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Towards a Framework for Socially Influencing Systems: Meta-Analysis of Four PLS-SEM Based Studies

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Abstract. People continuously experience various types of engagement through social media, mobile interaction, location-based applications, and other technologically advanced environments. Often, integral parts of such socio-technical contexts often are information systems designed to change behaviors and attitudes of their users by leveraging powers of social influence, further defined as socially influencing systems (SIS). Drawing upon socio-psychological theories, this paper initially reviews and presents a typology of relevant social influence aspects. Following that, it analyzes four partial least squares structural equation modeling (PLS-SEM) based empirical studies to examine the interconnectedness of their social influence aspects. As a result, the analysis provides grounds for seminal steps towards the development and advancement of a framework for designing and evaluating socially influencing systems. The main findings can also deepen understanding of how to effectively harness social influence for enhanced user engagement in socio-technical environments and guide persuasive engineering of future socially influencing systems.

Keywords: socially influencing systems, framework, persuasive technology

1 Introduction

The dynamic evolution of social media, mobile connectivity, and a digital economy is continuously reshaping how businesses approach and engage customers [1]. Rapidly growing connectedness not only provides new methods for organizations to retain existing relationships with consumers, but also opens new ways to enrich customer engagement experiences and foster innovation [21]. Along the way, businesses and customers tend to naturally follow new market trends and steadily develop an understanding of the spectrum of opportunities provided by emerging technologies. People seamlessly acquire new habits of interaction and consumption behavior, which then set their expectations about how products and services should be designed [34].

Customers increasingly demand products and services that better match their needs and individual preferences [29]. Therefore, businesses face a need to continuously understand the individual and evolving expectations of their customers [26]. Thus, organizations stand to benefit from systems that are designed to reach customers more proactively and provide convenient ways for interaction [32].

The Internet has become increasingly mobile and social over the last decade [1]. Social media has rapidly expanded and businesses tend to use social media more often for the development of customer relationships. Simultaneously, these advancements exert various effects on everyday life by changing human behavior in both virtual and physical spaces. For example, it has become common for people to use social media through mobile devices [10]. The combination of socially dynamic and technologically advanced contexts has gradually introduced unique modes for businesses to engage customers almost instantly. Such socio-technical spaces often comprise information systems designed to change behavior and attitudes of their users by leveraging powers of social influence, further described as socially influencing systems [38].

To enrich an understanding of how to effectively harness social influence for enhanced user engagement through socio-technical environments, this paper continues with the following sections. In the next, a social cognitive perspective on human behavior is described. Then, the paper introduces a concept of socially influencing systems and reviews a typology of relevant social influence aspects. Thereafter, it provides a meta-analysis of four empirical studies based on partial least squares structural equation modeling (PLS-SEM) methodology and reports seminal steps towards a framework structure for designing and evaluating socially influencing systems. Finally, implications of the main outcomes are discussed and conclusions drawn.

2 Social Cognitive Foundation

According to Ryan and Deci [36], whether people become proactive and engaged depends largely on the social environments in which they develop and function. Bandura [5] has extended this perspective by suggesting that human self-development, adaptation, and change are embedded in social systems. In such systems, according to social cognitive theory [4], personal, behavioral, and environmental factors all interact continuously, perpetually influencing each other and determining the effect of each. There is an endless dynamic interplay between people, their behavior, and the environments where their behavior occurs.

The described triadic reciprocal determinism unfolds multiple angles for studying behavioral change, including environmental and personal change. Human behavior alters environmental conditions and, in turn, is changed by the same conditions that it creates [4]. Along the same vein, social cognitive theory suggests exploring how ambient environments maintain aspects of social persuasion.

Theories of persuasion often aim at describing either influences on or changes in behavior and attitudes on individual, group, and societal levels [33]. According to Fogg [19], persuasive technologies can be designed as social actors and are therefore capable of social influence even in the absence of other people in an immediate physical space. When properly designed, such persuasive technologies can become very effective for inducing behavioral and attitudinal changes in novel socio-technical contexts. Exploring the ability of persuasive technologies and systems to engage users is an essential direction for future research [9].

3 Socially Influencing Systems (SIS)

Social influence, as a substantive phenomenon, has a longstanding history in psychology [12], providing insights on various forms of potential influences on human behavior by the actual, imagined, or implied presence of other people [35]. Along its history, social influence has often been associated with compliance, identification, internalization, obedience, and persuasion, although at the same time kept distinct from conformity, power, and authority. Recent research on social influence mainly has been addressing either minority influence in group settings, dynamic social impact theory, social influence in expectation states theory, or persuasion [8], the latter being broadly defined as change in behavior or attitudes due to information received from others [13-14].

Human beings can experience social influence not only from others in physical proximity around them, but likewise through information systems that are engineered to serve such purpose. Information systems can exert social influence through their design and user interfaces when augmented with relevant social influence aspects, such as *social learning*, *social comparison*, *normative influence*, *social facilitation*, *cooperation*, *competition*, and *recognition* [38]. An information system becomes socially influencing when it has been enriched with social influence aspects to facilitate changes in behavior and attitudes of its users (Fig. 1).

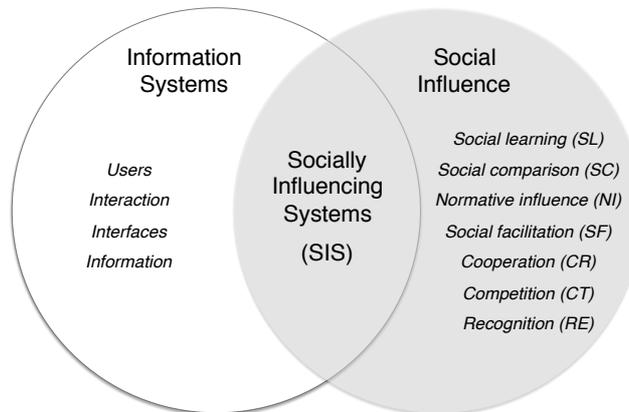


Fig. 1. Socially Influencing Systems

Besides a general comprehension of information system development and software engineering, designers of *socially influencing systems* are required to acquire or maintain a decent level of understanding about human behavior and social psychology. The foundation of the theory and research on socially influencing systems is underpinned by a list of fundamental theories originating from affined areas of social and cognitive psychology. The following are primary theories that are used in this research: social cognitive theory [4], social comparison theory [17], focus theory of normative conduct [13], social facilitation theory [20], cooperation theory [2], competition theory [15], and taxonomy of intrinsic motivators [25].

The listed theories suggest multiple sources of reference for the seven aforementioned social influence aspects that have the capacity to alter behavior and attitudes of users of socially influencing systems. Table 1 summarizes the descriptions, implementation examples, and relevant references of each aspect, while Fig. 2 provides more graphical representation of their sub-dimensions that are discussed and *highlighted* in the following sub-sections.

Table 1. Social influence aspects

Aspect	Description	Implementation example
Social learning (SL) [3-5]	Learning new behavior by observing how other people perform them.	Enabling users to see how others are using a system.
Social comparison (SC) [17], [40-42]	Comparing a behavior of an individual with behavior of others.	Names of active users grow larger as compared to passive users.
Normative influence (NI) [13], [16], [23]	People tend to follow norms and experience peer pressure.	Presenting normative statements or how a majority of others behave.
Social facilitation (SF) [20], [44]	Influence on an individual when surrounded or watched by others.	Displaying how many others are using a system at the same time.
Cooperation (CR) [2], [25], [27]	Activity aimed at achieving a common goal or working together.	Exposing results of cooperative efforts through a system.
Competition (CT) [15], [25], [28]	Endeavoring to gain what others are striving to gain at the same time.	Demonstrating a list of users who are ordered based on their performance.
Recognition (RE) [6], [25], [37]	Value that a person derives from gaining acceptance and approval from others.	Receiving a special title that is displayed to everybody through a system.

3.1 Social learning

People learn from others by observing their behavior in social contexts [3]. This implies that the information from one individual to another can be transferred through imitation, teaching, and spoken or written language. According to Bandura [4], social learning is ubiquitous and potent, because it allows people to avoid the costs of individual learning. Accordingly, new behavioral patterns can be obtained through observational learning, for example, to share knowledge [11].

3.2 Social comparison

When individuals use information about other people to evaluate themselves, they engage in social comparison [17]. Specifically, social comparison is described as the

process of thinking about others in relation to the self [42]. This process affects motivation, because people tend to look for self-enhancement when comparing themselves *downward* with others who are worse off [40], or individuals look *upward* for self-improvement when seeking a positive example for comparison [41]. In any case, social comparison affects human attitude and behavior [31].

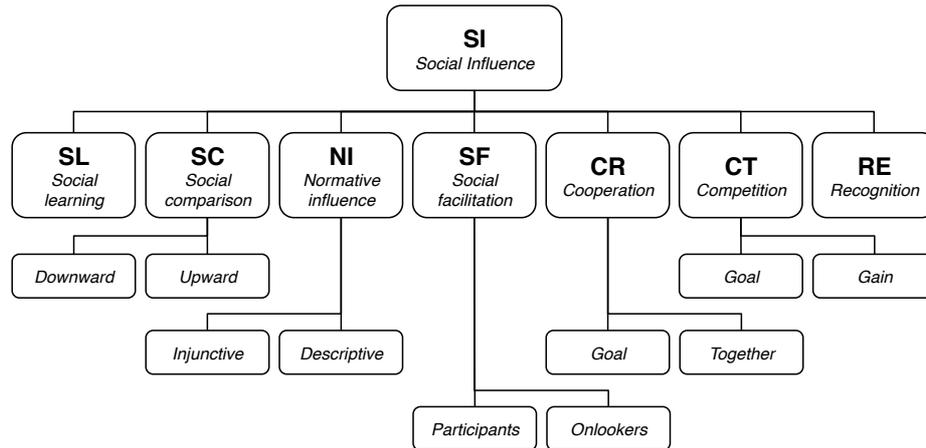


Fig. 2. Structure of the social influence aspects and their sub-dimensions

3.3 Normative influence

Influence of other people also leads individuals conforming in order to be liked and accepted [16]. Such human action is guided by perceptions of the popularity of certain behavior, that is, by social norms. Research emphasizes that both injunctive and descriptive norms are effective in altering behavior and attitudes of people [23]. *Injunctive* norms inform individuals about what ought to be done, whereas *descriptive* norms refer to what most people actually do [13]. Thus, normative influence affects a wide range of behaviors, e.g. blog usage [22].

3.4 Social facilitation

The mere or imagined presence of other people in social situations creates an atmosphere of evaluation, which enhances the speed and accuracy of well-practiced tasks, but reduces the performance of less familiar tasks [43]. These social facilitation effects occur in the presence of either passive *onlookers*, or people who are active *participants*, or both [20]. As a result, these effects influence human behavior [44].

3.5 Cooperation, competition, and recognition

Interpersonal factors of cooperation, competition, and recognition provide intrinsic motivation that would not be present in the absence of other people [25]. Competition

and cooperation are directed toward the same social end by at least two persons [27]. On a social level, people cooperate when they are striving to achieve the same *goal* or are they are working *together*, but compete when they are trying to achieve the same *goal* that is scarce or are seeking to *gain* what others are endeavoring to gain at the same time [28].

Combining the scores of independent tasks performed by different people can encourage cooperation, but providing some salient metric for individuals to compare their performances can promote competition [25]. Meanwhile, recognition can be experienced after competing or cooperating with others [37] or can simply be enjoyed when gaining acceptance and approval from others [6]. The three motivating factors influence various behaviors, including learning [25] and the use of podcasts for generating a sense of community [18].

4 Meta-Analysis

To enrich an understanding of how to effectively harness the previously reviewed social influence aspects for enhanced user engagement through socio-technical environments, this section presents a meta-analysis of four empirical studies conducted using partial least squares structural equation modeling (PLS-SEM) methodology.

The four studies (Table 2) were selected based on the shared methodological approach, context, and equal granularity in the exploration of three to seven of the social influence aspects [38]. To the best of accessible knowledge, there were no other comparable studies for inclusion into the present meta-analysis of four socially influencing systems.

Table 2. The list of analyzed studies [38]

Study	Description	Examined aspects
I	Empirical study involving 37 users of a socially influencing system designed for feedback collection through situated displays integrated with Twitter	SL, SF, CR, CT, RE
II	Empirical study involving 69 users of a socially influencing system designed for feedback collection through situated displays integrated with Twitter	SL, SC, NI
III	Empirical study involving 101 participants and a socially influencing system designed for collaborative engagement through situated displays integrated with Twitter	SL, SF, CR
IV	Empirical study involving 77 users of a socially influencing system designed for feedback collection through situated displays integrated with Twitter	SL, SC, NI, SF, CR, CT, RE

The analysis was performed in several consecutive steps. First, the structural models from all studies were reviewed in terms of the present social influence aspects and directed paths (arrows) interconnecting them (Table 3). Second, all seven aspects

were mapped out into a single model and all arrows from original models were drawn into the new model. Third, if there were several arrows connecting a pair of aspects, i.e. same directed path originated from several studies (Table 3), only one arrow was kept to represent all of them.

Table 3. Summary of the directed paths from all studies

Directed path between aspects		From study
Social facilitation → Social learning	SF → SL	III
Social facilitation → Social comparison	SF → SC	IV
Social facilitation → Cooperation	SF → CR	I
Social facilitation → Competition	SF → CT	I
Social learning → Social comparison	SL → SC	II
Social learning → Normative influence	SL → NI	II
Social learning → Cooperation	SL → CR	I, III, IV
Social comparison → Normative influence	SC → NI	II
Social comparison → Competition	SC → CT	IV
Competition → Recognition	CT → RE	IV
Recognition → Cooperation	RE → CR	I, IV
Cooperation → Normative influence	CR → NI	IV

Fourth, to obtain deeper understanding of particular interaction effects between the social influence aspects, each arrow was reviewed separately before its inclusion in the final framework structure of the meta-analysis (Fig. 3).

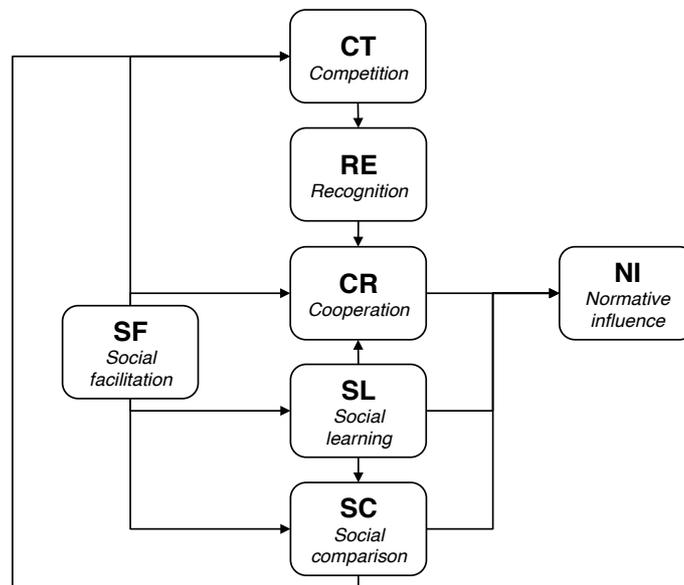


Fig. 3. Framework structure of the social influence aspects

In further analysis, the social facilitation [20] aspect was found to be the only aspect that has no inbound arrows from other social influence aspects in the original structural models. At the same time, the social facilitation aspect directly affected the social learning (study III), social comparison (study IV), competition, and cooperation (both in study I) aspects. The social learning [3-4] aspect was found as one of the most central aspects in all of the studies - having strong direct effects on the cooperation (studies I, III, and IV), normative influence (study II), and social comparison (study II) aspects. The social comparison [17] aspect was found to have strong direct effects on the normative influence (study II) and competition (study IV) aspects.

The competition [15] aspect was found to have strong direct effects on the recognition aspect (study IV). The recognition [6] aspect, in turn, was found to have a strong direct effect on the cooperation aspect (studies I and IV). But, the cooperation [2] aspect was found to have a strong direct effect on the normative influence aspect (study IV). Finally, the normative influence [13] aspect was found to be the only aspect that has no outbound arrows to other social influence aspects.

5 Towards a Framework for Socially Influencing Systems

The reviewed social influence aspects and the output of the meta-analysis provide grounds for making seminal steps towards the development of a solid framework for designing and evaluating socially influencing systems. The achieved results can help deepen understanding of how social influence aspects are affecting each other, and therefore advancing further theory development with regards to the role of each aspect in explaining and predicting how influential an envisioned socially influencing system will be.

5.1 How to Read the Framework

Designers of future socially influencing systems will find the structural framework (Fig. 3) beneficial with some additional guidance. Therefore, this section provides basic instruction for interpreting the presented interconnectedness of the social influence aspects. For example, the social facilitation aspect does not have any inbound arrows but has four outbound arrows directed to other aspects. This implies that social influence effects may commence as soon as other people are present [20]. In the presence of others [44], people can begin to learn from others [3-5], to compare themselves with others [17], and to cooperate [2] or to compete [15] with them.

Following the same logic, the arrow from the social comparison to the competition aspect implies that when people are able to compare themselves with others [17] they are likely to be prompted to compete [15] with those who are better than them, which also might create a sense of social norms [16]. The arrow from the competition to the recognition aspect explains that people who are ranked higher naturally receive some kind of public recognition [25] as others can see how well they have performed. Meanwhile, those who receive public recognition [6] can become more motivated to

keep up their excellent performance, which means that they would continue contributing to a collective goal in a cooperative context [28].

Social learning has always played an important role in the evolution of mankind [3-5], because it helps kids to learn quickly just by observing what adults do, to put it simply. The performed meta-analysis reveals that the vast majority of arrows going out from the social learning aspect bear very strong, large, and highly significant effects on succeeding aspects. The framework presents that in a social context people can learn how to compare themselves to others [17], cooperate [27], and read or create an understanding about social norms [16]. Besides, the more people cooperate the more likely they will experience cooperation as a norm for the particular occasion.

In the framework, the arrows are not meant to be completely isolated, i.e. if there is an aspect which has both inbound and outbound arrows, then there is a high likelihood that the aspect also plays a mediating role. For example, besides the direct effect of the social learning aspect on the normative influence aspect, the reviewed studies [38] also reveal significant mediating effects of both the social comparison and cooperation aspects on the relationship.

5.2 Implications for Further Research

The results of the meta-analysis reveal the strength and prominence of social influence aspects in designing socially influencing systems for user engagement. While the world gets increasingly interconnected, such systems could help build novel socio-technical environments for active participation and contribution rather than for passive consumption [30].

The paper reviewed four socially influencing systems (Table 2) that are potentially applicable and useful for engaging people in a wide range of contexts, including business and education. According to earlier studies, socially influencing systems could enable organizations to facilitate innovative collaborations with customers [32], designing novel models for better anticipation of market changes [34], effective responses to customer needs, and catalyzing innovations [21]. In education, these systems could positively impact student learning and engagement [7].

Further research should focus on testing the current framework and expanding research into other potential social influence aspects. Such studies would contribute to a richer and more elaborate understanding of various social influence aspects and their effects when software features them in user interfaces. The next steps should also include a deeper analysis of how social influence aspects can explain the perceived persuasiveness of socially influencing systems and predict user involvement, participation, and engagement with such systems [38].

Another direction for further research would be to study the design of particular implementations of social influence aspects. The number of different designs for a single social influence aspect is limitless. Thus, this research direction would reveal new design patterns that might have increased potential to shape user behavior and attitude. These designs then should be applied and tested in various contexts to find their best fit.

6 Conclusions

The presented meta-analysis is a highly relevant and timely research effort, because it advances the methodology for engineering future socially influential systems [24]. Along these lines, the present paper provides both researchers and practitioners with richer insights on how social influence aspects can help them to build socio-technical environments aimed at facilitating behavioral and attitudinal changes.

Drawing upon a list of fundamental socio-psychological theories, such as social cognitive theory [4], social comparison theory [17], focus theory of normative conduct [13], social facilitation theory [20], cooperation theory [2], competition theory [15], and taxonomy of intrinsic motivators [25], this paper explored a list of seven social influence aspects and their interconnectedness. In achieving that, four empirical studies based on partial least squares structural equation modeling (PLS-SEM) approach were methodologically analyzed.

Main contributions of the meta-analysis include the reviewed background of social influence aspects and the originated framework structure for designing and evaluating socially influencing systems. These contributions supplement the existing body of knowledge and can be instrumental for scholars focusing on research related to persuasive engineering of socially influencing systems for behavior change.

For the future, socially influencing systems can open up new seamless and natural channels for businesses to engage with customers. These channels can potentially play a significant role in advancing customer relationships, as they enable immediate interaction at the place and time where customers acquire new experiences about certain product or services.

Presented research includes a limited number of empirical studies that were available for the current review. Thus, scholars are encouraged to conduct similar studies in order to extend the meta-analysis [38] and overall understanding of the role of social aspects in the typology of computer-supported influence [39].

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