Social Collaboration Analytics for Enterprise Social Software: A Literature Review

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Abstract. Over the last years, research on benefits and success measurement of Enterprise Social Software (ESS) has gained momentum. Literature reviews in this topic area discuss methods for measuring ESS success and benefits and demonstrate that Social Collaboration Analytics is gaining increasing importance in the context of benefits research for ESS. This paper provides an overview of the literature on Social Collaboration Analytics for ESS. The selected literature can be categorised in seven key themes: *measuring system usage*, *identification of usage patterns*, *identification of types of users*, *analysis of groups*, *identification of expertise*, *network analysis* and *organisational impacts*. The paper concludes with a discussion of the importance of Social Collaboration Analytics for other relevant research streams.

Keywords: Enterprise Social Software, Enterprise Social Network, Data Analytics, Social Collaboration Analytics.

1 Introduction

Over the last decade, we have witnessed the emergence of a new type of collaboration software, the so-called "Enterprise Social Software" (ESS). The use of Social Media in private life has changed the way people communicate and exchange information. Consequently, companies have been experimenting with the "social features" (e.g. social profiles or tagging/commenting) of this software type [1], which has stimulated a renewed interest in Enterprise Collaboration Systems (ECS) both in research and practice [2, 3].

The existing literature on Enterprise Social Software is extensive and focuses particularly on the benefits of this kind of software, e.g. [2, 4]. Existing studies suggest that measuring the usage of ESS is an important aspect of benefits measurement [5, 6]. Consequently, we observe an increasing number of studies relying on ESS data. Despite of many attempts to measure *usage* of ESS, research papers providing an overview on possible approaches to Social Collaboration Analytics are scarce [2]. In order to address the perceived lack of clear definition in the terminology, we are providing a description of our basic terminology on *Social Collaboration Analytics* (SCA) [7] in chapter 2.

This paper reports on the results of a structured literature review on SCA. The literature review aims to identify, synthesize and conceptualise existing research related to SCA. The main objective is to (1) identify and document the *status quo of research*

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in this topic area. Further objectives are (2) to identify the aspects of the analysis of *system usage* and (3) to identify the *measurement approaches* (e.g. applied methods and metrics). Thus, this literature review complements existing literature reviews in the field of success measurement, e.g. [4].

The paper is organised as follows: we begin with a definition of the term *Social Collaboration Analytics*. This is followed by a description of the research design of the literature review. In chapter 4, we present the findings from our literature analysis. The paper concludes with a discussion on the current status quo in research on SCA and possible future research directions. The discussion is complemented with a note on the relevance of SCA in the context of research on Enterprise Social Software

2 Terminology

Schwade and Schubert [7] define Social Collaboration Analytics (SCA) as "the approach for analysing and displaying collaboration activity of users in socially-enabled collaboration systems". The relevant data for SCA are *organisational data* (e.g. organisational structure), *transactional data* (e.g. event records stored in databases or log files) and *content data* (user-generated content).

Throughout this paper, the term Enterprise Social Software is referred to as a collaboration software containing multiple social media features (e.g. social profile, recommend, comment, blogs, Wikis, etc.). In contrast to this, a single social software is a standalone application that is not (necessarily) integrated with other applications (e.g. an installation of WordPress). The term Enterprise Collaboration System (ECS) refers to "integrated systems which provide multiple applications (modules) under a uniform user interface" [7]. While Enterprise Social Networks (ESN) are structures between users in ESS, ESN *platforms* are Social Networking platforms deployed in an enterprise context [7].

3 Design of the Literature Review

The design of the literature review is guided by multiple academic sources [8–10]. Following these recommendations, five sequential and intertwined phases were developed. Figure 1 depicts the research design of the literature review.

The *definition of the review scope* is guided by the research objectives and thus the paper focusses on publications on *measuring ESS system usage*. The scope of the search process itself is described in a later section. The *conceptualisation of the topic* is derived from the objectives. Accordingly, a concept matrix as proposed by Webster and Watson [8] was developed. This concept matrix contains concepts and sub-themes that are relevant for the literature review and metadata of publications, the type of system that was investigated (e.g. ESS, ECS, ESN) and a preliminary classification of measurement concepts (e.g. applied methods and metrics, criteria such as user analysis, community analysis, network analysis).

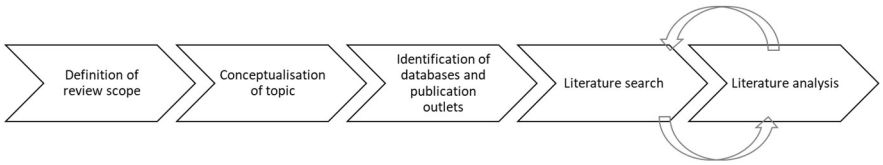

Figure 1. Research design of the literature review

Because the concept matrix was developed as an annotated bibliography in MS Excel, it allows a rigorous documentation of the whole literature review process. Thus, the concept matrix addresses the issue of recording and documenting the literature review. Following this, a keyword set was conceptualised which is shown in the following table.

Table 1. Overview of keywords and publication outlets

Keywords (technology)	ECS, Enterprise Collaboration System, Enterprise Social Network, ESN, {social, enterprise} collaboration, {collaboration, collaborative shared} workspace, enterprise 2.0, social software. Enterprise Social Software, Corporate Social Media, Corporate Social Software, groupware, cooperative system, BSCW, Groove, Notes, SharePoint, Connections
Keywords (analytics)	Metrics, measuring, measurement, measure, KPI, analytics, analysis, data, user {behaviour, interaction}, usage, usage analysis, activity, log, log file, database
Databases	Google Scholar, IEEE Explore, SpringerLink, ACM Digital Library, AIS eLibrary
Journals	EJIS, Information & Management, ISJ, Information Systems Management, ISR, IJeC, IJIM, JIS, JIT, MISQ, BISE, Journal of AIS, Journal of MIS, JSIS, Measuring Business Excellence, Computer Networks, Journal of Computer Mediated Communication
Authors	Nunamaker, Briggs, Grudin, Muller, Behrendt, Hacker/Viol, Richter
Date of publication	No restriction

Each search term consists of two parts. The first part refers to the technology and the second part refers to analytics. Each keyword from the technology branch was combined with all keywords from the analytics branch and Boolean operators were used where possible. This step is followed by the *identification of relevant databases and publication outlets*, which are listed in Table 1. The topic domain of SCA is an emerging topic. Therefore, the search process included conference proceedings as commonly suggested [8, 10].

The literature search and the literature analysis were designed as iterative activities. The *literature analysis* was conducted in three phases per publication. (1) A publication was added to the concept matrix if the title, abstract or keywords indicated a possible relevance. (2) The abstract was analysed in the second phase. The main criterion for classifying a publication as relevant for the literature review is that the abstract clearly points out that the publication addresses metrics, measurements or an analysis of ESS. (3) In the final phase, the publication was reviewed in detail according to the concept matrix. The final selection only contains publications, which describe the application of SCA, conceptual papers as well as papers performing content analysis of messages. Finally, a snowball search on the most relevant publications and an analysis of publication records of key authors in the field concluded the literature review.

4 Seven Key Themes for Social Collaboration Analytics

The following sections present an overview of the retrieved literature and the final conceptualisation of the identified topics. In total, 217 publications were retrieved of which 83 were included in a detailed analysis. The table below shows the number of publications per key theme. Adding up the individual counts does not lead to 83 because in some cases publications were assigned to multiple key themes.

Table 2. Number of publications per key theme

Key theme	*Number of publications*
Measuring system usage	30
Identification of usage patterns	7
Identification of types of users	10
Analysis of communities	7
Identification of expertise	6
Network analyses	14
Organisational impacts	13
Barriers to SCA	26

Besides the key themes, the literature review also identified several barriers to SCA. The identification of barriers to SCA was no intended objective for the literature review. However, as a considerable amount of publications mentions different kinds of barriers, barriers to SCA were also included as a review criterion. The iterative design of the literature review facilitated the inclusion of barriers to SCA as a further review criterion.

The measurement and analytics approaches in the literature were classified into seven key themes. The following sections contain the discussion of selected studies from each theme. Due to space limitations, this paper reports on the findings of selected key publications from the seven key themes.

4.1 Measuring system usage

There is a large volume of literature concerned with the *measurement of system usage*. What stands out from the literature on analysis of system usage is that a large proportion of studies is concerned with general usage measures and action specific usage measures. *General usage measures* provide a high-level overview on system usage. Shami et al. [11] provide usage statistics for ESS based on counting the number of events. Similarly, Behrendt et al. analyse the usage of communication features by counting the number of events for different communication features [12]. Herzog et al. [6] present an overview on methods and metrics (e.g. number of blog posts, and unique visitors), which can be used to measure ESS success. Following a similar idea, Steinhueser et al. [13] propose measuring ESS use by considering usage statistics, the degree of crosslinking, the number of hyperlinks, direct messages and comments.

In contrast to general usage measures, *action specific measures* contain some degree of aggregation and thus provide deeper indications on *how* a platform is used. Appelt [14] classifies user actions into different groups such as (1) creation of information, (2) modification of information or (3) reading of information. For each of the identified groups, the number of user actions is counted. As an addition to this, Jeners et al. [15] suggest investigating the most frequent activities such as reading, creating and changing content on a platform. In contrast to this, Muller et al. [16] differentiate between "producing" and "consuming" content. A further approach for measuring ESS usage is based on use cases. Richter et al. [5] identify seven collaborative actions (search, edit, rate, label, clarify, notify, share). For each of these collaborative actions, metrics are suggested. Similar metrics are proposed by Hacker et al. [17]. A more specialised aspect of measuring system usage is the investigation of *dynamics of ideas and innovations generation* [18]. An important observation can be made regarding the measurement of ESS usage *over time*. Only few authors include the aspect of time (e.g. measurements at multiple points in time) which would allow the tracking of ESS usage over time [5, 16, 17, 19]. The literature on measuring system usage also reveals that there are two basic intentions for conducting system analyses. In the more traditional research stream, analytics are conducted for deriving *design implications* [11, 16] (improving or changing the system). In recent years, a new research stream concerned with evaluation and success measurement [5, 6, 13] has emerged, with the objective of providing *decision makers* with information on platform usage and success.

4.2 Identification of usage patterns

Some of the publications included in our literature review discuss the concept of "usage patterns". The literature shows a variety of different approaches for the identification of usage patterns. Whereas Millen et al. [20] associate usage patterns with clickstreams in the context of *exploratory search patterns*, Ferron et al. [21] focus on patterns related to *communication and networking*. Muller et al. [22], on the other hand, refer to usage patterns as the *intensity and frequency of module use* in different communities. Boving and Simonsen [23] propose a more sequence-oriented understanding of usage patterns by arguing that usage patterns have to be viewed as a sequence of different

(inter)actions. Chaves and Córdoba [24] and Naderipour [25] follow a more sophisticated approach by conducting "pattern analysis" based on *process minin*g. This approach is based on a process-based understanding of usage patterns.

We believe that research on ESS would benefit from a harmonised understanding of the term "usage patterns" and might be guided by process-oriented concepts such as *collaboration scenarios* proposed by Schubert and Glitsch [26] or an application of *process mining* as described by Chaves and Córdoba [24] and Naderipour [25]. The transfer of process mining to ESS could give rise to a new research area, which we termed *Social Process Mining.*

4.3 Identification of types of users

In recent years, there has been an increasing amount of literature concerned with the *identification and measurement of different types of users in ESS.* Studies in this area typically discuss (structural) characteristics of user types. Two types of approaches can be observed. User types are identified either based on intensity of system usage or based on the nature of usage. In early approaches, user activity is distinguished by platform access [14] or the frequency of activities [15] (*intensity of usage*). In such studies users are considered as active when they access the collaboration system on average at least on two days per week [14]. Frequently, lurkers are an object of study in ESS. *Lurkers* are typically defined as "a community member who has made zero visible contributions to the community" [22]. Consequently, lurkers are identified by analysing consuming activities. Complementary to lurkers, the user types *contributors* and *uploaders* are defined. The behaviour of contributors is characterised by creating metadata and commenting on existing content. Uploaders typically create new content and can also engage in contributing and consuming activities [27]. Accordingly, in analyses, these user types are distinguished by counting the amount of creating, contributing and consuming activities. In recent publications, researchers suggest identifying user types based on the *nature of system usage*. Based on a literature review on knowledge worker roles Hacker et al. [28] propose a knowledge worker role typology that is adapted for the context of ESS. The authors identify different knowledge worker roles such as Helper, Sharer or Seeker. Each of these roles is characterised by performing a combination of distinct "knowledge actions". Following the proposed typology, each of these roles can be determined by quantifying the knowledge actions. An alternative approach also suggested by Hacker et al. [29] focusses on *dimensions of user behaviour* (e.g. social dispersion, engagement, focus, information sharing, discussing).

4.4 Analysis of communities

A small body of literature pays particular attention to the analysis of communities or workspace groups. Jeners and Prinz [19] introduce *metrics for measuring productivity* (average items created per member), *activity* (average events per member) and *cooperativity* (average edits per member) of workspaces. Further metrics are suggested for the evaluation of shared workspaces. The *degree of labour division* describes the distribution of activities among the members of a workspace. Additionally, the

responsiveness reveals how fast information in a workspace is accessed and it also shows which proportion of information is never accessed.

Researchers consistently argue that community mangers require meaningful reports for assessing the status and health of their community. Consequently, topics of interest are the assessment of *health and activity of communities* [30], *measurement of community success* [31] and the *comparison of key characteristics of different communities*) [32]. Typically, community analyses rely on similar metrics. *Participation metrics* include the overall activity of the platform, the number of posts, views and the types of contributions on the platform. *People metrics* reflect membership-changes, top contributors and the geographical location of users. *Content metrics* display popular topics and the value of single posts.

4.5 Identification of expertise

A further topic of interest is the identification and location of expertise in ESS. Nasirifard and Peristeras [33] demonstrate a two phase approach for the identification of expertise. First, documents are assigned with topics based on keyphrase extraction. Authors are assigned with the topics of the documents created by them. The second phase is the log file analysis. The authors assume that if a user creates or revises a document, there is a higher expertise on a topic compared to a read event. Therefore, Nasirifard and Peristeras distinguish between *expert in* and *familiar with*. John and Seligmann [34] discuss the potential of collaborative tagging and propose a mechanism for ranking expertise based on tags called ExpertRank. Based on the number of created bookmarks and the tags of these bookmarks, an "expertise rank" for this topic is assigned to the authors.

Considering that many surveys on the introduction of ESS [35] suggest that these systems are introduced with the intention to ease access to knowledge and experts, it is surprising that the number of publications on the identification of expertise is comparably small.

4.6 Network analysis

A popular theme related to SCA is the *analysis of networks* in Enterprise Social Software. Several publications propose *measures and characteristics for networks* and different *types of networks*. In an early study, Smith et al. [36] provide a typology for analysing networks in ESS. As underlying metrics, SNA metrics such as betweenness centrality, closeness centrality, eigenvector centrality, clustering coefficient are applied. Smith et al. [36] argue that that the analysis of networks can reveal data about social interactions that were previously invisible. This information can also be used to identify and foster important content and contributors. In contrast to this, Behrendt et al. [37] focus on communication networks. They analyse how fast new information travels across a network and how actions of participants affect the exchange of information. The authors describe different types of communication networks such as 1:1 communication, 1:n communication and m:n communication.

Researchers have also shown an increasing interest in the investigation of *connectedness of users*. Wu et al. [38] analyse the closeness of relationships between employees based on interactions in ESS by computing behavioural metrics for a subject's behavioural factors, friends' behavioural factors, subject-friend interaction factors, mutual connection factors and company direction factors. Steinhueser et al. [13] and Hacker et al. [17] suggest analysing the connectedness of users as an indicator of networking behaviour and general platform usage.

While the before mentioned researchers focus on analysing *user-centric* networks, Nasirifard et al. [39] suggest analysing *document-centric* networks. The authors argue that document-centric networks, which are constructed based on activities on documents, provide better insights on actual collaboration behaviour than user-centric networks.

4.7 Organisational impacts

Recent years have shown an increasing interest in measuring organisational impacts of and on ESS. A frequently addressed issue is the *impact of hierarchies on networking behaviour*. In this research stream, researchers are investigating how a user's position in the organisation influences activities in ESS. Behrendt et al. [40] examine the impact of formal organisational hierarchy on users' network positions in ESS and the creation of ties in ESS. In a similar study, Stieglitz et al. [41] examine the impact of hierarchy on ESN behaviour. With the influence of a user's position in the hierarchy (formal influence) and the influence of contributions (informal influence) on the response rate/time of questions, Riemer et al. [42] explore a closely related aspect. The three studies have in common that researchers work with two datasets. One dataset contains actions in the ESS, which can be statistically analysed and the second dataset contains information on the position of an employee in the hierarchy of the organisation.

The literature on organisational impacts reveals particular interest on the *effects of geographical dispersion* on user activity in ESS. Warshaw et al. [43] display them by determining the spatial distance between users, the timezone differences and the isolation of actors. These measures are then related to user activity. Similarly, Recker and Lekse [18] investigate whether the geographical distance between users influences intensity of communication and knowledge sharing. In close relation to geographical dispersion, recent years have shown an increasing interest in measuring and identifying intra-organisational *boundary spanning* activities in ESS [44, 45].

5 Conclusion and Directions for Future Research

Our literature review aimed to identify and classify studies in the field of Social Collaboration Analytics (i.e. analysis of the use of Enterprise Social Software). We identified seven different key themes: (1) *measuring system usage* (2) *identification of usage patterns,* (3) *identification of types of users,* (4) *analysis of communities,* (5) *identification of expertise,* (6) *network analysis and* (7*) organisational impacts*. The following sections discuss further findings related to methodology, limitations of

current research and propositions for future research. Finally, we discuss Social Collaboration Analytics in context of existing ESS research.

The classification of the studies provided in this literature review shows that most studies are about aspects related to networking or general system usage. We observed a lack of research on measuring collaboration activities and patterns. A reasonable explanation for this is that both concepts draw on methods and metrics that are already established and matured in other contexts (especially Web Analytics and Social Network Analysis). For a better understanding of the usage of collaboration software, there is a pressing need for measuring and understanding collaboration activities.

The majority of researchers suggest applying mixed-methods approaches for measuring system usage [12]. Consequently, the majority of studies makes use of additional surveys or interviews complementary to analysing system data. The literature review further shows, that most authors adapt a case study design. A possible explanation is provided by Behrendt et al. [40] who argue that case studies allow to investigate user behaviour in a specific context without interfering the ESS. It can further be observed that studies on analytics in ESS often lack a structure and guidance of the analytics process. In most of the studies, the steps for collecting and preparing data are not described. The most likely cause of this is that researchers often do not have the possibility to extract system data themselves. Instead, the authors are frequently provided with a prepared data set in MS Excel or CSV format [40, 42] and thus have no influence on the extraction and data preparation.

Recent research suggests making use of the CRISP-DM as a guidance for SCA [7, 17]. Behrendt et al. [12] provide descriptions of data dimensions in ESS and a conceptualisation of digital traces [46], which are refined by Schwade and Schubert for the purpose of Social Collaboration Analytics (SCA) [7]. The Social Collaboration Analytics Framework [7] provides additional guidance for developing questions that can be posed to an existing data set and for developing the respective data queries. Consequently, we identified the publication by Behrendt et al. [12], Hacker et al. [17] as well as Schwade and Schubert [7] as key publications in the field, which could provide guidance for future research in this topic area.

In a recent literature review on Enterprise Social Networks, Viol and Hess [2] identified the meta-topics (1) *implementation*, (2) *motivation to adopt and use*, (3) *usage and behaviour*, (4) *impact on organisation*, (5) *success measurement* and (6) *data analytics* as the predominant research streams on ESS. The following concluding part of our paper discusses these meta-topics in relation with the key themes identified in our literature review to establish a view of SCA in context. There is no direct relation between the meta-topics *implementation of ESS* and *motivation to adopt and use* and the measurement concepts. However, there are some studies attempting the measurement of the adoption of systems. According to Viol and Hess [2], the meta-topic *usage and behaviour* publications aims to identify how employees use ESS and to identify usage patterns. This is also true for the measurement concept *usage patterns*. Therefore, this aspect of analytics has potential to support and to contribute to the biggest research stream on ESN according to Viol and Hess [2]. The same applies to the impact of ESN on organisations. This demonstrates that the meta-topic *data analytics* and thus the measurement concepts identified in this literature review are

intertwined with their research meta-topics and that SCA can contribute to ESS research. This argument is strengthened by the observation that publications on success measurement increasingly make use of system measurements.

In this paper, we identified key themes for SCA from the literature. However, we have not yet confirmed whether these key themes are relevant in practice. In the current phase of our research on SCA, we are working with practitioners in order to identify and develop meaningful methods and metrics, which are also relevant in practice. Thus, the key themes provide the foundation for future research on SCA.

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