Toward User-Centric Management of Organizational Information Systems

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ABSTRACT

We identify the essential action domains for effective user-oriented management of organizational information systems. The study extrapolates the analytic findings from a large-scale information system of knowledge-intensive organization. The observations outline the actionable knowledge indispensable for usability improvements of information portals. The initial step is a wide deployment of behavioral analytics, in order to identify vital user characteristics. This knowledge empowers re-engineering of the existing business processes and design of new ones. The development should account for the essential elements of human interactions in digital environments. The information systems should employ user assistance services and adaptive personalization features.

Keywords

Actionable Knowledge Discovery, Usability Management, Information Systems, Behavioral Analytics, Knowledge Workers, Personalization.

1.0 INTRODUCTION

Organizations in the modern knowledge economy are increasingly committing significant resources to the information technology infrastructure and systems. The information systems should facilitate improved operational and working efficiency, availability, and business intelligence. If they are well implemented, the results may surpass the expectations. However, if they are poorly implemented, the costs may be staggering.

Advanced information systems are indispensable in knowledge-intensive organizations (Davenport, 2005; Alvesson, 2004). Knowledge workers exceedingly rely on the resources and services provided by them. What distinguishes good and bad organizational information systems is the extent by which they contribute to the enhanced performance of the workers and the whole organization. Several econometric indicators relate to the impact of the enterprise information systems on the operating efficiency. It is equally pertinent to examine the factors related to the efficiency of knowledge workers' use of the information systems. The essential characteristic here is the usability of the systems.

The usability denotes the methods for studying the principles behind the perceived efficiency of use of the information systems by the users (Seffah et al., 2006; Palmer, 2002). This necessitates detecting and analyzing the user behavior on the system from the recorded human-system interactions (Geczy et al., 2007).

Investigations of human dynamics in digital environments (Barabasi, 2005) have been attracting substantial attention from corporate spheres (Petre, Minocha, and Roberts, 2006). Corporations are collecting extensive behavioral data about their web customers and visitors. They are employing behavioral analytics for modeling and potentially predicting the customers' behavior (Park and Fader, 2004). Their primary target is revenue generation—by converting more web site visitors into customers, and directing the marketing to suitable groups and demographics (Moe, 2003). Unfortunately, the organizations' progress in improving usability of their own internal information systems is lacking. The improvements would benefit both: the organization and its members.

This study concentrates on the internal organizational information portals. It introduces imperative behavioral and usability analytics of knowledge workers, and presents a framework for acquiring actionable knowledge crucial for managerial efforts leading to the advancement of the internal information systems. The identified management action domains are vital for usability improvement.

2.0 CASE STUDY

The organizational information system investigated in this study is the large-scale distributed intranet portal of The National Institute of Advanced Industrial Science and Technology. The portal is significantly complex and voluminous in terms of data, traffic, and structure (Table 1). The web-core incorporates six servers connected to the high-speed backbone in a load-balanced configuration. Accessibility of available resources ranges from high-speed optical to wireless connectivity. Supported platforms extend to mobile devices.

Table 1: Case study web log data information.

Data Volume	~60 GB
Average Daily Volume	~54 MB
Number of Servers	6
Number of Log Files	6814
Average File Size	~9 MB
Time Period	3/2005 – 4/2006

The portal provides extensive range of web services and documents vital to the organization. The rich pool of intranet services is designed to support business processes for management, accounting and administration, research cooperation with industry and other institutes, and resource localization. Included are also bulletin boards and services for networking within the organization. The institute has a relatively large number of branches throughout the country, thus several services and resources are distributed. Approximate size of the visible web space is in excess of 1 GB, whereas the deep web space is substantially larger, but difficult to estimate due to the decentralized architecture and constantly altering back-end data.

The main user population of the enterprise portal comprises of the skilled knowledge workers. Significant traffic on the portal provides a large and rich web log data pool. The traffic was, however, both human and machine generated. Thus, the data required cleaning. The data preparation, filtering, and other processing are detailed in (Geczy et al., 2007). The data cleaning eliminated most of the machine generated traffic. Possible remaining machine traffic is statistically insignificant and does not affect the analytic results.

3.0 ANALYTICS

Current section introduces the basic elements for analyzing knowledge worker behavioral and usability characteristics in electronic environments. The elements were extracted from the collected and processed web log data. Further results of the exploratory analysis with valuable findings pertinent to the management of information systems are then introduced.

3.1 Approach Presentation

Knowledge worker interactions in web environments are suitably represented by the sequences of click-streams. The click-stream sequences of page transitions are segmented into sessions and subsequences. An illustrative depiction is presented in Figure 1.

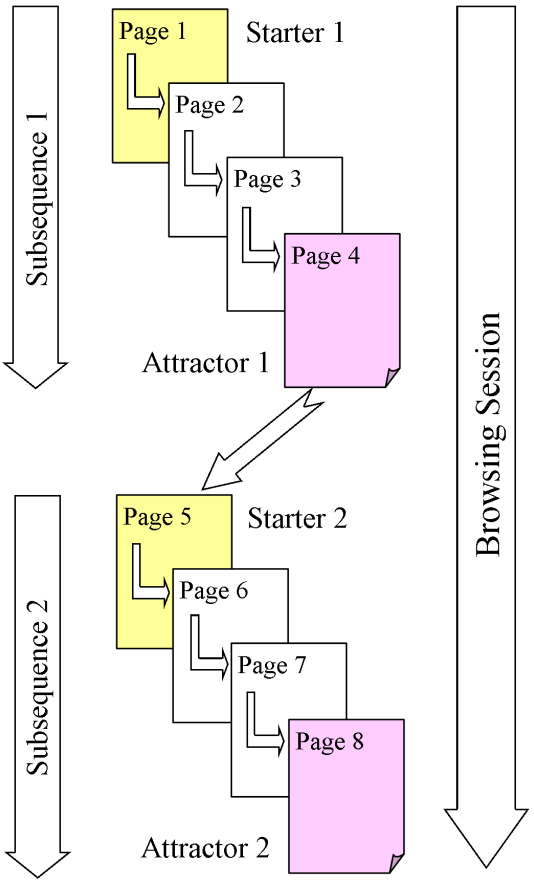

Figure 1. Depiction of click-stream segmentation. The illustrated browsing session consists of two subsequences. The initial element of the subsequence is the starter, and the final element is the attractor.

The sessions outline longer interactions undertaken by the users. They are further divided into the subtasks denoted by the subsequences. Segmentation is done according to the users' temporal activity characteristics.

Consider for example the following user activity. At the beginning of the working day, the user logins into the intranet system (subsequence 1) and is presented with the initial page. Then he/she invokes the attendance service to record the starting time of the current working day (subsequence 2). After that, the user proceeds to the web bulletin board, containing the latest organizational announcements, and reads an update on a corporate vacation policy (subsequence 3). The user's browsing session, in this case, consists of three subsequences representing distinct tasks.

Table 2: Session and subsequence statistics.

Sessions	3,454,243
Unique Sessions	2,704,067
Subsequences	7,335,577
Unique Subsequences	3,547,170

Valid Subsequences	3,156,310
Unique Valid Subsequences	1,644,848

Informative statistics on detected sessions and subsequences are presented in Table 2. The effect of filtering the machine generated traffic (automated network monitoring, verification, crawling and indexing, etc.) is also displayed. The initial data cleaning eliminated most of the non-human traffic, however, additional filtering was required after the subsequence extraction. It is noticeable that the data cleaning and filtering reduced the number of unique valid subsequences by 53.6%. Thus, the machine traffic was significant.

Another important matter was the detection of the navigation points where users initiated their browsing (sub)tasks? starters, as well as the targets of their (sub)tasks? attractors. Examining the starter-attractor pairs enables us to observe the elemental abstract patterns of knowledge workers' browsing behavior. The transitions between subsequences, indicated by the corresponding attractor-starter pairs, permit recognizing the formation of more complex browsing patterns? as sequences of interconnected elemental patterns.

3.2 Valuable Observations

Exploratory analysis of knowledge worker behavior in the large organizational intranet environment revealed numerous relevant usability and behavioral aspects. We present concise highlights of the main discoveries.

- **Underutilization of resources was exposed**. Knowledge workers utilized a small spectrum of starters and attractors. The size of the starter and attractor sets amounted for approximately 3.84% and 9.55% of the total navigation points, respectively.
- **Knowledge workers formed elemental and complex browsing patterns**. Strong repetition of small number of starter-attractor pairs indicated formation of the elemental patterns. Similar situation held for attractor-starter pairs. Frequent repetition of elemental patterns and transitional patterns exposes formation of complex browsing patterns.
- **Sessions contained three subsequences on average**. Users divided their more complex browsing tasks into several simpler subtasks.
- **General browsing strategy reflected knowledge of the starting navigation point and familiarity of the traversal pathway to the target**. Smaller number of starters repeated substantially more frequently than the adequate number of attractors. The starter-attractor frequency ratio was approximately 1:10.
- **Users' browsing behavior gradually habituated**. Extended use of the intranet information system resulted in browsing habituation. As users familiarized themselves with the targets, they exhibited faster navigational transitions.
- **Inter-sequence transitions were in the range of seconds**. The peak subsequence duration was in the range of four to six seconds. During this time, the users traversed four to five pages on average. This implies approximately one second per transition.
- **Attention span at the target was approximately seven minutes**. This was indicated by the detected delays between subsequences. The observed 6.5 minute average attention span is considerably short.

4.0 MANAGERIAL IMPLICATIONS

The management of the organizational information systems should inevitably take into account the presented analytic evidence. It exposes the actionable knowledge on several crucial aspects—with implications to various domains. The essential domains are addressed in the following subsections.

4.1 Analytics Deployment

System analytics play a vital role in detecting and identifying the strengths and weeknesses. Unfortunately, the organizations conventionally employ only hardware analytics, bandwidth balancing, and security concerns (Kamoun, 2005). The deployment of system analytics should be expanded to usability monitoring and behavioral analysis of the users.

Usability observations highlight how the organizational information system is utilized by the users. Some parts may be used effectively, whereas the other parts poorly. Our case study revealed significant underutilization of available resources. Large number of resources have been only occassionally accessed, and only the small set was frequently used. Knowing which critical resources are underutilized enables the accurate targeting of improvement efforts.

Behavioral analytics expose the interaction characterisitcs of the users with the organizational information system. It has been observed that knowledge workers have a significant tendency to form browsing and behavioral patterns. The identification of the significant patterns is essential for designing and engineering of efficient user-friendly business processes and services.

4.2 Business Process Engineering

Organizations are increasingly transfering internal business processes to their information platforms. This facilitates automation, availability, archiving, monitoring, and many other aspects. A number of business processes deployed on the internal systems require human involvements and interactions. The elements of human

interactions are rarely accounted for in the design and engineering stages. This decreases the user working efficiency and induces the negative experience effects.
Business process design and engineering should be in harmony with the fundamental elements of human interactions. It is often the case that the actual implementations of business processes result in multistage extended human-system interactions. The analytic findings indicate that the knowledge workers naturally divide their browsing tasks into three subtasks? on average. This suggests that the extensive and prolonged business processes should be re-engineered, so that they can be segmented into at most three sub-processes. Furthermore, each stage should require less than seven minutes of human attention.

Implementations of feedback and verification mechanisms are also pertinent for continuous improvement. Constructive user feedback may expose issues that have been neglected during the design and engineering of business processes. Additionally, it facilitates active user engagement.

4.3 Personalization

Different users have different browsing and working styles. Conventionally, the interactivity of organizational information systems with the human users has follwed the one-fit-all style; possibly with exceptions of few optional adjustments. This interfacing is inadequate. It is often the seed of underutilization.

Human interactivity should be approached in a personalized manner. Personalization may be realized essentially on two levels: group and individual. The group personalization expresses the interface adjustments for a set of users with similar behavioral and/or working characteristics. The personalization on the individual level allows delivery of personalized interfaces for individual users.

Personalization is tightly linked with profiling. Each user, or group, should have a well formed profile incorporating the essential elements of human-system interactions. Based on the profile characteristics, the interface adjustments should be carried out on-line. Profiling and clustering of users into groups follows directly from behavioral analytics. It should dynamically reflect the behavioral changes detected by anlytic methods.

Profiling and user clustering generates additional actionable knowledge. The knowledge can be effectively utilized throughout the organization (e.g. in human resources division).

4.4 Assistance Services

Proficiency in use of organizational information systems requires practice. It can be time and resource consuming. To accelerate the learning process, the users should be systematically assisted during their browsing experiences. On the other hand, the extensive use and increased proficiency is linked with habituation and lack of exploratory behavior. Suitable assistance services can facilitate steeper learning curve and improved attention management.

Assistance services should at least incorporate inforamtion technologies such as search, recommendations, and collaborative filtering. The effective search enables fast location of relevant resources. The search technology has been largely commoditized and is easily and economically deployable. The recommenadtion systems utilize the knowledge of use histories, preferences, and other analytics to offer suitable recommendations on resources and services of potential interest to the users (Adomavicius and Tuzhilin, 2005). The collaborative filtering technologies leverage the correlations between 'similar' users in providing assistance and recommendations (Jin et al., 2006).

Employing attention management systems facilitates disemination of critical information and resources to the relevant users in a timely and appropriate manner. They shoud be aligned with the organizational policies and strategies.

5.0 CONCLUSIONS

The study addresses key issues in user-centered management of organizational information systems. It draws from extensive analytic evidence obtained from a case study of a large-scale intranet portal of knowledge-intensive organization. The analysis revealed important behavioral and usability characteristics that translate to actionable knowledge for managers of information systems. Modern management requires effective deployment of behavioral and usability analytics along with several assistance services. The analytics provide a vital source of knowledge for decision-making processes. Design and engineering of business processes should be in balance with the essential elements of human interactions in electronic environments. The environments should incorporate adaptive personalization features.

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