PERCEIVED MAINTENANCE LOAD OF HIGH MAINTENANCE INFORMATION SYSTEMS: CONCEPTUALIZATION AND DEVELOPMENT

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Abstract

The purpose of this study is to present a new construct - perceived maintenance load (PML) – which captures the users' perceptions of maintenance load associated with using a High Maintenance Information Systems (HMIS). HMIS is a class of information systems that requires an ongoing maintenance effort to maintain the system in order to continuously derive its benefits. To develop the PML construct, the procedure recommended by Lewis et al. (2005) will be followed. This work-in-progress paper presents the first-stage results of this methodology only. The purpose and importance of the PML construct is specified and the conceptual definition of PML, which draws on the concepts of mental workload and rumination theories, is developed. Plans for future research are outlined.

Keywords: Perceived Maintenance Load, High Maintenance Information Systems, Mental Workload, Rumination, Conceptualization.

1 INTRODUCTION

Individuals across the world are increasingly utilizing information and communication technologies (ICTs) to support both their professional and personal activities. The use of ICTs is associated with mental workload that varies by their purpose and design. For many ICTs the mental workload involved is episodic in nature (i.e. it directly occurs with starting to use of a system and proceeds till the end of the use session -- e.g. using word processing software to write a document). However, for some ICTs, the mental workload involved is persistent in nature as these systems require users to periodically and persistently engage in updating or maintaining the system in order to derive the full set of benefits associated with its use (e.g. Personal Health Records (PHR), Facebook or LinkedIn). We refer to this emerging class of information systems as *High Maintenance İnformation Systems* (HMIS) – a term coined by Assadi and Hassanein (2010).

Facebook, as an example of an HMIS, is a platform for developing and maintaining relationships or, in other words, "social grooming" (Donath 2007) which refers to the desire to keep in touch with social ties and satisfy curiosity about others (Tufekci 2008). The amount of time and effort allocated to interact with others or the content, and the frequency and length of messages can be interpreted as the level of commitment to the relationships on Facebook (Ellison et al. 2014). To derive the gratification that comes with having an active social network, users must commit significant time and effort on an ongoing basis. Therefore, maintaining a Facebook account can have psychological and behavioural consequences (Gartner 2011; Maier et al. 2014) due to the fact that these social networking sites (SNSs) require high levels of engagement and interaction (Ayyagari et al. 2011). On the other hand, infrequent/insufficient maintenance of Facebook may result in deficits in psychological needs that are dependent on staying connected, and may result in anxiety (Kandell 1998) brought on by a perceived fear of missing out on the interactions that are taking place within one's social network (Przybylski et al. 2013). As such, a Facebook user may expend significant time and thought (which may have emotional impact) both during and in-between use sessions.

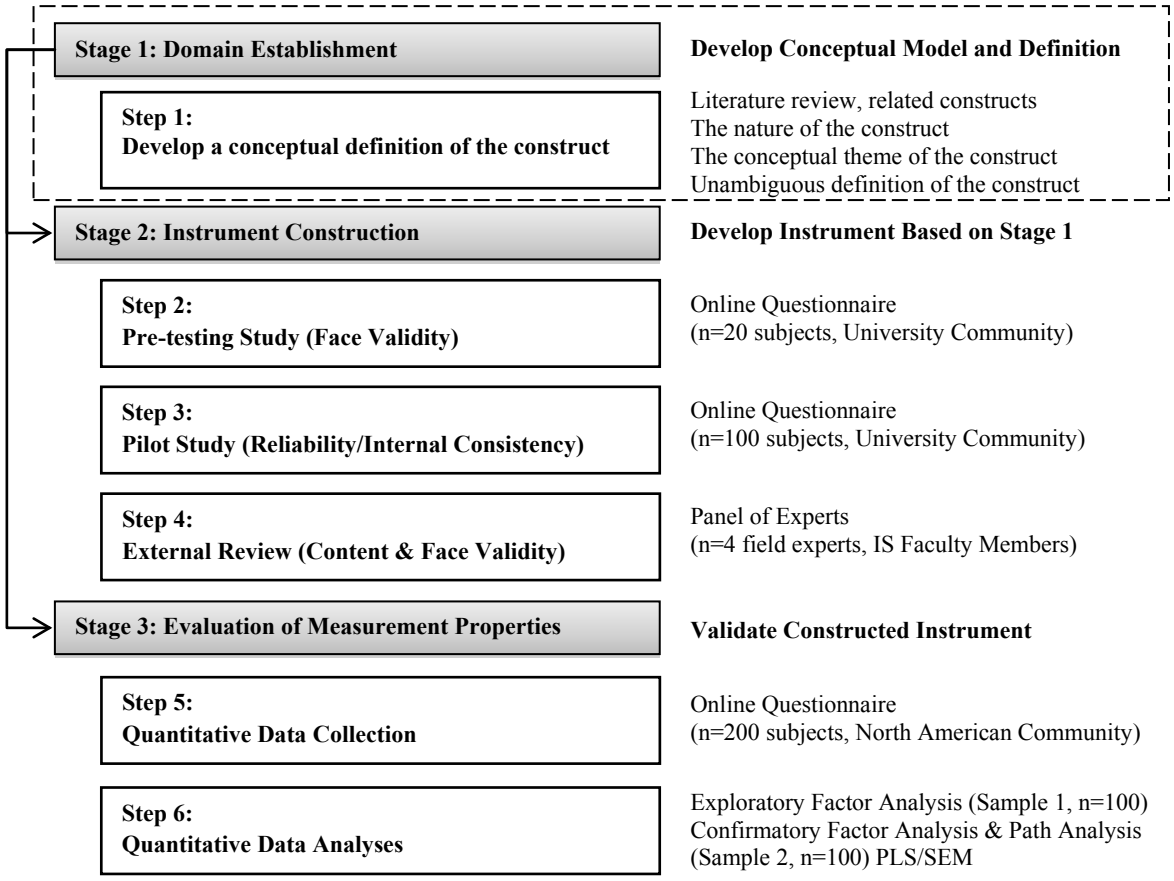
Personal Health Records (PHR) systems are another instance of an HMIS in a different context. A PHR is commonly used to house a user's health history. With the user's approval, physicians or other medical authorities are able to use information stored in a PHR to make informed health-related decisions. Failure to maintain the system through timely updates may lead to misinformed healthcare decisions (Tang et al. 2006). Accordingly, significant and ongoing time and effort/load (which may include cognitive and emotional load) is required to maintain the system, which can lead to user stress.

Existing models in the information systems (IS) acceptance and use literature focus on episodic use of systems, which recognize the impact of IS usage effort through such constructs as "perceived ease of use" (Davis 1989; Davis et al. 1989), "ease of use" (Moore & Benbasat 1991), "complexity" (Thompson et al. 1991), and "effort expectancy" (Venkatesh et al. 2003). However, the influence of these constructs on IS use will diminish as users become familiar with system use (Assadi and Hassanein 2010). Hence, the effect of "complexity" or "ease of use" doesn't have an impact on IS usage in the post-adoption term (Bhattacherjee 2001; Venkatesh et al. 2003). Further, these construct focus on time load and learning effort rather than congitive or emotional load. Thus, there is a lack of research regarding the impact of maintenance workload (hereafter referred to as "perceived maintenance load") on IS usage. This study addresses this gap in the existing IS literature. To this end, the proposed study will introduce a new construct - perceived maintenance load (PML) - with its different time, cognitive and emotional facets.

The remainder of this research-in-progress paper is organized as follows: Section 2 introduces the methodology employed for our construct development; Section 3 establishes the domain of the new construct outlining its roots in the literature, its nature and conceptual theme culminating in a format definition; Section 4 provides some conclusions and plans for future work.

2 PML CONSTRUCT DEVELOPMENT METHODOLOGY

In developing the new PML construct, we employ the methodology proposed by Lewis et al. (2005). The complete Lewis et al. (2005) methodology is outlined in Figure 1 where some of the steps follow guidelines from Moore & Benbasat (1991) and MacKenzie et al. (2011). This study reports on the first stage of this methodology (shown by the dashed box in Figure 1) with the outcome of developing a conceptual definition of PML.



(Adapted from Moore & Benbasat 1991; Lewis et al. 2005; MacKenzie et al. 2011)

Figure 1. Overview of Research Design

3 DOMAIN ESTABLISHMENT

The conceptual domain of the PML construct and its theoretical context were developed through a procedure suggested by MacKenzie et al. (2011) following four stages: (i) conduct a literature on relevant theories ii) determine the nature of the construct (Sartori 1984), the phenomena to which the focal construct pertains and the object to which the construct applies; (iii) specify the conceptual theme of the construct (attributes/characteristics, dimensionality, and stability); and (iv) define the PML construct and its sub-dimensions in unambiguous terms.

3.1 Literature Review

In order to conceptualize the construct of PML, this study draws on the concepts of mental workload and rumination, as these two concepts capture the effort/load of HMIS users both within and in-between use sessions.

3.1.1 Mental Workload

The term workload has been used broadly in the area of human factors (or ergonomics) to understand the way in which people perform a variety of tasks at home, at work, and at leisure (Baldwin 2012). It refers to the limited physiological and mental resources an individual allocates while performing a given task (De Waard 1996; Burian et al. 2013). Advancements in human-computer interaction mean that human activities are increasingly cognitively driven (Longo 2014). Therefore, the assessment of mental workload has become an important aspect for designing effective systems (Baldwin 2012) that reduce human errors, increase system safety, efficiency, comfort, and user satisfaction (Moray 1988; Rubio et al. 2004).

The aim of a mental workload assessment is to specify the number of mental activities required to perform a given task or combination of tasks and to receive an evaluation of system and user performance (Longo et al. 2012). The interaction among the task requirements, the conditions to perform the task, and the performer's abilities, behaviours, and perceptions composes the workload (Kantowitz 1988; Hart & Staveland 1988). Therefore, it is not only task-specific but also person-specific (Rouse et al. 1993), and hence is a relative concept. There are many subjective procedures for measuring mental workload such as the Cooper-Harper Scale (Cooper & Harper 1969), the Bedford Scale (Roscoe 1987; Roscoe & Ellis 1990), the SWAT (Subjective Workload Assessment Technique) (Reid & Nygren 1988), and the NASA-TLX (Task Load Index) (Hart & Staveland 1988).

In this paper, we focus on the SWAT due to its parsimony and relevance to the proposed PML construct. It consists of three dimensions (time load, mental effort load, and psychological stress load) that are described by a three-level scale for assessing mental workload. *Time load* refers to the amount of time a person has available to perform a task (Reid & Nygren 1988). As time load increases, time for other activities decreases, and overlaps and interruptions among tasks may occur (Dawes 2006). *Mental effort load* refers to the amount of attention and concentration a task requires (Reid & Nygren 1988, Dawes 2006). *Psychological stress load* refers to any situation that brings anxiety, frustration, and confusion during task performance and hinders its completion (Reid & Nygren 1988). As the level of stress increases, so too do anxiety, frustration, or confusion, which in turn requires more concentration and determination (Dawes 2006).

We believe that adopting mental workload theory in the field of IS acceptance and use have great potential for the investigation of the influences of mental load on users' perceptions towards IS usage for several reasons including: (i) Workload emerges from the interaction between task characteristics (requirements, circumstances, environment etc.) and user characteristics (skills, behaviours, and perceptions etc.) (Kantowitz 1988; Hart & Staveland 1988). Therefore, it has the potential to facilitate a better understanding of human-computer interaction; and (ii) Mental workload is broad concept that covers different facets of the load imposed by the task (e.g. time, cognitive, emotional).

3.1.2 Rumination

The term rumination comes from the psychology field and is concerned with several varieties of recurrent thinking. There are various psychological perspectives and definitions seeking to explain the phenomena such as Response Style Theory (RST) (Nolen-Hoeksema 1991) and Goal Progress Theory (GPT) (Martin et al. 1993). In RST, the context focuses on cognitive vulnerability to depression (Smith and Alloy 2009), particularly on possible causes and consequences of individuals' negative feelings. GPT, on the other hand, seeks to explain rumination as a function of goal progress. Here we focus on GPT due to its potential relevance to the field of technology acceptance and use.

In GPT, rumination is conceptualized as "repetitive thoughts about goal discrepancy" (Smith & Alloy 2009 p.23). Martin and Tesser (1989, 1996) believe that rumination is actually an example of the Zeigarnik effect (Zeigarnik 1938), which states that we tend to remember interrupted or uncompleted tasks more than already-completed tasks. The core assumption behind GPT is that most of our thoughts are goal-directed and we always aim to adjust our goals with current conditions by

continually comparing them. Where an absence/delay of advancement is noticed, rumination occurs (Martin & Tesser 1989; Carver and Scheier, 1990; Scott &McIntosh 1999). Rumination contains several subclasses. For example, individuals can ruminate about positive or negative content (emotional valence), past experience, present situation or future expectations (time period), and a completed or an incompleted task (focus of the thoughts).

The number of ruminative thoughts one has varies from individual to individual (Martin & Tesser 1996). The level of value that an individual places on a particular goal determines the amount of rumination in terms of duration and frequency. Thus, higher order goals instigate more ruminative thoughts (Carver 1996; Martin & Tesser 1996). Furthermore, individuals may easily withdraw from their lower order goals due to their lesser significance (Carver and Scheier 1990; Carver 1996).

We believe that GPT offers strong potential for the investigation of HMIS and is especially applicable to better understand the mental workload imposed upon HMIS users. HMIS-related rumination may be considered as users' repetitive thoughts of needing to maintain an HMIS. Rumination may arise in different settings and at various stages of maintaining an HMIS. For example, a Facebook user can ruminate about his/her social network, even when not using it. When the user shares something related to his/her important life events—either positive or negative—the user can then ruminate about potential feedback on the shared content, even when not online. Furthermore, the user may ruminate about potentially missed rewarding experiences on Facebook occurring while the user is absent (i.e. fear of missing out). These ruminations consist of a variety of modes, such as past experiences, a present situation, or future expectations that include positive or negative emotions. Another example of rumination occurs with PHR systems. A diabetes patient, for example, who is asked to use a PHR system, may worry about missed data submissions affecting the quality of information shared with his/her clinicians, which in turn might affect treatment decisions.

3.2 The Nature of PML

In response to the call from Sartori (1984) to specify the phenomena to which the focal construct pertains and the object to which the focal construct applies, we clearly identified the type of property the construct represents (e.g., thoughts, feelings, perceptions, actions, etc.) and the entity to which it applies (e.g., a person, a task, a process, an organization etc.) (MacKenzie et al. 2011). For example, the definition of IT capabilities, stating that "the ability to mobilize and deploy IT-based resources in combination or copresent with other resources and capabilities" (Bharadwaj 2000, p.171), should focus on a firm's (entity) abilities or comptecencies in the IT area (general property).

PML is associated with a user's (the object which the focal construct PML applies to) perception about using an HMIS (the property that the focal construct PML represents). Therefore, the definition of the construct PML should focus on a person's (entity) perception regarding the use of HMIS.

3.3 The Conceptual Theme of PML

In this section, the conceptual theme of the construct of PML is specified. To this end, its potential distinguishable facets/sub-dimensions are presented, its unique attributes/characteristics are outlined, and finally its stability over time, across situations, and across cases are discussed.

In terms of dimensionality and on the basis of the generic, subjective mental workload scope that we reviewed earlier, mental workload consists of different demands or loads. Due to its parsimony, the proposed construct of PML relies on SWAT (Reid & Nygren 1988), which represents the composition of time load, mental effort load, and psychological stress load. Thus, the construct of PML is multidimensional. Thus it is possible for a change in PML to be associated with a change only in time load and not cognitive or emotional load (e.g. a Facebook user experiencing increased time load without an increase in emotional stress load). Therefore, PML is a second-order construct that consists of three formative indicators. Each indicator represents different aspects of PML that could be separate constructs but remain integral parts of PML at a more abstract level.

PML differs in multiple ways from existing workload-related constructs that are commonly used in the field of IS acceptance and use, including "perceived ease of use" (PEOU) (Davis 1989; Davis et al. 1989), "complexity" (Thompson et al. 1991), "ease of use" (Moore & Benbasat 1991), and "effort expectancy" (Venkatesh et al. 2003). First, PML offers a more comprehensive view of the workload users experience with HMIS both during and in-between use sessions while existing work-load related constructs only focus on the workload during use sessions. We argue that the workload (i.e. PML) which occurs in-between sessions, affects user's perceptions towards acceptance, use, and continuous intention to use HMIS as well. Second, PML does a better job at capturing the variety of workloads users experience in interacting with an HMIS (i.e. Time, Cognitive and Emotional loads) while existing constructs tend to only capture initial user expectations regarding the time and effort required to initially learn how to operate an IS. In so doing, these existing workload-related constructs ignore the psychological consequences of IS usage. PML, on the other hand, covers workload in three distinct aspects based on SWAT (Baldauf et al. 2009, p. 3): "temporal density of events" related to maintaining an HMIS (time load); "required concentration" to maintain an HMIS (cognitive load); and "subjective feelings of emotional stress and anxiousness" imposed upon the users of HMIS (emotional load). Finally, PML has the potential for use used in both pre-adoption and post-adoption models as it is expected to vary over time.

It is interesting to note that while some of the existing workload-related constructs from the IS literature capture some of the aspects under the proposed PML construct, none of these constructs singularly captures all the dimensions captured by the proposed PML construct. It is also interesting to note that none of these constructs are concerned with the emotional load that may result from using/maintaining an HMIS.

With respect to stability, PML is expected to vary over time as it has the potential to evolve as users gain experience in using HMIS. There are some possible factors that can effect this evolvement. Firstly, the usage behaviour of an HMIS tends to become habitual. Nevertheless, maintaining an HMIS would continually impose mental workload on the user. For example, assume that an individual checks his/her email frequently. The "checking" behaviour can become habitual, but the user still needs to allocate time and effort to filter, read, understand, and respond to those emails. The second factor that may effect PML over time is enjoyment. If the user becomes immersed in HMIS usage due to enjoyment of the activity, his/her perceptions may change or become less susceptible to PML. Regarding case and situation stability, PML is more applicable to HMIS such as Facebook, LinkedIn, PHR and similar mobile health applications. PML is expected to generalize across HMIS cases and across different situations such as voluntary (Facebook, LinkedIn, M-Health applications) versus compulsory usage (maintaining an Enterprise Resource Planning system or an official email address); or utilitarian (LinkedIn, Diet Tracker Applications) versus hedonic usage (Facebook, Tumblr) of IS systems.

3.4 The Definition of PML

Considering all the above-mentioned characteristics, we propose the following definition of perceived maintenance load:

Perceived maintenance load (PML) refers the time, cognitive and emotional loads experienced by a user within and in-between use sessions of a high maintenance information systems (HMIS).

PML consists of three sub-dimensions, namely time load, cognitive load, and emotional load that affect users during and in between HMIS use session as shown in Figure 2.

Time load refers to the amount of time a person needs to allocate to the maintenance of an HMIS both during and between use sessions. HMIS require a high level of engagement and interaction which can be time consuming. According to a Pew Research Center study (Rainie et al. 2013, p. 2), more than one-fifth (21%) of Facebook users stop maintaining their accounts due to the time demands it imposes on them. Because of its nature, HMIS can be seen as a daily activity and also become dominant over other daily routines. Therefore, increasing engagement and interaction with these systems requires

additional time. HMIS may also impose time load between use sessions. For example, a Facebook user may spend some time between use sessions pondering what content to share and how to best share it.

Cognitive load refers to the degree to which a person believes that using an HMIS requires mental activity both during and between use sessions. Maintaining an HMIS can be laborious, as it requires mental activities such as calculations, making decisions, memorization, retrieving information, and so forth. For instance, a PHR user must input and track his/her daily intake of calories and nutrients. The user may have to calculate the values of the food that he/she would like to eat, or may estimate his/her daily needs after having an extra intake of nutrients. Another example is that of maintaining a social network through Facebook, which may induce a cognitive load upon the user. He/she must follow the newsfeed, read the shared contents, remember the contacts, or retrieve past experiences to formulate better responses. HMIS may impose cognitive load to users between use sessions, as well. For example, in a PHR, when keeping a dietary record, recalling meals eaten and thinking about the next use session may increase cognitive load, even when not using the system.

Emotional load refers to the degree to which a person believes that maintaining an HMIS would be an emotional burden in cases of insufficient maintenance effort both during and between use sessions. For example, avid Facebook users may experience stress and tension when they are not able to access their accounts. They may be worried that conversations or postings are occurring where they could be providing timely commentary. This fear of missing out and not being involved in the current conversation can incur emotional burden between use sessions.

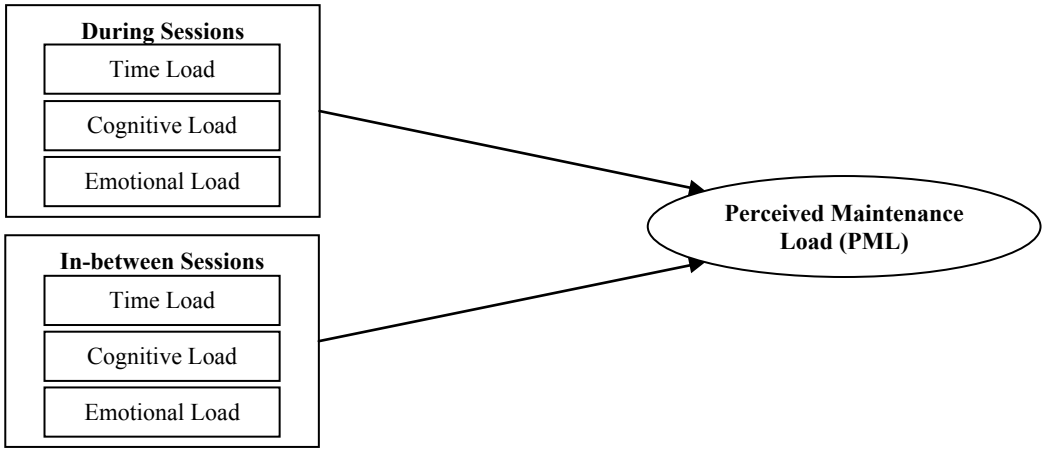


Figure 2. Proposed PML Construct and its Sub-Dimensions

To clarify the domain of PML relative to other related workload constructs from the literature, Table 1 in Appendix A examines the three dimensions of PML presenting sample potential items for measuring it both during and in-between Facebok use sessions as an HMIS instance.

4 CONCLUSIONS AND FUTURE WORK

In this work-in-progress study, we have introduced the new construct of perceived maintenance load (PML) to measure individuals' perceptions regarding the load they have to incur on a regular basis while using and in-between use sessions of an HMIS. As HMIS require ongoing engagement and interaction, they impose various loads on the user, even when not directly using these systems. In order to explain this phenomenon associated with HMIS, we have conceptualized the construct of PML based on the concepts of mental workload and rumination theories. We have also identified the conceptual theme of the PML construct, including its unique characteristics, dimensionality, and stability. In this paper, we have completed Stage 1 of Lewis et al.'s (2005) methodology for developing the new construct of PML. Future work will continue our PML development by following Stage 2 (instrument construction) and Stage 3 (evaluation of measurement properties) of this

methodology. The outcome of this process will be a fully specified PML construct. This addresses a gap in the academic literature, as no other construct currently captures the user's load during and in-between use sessions of HMIS. From a practical standpoint, this study will lead to better predictions of user preferences in using HMIS. Utilizing this new construct in adoption models of HMIS can help practitioners in terms of development, promotion, and encouraging continual use of these systems.

APPENDIX A - Potential Items for the Proposed PML Constructs

Temporal Orientation	Proposed PML Dimensions	Sample Potential Items
During use sessions	Time Load	• Maintaining my Facebook account makes me unable to follow my desired work/study schedule. • Maintaining my Facebook account requires significant time commitment. • Maintaining my Facebook account interferes with my other commitments.
	Cognitive Load	• Maintaining my Facebook account is cognitively demanding. • Maintaining my Facebook account is cognitively laborious. • Maintaining my Facebook account requires extensive concentration.
	Emotional Load	• I get stressed thinking of how much time I need to dedicate to maintaining my Facebook account. • I worry when I logon to Facebook and realize that I am late in responding to a friend's message. • I feel anxious if when I realize that I have missed out on any activity on my Facebook account that I usually engage in.
In-between use sessions	Time Load	• Thinking about maintaining my Facebook account interferes with my other commitments. • Thinking about maintaining my Facebook account makes me unable to follow my desired schedule. • I spend a lot of time thinking about interactions I have had on my Facebook account.
	Cognitive Load	• Thinking about maintaining Facebook preoccupies me. • Thinking about interactions I have had on my Facebook account is cognitively demanding. • Thinking about interactions I might have on my Facebook account is cognitively demanding.
	Emotional Load	• I feel anxious when I can't update my Facebook account in a timely manner. • I worry that I might miss a request from my Facebook account. • I get nervous that I might be missing out on something important on my Facebook account.

Table 1. Potential Items for the Proposed PML Constructs

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