [13] with a structured approach including detailed information about the search approach, used databases, search strategy, and study selection criteria. Specifically, we expand the work by Finneran and Zhang [6] by flow dimensions and consequences, as well as incorporate the six flow constructs proposed by Siekpe [13]. Further, building on the nine stream suggestions by Mahnke et al. [8], we consolidate four streams of flow literature by analyzing the operationalization of the identified constructs. In addition, on the basis of our SLR and previous work [6, 8, 13], we synthesize the knowledge of flow in those four streams and develop an integrative theoretical framework, consisting of overarching flow categories, as well as sub-categories (cf. Figure 3). This framework can serve as a 'route map' in understanding the relations between various flow components and their interactions, as well as provide different academic perspectives on flow [14]. Finally, we cluster the identified articles in this framework accordingly to illustrate the most prominent streams and gaps (cf. Table 2).

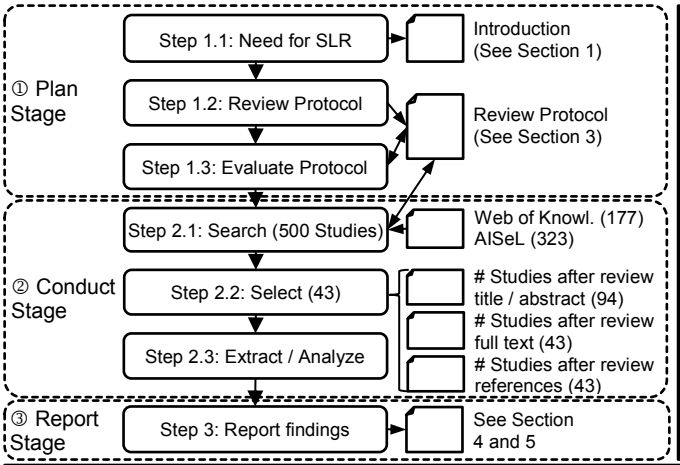
This paper makes five key contributions to IS research and practice. First, we introduce a comprehensive, integrative theoretical framework of flow in IS research [14]. This high-level framework can support both, IS researchers and practitioners to conceptualize the flow phenomenon and guide the design of IS artefacts. Second, we provide a detailed overview of four major flow streams in IS research and position these streams within our integrative theoretical framework. Third, we summarize the results of the literature with respect to the major antecedents and consequences of flow. Fourth, we provide a detailed overview on the commonly used flow constructs within IS research and identify the major challenges in their operationalization. Finally, our review provides suggestions for further research within IS.

2 Fundamentals of Flow

Flow was first investigated by psychologist Mihaly Csikszentmihalyi, who developed a theory of flow in the 1970s based on qualitative interviews with individuals performing (autotelic) activities in a non-professional context without extrinsic rewards

[4]. During the analysis a pattern emerged in which individuals were fully immersed and concentrated on a task at hand – the so called "flow experience" [4]. Further, Csikszentmihalyi differentiated between different degrees of flow ranging from micro-flow (e.g., perceived at taking a coffee break) and deep-flow (e.g., perceived while painting a picture) [4]. Initially, researchers hypothesized that flow experience occurs only in cases, where the performer of an activity does not receive any extrinsic reward (e.g., financial benefits) [4]. However, further studies showed that flow constitutes a general phenomenon occurring in both, extrinsically (e.g., working environment) [2] and intrinsically (e.g., painting, music) motivated activities [4]. Due to this high generalizability and recent enhancements in IS capabilities to foster flow (e.g., via providing multi-media-rich task support), the concept of flow has been widely adopted by researchers to understand user behavior in engaging and interactive technology contexts [1]. For instance, based on an analysis of 43 employees using an e-mail application, researchers established a direct link between flow experience and actual technology use. In the same study, researchers also found a correlation between flow and other constructs, such as perceived communication quality and perceived effectiveness [2]. Generally, the flow phenomenon has been applied in various domains, such as E-Learning [15], E-Commerce [16], Web-Sites [17], Games [18], and Virtual Worlds [19] in order to explain and study user perception and behaviors. Building upon several empirical flow studies in computer-mediated environments, scholars examined the concept through three different angles: (1) *flow antecedents*, (2) *flow experience*, and (3) *flow consequences* [3, 6, 12, 20]. However, the conceptualizations, antecedents, and consequences vary across studies (e.g., [9, 21]).

3 Method



Distribution of Flow Articles in Top IS Outlets

Source	# Hits	# Selected	%
MISQ	28	6	14
ISR	27	1	2.3
JMIS	26	3	7
EJIS	12	2	4.7
I&M	49	16	37.2
ISJ	12	2	4.7
JAIS	13	2	4.7
JSIS	10	0	0
ICIS	223	8	18.6
ECIS	100	3	7
Sum	500	43	~ 100

MISQ: MIS Quarterly; **ISR**: Information Systems Research; **JMIS**: Journal of Management Information Systems; **EJIS**: European Journal of Information Systems; **I&M**: Information & Management; **ISJ**: Information Systems Journal; **JAIS**: Journal of the AIS; **JSIS**: Journal of Strategic Information Systems; **ICIS**: International Conference on Inform. Systems; **ECIS**: European Conference on Inform. Systems

Figure 1. Stages of the SLR and Distribution of Flow Articles

In order to evaluate the current state of flow research within top IS outlets, we conduct a SLR following the guidelines by Kitchenham [22]. The SLR is subdivided into three stages (plan, conduct, and report; cf. Figure 1). During the **plan stage**, we identified the need for a SLR. In a second step, we developed a review protocol and evaluated it. During the **conduct stage**, we executed the search, selected appropriate studies, and analyzed them. Finally, during the **report stage**, we documented our findings.

Research Questions. To keep our systematic review focused, and to answer the overarching research question, we defined several subordinate questions (cf. Table 1).

Table 1. Subordinate Research Questions

RQ #	Research Questions
RQ1	What are the different streams of flow in top IS outlets and how can they be conceptualized into an integrative theoretical framework?
RQ2	What are the antecedents of flow in top IS outlets?
RQ3	How is the flow phenomenon conceptualized and operationalized in top IS outlets?
RQ4	What are the consequences of the flow phenomenon in top IS outlets?

Search Strategy. To support the search process (Step 2.1, Figure 1), we first selected libraries based on our research questions. As our goal was to provide a holistic overview on the state-of-the-art in flow research within the IS domain, our 'field' is the discipline of IS. To get an overview of high quality studies, we decided to include top-tier **IS journals** (cf. Figure 1) from the *IS Senior Scholars' basket of eight*. We also decided to include two major **IS conferences**, namely the *International Conference on Information Systems* (ICIS) and the *European Conference on Information Systems* (ECIS). The outlets were carefully selected on the basis of a ranking list (http://www.core.edu.au/conference-portal), as well as suggestions made by literature to include especially journals and conferences with high quality and reputation [23]. However, it should be mentioned, that we did not include research-in-progress papers. Based on the identified outlets and field of interest, we selected the *ISI Web of Knowledge* as **database to search** for the IS journals. In addition, we selected the *AIS Electronic Library* (AISeL) to retrieve conference proceedings (ICIS, ECIS). The **search string** to conduct our systematic search (Step 2.1, Figure 1) was developed in several steps. First, we extracted "flow" as a starting term from our research questions. Second, we used the term "flow AND information systems" to search for publications within IS using Google Scholar. By reviewing the first 20 hits and by sorting out papers without a focus on the psychological phenomenon of flow, we identified two highly cited papers. Namely, Agarwal and Karahanna [1] and Hsu and Lu [24]. By reviewing the full text, we extracted the term "cognitive absorption" and "cognitive engagement" as highly relevant flow derivations. In a third step, we searched for synonyms but did not find any appropriate synonyms for our study context. Finally, we used Boolean-operators in order to create the final search string: *flow OR cognitive engagement OR cognitive absorption*. Next, we applied the final search string to the **title**, **abstract,** and **keywords section** of publications in the specified digital libraries. We did **not limit** our search to a specific **time period**, as the aim of our SLR was to provide a holistic overview. The overall hits, as well as the final number of selected studies and the percentage distribution are depicted in Figure 1.

Study Selection Criteria. We carefully defined the following inclusion and exclusion criteria: (1) Only empirical studies were included, (2) studies using flow, cognitive engagement, or cognitive absorption in their hypothesis development were included, whereas (3) studies not referencing to the psychological phenomenon of flow were excluded. In the publication selection process (Step 2.2, Figure 1) the criteria were applied to title, abstract, and keyword section excluding 406 inappropriate studies. Second the criteria were applied to full text, again excluding 51 studies. Finally, we reviewed the references but did not find any additional publications, as our SLR is focused on the defined IS outlets and we already found all studies in the selected databases. In summary, we found 43 relevant studies.

4 Flow Streams within IS Research

As depicted in Figure 2, our SLR reveals that starting from 2002, flow received wider attention in IS research and is still very active with an increasing amount of publications. Thereby, on average three papers were published per year in top IS outlets from 2002 to 2016. As 2016 is ongoing, only two studies were found in this year. In the next sections we describe the identified four streams of flow research in IS.

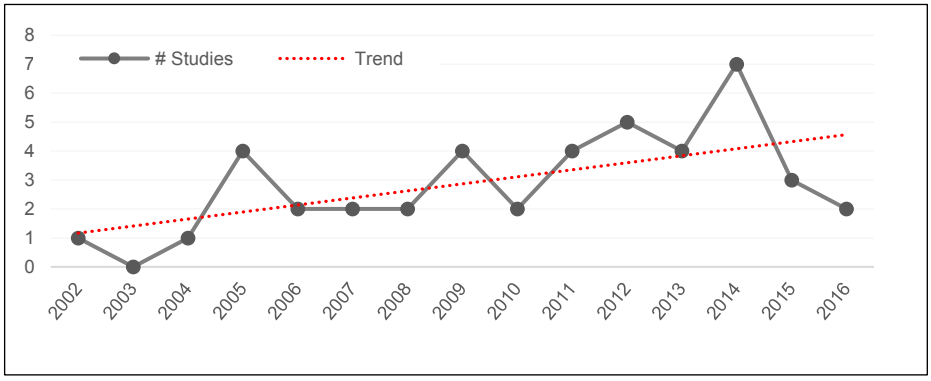


Figure 2. Distribution of Studies over the Years

Stream 1 – Jackson / Marsh / Ghani / Deshpande / Supnick / Rooney. The first stream [3, 20, 25] is based on the work of Jackson and Marsh [25] as well as Ghani et al. [3, 20] entailing nine references. Both research groups use concentration as flow construct consisting of identical items, such as "My attention was focused entirely on what I was doing." [25, p. 34] and "Attention is focused on activity" [20, p. 390]. In addition, the construct of "autotelic experience" used by Jackson and Marsh [25] and the construct of "enjoyment" used by Ghani et al. [3, 20] are highly related as both entail items of positive emotions such as fun or enjoyment [3, 20, 25]. Further, articles in this stream cite and refer particularly to both research groups when conceptualizing flow. For instance, Guo et al. [26] use concentration according to Ghani et al. [20] and combine it with dimensions from Jackson and Marsh [25]. However, it is important to

note that some studies in this stream only refer to one research group (primarily Ghani et al. [3]). We assume the reason behind this dominance resides in Ghani et al.'s [3, 20] specific IS focus, whereas Jackson and Marsh [25] are originally allocated in the sports domain. Jackson and Marsh [25] developed the flow state scale in accordance with the proposed characteristics of flow suggested by Csikszentmihalyi [4, 11]. Thereby, the researchers used the following dimensions: (1) challenge-skill balance, (2) clear goals, (3) unambiguous feedback, (4) autotelic experience (5) action-awareness merging, (6) sense of control, (7) loss of self-consciousness, (8) transformation of time, and (9) concentration on the task at hand. Among these dimensions, empirical evidence has shown that **challenge-skill balance**, **clear goals**, and **unambiguous feedback** represent major antecedents of flow [27]. Supported by theory [11] and evidence in literature [28–30], the construct of **autotelic experience** (e.g., operationalized by authors as enjoyment or positive affect [8, 26]) constitutes an important outcome variable of flow. The other characteristics pertain to the phenomenon itself. Particularly, **action-awareness merging** refers to a state, where due to a deep level of involvement, an activity becomes automatic or spontaneous [25]. **Sense of control** refers to the feelings and perceptions of being in charge of the interaction [25]. **Loss of self-consciousness** is described as disappearance of concerns for the self [25]. Further, the **transformation of time** construct proposed by Jackson and Marsh [25] emphasized the altering of time (e.g., slower or faster) [25]. Finally, **concentration on the task at hand** refers to feelings of being focused and concentrated on the task at hand [25]. Ghani et al. [3, 20] conceptualize flow with two main characteristics. Enjoyment resulting from the activity and total concentration [3, 20]. This stream (as depicted in Table 2) predominantly investigates flow in the context of E-Learning and E-Commerce. Thereby flow is investigated multi-dimensionally using constructs such as concentration (66.7 %), and sense of control (55.6 %). With regard to the antecedents, artefact-related antecedents (88.9 %) are highly used. As for flow consequences, this stream predominantly uses behavior-related constructs (77.8 %).

Stream 2 – Agarwal / Karahanna / Skadberg / Kimmel. Within the second stream [1, 31] (17 reference articles), the most common conceptualization of flow is mainly based on Agarwal and Karahanna [1]. The concept of cognitive absorption (CA) includes five dimensions: (1) curiosity, (2) control, (3) focused immersion, (4) temporal dissociation, and (5) heightened enjoyment. Thereby, **control (control of interaction)** is defined as "the user's perception of being in charge of the interaction" [1, p. 673] and **curiosity** refers to "heightened arousal of sensory and cognitive curiosity" [1, p. 668] (cf. third stream). The dimension of **focused immersion** "suggests that all of the attentional resources of an individual are focused on the particular task, thereby reducing the level of cognitive burden associated with task performance." [1, p. 675] **Temporal dissociation** is defined as "the inability to register the passage of time while engaged in interaction" [1, p. 673] and finally, **heightened enjoyment** is "capturing the pleasurable aspects of the interaction" [1, p. 673]. In the same veins like Agarwal and Karahanna [1], Skadberg and Kimmel [31] also conceptualized flow with the dimensions of **enjoyment** and **time distortion** [31]. Thereby, time distortion as well as enjoyment are highly related to the construct of temporal dissociation and enjoyment suggested by Agarwal and Karahanna [1]. This stream (as depicted in Table 2)

predominantly investigates flow in the context of the Web, followed by E-Learning and Virtual Worlds. Thereby, most authors in this stream investigate flow as a second-order multidimensional phenomenon through the lens of CA [1]. Constructs of focused immersion (94.1 %) and transformation of time (94.1 %) are used most dominantly. Further, artefact-related antecedents (41.2 %) are dominant, followed by person-related antecedents (23.5 %). As for the flow consequences in this stream, behavior-related constructs (82.4 %) are prior to cognition-related consequences (64.7 %).

Stream 3 – Webster / Trevino / Ryan / Ho. The third stream [2, 32, 33] entails the lowest number of references (seven articles). It originates from the studies of Webster et al. [2] and Trevino and Webster [33] who both suggested four dimensions of flow experience: (1) sense of control over the interaction, (2) curiosity, (3) intrinsic interest, and (4) attention focus [2]. In a later study, Webster and Ho [32] conceptualize the last three dimensions as cognitive engagement. Similar to the definition in the first stream, the dimensions of **sense of control** refers to the feelings of control, as well as the actual control over the interaction [2], whereas **curiosity** illustrates the arousal of sensory or cognitive curiosity [2] (cf. second stream). **Intrinsic interest** is defined as cognitive arousal as well as imagination [2]. The construct of **attention focus** suggests, that the "attention is narrowed to a limited stimulus field, filtering out irrelevant thoughts and perceptions." [2, p. 413] In this stream, authors predominantly investigate the phenomenon of flow through the lens of cognitive engagement [32]. As depicted in Table 2, authors within this stream primarily use the constructs of attention focus and intrinsic interest (both 100 %), followed by curiosity (71.4 %). With regard to the antecedents, artefact-related antecedents (71.42 %) are used most widely. Further, behavior-related constructs (85.7 %) are dominant.

Stream 4 – Novak / Hoffman / Yung / Engeser / Rheinberg. The fourth stream [5, 10, 34] addresses flow from a wider and more general perspective. Hence in Figure 3 this stream is positioned at a higher conceptual level than the other three streams. Novak et al. [5] and Hoffman and Novak [34] contributed to this stream (ten articles) by measuring flow as a one-dimensional construct with a narrative description of flow experience [5, 34]. The operationalization consists of items such as "In general, how frequently would you say you have experienced "flow" when you use the Web?" [5, p. 28]. Similarly, Engeser and Rheinberg [10] also contributed to this stream on a higher conceptual level as they propose a comprehensive flow short scale to measure flow during all activities [10]. Conducting a factor analysis, the researchers found two overreaching and broadly defined factors which they labeled "fluency" and "absorption" consisting of items such as "My thoughts/activities run fluid and smoothly", or "I am completely lost in thoughts" [10, p. 170]. This stream predominantly investigates flow in the context of the Web and Games. With regard to the antecedents, artefact-related antecedents (50 %) are used most. As for flow consequences, all studies include behavior-related constructs in this stream.

Table 2. Flow Streams in Top IS Outlets

	Authors	Stream Ref.	Antecedents						Flow	Absorption						CNT		CE			Conse.			
			Pers.(P)	P & A	Artef.(A)	A & T	Task(T)	T & P		AAM	FIM	CON	TDI	TRT	LSC	COI	SOC	CUR	ATF	INI	Cognit.	Affect.	Behav.	Perform.
Stream 1	Guo et al. [26]	[20, 25]		X			X	X				X		X	X						X	X	I	
	Zhang et al. [35]	[20]		X	X							X									X	X	I	
	Guo et al. [36]	[20, 25]		X	X		X	X				X		X	X		X				X	X	I	P
	Nah et al. [30]	[3]		X	X																X		I	
	Nah et al. [37]	[3]		X	X																X		I	
	Guo & Poole [27]	[25]			X		X	X		X		X	X		X		X							
	Phang et al. [38]	[3]	X	X	X							X					X							P
	Kamis et al. [39]	[3]			X		X										X						I	
	Koufaris [40]	[3]			X			X				X					X						I	
Stream 2	Visinescu et al. [41]	[1]			X						X		X					X			X		I	
	Mimoun et al. [42]	[1]									X		X			X		X						O
	Wang & Hsu [43]	[31]					X	X			X		X								X			O
	Lowry et al. [44]	[1]			X						X		X			X		X					I	
	Goel et al. [45]	[1]	X	X	X						X		X					X			X		A	P
	Goel et al. [46]	[1]		X							X		X										I	
	Lee et al. [47]	[1]			X						X		X								X	X	I	
	Chandra et al. [19]	[1]	X			X					X		X			X		X			X		I	
	Weniger et al. [48]	[1]	X		X						X		X			X		X			X	E	I	
	Goel et al. [49]	[1]		X				X					X										I	
	Deng et al. [50]	[1]									X		X			X		X			X	X	I	
	Xue & Hock-Hai [18]	[1]			X						X		X			X		X					I	
	Jia et al. [51]	[1]									X		X			X		X				X	A	
	Wakefield et al. [29]	[1]									X		X			X		X			X	E	I	
	Shang et al. [52]	[1]									X		X			X		X			X		A	
	Saadé & Bahli [53]	[1]									X		X								X		I	
	Hess et al. [54]	[1]	X		X						X										X			O
Stream 3	Yi et al. [16]	[32]			X														X	X			I	
	Zhang et al. [55]	[2]		X	X													X	X	X			I	
	Moon et al. [17]	[2, 33]	X													X		X	X	X			A	
	Animesh et al. [56]	[2]		X	X													X	X	X			I	
	Scott & Walczak [57]	[32]																	X	X	X		I	
	Webster & Ahuja [58]	[32]		X	X													X	X	X			I	O
	Jiang & Benbasat [21]	[2]			X											X		X	X	X				
Stream 4	Rodríguez et al. [15]	[5]	X	X	X				X														❶	
	Bilgihan et al. [59]	[5]			X				X												X		I	
	Mahnke et al. [8]	[10]	X				X	X	X													X	I	
	Huang et al. [60]	[5]		X					X												X	X	I	
	Kim et al. [28]	[5]		X	X				X														I	
	Sharkey et al. [61]	[3, 5]							X														I	P
	Mahnke et al. [9]	[10]							X													X	I	
	Theotokis et al. [62]	[5]										X				X		X			X	X	I	
	Ha et al. [63]	[5]		X	X				X														I	
	Hsu & Lu [24]	[5]			X				X														I	

AAM: Action Awareness Merge; **FIM**: Focused Immersion; **CON**: Concentration; **ATF**: Attention Focus; **TDI**: Temporal Dissociation; **TRT**: Transformation of Time; **LSC**: Loss of Self-Consciousness; **COI**: Control of Interaction; **SOC**: Sense of Control; **CUR** Curiosity; **INI**: Intrinsic Interest; **P**: Perceived; **I**: Intention; **O**: Objectively; **A**: Actual Behavior; **E**: Enjoyment; **CNT**: Control; **CE**: Cognitive Engagement; ❶: Intention & Actual Behavior

5 Integrative Theoretical Framework of Flow in IS Research

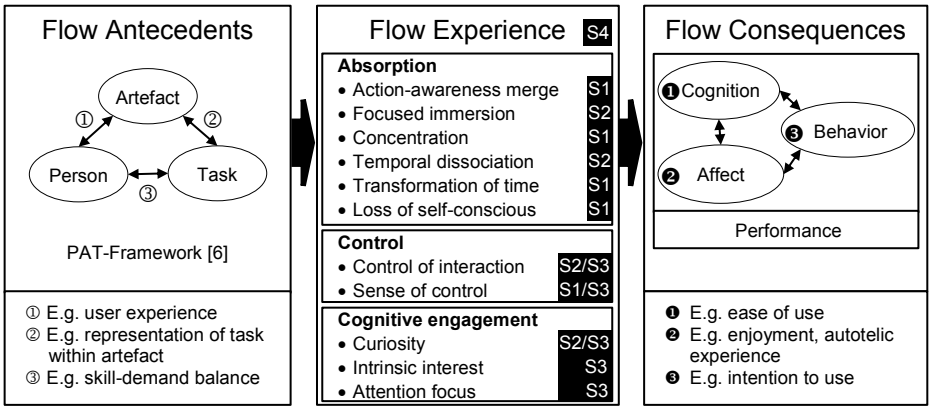
In order to address RQ1, we follow the approach of Baumeister and Leary [14] and conceptualize the results of the extant literature in an integrative theoretical framework [14]. By reviewing our final set of primary studies, several interesting patterns appear. First, all of the studies explicitly or implicitly subdivide their research models into *flow antecedents*, *flow experience*, and *flow consequences* [26]. As the separation of flow into this threefold pattern is also generally agreed upon in IS literature [3, 6, 12, 20], we adopt this separation for our theoretical framework.

Flow antecedents. We found that some of the antecedents are related to **tasks-characteristics,** such as clarity of goals [36], and immediate feedback on the task [26]. Other antecedents of flow are related to the **UI**. For instance, in one study, scholars manipulate filler interfaces on travel booking sites to evaluate the effects on flow and perceived waiting time [47]. In a third category of studies, researchers investigate **person-characteristics**, such as gender [54]. Therefore, we follow the approach of Finneran and Zhang [6] and sub-divide antecedents of flow into (1) **P**erson, (2) **A**rtefact, and (3) **T**ask (*PAT-Framework)*. Moreover, in reviewing the results of the extant literature, we do find several constructs rather allocated between the categories of person, artefact, and task. For instance, researchers investigated the influence of skill-demand balance on flow [8, 27, 43]. As such, the balance between demand and skill is neither a pure task-characteristic nor a pure person-characteristic. Similarly, other characteristics, such as user experience (allocated between person and artefact) and the representation of tasks (allocated between artefact and task) are allocated between two characteristics. Thus, we introduce categories between the defined antecedents-sections of person, task, and artefact as depicted in Figure 3.

Flow consequences. We identified three major categories of flow consequences: (1) **cognition**, (2) **affect**, and (3) **behavior**. The proposed categories are well-rooted in recent social psychology research, suggesting that attitude consists of these three distinct dimensions [64]. The affect-related component constitutes the hedonic aspect of the attitude towards an IS, such as moods and emotions. In contrast, the cognition-related component constitutes the utilitarian aspect based on beliefs such as ease of use or usefulness. The behavior-related component depicts the response resulting from affect and cognition (e.g., the intention to use an IS). As we found studies investigating the flow impact on performance, we also add performance to the consequence-section.

Flow experience. With regard to flow, we do not consider autotelic experience as part of flow because Csikszentmihalyi [4, 11] argued that positive affect and flow are two distinct constructs. Thereby, the suggestions made by theorists are also relined by evidence of recent research in this direction [28–30]. In order to integrate the various flow constructs used in IS research (cf. stream section), we first extracted constructs related to the flow dimension of **absorption** [8]. By reviewing six stream research teams [1–3, 20, 25, 32], we extract four constructs. In a second step, we analyze the construct definition and operationalization and identify two distinct constructs, namely, **focused immersion** and **concentration**. Thereby the constructs differ in conceptualization as well as operationalization. **Concentration** consists of items measuring focus, concentration, absorption, and attention [3, 20, 25], whereas **focused**

immersion measures absorption, immersion, the blocking of other attentional demand, and if an individual's attention is distracted easily or not [1]. Focused immersion "suggests that all of the attentional resources of an individual are focused on the particular task, thereby reducing the level of cognitive burden associated with task performance" [1, p. 675]. In a second step, we extract and compare different conceptualizations of time-related constructs used by three authors [1, 25, 31]. As result, we identify two distinct constructs. **Temporal dissociation** emphasize a lost sense of time and a faster time passage [1, 31], whereas **transformation of time** emphasizes the altering of time (slower, faster or stop of time) [25]. As Jackson and Marsh [25] also proposed constructs related to absorption, we add **loss of self-consciousness** and **action-awareness merging** to the integrative theoretical framework. Next, we extract and integrate dimensions used to measure **control**. Thereby, we identify three control-related constructs suggested by literature [1, 2, 25]. By reviewing the conceptualization as well as the operationalization, we identify two distinct constructs. **Control of the interaction** refers to the feelings and perceptions of being in charge of the interaction but also to the actual control over the interaction [1, 2]. In contrast, **sense of control** is solely referring to feelings of being in charge [25]. Finally, by complementing our framework with the dimension of **cognitive engagement** proposed by Webster and Ho [32] and the related dimensions **curiosity**, **intrinsic interest,** and **attention focus** [32], we finalize our integrative theoretical framework as depicted in Figure 3. To provide a comprehensive overview, the framework also lists all research teams in the four streams and maps them to the identified constructs.



Stream	Authors	# Ref
S1	Jackson & Marsh 1996 [25], Ghani 1991 [3], Ghani & Deshpande 1994 [20]	9
S2	Agarwal & Karahanna 2000 [1], Skadberg & Kimmel 2004 [31]	17
S3	Webster et al. 1993 [2], Webster & Ho 1997 [32], Trevino & Webster 1992 [33]	7
S4	Novak et al. 2000 [5], Hoffman & Novak 1996 [34], Engeser & Rheinberg 2008 [10]	10

Figure 3. Integrative Theoretical Framework of Flow in IS Research

6 Discussion, Future Directions and Conclusion

Despite the growing relevance of the flow construct within IS research for understanding user behaviour and informing the design of IS artefacts, challenges remain in terms of its conceptualization, reliability, and validity [5–9]. We provided a holistic overview on the state-of-the-art in flow research within top IS outlets. In the following we discuss our results along the previously defined four research questions.

Discussion. As for **RQ1**, we identify four major flow streams and comprehensively describe them in Section 4. Reviewing the extant literature, we present an integrative theoretical framework conceptualizing the state-of-the-art in flow research (cf. Figure 3). Further, we map the identified stream research teams to our framework identifying overlaps and differences across the streams. Such understanding supports IS researchers and practitioners to get an overview of the major dimensions to consider when investigating the flow phenomenon. As for **RQ2**, pertaining to the antecedents of flow, we find that most studies use artefact-related antecedents (25 studies) and investigate their effect on flow. The second most used antecedent category is located between person and artefact (15 studies). Furthermore, seven studies investigate antecedents located between person and task (e.g., challenge-skill balance) and another seven studies focus on person-related antecedents, such as skills and personal innovativeness. Finally, six studies use task-related antecedents, such as clarity of goals and investigate. Pertaining to the operationalization of flow in IS research (**RQ3**), our review reveals 11 distinct flow constructs. As depicted in Figure 3, these constructs can be categorized into absorption, control, and cognitive engagement. By mapping the four major streams to the different flow constructs, it becomes apparent that there is a different emphasis on flow dimensions across the literature. While some streams focus on a more general understanding of flow (S4), other streams aim at a more detailed understanding of absorption and control (S1), or focus primarily on cognitive engagement (S3). Finally, with respect to the flow consequences (**RQ4**), our review reveals that almost all of the reviewed studies measure behavior-related consequences (37 studies). The operationalization of this measurement varies though, with 32 studies focusing on behavior-related intentions (e.g., continuance intention, or the intention to buy online), while five studies measured actual user behavior (e.g., actual technology usage or actual continuance in an E-Learning course). Further, there is also a focus on cognition and affect-related consequences of flow. In 20 studies, cognition-related consequences of flow (e.g., ease of use) are measured, whereas 12 studies describe affect-related consequences (e.g., enjoyment). With regard to performance, four studies assessed perceived performance as flow consequence. Finally, another four studies measured performance outcomes objectively (e.g., time for task completion).

Future directions. Our findings suggests several important future directions in IS flow research. First, four major streams were identified in this SLR. However, it became apparent that some streams address flow from a wider and more general perspective, while others apply a more detailed perspective, focusing on different dimensions of flow. In order to contribute to a profound understanding of flow in user experience engineering, future research may reconcile the different views and conceptualizations of flow, thereby establishing a unified theory of flow in IS research.

Second, with regard to flow antecedents, the study of Finneran and Zhang [6] proposes testable propositions that future research could address in a series of (controlled) lab experiments. For instance, understanding whether a clear fit between task and artefact leads to a flow experience could comprise a promising starting point in this direction. In addition, future research should also examine the antecedents located between person and task (e.g., challenge-skill balance), user-related antecedents (e.g., skill, gender etc.), and task-related antecedents (e.g., clarity of goals), which are so far scarcely addressed. With regard to the antecedent category of IS artefacts, which represents the category with the highest number of research studies, many undiscovered artefact characteristics are still not investigated using the lens of flow theory. For instance, future research may uncover if and how IT-mediated interruptions influence the perception of flow and what characteristics of the interruption are affecting flow. Third, additional work is needed on flow consequences. Our SLR revealed that objectively measured performance outcomes are scarce (four studies). Thereby, literature reports contradicting findings in whether flow leads to higher performance or not, hinting at the importance of considering further characteristics of the user environment, which might explain such differences. Thus, using objectively measured performance outcomes may provide valuable new insights for this ongoing discussion, particularly when applied to different contexts. Finally, our SLR reveals that at this stage only one study in top IS outlets employed neurophysiological measurements to investigate flow [43]. However, considering neurophysiological measurements of flow seems to be a promising research avenue, as flow may appear only briefly during activities and such neurophysiological measurements enable the researcher to analyze flow in situations without interrupting the user. Hence, future studies may put further emphasis on complementing self-reported flow measurement scales with neurophysiological measurements, such as electroencephalography, eye tracking, skin conductance, and heart rate.

We are aware that our paper has **limitations**. Due to the focus on top IS outlets (basket of eight, ECIS, and ICIS), promising articles from other reference disciplines (e.g., psychology) were sorted out. However, including top IS outlets in SLR represents a common practice within IS research as "major contributions are likely to be in the leading journals" and conferences [23, p. xvi]. Further, any bias in the selected keywords may also provoke a bias in the conceptualization. To reduce this probability, we carefully subdivided our SLR activities into three stages (plan, conduct, and report; cf. Figure 1) following the structured guidelines by Kitchenham [22].

Conclusion. With the advances in user experience engineering, the phenomenon of flow has become increasingly relevant for IS research and practice. Designing highly interactive and engaging interfaces requires a profound understanding of the flow phenomenon and its role in user experience in pre- and post-adoptive scenarios. By identifying the various streams of flow-related studies in IS research and conceptualizing these streams in an integrative theoretical framework along the dimensions of absorption, control, and cognitive engagement, we hope that this paper contributes to reconcile the numerous ways the flow construct has been operationalized in IS research. We believe that a unified conceptualization of flow in future research will be a cornerstone of user experience engineering and the design of engaging IS artefacts.

References

1. Agarwal, R., Karahanna, E.: Time flies when you're having fun: Cognitive absorption and beliefs about information technology usage. MIS Q. 24, 665 (2000).
2. Webster, J., Trevino, L.K., Ryan, L.: The dimensionality and correlates of flow in human-computer interactions. Comput. Human Behav. 9, 411–426 (1993).
3. Ghani, J.A., Supnick, R., Rooney, P.: The experience of flow in computer-mediated and in face-to-face groups. ICIS Proc. Paper 9 (1991).
4. Csikszentmihalyi, M.: Beyond Boredom and Anxiety. Jossey-Bass, San Francisco (1975).
5. Novak, T., Hoffman, D., Yung, Y.: Measuring the customer experience in online environments: A structural modeling approach. Mark. Sci. 19, 22–44 (2000).
6. Finneran, C.M., Zhang, P.: A person-artefact-task (PAT) model of flow antecedents in computer-mediated environments. Int. J. Hum. Comput. Stud. 59, 475–496 (2003).
7. Finneran, C.M., Zhang, P.: Flow in computer-mediated environments: Promises and challenges. Commun. AIS. 82–101 (2005).
8. Mahnke, R., Benlian, A., Hess, T.: Flow experience in information systems research: Revisiting its conceptualization, conditions, and effects. ICIS Proc. 1–22 (2014).
9. Mahnke, R., Wagner, T., Benlian, A.: Flow experience on the web: Measurement validation and mixed method survey of flow activities. ECIS Proc. (2012).
10. Engeser, S., Rheinberg, F.: Flow, performance and moderators of challenge-skill balance. Motiv. Emot. 32, 158–172 (2008).
11. Csikszentmihalyi, M.: Flow: The Psychology of Optimal Experience. Harper and Row, New York (1990).
12. Choi, D.H., Kim, J., Kim, S.H.: ERP training with a web-based electronic learning system: The flow theory perspective. Int. J. Hum. Comput. Stud. 65, 223–243 (2007).
13. Siekpe, J.S.: An Examination of the multidimensioinality of flow construct in a computer-mediated environment. J. Electron. Commer. Res. 6, 31–43 (2005).
14. Baumeister, Roy, F., Leary, Mark, R.: Writing narrative literature reviews. Rev. Gen. Psychol. 3, 311–320 (1997).
15. Rodríguez-Ardura, I., Meseguer-Artola, A.: E-learning continuance: The impact of interactivity and the mediating role of imagery, presence and flow. Inf. Manag. 53, 504–516 (2016).
16. Yi, C., Jiang, Z. (Jack), Benbasat, I.: Enticing and engaging consumers via online product presentations. J. Manag. Inf. Syst. 31, 213–242 (2015).
17. Moon, Y.J., Kim, W.G., Armstrong, D.J.: Exploring neuroticism and extraversion in flow and user generated content consumption. Inf. Manag. 51, 347–358 (2014).
18. Xue, Y., Hock-Hai, T.: The conflict between absorption and self-control in playing computer games. ICIS Proc. 132 (2008).
19. Chandra, S., Srivastava, S., Theng, Y.: Cognitive absorption and trust for workplace collaboration in virtual worlds. J. Assoc. Inf. Syst. 13, 797–835 (2012).
20. Ghani, J.A., Deshpande, S.P.: Task characteristics and the experience of optimal flow in human-computer interaction. J. Psychol. 128, 381–391 (1994).
21. Jiang, Z., Benbasat, I.: Virtual product experience. J. Manag. Inf. Syst. 21, 111–147 (2005).
22. Kitchenham, B., Charters, S.: Guidelines for performing systematic literature reviews in software engineering. Engineering. 45, 1051 (2007).

23. Webster, J., Watson, R.T.: Analyzing the past to prepare for the future: Writing a literature review. MIS Q. 26, xiii–xxiii (2002).
24. Hsu, C.-L., Lu, H.-P.: Why do people play on-line games? An extended TAM with social influences and flow experience. Inf. Manag. 41, 853–868 (2004).
25. Jackson, S.A., Marsh, H.W.: Development and validation of a scale to measure optimal experience: The flow state scale. J. Sport Exerc. Psychol. 18, 17–35 (1996).
26. Guo, Z., Xiao, L., Van Toorn, C., Lai, Y., Seo, C.: Promoting online learners' continuance intention. Inf. Manag. 53, 279–295 (2016).
27. Guo, Y.M., Poole, M.S.: Antecedents of flow in online shopping: A test of alternative models. Inf. Syst. J. 19, 369–390 (2009).
28. Kim, H., Suh, K.-S., Lee, U.-K.: Effects of collaborative online shopping on shopping experience through social and relational perspectives. Inf. Manag. 50, 169–180 (2013).
29. Wakefield, R.L., Whitten, D.: Mobile computing: A user study on hedonic/utilitarian mobile device usage. Eur. J. Inf. Syst. 15, 292–300 (2006).
30. Nah, F.F.-H., Eschenbrenner, B., DeWester, D.: Enhancing brand equity through flow and telepresence. MIS Q. 35, 731-A19 (2011).
31. Skadberg, Y.X., Kimmel, J.R.: Visitors' flow experience while browsing a web site. Comput. Human Behav. 20, 403–422 (2004).
32. Webster, J., Ho, H.: Audience engagement in multimedia presentations. DATA BASE Adv. Inf. Syst. 28, 63–77 (1997).
33. Trevino, L.K., Webster, J.: Flow in computer-mediated communication. Communic. Res. 19, 539–573 (1992).
34. Hoffman, D.L., Novak, T.P.: Marketing in hypermedia environment foundations: Conceptual foundations. J. Mark. 60, 50–68 (1996).
35. Zhang, K., Chen, C., Zhao, S., Lee, M.: Compulsive smartphone use: The roles of flow, reinforcement motives, and convenience. ICIS Proc. (2014).
36. Guo, Z., Xiao, L., Seo, C., Lai, Y.: Flow experience and continuance intention toward online learning: an integrated framework. ICIS Proc. 1–21 (2012).
37. Nah, F.F.-H., Eschenbrenner, B., DeWester, D.: Enhancing brand equity through flow and telepresence: A comparison of 2D and 3D virtual worlds. ICIS Proc. (2010).
38. Phang, C.W., Kankanhalli, A.: How do perceptions of virtual worlds lead to enhanced learning? An empirical investigation. ICIS Proc. (2009).
39. Kamis, A., Koufaris, M., Stern, T.: Using an attribute-based decision support system for user-customized products online: An experimental investigation. MIS Q. 32, 159–177 (2008).
40. Koufaris, M.: Applying the technology acceptance model and flow theory to online consumer behavior. Inf. Syst. Res. 13, 205–223 (2002).
41. Visinescu, L.L., Sidorova, A., Jones, M.C., Prybutok, V.R.: The influence of website dimensionality on customer experiences, perceptions and behavioral intentions. Inf. Manag. 52, 1–17 (2015).
42. Ben Mimoun, M.S., Garnier, M., Ladwein, R., Benavent, C.: Determinants of e-consumer productivity in product retrieval on a commercial website: An experimental approach. Inf. Manag. 51, 375–390 (2014).
43. Wang, C.-C., Hsu, M.-C.: An exploratory study using inexpensive electroencephalography (EEG) to understand flow experience in computer-based instruction. Inf. Manag. 51, 912–923 (2014).

44. Lowry, P.B., Gaskin, J.E., Twyman, N.W., Hammer, B., Roberts, T.L.: Taking "fun and games" seriously. J. AIS. 14, 617–671 (2013).
45. Goel, L., Johnson, N.A., Junglas, I., Ives, B.: How cues of what can be done in a virtual world influence learning: An affordance perspective. Inf. Manag. 50, 197–206 (2013).
46. Goel, L., Johnson, N., Junglas, I., Ives, B.: Predicting users' return to virtual worlds: A social perspective. Inf. Syst. J. 23, 35–63 (2013).
47. Lee, Y., Chen, A., Ilie, V.: Can online wait be managed? The effect of filler interfaces and presentation modes on perceived waiting time online. MIS Q. 36, 365–394 (2012).
48. Weniger, S., Loebbecke, C.: Researching cognitive absorption in the context of fun-oriented information systems usage: An exploratory study. ECIS Proc. (2011).
49. Goel, L., Johnson, N.A., Junglas, I., Ives, B.: From space to place: Predicting users' intentions to return to virtual worlds. MIS Q. 35, 749-A5 (2011).
50. Deng, L., Turner, D.E., Gehling, R., Prince, B.: User experience, satisfaction, and continual usage intention of IT. Eur. J. Inf. Syst. 19, 60–75 (2010).
51. Jia, R., Hartke, H., Pearson, J.: Can computer playfulness and cognitive absorption lead to problematic technology usage? ICIS Proc. (2007).
52. Shang, R.-A., Chen, Y.-C., Shen, L.: Extrinsic versus intrinsic motivations for consumers to shop on-line. Inf. Manag. 42, 401–413 (2005).
53. Saadé, R., Bahli, B.: The impact of cognitive absorption on perceived usefulness and perceived ease of use in on-line learning. Inf. Manag. 42, 317–327 (2005).
54. Hess, T.J., Fuller, M. a., Mathew, J.: Involvement and decision-making performance with a decision aid. J. Manag. Inf. Syst. 22, 15–54 (2005).
55. Zhang, H., Lu, Y., Gupta, S., Zhao, L.: What motivates customers to participate in social commerce? The impact of technological environments and virtual customer experiences. Inf. Manag. 51, 1017–1030 (2014).
56. Animesh, A., Pinsonneault, A., Yang, S.B., Oh, W.: An odyssey into virtual worlds. MIS Q. 35, 789–810 (2011).
57. Scott, J.E., Walczak, S.: Cognitive engagement with a multimedia ERP training tool. Inf. Manag. 46, 221–232 (2009).
58. Webster, J., Ahuja, J.S.: Enhancing the design of web navigation systems: The influence of user disorientation on engagement and performance. MIS Q. 30, 661–678 (2006).
59. Bilgihan, A., Nusair, K., Okumus, F., Cobanoglu, C.: Applying flow theory to booking experiences. Inf. Manag. 52, 668–678 (2015).
60. Huang, L.-Y., Hsieh, Y.-J., Wu, Y.-C.J.: Gratifications and social network service usage: The mediating role of online experience. Inf. Manag. 51, 774–782 (2014).
61. Sharkey, U., Acton, T., Conboy, K.: Optimal experience in online shopping: The influence of flow. ECIS Proc. (2012).
62. Theotokis, A., Doukidis, G.: When adoption brings addiction: A use-diffusion model for social information systems. ICIS Proc. 13 (2009).
63. Ha, I., Yoon, Y., Choi, M.: Determinants of adoption of mobile games under mobile broadband wireless access environment. Inf. Manag. 44, 276–286 (2007).
64. Solomon, M.R.: Consumer behavior: Buying, having, and being. Prentice Hall, New York (2014).