FOUNDATIONS FOR EFFECTIVE PORTAL SERVICE MANAGEMENT

Peter Géczy, National Institute of Advanced Industrial Science and Technology (AIST)
Noriaki Izumi, National Institute of Advanced Industrial Science and Technology (AIST)
Koiti Hasida, National Institute of Advanced Industrial Science and Technology (AIST)

ABSTRACT

Organizational portals are vital parts of knowledge-intensive organizations. They play several critical roles: a) provide a platform for deployment of web-based services; b) envelop distributed internal resources; and c) present a centralized access to resources and services. Portal services often incorporate digitalized organizational business processes. Digitalization enables automation of business processes and facilitates improved management and operating efficiency of organizations. Despite advancements in technology and significant investments, it is commonly observed that web services implementing business processes have low usability. Generally, low usability results from misalignment between natural characteristics of human interactions with services in digital environments and their design and implementation. Human-service interaction analytics expose hidden difficulties and enable effective innovation and management of portal services. We present pertinent managerial implications of analytic findings from a case study of a large-scale organizational portal with a significant number of services. The findings provide actionable knowledge for effective evidence-based management, reengineering and innovation of portal services.

KEYWORDS: analytics, portals, web services, management, knowledge-intensive organizations, actionable knowledge discovery.

JEL: M15; O32; O33; L86; L89

INTRODUCTION

"The overwhelming majority of organizations, however, have neither a finely honed analytical capability nor a detailed plan to develop one." (Davenport and Harris, 2007). Absence of analytical capabilities represents missing opportunities in alleviated operating efficiency of organizations and working efficiency of their members. Conversely, it provides significant strategic advantage for a small number of organizations with analytical capabilities. This matter is notably pronounced in information technology domains. Organizations deploy internally a broad spectrum of information technologies. They include technologies such as intranets, web-based portals and decision support systems. Significant resources are devoted to management and maintenance of organizational information systems and infrastructures. Knowledge-intensive organizations and workers increasingly rely on services available at internal web portals (Alvesson, 2004; Davenport, 2005). The services often incorporate essential business processes that have been migrated to portal platforms. They play a vital role in functioning of organizations.

Contemporary organizational information systems have been employing service-oriented technologies (Sullivan, 2004). Service orientation enables efficient re-use of existing organizational information resources and economic deployment of new ones. There has been lack of coordination in early adoptions of information systems in organizations. Insufficient attention has been paid to the overall strategy. It has resulted in dispersing systems with overlapping functionalities within organization that have been largely incompatible. The need to coordinate the information technology resources has surfaced. Organizational portals have become the solution (Collins, 2000). They facilitate gateway to distributed resources.

Usability of portals and their services has been relatively low despite considerable advances in web technologies and organizational investments (Géczy et al., 2007). Services and resources on organizational portals are often underutilized. Implementations and executions of business processes via web services have been difficult. Progress and improvements in portal services, their usability, and innovation, have been relatively slow. Organizations have been extensively focusing on their external web presence (Petre et al., 2006; Park et al., 2004). Internal web presence and demands of knowledge workers for efficient portal interaction have been largely sidelined.

This work addresses the pressing needs for effective management, engineering and innovation of organizational portal services. We advocate evidence-based management approach drawing from viable and timely derived analytic evidence. The introduced material is complemented by a case study of a large-scale web portal of knowledge-intensive organization.

The manuscript is organized as follows. The literature review section is followed by the 'Analytics-based Management Strategy' section. It describes the essential four stages of analytically founded management strategy for portal service management. The next section, 'Data Collection and Case Study', presents concise overview of the organization in our case study and the analyzed data. Analytic and interaction framework is provided in the section 'Interaction and Usability Analytics Deployment'. The pertinent findings of analysis and identified problems with organizational portal services are described in the section 'Observation and Problem Identification'. The exploratory findings are constructive and translate directly to several implementable solutions. High priority management solutions are introduced in the section 'Solution Management'. The presentation finishes with a concise summary of the essential points, limitations and directions for future research in the section 'Conclusions'.

LITERATURE REVIEW

Organizational web portals have been at the forefront in increasing productivity of workers and efficiency of use of information technologies (Collins, 2000). Earlier adoptions of information technologies by organizations have led to distribution of resources and incompatibilities between implemented systems. Resources and services have been accessible locally within their implemented areas. Web portals have changed this. They have provided single point access to distributed resources and services within the whole organization via service-oriented technologies (Sullivan, 2004).

Usability of portals and their services plays an important role in alleviating operating and working efficiency. Various approaches to evaluating usability have been explored. Popular approaches are metric-based—surveyed by Dhyani and Ng (2002). Tullis and Albert (2008) have presented six categories of metrics: performance, issues-based, self-reported, web navigation, derived, and behavioral/physiological. They have also explored methods for collecting, analyzing and presenting the data. Metric-based approaches utilize measuring of several variables of human-web interaction process and constructing formulas for evaluating particular characteristics. Human interactions are divided with respect to temporal characteristics into sessions. Further measurements and metrics are performed within the temporal segments of sessions (Huntington et al., 2008; Géczy et al., 2007). Based on the acquired measurements and derived metrics, usability models for portals and their services are created. Bosov (2009) debates that proper observation and modeling of web portal functioning requires accounting for two characteristics: efficiency of information sources and user activity. He introduces technique for determining model parameters and presents mathematical models for portal operation. His model provides a plausible higher-order perspective on portal functioning. However, the usability of portals is significantly affected also by the quality of services they provide. Yang et al. (2005) have been suggesting evaluation of portal service quality according to five aspects: usability, usefulness of content, adequacy of information, accessibility and interaction. They argue that these five dimensions suitably expose service quality.

It has been observed that organizational portals and their services have relatively low usability. Géczy et al. (2007) have observed that users at large scale organizational portals often experience difficulties in executing tasks and locating relevant resources. These are two primary activities of users performed at organizational portals. Business processes implemented by web services have an extensive number of stages that are tedious to execute by users. Negative experience during the task execution significantly affects the perceived usability of a portal. Finding suitable resources in a timely manner has also been reported problematic. Among the most popular services on organizational portals are personal services. Telang and Mukhopadhyay (2005) have been investigating search, information and personal services on several portals and demographics. They argue that these three complementary categories of services lead to different portal uses. The results have shown that the strongest demand has been for personal services while the weakest demand has been for search services. Dissatisfaction with search results has negatively affected future user decisions. Personal and information services have led to prolonged length of portal visits.

Improving usability of organizational portals requires active management effort at several stages. Burton-Jones and Gallivan (2007) have suggested approaching information systems and their use in organizations through several levels. One level at a time may lead to incomplete and disjointed view of how information systems are used and managed in practice. Kotorov and Hsu (2001) have proposed a management model for organizational portals similar to the management model for newspaper production. They have argued that it provides the adequate organizational structure for overcoming the inherent limitations of enterprise portals. Significant efforts in managing organizational information systems and portals have been devoted to the best practices (Sullivan 2004). Best practices are a useful approach; however, they rely on knowledge accumulated over extended period of time that can be summarized in generalized terms. Rapid progress of information technologies necessitates a management approach capable of timely responding to issues. We advocate evidence-based management approach built on analytically obtained evidence. Davenport and Harris (2007) have recommended effective use of analytics. Analytics provide well-timed business intelligence suitable for gaining and maintaining competitive advantage. They are also pertinent for managing organizational information systems.

ANALYTICS-BASED MANAGEMENT STRATEGY

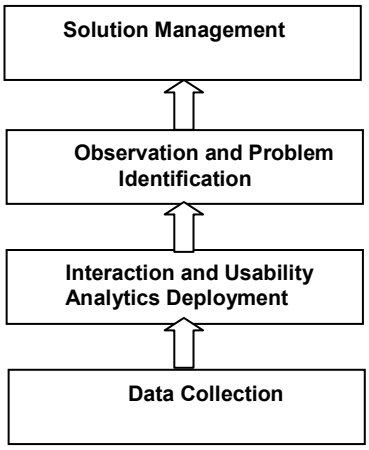
The study emphasizes evidence-based management strategy that relies on suitable utilization of analytics. The management strategy incorporates a sequence of steps leading toward relevant managerial action domains. The sequence is illustrated in Figure 1. It incorporates four essential stages: data collection, interaction and usability analytics deployment, observation and problem identification, and solution management. Note these are the core steps. Depending on particular case, the sequence may be expanded. Following paragraphs concisely describe the individual stages.

The initial stage is the collection of viable data on interaction and usability of services. The clean and preprocessed data is analyzed according to properly designed and deployed framework. The analytic findings expose usability and interaction characteristics that lead to the identification of problems. Constructive problem identification enables effective solution management.

Data Collection. The initial requirement is a suitable collection of data directly and indirectly relevant to web portal services and usability. Three pertinent issues should be addressed in data collection techniques: data quality, availability and voluminosity. Data quality is inherently related to the analytic targets and observations; thus, qualitative indicators may vary accordingly. Generally, higher quality data allows for greater depth and accuracy of observations. Availability of data relates to timelines. Data may be available for analysis immediately or after a certain period. Immediate data availability enables online analytics—processing directly after monitored interactions occur. The other approach is to collect data during a certain period and make it available then. For instance, data may be collected during the day and

processed during the night—when greater computing power is accessible and energy costs are lower. Voluminosity relates to the quantity of data. Larger volumes of data may provide more details; however, they are also more costly in terms of collection and processing.

Figure 1: Progressive Sequence of Stages in the Analytically Founded Management Strategy



Interaction and Usability Analytics Deployment

Collected data should permit suitable exploratory analysis of interactions of users with portal services. Relevant analytics should encompass both temporal and navigational characteristics of users. Temporal analytics highlight interaction dynamics of users with services. It is important to account for temporal features of users' activity and inactivity.Inactivity periods may indicate bottlenecks in interaction efficiencies. Navigational analytics expose how users navigate through the navigational and hyperlink structures of portal services. Shorter navigational pathways are generally more desirable than longer ones. Important issue is also derivation of proper usability metrics from analytically obtained data. The metrics may serve as indicators for triggering corrective actions. Certain corrective actions may be automated while others may require further elucidation and identification of problems.

Observation and Problem Identification

Analytics enable observation of natural human-service interactions. The observations should encompass how users utilize different portal services and whether the use characteristics are aligned with the design goals and future expectations. It is suitable to observe both individuality of users and similarity among specific user groups. Although each user is different, some common human-service interaction patterns usually emerge. Usability observations shall expose which services are used often, or sporadically, as well as overall portal and service statistics. They may also indicate which services users use effectively and which not. Services that are used rarely, and/or ineffectively, signal potential problems. The problems may be wide ranging. Further analysis of such services reveals the problematic aspects and allows identification of viable solutions.

Solution Management

Identified problems and their solutions should be properly managed. Certain problems may necessitate immediate action; for instance, if the service is mission-critical or the problem is related to information security. In this case, a proper crisis management and guidelines are pertinent. Noncritical problems may be addressed in a planed manner—allowing optimal management of available resources while maintaining timely solution delivery. When managing solutions to noncritical service problems, it is

beneficial to identify suitable action domains that reflect both commonly observed issues and novel ones. Identification of management action domains permits more efficient allocation of human, technological and other resources. The set of action domains should not be extensive, in order to avoid excessive fragmentation of available resources.

DATA COLLECTION AND CASE STUDY

Various data collection methods can be utilized for elucidating human-service interactions. There are two suitable techniques for organizational environments: server-side and client-side. Web servers on which services run have capability to store interaction information into log files—hence, the server-side collection. Scripts executed locally on users' computers do the client-side data collection. Both techniques provide reasonably accurate data. While server-side data collection is independent of user setup, client-side data collection requires enabled scripting.

The presented case study utilized server-side web logs of a large-scale distributed intranet web portal of The National Institute of Advanced Industrial Science and Technology. The portal hosts over eight-hundred services and over three-million resources. It provides extensive and rich set of real-world data.

Table 1: Summary of Data

Data Volume	~60 GB
Number of Services	855
Number of Servers	6
Number of Log Records	315,005,952
Number of Resources	3,015,848
Time Period	1 Year

Information on data used in our case study. Analyzed one-year web log data was large—in excess of sixty giga bytes. Six web servers collected the data. The data contained over three-hundred-million log records. There were significant numbers of services and resources. The organizational portal had eight-hundred-fifty-five services. The data analysis was computationally intensive.

Web logs contain sufficient information about users' interactions with portal services. However, web logs also contain information irrelevant for our analytic purposes; such as machine generated portal traffic. Web log data requires processing before it can be used for analyzing human-service interactions. The data preparation is detailed in (Géczy et al., 2007).

Portal services implement a broad range of business process in the organization. The services support resource management, administrative processes and accounting. They also include services facilitating cooperation with industry and other institutes. The primary users of portal services and resources are skilled knowledge workers. They include management and administrative personnel, researchers, engineers, technical staff, and assistants. Different knowledge workers utilize different services and resources. Some services and resources are restricted; however, majority is accessible to all users. Varying use of services by a large number of knowledge workers has been reflected in diverse interaction and usability characteristics.

INTERACTION AND USABILITY ANALYTICS DEPLOYMENT

Proper analytic and usability framework are pertinent for viable observations. Design and implementation of an analytic framework should be aligned with organizational requirements and available resources. Online and offline analytics may be implemented. Online analytics are desirable for

critical aspects of organizational portals, such as mission-critical services and security issues. Offline analytics are suitable for planed improvements and updates.

Data collected about human behavior in portal environments and interactions with services should incorporate both temporal and navigational dimensions. Temporal dimension enables exploration of interaction dynamics while navigational dimension allows investigation of hyperlink structures and navigational pathways. These attributes are also appropriate for usability observations. Web log data collected by web servers contains both temporal and navigational information. After preprocessing and cleaning, it is well suited for analytics (Géczy et al., 2007).

Recent analysis of temporal dynamics of humans in digital environments revealed various significant features (Barabasi, 2005). Users exhibit rapid activity periods followed by longer inactivity periods (Dezso et al., 2006). Users execute certain interactive tasks rapidly while others they complete after a comparatively longer delay. These dynamics allow temporal segmentations of interactions. The interaction sequences can be divided into segments of various durations: longer segments are sessions that can be further divided into subsequences reflecting tasks of various complexities. Sessions and subsequences contain points through which users navigated to accomplish their browsing goals. These underlying findings are directly applicable to human-service interactions. They encompass essential temporal and navigational aspects. Extension of this concept to feasible human-service interaction analytics necessitates accounting for further specifics related to web services.

Web services interact with both humans and other services. Service-to-service interactions have been extensively modeled (Zaha et al., 2006; Vinoski, 2002). Explorations of human-service interactions have been performed relatively recently (Géczy et al., 2008). In observing human-service interactions, it is beneficial to categorize services with respect to their composition and interactivity. According to the service composition, we can distinguish two main categories: atomic and compound services. Atomic services are functional elements that do not utilize functionality of other services. Compound services are functional elements employing functionality of one or more atomic or compound services. According to human-service interaction dynamics, we differentiate two main groups: passive and active human-service interactions. Passive human-service interactions exhibit one-way interaction patterns: service→human, or human→service. Active human-service interactions exhibit two-way interactive pattern: service↔human.

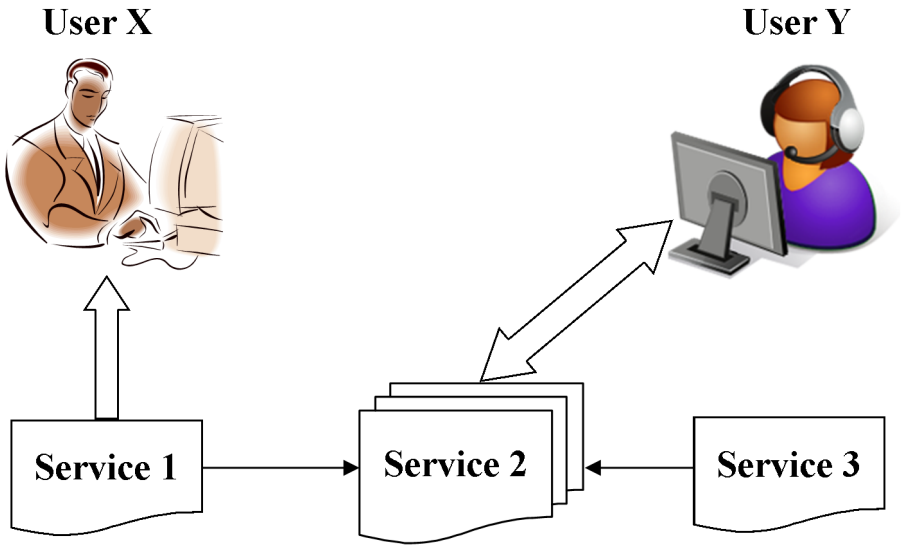
The concept of interactive and compositional segregation is illustrated in Figure 2. Services 1 and 3 are atomic because they do not employ functionality of other services. Service 2 is a compound service employing functionalities of services 1 and 3. Service 3 interacts only with service 2; hence, it is a non-human interacting service. Service 1 interacts with user X monodirectionally—depicting passive human-service interactions (for instance, when user reads displayed information). Service 2 interacts with user Y bidirectionally—portraying active human-service interactions (for example, interactive multimedia). Services 1 and 3 supply their functionalities to service 2, which is outlined by monodirectional service-to-service interactions.

Services provide functionalities to other services or humans. Their functionalities may be atomic or compound. The atomic services do not utilize functionalities of other services (services 1 and 3). The compound servicers utilize other services (service 2). Services can interact with humans passively or actively. The passive human-service interactions are one-way interactions from services to humans (service 1→user X), or vice-versa. The active human-service interactions are two-way interactions between services and humans (service 2↔user Y).

Deployment of the described analytic concept within organizations should account for at least three primary issues: specific analytic needs, available resources and legal aspects. Analytic needs of an organization should be clearly outlined prior to deployment. It saves overhead and running costs. At

large organizations and portals, data is voluminous. Analytic processing and utilization may require extra resources—both computational and human. Behavioral data is sensitive. Legal compliance with privacy and security regulations is required.

Figure 2: Illustration of Service Composition and Interactivity



OBSERVATION AND PROBLEM IDENTIFICATION

The presented interaction and usability analytic concept exposes numerous characteristics of portal users. Our case study revealed several important findings. Selected observations highlight interaction and use features of knowledge workers as well as problematic issues. Relevant findings are concisely described in the following paragraphs.

Underutilization. Knowledge workers have considerably underutilized available portal services. Approximately ten services have been frequently used (out of 855). More than half of the services have been used rarely. Almost 50% of use has been attributed to only three services.

Navigation Strategy. An interesting navigation strategy of knowledge workers has been exposed. They have been most familiar with the starting navigation points. General navigation strategy can be described as follows: knowledge of the starting point and recollection of the navigational path to the target.

Task Segmentation. Knowledge workers have divided their more complex interactive and navigation tasks into three subtasks. Complex interactive sessions have contained on average three subsequences. Within the subsequences, there have been approximately five interactions.
Active Human-Service Interactions: Active interactions have been within the range of seconds. Average interactive subsequence has lasted 30.68 seconds. During this half minute, users have made about five interactions, that is, one interaction per six seconds. This implies that effective active service interactions should be executable in a few seconds.

Passive Human-Service Interactions: Passive interactions have been in the range of minutes. Knowledge workers' inactivity periods exposed this finding. Average delay between transitions has been approximately 6 minutes 28 seconds. During this period, users have exhibited significant passivity, such as reading displayed information.

Usability and interaction observations display several important characteristics. They highlight how knowledge workers interact with web portal services, which services are used frequently and efficiently, and overall usability statistics. The findings also show problematic issues. They expose underutilized services and resources, and bring to light conflicting aspects requiring corrections.

SOLUTION MANAGEMENT

Analytics are the enabler of evidence-based management—a progressive step in information systems management and innovation (Hamel, 2007). Managerial activities and decisions are based on viable and timely generated evidence. Formerly, information technology management in organizations relied principally on tacit knowledge accumulated over the years of experience and/or mentoring. Although valuable, experience-based tacit knowledge takes relatively long time to gain and transfer. However, the progress in information technologies is fast. This discrepancy results in late deployment and mismanagement of new technologies due to tacit knowledge gaps—consequently, leading to losses for organizations.

Evidence-based management style is preferable in rapidly evolving information technology climate. Furthermore, it beneficially complements the experience-based management style. Analytically obtained evidence and well-identified problems substantially eliminate guesswork in critical decision-making. Human-service interaction observations translate to actionable knowledge. Desirable management action domains can be identified—allowing planning, allocating resources, and delivering timely solutions. Relevant domains originating from the case study are concisely described in the following paragraphs.

Outsourcing versus Reengineering Decision-Making

The case study revealed a significant underutilization of web portal services. Services that are unused or sporadically used contribute to waste of resources and information overload. Unused noncritical services should be eliminated. Critical services with problematic use should be reengineered based on available analytic evidence, in order to improve their usability. Occasionally accessed services with low usability require further decision-making. They can be outsourced or reengineered. Resource-intensive services may be economically outsourced. Infrequently used services with low usability may be economically reengineered.

Structural Reengineering. Structural complexity of portal services should be suitably managed. This relates to determining atomic and compound service structures as well as segmentation of complex business processes. Well-determined structures of compound services provide several benefits over a lifetime of services. The observations indicate that users divide their complex portal tasks into three subtasks. However, it is often the case that business processes are divided into more than three stages. While this may be proper in paper-based implementations, it is not recommended in web-based implementations. It is advisable to follow natural task segmentation of users obtained by analytics and reengineer services accordingly.

Interaction Reengineering. Aiming at efficient interaction dynamics is another important management action domain. Interaction reengineering of portal services should be aligned with the observed elemental characteristics of active and passive human-service interactions. Passive human-service interactions should be limited to 7 minutes. Depending on information presentation, 7 minutes translates to different amounts processable data. Consider text-based presentation. Average adult screen reading speed is 200 words per minute with comprehension of 60%, that is, effectively 120 words per minute. A user can effectively process approximately 840 words in 7 minutes. Analogously, active human-service interactions. Users should be able to interact with services within a few seconds.

Innovation. Operations within organizations and business processes often undergo changes. Successful management of portal services should account for changes during a service life cycle. Critical services should be closely monitored and properly innovated. They should be re-aligned with the observed use characteristics and organizational policies. Novel and/or existing information technologies can also alleviate usability of portal services. Assistance services may be deployed. Recommendation and collaborative filtering systems may offer help when interacting with a service. They also contribute to increased learning speed of new and/or inexperienced users. Personalization is also beneficial. Functionality and interactivity of services may reflect individual or group characteristics.

The introduced management action domains originate from the deployed analytics and identified problems. They address the essential matters in effective management of portal services and aim at improving usability and efficiency. Domain identification helps focusing both human and technology resources on vital aspects. Depending on availability of resources, managers can identify more or less specific domains—targeting particular issues for their organizations.

CONCLUSIONS

We presented evidence-based management of organizational portal services. The management strategy advocates incorporation of four stages: data collection, interaction and usability analytics deployment, observation and problem identification, and solution management. The first step is collection of reliable data about human-service interactions and portal usability. Noninvasive data collection methods are preferable. Deployment and utilization of analytics is the second step. Suitable analytics provide pertinent evidence on how users interact with portals and their services—they highlight behavioral and usability aspects. Observation of characteristics of human interactions in web environments helps to identify problematic aspects of services to a substantial detail. Having identified concrete problems, managers can supervise innovation and timely deployment of suitable solutions. Identification of specific action domains allows for efficient solution management and critical decision-making. The work is supported by a case study of a large-scale portal of knowledge-intensive organization. The outlined stages in evidence-based management style are complemented with examples from the case study. Possible limitation of the study is the reliance on web log data only. Additional data can be collected using client-side scripts. However, this requires enabled scripting in browsers. Without it, client-side scripts would not run and no data would be collected. Client-side scripting should be approached with caution in organizational environments since its enabling has security risks. Future directions of the study shall include extensions of analytic capabilities, solution management, and elucidation of interlinks with business intelligence systems.

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BIOGRAPHY

Dr. Peter Géczy is a senior researcher at the National Institute of Advanced Industrial Science and Technology (AIST). He can be contacted at: AIST, 2-3-26 Aomi Koto-ku, Tokyo 135-0064, Japan. p.geczy@aist.go.jp

Dr. Noriaki Izumi is a chief researcher at the National Institute of Advanced Industrial Science and Technology (AIST). He can be contacted at: AIST, 2-3-26 Aomi Koto-ku, Tokyo 135-0064, Japan.

Dr. Kôiti Hasida is a laboratory head at the National Institute of Advanced Industrial Science and Technology (AIST). He can be contacted at: AIST, 2-3-26 Aomi Koto-ku, Tokyo 135-0064, Japan.