Using Social Analytics for Studying Work-Networks: A Novel, Initial Approach

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***Abstract*—This paper contributes to the emerging field of social-analytics in computer-supported cooperative work by introducing a novel methodology for investigating the "work-networks" that emerge from everyday interactions among workers, artifacts, and organizational structures. Particularly, it presents and discusses an early implementation of this methodology in the context of a large, global IT service delivery organization. It analyzes the pattern of work interactions that emerge from the mining of common use of internal social media systems, log data of service delivery management systems, and organizational structures. Such analyses enabled us to unearth potential deficiencies in the ways in which the organization make use of collaborative systems, share and spread knowledge among its workers.**

Keywords—social networks; work networks; service delivery; service factories; social analytics

I. INTRODUCTION

Studying the means whereby everyday work is achieved lies at the core of computer supported cooperative work. Although, this is hardly a new topic in computer supported cooperative work (CSCW) and adjacent fields (e.g. collaborative systems) and greatly explored by various lies of research, it is free of any particular mooring that ties it to a particular, preconceived structural form. That is to say, the more it is investigated and the more we employ new methods for its investigations, the more we are capable of unpacking new meanings and understandings.

In particular, to understand the ways in which collaboration is mediated by material artifacts, technologies, and the like is critical for both the design and assessment of collaborative systems.

More recently, with the emergence of social analytics—the use of data mining to investigate social/relational data—the studies of what has been dubbed "articulate work" [1] shifted from primarily investigating the formal/informal processes and communications channels to the (oft-invisible) patterns of interactions that emerge from the information traces people leave behind on electronic environments. The field of social analytics brings together traditional data mining and social network analysis techniques to investigate the underlying pattern of interactions that emerge from human "traces" left behind when utilizing various kinds of digital media – be it a collaborative system, social media, task management system, workflow management system, and so forth.

The results from such analyses are particularly meaningful when overlapped with in-depth understanding of everyday work practices as traditionally studied in CSCW, such as in [2]. The studies of workplace are often intended to inform system design and development (collaborative and otherwise), but as Plowman et al. [2] pointed out early, there is hardly an agreement as to the effectiveness of such studies in positively influencing both the design as well as the results of a system deployment in a workplace. This is due in part to the complex, mutually influenced, and ever changing relationships between working settings and artifacts. More importantly, the perceived 'usefulness' of a technology is contingent on and influenced by reconfiguration of work as result of its own deployment [3]. Hence, studying not only social and cultural nature of work, but the underlying networks that emerge from the interplay of organizational structures, work artifacts, social networks, and the like—what we dubbed, work-networks—becomes critical in elucidating how the work gets in fact accomplished and consequently better understanding the roles and values that collaborative systems play in such contexts.

This research partially described in this paper attempts then to contribute to this ongoing research agenda by devising and implementing a novel methodology for studying work-networks. This methodology explores workers' everyday interactions among themselves, work artifacts and systems, and organizational structures (such as, hierarchies, work shifts, and the like) by means of mapping out the digital traces they leave behind as they carry out their everyday work. In particular, we mined their collective use of social systems and the logs of service responses within a large IT service delivery organization. Our preliminary findings show the limited adoption and use of standard collaborative systems in support of knowledge sharing and dissemination, the uneven distribution of expertise and skills across work shifts, and limited opportunities for collaboration across departments. These results were then validated by our ongoing fieldwork that has been exploring the nature of service work in this very same work setting.

This paper is structured as follows. The paper starts briefly reviewing one of the main tenets in workplace studies, namely, articulation work, which highly influenced not only the entire CSCW community, but also our own work. It follows describing the organization in which we carried out the research and important concepts in IT service delivery. We follow by briefly describing the methodology in question, and the results from this primary investigation.

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We conclude by discussing our findings and ideas for future work.

II. Literature Review

Understanding the challenges of the design and use of socio-technical systems in the context of day-to-day work practices is scarcely a novel pursuit to the CSCW community. Such a kind of endeavor has been part of this community's trope from the get-go. In particular, a number of early studies have significantly shaped the ways in which we, as a research community (or at least part of it), theorize the dynamic, complex, and recursive relationships between distributed work practices and their technological support. This literature review very briefly discuss the contributions of this line of research in the understanding and (re)conceptualizing collaborative work and its technological support.

In the past decade, we have also witnessed the growth of the use of social networks, in CSCW, as both a theoretical construct for framing how workers seek and share knowledge as well as a model for the design of collaborative systems. For the most part, aside from early accounts of how workers in fact share information via their personal and work networks, most of the more recent publications focused on either the design and implementation of social network systems (SNS) [4-7] or their evaluation [7-10]. In contrast, this paper investigates a methodology based on techniques from social network analysis to help unpack the patterns of interactions that emerge from how workers engage with one another while attempting to accomplish their work.

A. Brief Account of Work Practice Studies

Grounded in studies of everyday work practices, settings, and technologies, workplace studies offered alternative framings for understanding what was suggested as the dialectic relationship between "traditions and transcendences" [11], namely, the ways in which work indeed is accomplished and the imaged ways in which we design technology to support it.

Schmidt and Bannon make a critical distinction between distributed work and articulation work and discuss its relevance to CSCW [1]. In particular, they describe articulation work as the means by which collaborative work gets accomplished given the need for workers to coordinate activities across time, space, and individuals. Suchman et al.'s, on the other hand, focus on reconfigurations of technology production and use as integral aspect of everyday social practices [3]. They were particularly concerned with how meanings, such as, the usefulness of a system, is an accomplishment of everyday practices rather than the result of the system design along. Star et al.'s look into the substrates that support and even enable not only our everyday work, but even our daily life. Their re-conceptualization of infrastructures as inherently relational, inverts the notion of infrastructure as a built and maintained "thing" upon which something else operates and runs toward the notion of infrastructure as embedded in enmeshed networks of people, social practices, power, and other infrastructures [12, 13]. In brief, these pieces amount to this critical line of investigation in CSCW that enables us to understand the complex, heterogeneous, and often unsettled nature of work settings.

Methodologically, these studies often rest on in-depth qualitative studies, in particular, ethnomethodology, which is primarily concerned the orderly nature of social actions [14]. As such, they have helped us understand how things (be it, work, meaning, context) are the accomplishments of people's everyday actions and engagements. To this end, they make use of discourse analyses as means to investigate how context/meaning emerges from ordinary encounters among people.

B. Social Networks & Social Analytics

Studies of social networks within organizations are nothing new. In 1987, Monge and Contractor [9] utilized social network analysis to study the communication patterns among workers as means to understand the ways in which information flows within and across organizations, strategic alliances are formed, and the like. They examined and proposed the theoretical mechanisms whereby researchers could study the various networks that emerge in organization contexts.

More recently, in the late 90's and early 2000's, a new breed of research, in both organizational and computer sciences, renewed their interests in exploring the role that social networks play in support of everyday work practices. Significantly, in the emerging rhetoric of knowledge society, networked organizations, and knowledge workers the attention shifted from "*what* one knows" (and consequently, the traditional questions around knowledge sharing, storing, and disseminating) toward "*who* one knows" (and consequently, the questions and concerns around managing one's personal work networks.) In this new context, one important aspect of carrying out one's work pertained to "networking" [15, 16], that is, the oft-invisible job of creating, maintaining, and expanding one's network so as to support various facets of the traditional getting the job done. In fact, they go on suggesting that in current networked organizations, workers are challenged by the ongoing demands for accessing updated information as well as key stakeholders within and across organizational boundaries by drawing on the personal social networks they develop and maintain.

While, Nardi et al. [15] carried out a series of qualitative studies of such working settings to study "networking" practices, Cross and his colleagues [4], employed social network analysis to investigate the underlying networking practices of 20 top-executives of a number of large organizations. In so doing, they were capable of pinning down particular network constraints, such as, network hubs, that had the potential to affect the performance of such companies. Similarly, in a recent short paper, Novak et al. utilized social network analysis to study organizational design and diagnose gaps in communication and collaboration patterns within organizations [10]. Finally, Cross and Parker [17] offer a comprehensive account of how social network analysis can be employed to review the "invisible" practices of "networking." Our research builds on

both lines of research building a hybrid methodologies that juxtapose qualitative studies of workplaces and social network analysis in order to unveil and understand the ways in which workers accomplish their work in the context of highly distributed and complex working settings.

More recently, with the widespread use of social network systems within and outside organization, incredible large sets of relational (or social) data became available for a variety of different kinds of analysis. The emergence of social analytics came to fill the gap of exploring and charactering relational data that was not present in traditional data mining, which in turn focused primarily on data attributes. Social analytics thus enable the investigation of increasingly more complex networks. Such studies focus on revealing useful properties of relational data represented by graphs[1], which in turn represent characteristics that are common across different complex networks. Such properties are, to name a few relevant ones, the power-law degree distributions [18], the diameter shrinkage present in evolving networks [19], and the Small World phenomenon [20]. These patterns help us understand not only the interactions among people's social networks [21] but the dissemination of information and diseases [22], intrusion detection [23] and so on.

Networks where nodes are people or groups of people and edges represent social interaction of sorts [24] are slightly different from others kinds of networks, such as presented in [25]. They have non-trivial clustering or network transitivity, and they show positive correlations, also known as assortative mixing, between the degrees of adjacent vertices—that is, they display a high degree of commonality among nodes. For example, communities can be thought of as sets of nodes that share common properties in a complex network [23]. The challenges thus come from detecting the communities among very large sets of nodes given the large number of edges among them. Such issues become inherent challenges in the use of social analytics in the context of work networks where researcher explore the juxtaposition of a variety of social relatedness, namely, org-trees, communication networks, co-authoring, virtual community participation, and others.

C. IT Service Delivery Research

Although service delivery is often structured as a routine, serialized, and individual problem-solving activity [26], research studies have shown it to be inherently and intensively collaborative [27], and contingent on local socio-technological contexts [28].

Haber et al. [27], for example, carried out a multi-year and multi-site fieldwork on the work of system administrators (sysadmins) and found that they tend to spend the great majority of troubleshooting time collaborating with other people via multiple communication channels. Often, they collaboratively troubleshoot the infrastructure in question, but at time, they in fact "troubleshoot" each other (i.e. attempting to amend misunderstandings and misconceptions.)

Local nuances of technological and social contexts, on the other hand, greatly affect the ways in which they go about solving particular problems. Blomberg [26] describes how service deliver workers from four sites, located in three different countries, contingently reacted to organizational changes and how that in turn affected their ability to effectively respond to service requests. Those studies in fact demonstrate that such contingencies are determined by a number of institutional, technological, and socio-cultural factors, such as, the particular infrastructure in question, the configuration of the work settings, the nature of the problem at hand, the severity of the problem for the company's client, and more.

The complexity of service delivery in part rests on the very nature of the work practices – great people interdependences, organizational structures, and computing infrastructures, where these elements are all heterogeneous. On the other hand, ongoing organization changes (i.e., standardization, re-orgs, operational optimizations, and the like) clearly affect the ways in which those involved, such as, sysadmins, customer experts, infrastructure architects, dispatchers, and the like, get the work done. Still, the mismatch between clients' and' takes on the problem in question only adds to the complexity and challenges of everyday service delivery work routines.

From a client's perspective, a problem ranges from a simple announce that needs to be fixed so that one can get back to her/his routine to a glitch that prevents her/him to get the work done to a multi-million dollar business loss. From the sysadmin's perspective, it goes from a trivial password reset to unplanned fail of communication between a legacy DB server and a recently updated web-service on its company's customer's server to a misconstrued mapping of firewall setup that prevents a recently implemented multi-site payroll application from getting a consolidated information of a company's workers.

III. CASE STUDY

The overall objective of our research is to better understand the social interactions and engagements that take place inside this large IT service delivery organization in order to devise new methods and technologies in support of workers' everyday work needs. In the particular, the work reported in this paper is primarily interested in:

- Exploring the different configurations of social organization by means of investigating and analyzing publicly available relational/social data. Namely, we looked into the use of internal social media systems as proxies for collaborative practices; and
- Understanding service delivery as engendered in everyday (social/work) interactions by means of investigating and analyzing log-data from services handled by sysadmins. In other words, we looked into service resolution logs as a proxy for eliciting common (or not) knowledge sharing practices and

[1] Graphs are useful because they serve as mathematical representations of network structures and appear in a host of domains. They are particularly useful to represent how things are either physically or logically linked to one another in a network structure.

skills across the various departments within the organization.

We will next further detail the context of our research work, the methodology we employed, and the preliminary results.

A. Research Context

Our study took place at a large IT service delivery organization, Big Service Factory (BSF.) BSF is a large-scale IT service-operation company where hundreds or even thousands of support personnel manage complex IT infrastructures comprised of thousands of (heterogeneous) servers, routers, and other IT equipment, often from multiple customers, concurrently. Its employees are very specialized, often focused on specific tasks repeated exactly many times a day. In particular, these professionals are sysadmins (system adminstrators), who are responsible for some of the most critical functions necessary to maintain the customers' IT infrastructures running well and efficiently. Despite the specialization, the work of sysadmins is highly dynamic, collaborative, and interdependent [27].

Due to the highly competitive market, about seven years ago, BSF implemented a new organizational structure in which departments were primarily structured according to technical competencies: namely, based on common skills, competencies, and activities performed. They are: UNIX OS, Windows OS, applications, and security. For example: UNIX OS, responsible for dealing with issues with UNIX-based server systems; and security, responsible for backups, updates, and similar issues across OSs. These departments are responsible for handling incidents, where an incident is defined as "any event that is not part of the standard operation of a service and causes, or may cause, an interruption to or a reduction in the quality of that service" (The ITIL Open Guide, 2011). Each incident (or service request) is managed through an IT object often referred to as a ticket, which aggregates all the key information about the incident.

B. Methodology

The methodology is comprised of the integration of social analytics and qualitative analysis of work practices in order to study an organization's work networks.

The social analysis is employed for analyzing the various forms of relational data (or traces) collected via a variety of systems workers make use of in their everyday work (e.g., communication systems, such as, IM communicator, and emails, work management systems, such as incident management systems and workflow system, and social systems, such as community, blogs, and Twitter -like systems.)

After gathering the data from one of the incident management systems from the past 10 months, we consolidated a list of sysadmins of whom we would analyze the work-networks. In this preliminary study, the networks where generated from two types of data: tickets from the incident management system and social data from an internally developed system, named Social Networks and Discovery (SaND) [29].

Tickets describe particular incidents (be it automatically generated by monitoring systems or manually generated by BSF's customers' reports.) We extracted from these tickets a number of features that characterize the sysadmins who are solved them. Information, such as, work shifts, department, customers, dates, descriptions of the problem and so on provided enough contextual information for our analyses. To build the networks, we assigned node and edge values, where nodes convey sysadmins assigned to the tickets in the log-data (we employed a threshold of a minimum of 100 tickets solves;) and, edges represent the relationship among sysadmins. We utilized adjacency matrix in order to compute the edges.

As will be discussed next, we explored two particular characteristics across work-shifts as defined by department and expertise. We defined that for sysadmins to be connected, they should have been solving more than 30 percent of their total number of tickets in a particular shift. It is noteworthy that a sysadmin might appear in more than one shift, consequently. For expertise, we used the severity level of the tickets they solved as a proxy for their particular level of expertise. Similarly, we defined that for sysadmins to be experts (or more knowledgeable workers), 50% or more of the tickets they solved should be of high severity (i.e. severity level 1).

For social data, we built a complex network using SaND. It is an aggregation tool for information discovery and analysis over the public social data on organization's intranet. It leverages complex relationships between content, people and tags, and its integrated index supports a combination of content-based analysis and people-based analysis. SaND provides several social aggregation services including social search, personalized item recommendations, personalized people recommendations, finding social paths between people, and additional social network services [30]. For the selected sysadmins, we run a query on SaND so as to gather the social connections among these individuals. These connections represent a juxtaposition of connections due to directed manager, participation in similar virtual community, co-authoring, reading/writing same files, and the like.

To generate the visualization we used Gephi (http://gephi.org/) and detected the communities via modularity [31].

Finally, to create ground-truth of our analyses and interpretations of the resulted graphs, we used grounds-up data from our ongoing qualitative research, which investigates the everyday work practices of this IT service delivery organization (reported elsewhere [32, 33]).

C. Emerging Networks from Social Analytics

1) The use of social media within organization

First, we were interested in investigating the collective interactions and knowledge productions on existing social systems available to all BSF employees as means to support knowledge sharing and dissemination. We thus collected all possible interaction among our selected list of sysadmins from public available data sources. That is, by means of SaND, we attempted to map out all social and collaborative activities as result of, among other things, co-authorship

(papers and patents), and joint community participation. We dropped the org-chart information (hierarchy) from SaND for it would render the graph meaningless provided that all sysadmins would be one or two degree connected to one another.

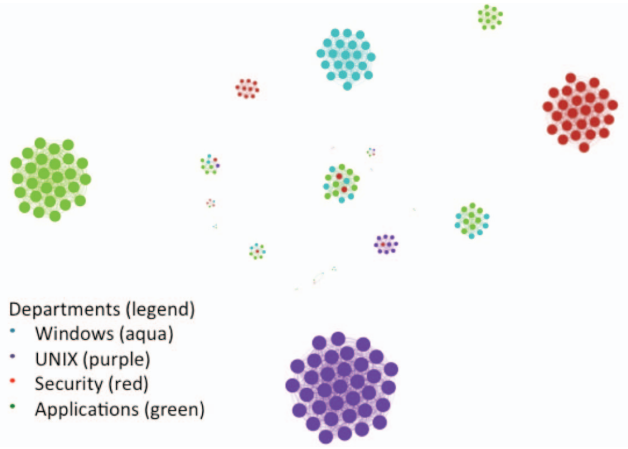

Figure 1. Organization clusters as result of SaND analyses of publicly available data from standard social media systems.

Somewhat to our surprise, we were solely able to detect the organizational structure as the result of plotting the graph generated by SaND. In fact, the original graph is a clique, meaning, fully connected graph, showing everyone was linked to everyone else. This of course rendered the result meaningless. Hence, we had to increase the threshold (minimum number (n) of shared features to determine a link between two sysadmins, where n=100) so as to reduce the number of edges among sysadmins, consequently increasing our standards for social relatedness. As result, we ended up reaching the actual organizational structure of departments.

Figure 1 (above) clearly depicts the four main departments (main clusters), and a number of small groups that represent particular co-located teams that support particular customers. That is to say, the only meaningful clustering that emerged from SaND was the actual org structure – people from the same departments. This somewhat disappointing result, in fact, resonated with what we observed in the field, where in general there is a low level of adoption of standard (company-wide) social systems, and a strong reliance on local, private collaborative tools to support their everyday work. Nonetheless, raw organizational structures, such as organizational hierarchies, org-trees, and the like, are critical elements that mediate (both enabling and constraining) social interactions within organizations. They are key elements in the formation of work-networks. Therefore, if nothing else, this results tell us that the organizational framework implemented in BSF has a definite influence in the ways in which sysadmins accomplish their work.

2) Knowledge Sharing Across Departments

Next, we explored the ways in which knowledge is shared and expertise flows across the departments' boundaries. That is, we started from the log data of internal incident management systems (over 10 month period), i.e. ticket logs, in order to build patterns of service resolution for each individual sysadmin. In this preliminary approach, we defined that individuals working on a similar work shift would be likely to encounter others during their work hours, hence creating opportunities for knowledge sharing. This was motivated by our ongoing field research [33]. We then looked into individuals who responded to service requests at similar work shift. . In so doing, we attempted to identify who was addressing similar service requests across the different departments. As a proxy for face-to-face interacting, we intended to find out whether individuals that have high probability to work together and addressing issues of similar nature, from a statistical perspective, were collocated. That is, we want to see the extent to which the organization structures facilitated or somewhat hindered workers' needs for accessing coworkers who could more likely help them solve their problems at hand.

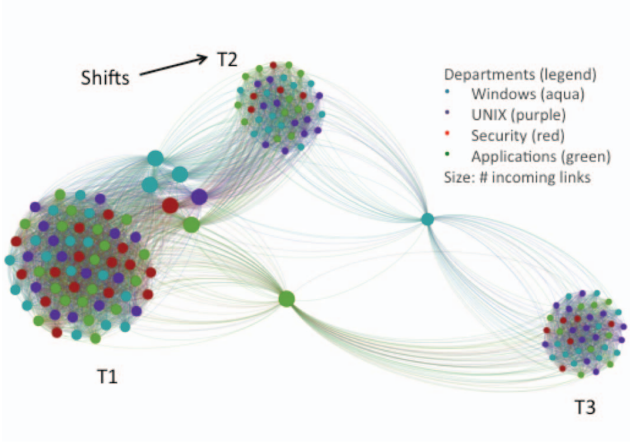

Figure 2. Work-shift-based clusters across departments.

The analysis resulted in three clear clusters, that after a follow-on analysis we found them to reflect the three main work-shifts (morning, late-afternoon, and night.) Within each cluster we observed an even distribution of sysadmins from the four aforementioned departments. In this respect, we concluded that the organization of work was clearly capable of supporting and addressing incidents related to any of the main issues in IT service delivery. Also, it suggests the opportunities for knowledge sharing and dissemination within individual work-shifts in which there is a higher probability of face-to-face encounters (informal and otherwise.)

More interesting is, nevertheless, to observe the small number of individuals who "bridge" the different shifts. While we are yet to fully explore this graph, we anticipate that these bridges, which are evident in Figure 2, represent sysadmins who overtime moved from one shift to another. To ensure a healthy organization where knowledge and experiences flow not only across, we would expect a larger number of links across shifts, rather than just a small number of bridges.

3) Expertise Across Departments

Based on the previous similarity analysis, what if we highlighted not the departments for which sysadmins were mostly working, but instead the urgency of the service requests they were resolving. That is, we colored individuals who were resolving service requests (or incidents) of similar severity levels, statistically speaking. In this case, we utilized the severity level of service requests as a proxy for the level of expertise of sysadmins, given that junior sysadmins tend to solve lower severity requests, whereas high severity ones are often addressed by more knowledgeable workers, or simply experts.

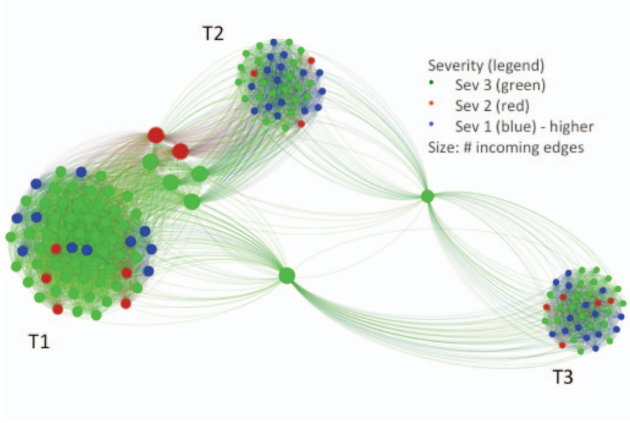

Figure 3. Work-shift-based clusters across levels of service severity.

Interestingly, a similar pattern around work-shifts emerged from this analysis. Differently from the aforementioned one, however, we observed a surprising, but significant, larger proportion of higher-severity incidents being addressed in the late-afternoon and night-shifts (see Figure 3.) The potential issue that arises is the fact that a larger proportion of difficult problems are being addressed when a smaller contingency of experts tend not be easily available.

D. Qualitative Studies of Service Practices

As pointed out earlier, the research herein presented is part of a larger research program that attempt to understand and characterize the work practices and process of a large-scale IT service delivery organization, which has in part been reported elsewhere [32, 33]. We are investigating the various layers of interaction and practices that result in the ways that sysadmins accomplish their job. And, herein, we have been particularly interested in unveiling the underlying networks structures that emerge from their engagement with one another, with the organization structures themselves, and the various artifacts that support and mediate their work (e.g. incident management tools.) In this section, we briefly discuss the findings presented previously in light of our ongoing qualitative research of service delivery practices.

Since 2010, employees from different departments of BSF were interviewed and observed. Over 20 unstructured and semi-structured interviews, in addition to hours of non-participant observation, were carried out. The interviews focused on unpacking the main issues and challenges they encounter in carrying out their everyday service delivery tasks, where observations focused on the collaborative nature of sysadmins' work, the overall context of work, and the usage of existing tools (in support of communication and collaboration practices.)

In addition, a survey was conducted to validate our findings across a broader population. We restricted the survey to sysadmins who worked handling tickets. The survey had a statistically significant number of respondents, over 200 responses. Informants were selected based on a stratified random sampling [15] based on the following stratum: department, expertise level, and gender. Data from the survey was imported into a standard tool for statistical analysis. The results from the survey have been reported in greater details elsewhere [33].

From these studies, we were able to gain a better understanding of some specific meanings that the emerging networks aforementioned manifest. From the qualitative studies, we observed that service delivery is a rather complex, collaborative activity that requires ongoing information flows across several departments. Surprisingly, the emerging network from the social media analysis (see Section III.C.1) conveying a rather simple structure, clustered by and large around the formal organizational structures (i.e., org-tree.) In fact, SaND was unable to detect a significant number of interactions among sysadmins by means of enterprise social systems, although, BSF highly promotes their use. In fact, from our fieldwork, nonetheless, we found that (1) sysadmins barely ever use these social systems and (2) different departments have created and use their own. For one, SaND was unable to capture these interactions given that these tools hold only password-protected information – not publicly available data. On the other hand, this shows the disconnection between bottoms-up efforts and organization standard processes.

The qualitative studies also showed that the most important information "source" for sysadmins is another employee. This means that the information foraging behavior is highly dependent on finding the appropriate person to help them out, which in turn results in the need for direct contact with those information providers. From the knowledge sharing analyses (Section III.C.2 & III.C.3) we found that there seems to exist sufficient overlap of skills type and levels within particular work-shifts, but limited opportunities for cross-pollination across them. This is critical in light of the fact that for the most part sysadmins in late shifts (late-afternoon and night) are facing a larger proportion of higher severity incidents, which we know from our fieldwork require the involvement of a larger contingency (that is, more than one sysadmin to solve them).

IV. Discussion & Next Steps

These analyses represent our early investigation of the use of social analytics to map out the work-networks of BSF. We believe though that they already offered us interesting insights as to the ways in which existing organization structures (such as, work-shift, departments, and the like) affect how knowledge, collaboration are shared,

disseminated, and engender in how sysadmins carry out their work. By no means these are strikingly new findings, but they provide clear evidences of the value of the proposed methodology for studying and better understanding such work networks in the context of large, complex IT service delivery organization (and other organizations, as well.)

As we pointed out, we utilized a few metrics (such as, log data, community participation, co-authoring, and the like) as proxies for social relatedness as well as skill and ticket-severity similarities. As such, they indirectly account for the underlying 'networking' practices sysadmins perform so as to accomplish their everyday work activities. Put it simply, we explored the digital traces imprint on the various computational settings that support and mediate today's everyday work practices. These are not perfect but a good enough approximation. We thus acknowledge their limits.

To address such limitations, first, we plan to further investigate collective production and sharing of information as captured by SaND. Our early study showed some of the limits to which it has been capable of capturing the ongoing conversations and collaborations that take place in the organization, but not publicly. For one, we will employ new metrics and improve thresholds in order to draw on a richer characterization of social media use and social relatedness. On a different note, we plan to complement such types of metrics with face-to-face data, such as reported in [34]. The goal is capture not only the interactions that take place via digital social media, but traditional face-to-face encounters. This is particularly relevant given that the organization promotes and support co-location, although part of its workforce is distributed space- and time-wise.

Second, we plan to employ other similarity metrics. In this study, we utilized the sum of products (permanent) to measure the degree to which sysadmins are related to one another. This is a first approximation. Social analytics offer other algorithms for measuring distances among entities, notwithstanding. For instance, we will next re-compute the similarities using the cosine of n number of features, which is a standard way to measure distance in multidimensional space. This will provide us with a more refined for weighting particular features when computing the similarity between two entities.

V. Final Remarks

In light of this early study, we were able to draw a clearer picture of BSF working environments and diagnose some of the issues workers face everyday. We believe that the integration of both social analytics and qualitative research has the potential to truly shed new lights on the 'hidden' ways that workers of highly complex, distributed, and interdependent organizations accomplish their work. As we pointed out, this work is ongoing and there is a lot of room for improvements and more importantly further investigation. However, we think that this early study can already contribute to the ways the CSCW community at large employ the emerging field of social analytics for investigating articulate and 'non-articulate' work.

References

[1] K. Schmidt and L. Bannon, "Taking CSCW Seriously: Supporting Articulation Work," *Journal of Computer Supported Cooperative Work,* vol. 1, pp. 7-40, 1992.

[2] L. Plowman, Y. Rogers, and M. Ramage, "What are workplace studies for?," presented at the Proceedings of the fourth conference on European Conference on Computer-Supported Cooperative Work, Stockholm, Sweden, 1995.

[3] L. Suchman, "Working relations of technology production and use," *Computer Supported Cooperative Work (CSCW),* vol. 2, pp. 21-39, 1994.

[4] R. Cross, A. Parker, L. Prusak, and S. P. Borgatti, "Knowing what we know: Supporting knowledge creation and sharing in social networks," *Organizational Dynamics,* vol. 30, pp. 100-120, 2001.

[5] J. DiMicco, D. R. Millen, W. Geyer, C. Dugan, B. Brownholtz, and M. Muller, "Motivations for social networking at work," presented at the Proceedings of the 2008 ACM conference on Computer supported cooperative work, San Diego, CA, USA, 2008.

[6] K. Ehrlich, C.-Y. Lin, and V. Griffiths-Fisher, "Searching for experts in the enterprise: combining text and social network analysis," presented at the Proceedings of the 2007 international ACM conference on Supporting group work, Sanibel Island, Florida, USA, 2007.

[7] S. P. Goggins, K. Galyen, and J. Laffey, "Network analysis of trace data for the support of group work: activity patterns in a completely online course," presented at the Proceedings of the 16th ACM international conference on Supporting group work, Sanibel Island, Florida, USA, 2010.

[8] D. Martin, J. O'neill, D. Randall, and M. Rouncefield, "How Can I Help You? Call Centres, Classification Work and Coordination," *Computer Supported Cooperative Work (CSCW),* vol. 16, pp. 231-264, 2007.

[9] P. R. Monge and N. S. Contractor, "Emergent communication networks," in *Handbook of organizational communication: An interdisciplinary perspective*, E. M. Jablin, L. L. Putnam, K. H. Roberts, and L. W. Porter, Eds., ed Newbury Park, CA: Sage, 1987, pp. 304-342.

[10] D. Novak, M. Rennaker, and P. Turner. (2011) Using Organizational Network Analysis to Improve Across Organizational Boundaries. *People & Strategy*. 32-37.

[11] P. Ehn, *Work-Oriented Design of Computer Artifacts*. Stockholm, Sweden: Almquist & Wiksell International, 1988.

[12] S. L. Star and J. R. Griesemer, "Institutional Ecology, Translations and Boundary Objects: Amateurs and Professionals in Berkeley's Museum of Vertebrate Zoology," *Social Studies of Science,* vol. 19, pp. 387-420, 1989.

[13] S. L. Star and K. Ruhkeder, "Steps Towards an Ecology of Infrastructure," in *Computer Supported Cooperative Work*, Chappel Hill, NC, USA, 1994, pp. 253-264.

[14] P. Dourish, "What we talk about when we talk about context," *Personal Ubiquitous Comput.,* vol. 8, pp. 19-30, 2004.

[15] B. Nardi, S. Whittaker, and H. Schwarz, "NetWORKers and their Activity in Intensional Networks," *Journal of Computer Supported Cooperative Work,* vol. 11, pp. 205-242, 2002.

[16] B. A. Nardi, S. Whittaker, E. Isaacs, M. Creech, J. Johnson, and J. Hainsworth, "Integrating communication and information through ContactMap," *Communications of the ACM,* vol. 45, pp. 89-95, 2002.

[17] R. L. Cross and A. Parker, *The Hidden Power of Social Networks: Understanding How Work Really Gets Done in Organizations*. Boston, Massachusetts: Harvard Business School Press, 2004.

[18] R. Albert, H. Jeong, and A.-L. Barabasi, "The diameter of the world wide web," ed, 1999.

[19] J. Leskovec, D. Chakrabarti, J. M. Kleinberg, and C. Faloutsos, "Realistic, Mathematically Tractable Graph Generation and Evolution, Using Kronecker Multiplication," *PKDD,* pp. 133-145, 2005.

[20] S. Milgram, "The Small World Problem," *Psychology Today,* vol. 2, pp. 60--67, 1967.

[21] J. Leskovec, K. J. Lang, A. Dasgupta, and M. W. Mahoney, "Community Structure in Large Networks: Natural Cluster Sizes and the Absence of Large Well-Defined Clusters," *CoRR,* vol. abs/0810.1355, 2008.

[22] D. Chakrabarti, Y. Wang, C. Wang, J. Leskovec, and C. Faloutsos, "Epidemic thresholds in real networks," *ACM Trans. Inf. Syst. Secur.,* vol. 10, pp. 1--26, 2008.

[23] S. Fortunato, "Community detection in graphs," *Physics Reports,* vol. 486, pp. 75--174, February 2010.

[24] L. Backstrom and J. Leskovec, "Supervised random walks: predicting and recommending links in social networks," presented at the Proceedings of the Forth International Conference on Web Search and Web Data Mining, WSDM 2011, Hong Kong, China, February 9-12, 2011, 2011.

[25] M. E. J. Newman, "The Structure and Function of Complex Networks," *SIAM Review,* vol. 45, pp. 167--256, 2003.

[26] H. Anderson, G. L. Moe, and L. Wong, "A data center goes lean," Spring 2011 2011.

[27] E. M. Haber, E. Kandogan, and P. P. Maglio, "Collaboration in system administration," *Commun. ACM,* vol. 54, pp. 46-53, 2011.

[28] J. Blomberg, "Trajectories of Change in Global Enterprise Transformation," *Ethnographic Praxis in Industry Conference Proceedings,* vol. 2011, 2011.

[29] I. Ronen, E. Shahar, S. Ur, E. Uziel, S. Yogev, N. Zwerdling, D. Carmel, I. Guy, N. Har'el, and S. Ofek-Koifman, "Social networks and discovery in the enterprise (SaND)," presented at the Proceedings of the 32nd international ACM SIGIR conference on Research and development in information retrieval, New York, NY, USA, 2009.

[30] D. Carmel, N. Zwerdling, I. Guy, S. Ofek-Koifman, N. Har'el, I. Ronen, E. Uziel, S. Yogev, and S. Chernov, "Personalized social search based on the user's social network," presented at the Proceedings of the 18th ACM conference on Information and knowledge management, New York, NY, USA, 2009.

[31] M. E. J. Newman, "Modularity and community structure in networks," *Proceedings of the National Academy of Sciences,* vol. 103, pp. 8577--8582, June 2006.

[32] C. R. B. D. Souza, C. S. Pinhanez, and V. Cavalcante, "Knowledge and information and needs of system administrators in IT service factories," presented at the Proceedings of the 10th Brazilian Symposium on on Human Factors in Computing Systems and the 5th Latin American Conference on Human-Computer Interaction, Porto de Galinhas, Pernambuco, Brazil, 2011.

[33] C. R. B. d. Souza, C. S. Pinhanez, and V. F. Cavalcante, "Information needs of system administrators in information technology service factories," presented at the Proceedings of the 5th ACM Symposium on Computer Human Interaction for Management of Information Technology, Cambridge, Massachusetts, 2011.

[34] B. N. Waber, D. Olguin Olguin, T. Kim, and A. Pentland. (2010, Productivity Through Coffee Breaks: Changing Social Networks by Changing Break Structure. *Social Science Research Network*. Available: http://ssrn.com/abstract=1586375