



**The Open University of Israel**  
Department of Management and Economics



# **Proceedings of the 5<sup>th</sup> Israel Association for Information Systems (ILAIS) Conference**

**June 29, 2011**

**The Open University of Israel  
Raanana, Israel**

**Editors: Nitza Geri and Yoram M Kalman**

**The Israel Association for Information Systems ([ILAIS](#))** was founded in 2005 as the Israeli chapter of the Association for Information Systems ([AIS](#)). The goal of ILAIS is to promote the exchange of ideas, experiences and knowledge among IS scholars and professionals engaged in IS development, management and use.

## Conference Program

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09:00-09:30 Registration

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09:30-10:30 **Opening Session** **Neudorfer Hall**  
Chair: **Nitza Geri**, The Open University of Israel

*Greetings:*

**Sonia Roccas**, Dean of Academic Studies, The Open University of Israel

**Phillip Ein-Dor**, ILAIS Chair, The Academic College of Tel-Aviv-Yaffo

**Dov Te'eni**, AIS President-Elect, Tel Aviv University

*Opening lecture:*

**Tamir Tassa**, The Open University of Israel

***Preserving Privacy in Data Publishing by Anonymization***

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10:30-11:00 Coffee break

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11:00-12:00 **Session A** **Neudorfer Hall**  
Chair: **Nava Pliskin**, Ben-Gurion University of the Negev

**Daphne Raban** (University of Haifa), **Ganit Richter** (University of Haifa), **Yaniv Corem** (IBM Research – Haifa)

*Harnessing the Power of Games to Enhance Organizational Knowledge Sharing*

**Shy Cucuy** (Ben-Gurion University), **Lior Fink** (Ben-Gurion University),

**Yossi Lichtenstein** (The College of Management Academic Studies)

*Staging System Deployment -A Real Options Analysis*

**Nitza Geri** (The Open University), **Rica Gonen** (The Open University)

*Reducing Free Exposure in Sponsored Search Auctions*

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12:00-13:00 Lunch

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13:00-13:30 **Preview session** **Neudorfer Hall**  
Chair: **Yoram Kalman**, The Open University of Israel

*Preview session of the parallel papers in Sessions B1-B3*

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13:30-13:40 Break

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**13:40-15:20 Parallel sessions B1-B3**

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**Parallel Session B1 Kanbar Hall**

Chair: **Lior Fink**, Ben-Gurion University of the Negev

**Ruti Gafni** (The Open University)

*Exploring Mobile Access to a Corporate Website*

**Helen Hasan** (University of Wollongong), **Irit Alony** (University of Wollongong)

*Suggesting a Practical Agenda for Green IS – Recent Solutions within a Framework of Efficiency, Information, and Effectiveness*

**Saggi Nevo** (University at Albany), **Dorit Nevo** (York University)

*Dissatisfaction Does Not Mean Rejection: A Conceptual Model of Mindful and Unfaithful IT Reinvention*

**Michael Jones** (University of Wollongong)

*Use of Qualitative Data Analysis Software in IS Research*

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**Parallel Session B2 Neudorfer Hall**

Chair: **Roy Gelbard**, Bar-Ilan University

**Adir Even** (Ben-Gurion University), **Yisrael Parmet** (Ben-Gurion University), **Erez Laks** (Ben-Gurion University)

*An Exploratory Study of Internet-Banking Usage*

**Jae-Hwa Lee** (KAIST), **Aviv Segev** (KAIST)

*Information Learning with Knowledge Maps*

**Arie Jacobi** (Ono Academic College), **Ofir Ben-Assuli** (Ono Academic College)

*Distortion of a Message Propagated in a Social Network*

**Igor Kanovsky** (Academic College of Emek Yezreel), **Omer Yaari** (Academic College of Emek Yezreel)

*Model of Opinion Spreading in Social Networks*

**Elad Moskovitz** (Ben-Gurion University), **Adir Even** (Ben-Gurion University)

*Exploring the Impact of a Performance Measurement System in the Israeli Police Force*

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**Parallel Session B3 Kruger Hall**

Chair: **Rica Gonen**, The Open University of Israel

**Edi Karni** (Johns Hopkins University), **Moshe Leshno** (Tel Aviv University),

**Sivan Rapaport** (Ben-Gurion University)

*A Medical Decision Support System (DSS): Theory and Application to Prenatal Diagnostic Testing*

**Dizza Beimel** (Ruppin Academic Center), **Mor Peleg** (University of Haifa)

*Implementing SitBAC as a Knowledge Framework Using OWL and SWRL*

**Daphne Raban** (University of Haifa), **Maya Mazor** (University of Haifa)  
*The Value of Information as an Experience good in the Amazon Mechanical Turk Marketplace*

**Alex Rozenberg** (University of Haifa)  
*Attention in CMC: Information-Overloaded Knowledge Workers*

**Elan Sasson** (Ben-Gurion University), **Gilad Ravid** (Ben-Gurion University),  
**Nava Pliskin** (Ben-Gurion University)  
*Harnessing Text Mining and Bibliometric Web Counts for Modeling IT Assessment: Framework and Automated Tool*

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15:20-15:40 Coffee break

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15:40-16:40 **Session C** **Neudorfer Hall**  
Chair: **Daphne Raban**, University of Haifa

**Yoram Kalman** (The Open University)  
*HCI Markers and their Usefulness in Monitoring Personal Health*

**Alon Peled** (The Hebrew University of Jerusalem)  
*Trading Federal Data*

**Ofira Shmueli** (Ben-Gurion University), **Lior Fink** (Ben-Gurion University),  
**Nava Pliskin** (Ben-Gurion University)  
*Explaining Overspecification in Software Projects: An empirical Investigation of Behavioral Effects*

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16:40-17:00 Coffee break

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17:00-18:30 **ILAIS Meeting** **Neudorfer Hall**  
Chair: **Phillip Ein-Dor**, ILAIS Chair (The Academic College of Tel-Aviv-Yaffo)

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**ILAIS 2011 Program committee**

Nitza Geri	Program Co-Chair, The Open University of Israel
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Aviv Shachak	University of Toronto, Canada
Noam Tractinsky	Ben-Gurion University of the Negev, Israel

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## IMPLEMENTING SITBAC AS A KNOWLEDGE FRAMEWORK USING OWL AND SWRL

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**Keywords:** Access control, Knowledge framework, OWL, SWRL

### INTRODUCTION

In recent years, organizations have been moving from a paper-based to a paper-less state as a result of a computerization process. More and more information is collected, stored and managed in digital form using modern technologies. Some of the data, maintained within an organization's databases, is considered to be *confidential*. For example, *patient health records*, which may hold sensitive information. In such cases, the organization is responsible for establishing a data-access policy in order to maintain confidentiality.

According to the *US Health Insurance Portability and Accountability Act (HIPAA)* (US Dept of Health and Human Services, 2003), which established the first comprehensive federal rule protecting the privacy of health information, **confidentiality** is defined as "the property that data or information is not made available or disclosed to unauthorized persons or processes". In the spirit of this definition, preserving confidentiality involves restricting access to data through authorization and access-control models. One of the leading access-control models is the *Role-Based Access Control (RBAC)* (Sandhu, Coyne, & Youman, 1996). According to RBAC, authorization to access particular data resources in the organization should be a function of the data requestor's role. One of the advantages of RBAC is its simplicity. However, the model's simplicity turns to be a disadvantage as it limits its expressive power. We have seen this limitation when we conducted a qualitative study to identify real-world scenarios of data-access requests to patients' data (Peleg, Beimel, Dori, & Denekamp, 2008). Sometimes, the role prevents medical personnel from accessing data that is required in particular scenarios.

Based on the above, we proposed a different conceptual approach, which enables to formally represent context-based scenarios of data-access within the healthcare domain. The scenarios describe which tasks a data requestor can carry out, with respect to various *contextual factors* (e.g., the location of the data requestor, the status of the patient, and the time of access). Within our model, we structure the scenarios into **Situations**, where Situation is defined as a formal, computer-interpretable representation of a data-access scenario. Thus, by structuring a Situation, we represent an organizational data-access rule. We named our access-control conceptual approach **Situation-Based Access Control**, or **SitBAC** for short (Peleg, et al., 2008). SitBAC includes abstractions for modeling the entities involved in data-access scenarios - *Patient, Data-Requestor, Task, Legal-Authorization, EHR*, and *Response* - along with their Properties and the Relations among them.

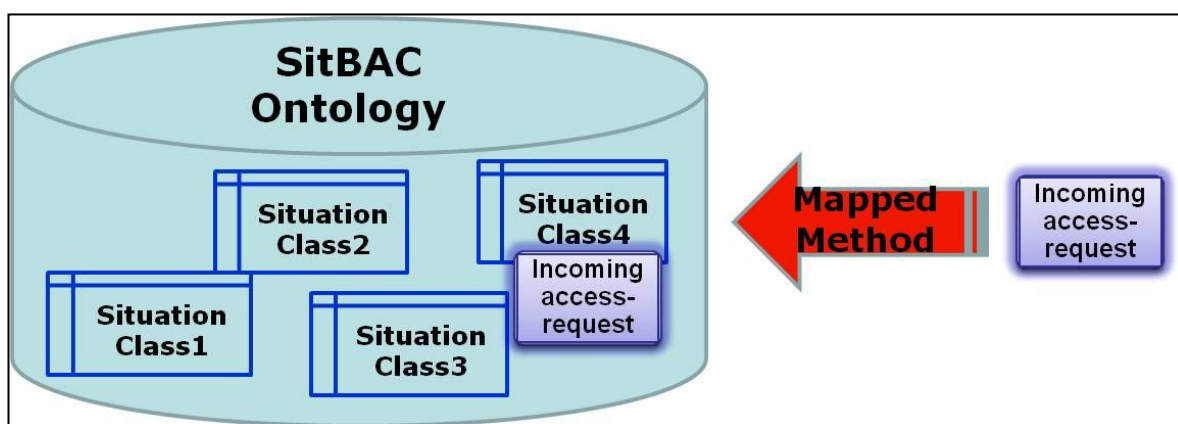
## OBJECTIVES

In this abstract, we present **SitBAC knowledge framework**, a formal access-control framework, which is based on the conceptual SitBAC model (Peleg, et al., 2008) and enables organizations to define and carry out confidentiality-preserving data-access policies. In particular, we focus on healthcare organizations and health data, stored in electronic health records (EHRs).

## METHODS

The idea behind SitBAC knowledge framework is to formally represent the organization's data-access rules as *Situation classes*, and an incoming access-request as an *Individual* (instance) of a Situation class. Within the framework, the individual is mapped into one of the Situation classes in order to infer its appropriate response, i.e., the incoming access-request is either approved or denied. Figure 1 illustrates the above idea.

For that purpose, we chose to base SitBAC knowledge framework on a shared **knowledge model**, or ontology. According to (Gruber, 1995), an ontology specifies commonly agreed, content-specific definitions for the sharing and reuse of knowledge. Ontologies define a common terminology of the *entities* (concepts) that are assumed to exist in some area of interest, their *attributes*, and the *relationships* that hold among them.



**Figure 1: The SitBAC knowledge framework approach**

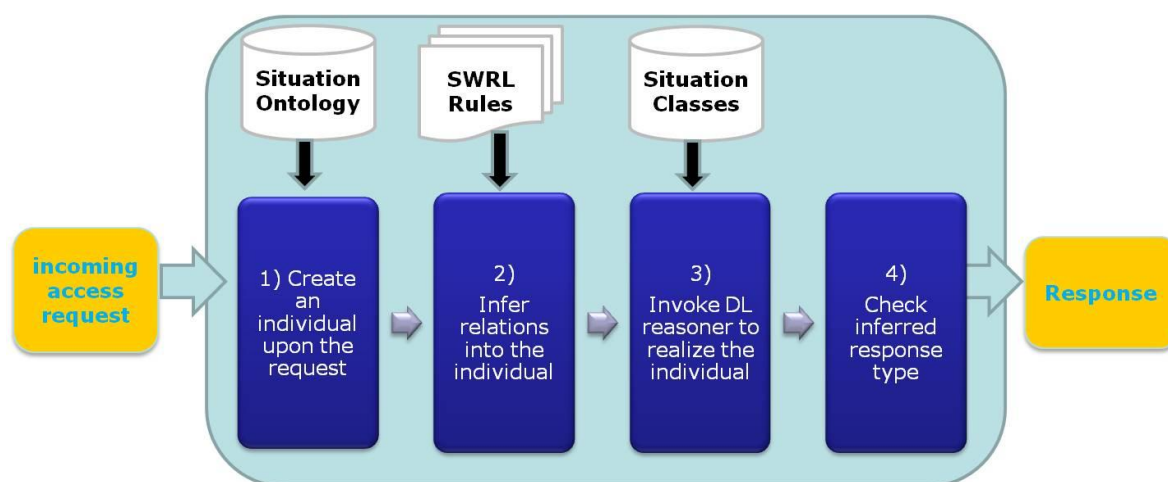
In order to specify the **SitBAC ontology**, we chose the **Web Ontology Language (OWL)** (Web Ontology Research Group, 2004) as our ontology representation language, and the *Protégé* knowledge-modeling as our specification tool. The two main reasons for choosing OWL are:

- (1) OWL is designed for sharing information over the web, thus, it can be used by a group of healthcare organizations to define and share a common data-access policy by creating a set of *data-access rule classes* (represented via Situation classes).
- (2) OWL is a **Description Logics (DL)** (Baader, Calvanese, McGuinness, Nardi, & Patel-Schneider, 2003) language, thus, we can use a description-logics reasoner that provides classification and realization services (as explained in next paragraph).

In our work, we used a DL reasoner to (1) classify the data-access rule classes (Situation classes) and (2) to realize an incoming access-request (represented via an individual of a Situation class) as a member of a data-access rule class, from which the appropriate ‘approved/denied’ response is inferred.

However, the basic data included in the individual is insufficient and additional knowledge is required in order to accomplish the realization process. To produce the missing knowledge, we used a **Semantic Web Rule Language (SWRL)** (Horrocks et al., 2004) engine that inferred the required new facts regarding the individual by chains of properties (e.g., the data requestor's department is equal to the patient's location).

Figure 2 presents the various stages an incoming access-request goes through in order to produce the correct ‘approved/denied’ response.



**Figure 2. The stages an incoming access request is going through**

On top of the above, we designed the SitBAC ontology, including the formal representations for the SitBAC abstractions and the Situation classes, to be *minimal*, *complete*, and *non-conflicting*, taking advantage of ontology exception patterns and using a DL reasoner to discover potential duplications of data-access rule classes.

## CONCLUSIONS

In this abstract, we present a context-based access-control framework that aims to support the goal of confidentiality preservation through the use of context attributes and an associated method that operates on them. Our SitBAC knowledge framework is distinct as it (1) is based on a conceptual knowledge model derived from extensive qualitative research which elicited 127 data-access scenarios from the healthcare domain; (2) captures data-access scenarios specific to the healthcare domain and represents the associated context via ontological formalism; and (3) enables the use of a DL reasoner, which is a powerful tool for real-time evaluation of incoming access-requests.

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# STAGING SYSTEM DEPLOYMENT – A REAL OPTIONS ANALYSIS

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**Keywords:** staging, real-option, deployment, CRM

## INTRODUCTION & OBJECTIVES

Deployment of enterprise systems in large organizations is one of the most challenging tasks of IT managers nowadays. Challenges include change in business processes and data, multiple organizational stakeholders with differing interests, the need to deploy while continued operations, as well as the interaction with product and customization vendors (Gosian 2004, Soh et al. 2000). Research describes enterprise system deployment as a sequence of stages, including design, implementation, stabilization, continuous improvement, and transformation (Ross and Vitale 2000). However, there is rarely a theoretical perspective that guides this life-cycle analysis of system deployment. An exception is the option-based risk management approach suggested by Debrecey et al. (2005) for ERP deployment. Sequential deployment of ERP modules allows organizations to benefit from learning by doing and to avoid the huge irretrievable costs associated with fully-committed ERP failure. However, Debrecey et al. (2005) do not provide empirical evidence to support their approach.

The current study follows this single work by studying an actual deployment of an enterprise system in a large organization through an option theory perspective. We analyze in detail the deployment (or project) phase where a formal team, including IT consultants, programmers, and key users, is responsible for getting the system up and running (Hsiao-Lan 2005). Given access to project documents as well as to the project manager, we are able to describe and quantify the risks and the staging options as planned by the organization. In addition, we suggest additional staging options and calculate their value.

The current study is thus the first to analyze the staging of system deployment, through option theory applied to actual deployment data. Therefore the study contributes to the emerging literature on real options in MIS (Benaroch 2002). It also provides advice to practitioners on staging, its relations to risks, and the quantification of its value.

## METHOD & EMPIRICAL CONTEXT

The research site is a large service provider enterprise with several million customers. It serves both businesses and private customers through a Commercial Business Unit and a Private Business Unit organized along geographical lines. The firm includes also a large engineering and communication division, an Information Technology Division and several call centers.

The current study focuses on the deployment of an enterprise-wide Customer Relationship Management (CRM) system that replaces several systems that have specific limited CRM functionalities. These include two sales management systems, each specifically developed and operated by each of the main business units, and two technical help desk management systems, again separately developed and operated for the two units. In addition, the new CRM system replaces some functionality of the billing system, a technician assignment and scheduling system, and an order management fulfillment system.

We were given access to the project planning documentation and to the project manager. We conducted about ten two-hour long interviews with that manager, mostly in order to understand the documentation, identify and prioritize risks, calculate costs and benefits of the project, and discuss planned and other staging options.

We found that the complexity of organization and system, as well as the need to convert the firm's data architecture from a billing-centered structure to a CRM-centered structure, highlighted the issue of deployment policy at the early stages of project planning. On the one hand, a single cutoff point between the old systems and the new CRM system was advocated by the business units and the CEO. Such a quick, clean cutoff would confine operational glitches to a short period of time, and remove the need to operate old and new systems in parallel. On the other hand, gradual deployment was considered by the IT division as a means of stabilizing the system before full deployment. The gradual approach covered various alternatives, including a pilot confined to a specific geographical area and to a small number of customers, staged deployment of the system first at one business unit and then at the other business units, and scaled-down deployment of most CRM-functionality excluding the sales module.

Several top management discussions about the deployment principle were held. At the same time, the IT Division and the project office studied several alternatives and assessed the extent of deployment constraints and risks. The result of this process was the decision to deploy the system gradually. The project was divided into eight main modules or sub-projects, including product and services catalogue, sales management, technical help desk management, customer preservation, and data conversion.

## RESULTS

We find that managers at the research site are well aware of deployment risks, and systematically stage the deployment of the system. However, our analysis reveals that staging at this organization is mostly related to resource constraints and less towards risk mitigation. The additional staging options that we suggest explicitly mitigate major risks, creating optional value much larger than that created by the organization's planned staging.

## CONCLUSION

The technical and organizational complexity of enterprise system deployment calls for the use of rigorous quantitative techniques in managing such projects. The current theory-driven study shows how staging options are used, and can be used further, to deal with the challenges of enterprise system deployment.

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## AN EXPLORATORY STUDY OF INTERNET-BANKING USAGE PATTERNS

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**Keywords:** Internet Banking, Business Intelligence, Information-Systems Usage.

### INTRODUCTION

The Internet has revolutionized the distribution and consumption of products and services in many different business contexts. The introduction of Internet-based service often raises the question of adoption – the extent to which customers will embrace novel offerings. Better understanding of usage and adoption can help addressing customers' needs, and direct customization of services to better meet those needs. This study explores adoption in the context of Internet-Banking (IB) services. Since the introduction of the Internet, many banking services have been transformed to use this new media. As a result of the growing demand, banks today invest vast amount in developing their IB capabilities, where a key motivation for investing in IB is cost saving – as the Internet is a relatively cheap way for delivering banking services. Further, it enables reducing branch networks and downsizing the staff.



**Figure 1. A Sample "Personal Finance Management" Screen**

Understanding the key drivers that affect IB adoption has become a key issue for the banking sector. This issue of IB development has also been a key concert for Bank Ha'Poalim - a large Israeli bank. The analysis in this study was performed with a large sample (66,555 records) of the bank's customer accounts, and their associated IB activity. The analysis examines how financial status affects IB usage, comparing three usage forms. The first two - account inquiries, and financial transactions – have been offered by the bank long before the study was conducted. The third is the "Personal Finance Management" (PFM) tool - an innovative Business-Intelligence (BI) utility, which lets customers view, dissect and analyze their own incomes and expenses (Figure 1). Offering BI utilities to a broad customer-base is not a common practice today. Among the goals of this study was to observe whether or not the bank's customer-base is willing to adopt such an innovative IB utility, when being offered together with the more traditional core IB applications. The analysis indeed highlights a major difference between the traditional IB services, versus the more novel PFM, in terms of usage.

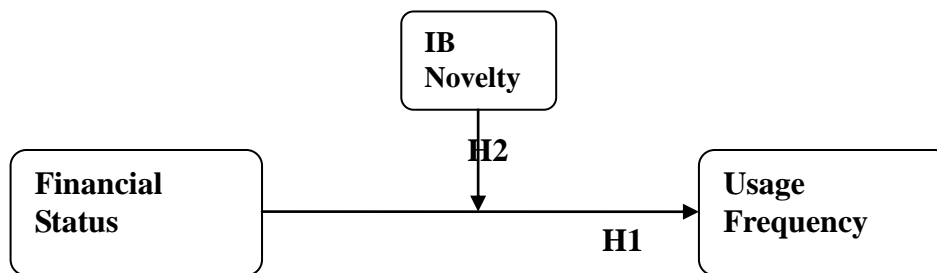
## RESEARCH SETTINGS

**Model Development:** the study was directed by the model shown in Figure 2. The dependent variable is the *Usage Frequency*, measured by the count of usage actions, within a given time-frame. The independent variable is the *Financial Status*, measured in terms of income. Financials may have major effect on the adoption and the use of IB; hence:

**H1: Financial status positively affects Usage Frequency**

IB Novelty reflects the newness and the innovativeness of a certain IB tools. The model assumes that IB Novelty will act as a moderator – i.e., it will influence the effect of the financial status on usage frequency; hence:

**H2: With lower IB novelty, the effect of Financial Status on Usage Frequency will be more significant**



**Figure 2. Research Model.**

The evaluation included three IB tools, each reflecting a different magnitude of IB novelty: (a) *Query*: an inquiry regarding account status, loans, or the value of financial assets, perceived as having a low level of IB novelty. (b) *Transaction*: a requested for a banking action, such as transferring funds between accounts, or purchasing/selling a financial asset. A transaction is perceived as having a medium level of IB novelty. (c) *Analysis*: the use of the PFM requires higher sophistication; hence, perceived as having a high level of IB novelty.

**Data Preparation:** The study was based on a random sample of 66,555 accounts that have registered to use the bank's website. 52,438 among the accounts in this subset (78%) have registered to perform transactions, and only 9,462 (14%) have registered to use the PFM utility for analysis. The datasets also contained the income per customer and the usage-frequency numbers for the three IB forms – all these numbers were aggregates, and divided into bins. A preliminary analysis of IB usage (Table 1) shows that among the 66,555 accounts, 38,973 (59%) executed at least one query. Among the 52,438 accounts registered to perform transactions, only 12,380 (23%) performed at least one, and among the 9,462 registered to use the PFM, only 5,296 (56%) have used it at least once. Usage is subject to high inequality – a small group of intensive users (~2%), were shown to be apply a large proportion of the activity.

**Table 1. Preliminary Usage Analysis**

	<i>Reg. Accounts</i>	<i>Active Accounts (Prop.)</i>	<i>Intensive Users</i>		<i>Other Users</i>	
			<i>Pop. Prop.</i>	<i>Use Prop.</i>	<i>Pop. Prop.</i>	<i>Use Prop.</i>
<b>Q.</b>	66,555	38,973 (59%)	2.1%	59.2%	97.9%	40.8%
<b>T.</b>	52,438	12,380 (23%)	1.9%	56.4%	98.1%	43.6%
<b>A.</b>	9,462	5,296 (56%)	2.0%	21.3%	98.0%	78.7%

**Analysis Method:** To assess the impact, we used two methods that combine a quantitative assessment, based on standard statistical method, together with a qualitative assessment, based on data visualization. The first method, the Delta Test (Figure 3) is base on assessing the DV numbers against the IV bins. For each bin, the bin's proportion of actual usage is compared to the bin's

proportion in the population. The ratio between these two proportions, and then the delta between each two consecutive ratios, are calculated. As can be seen in Figure 3 – the visualization of proportions and ratios can provide a qualitative assessment of the impact. With an IV that has a strong impact on the DV – we expect to see high margins between usage versus population proportions, major differences between the ratios, and relatively high deltas. As a quantitative measure for the impact, we consider average of the delta numbers among all the bins - the greater is the average delta – the stronger is the impact.

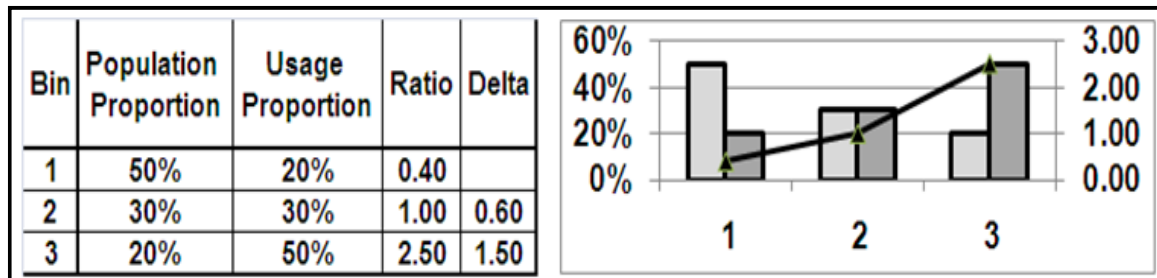


Figure 3. The Delta Test

The Trend Test (Figure 4) extends the previous method by considering the bins not only for the IV but also for the DV. This binning permits the use of the statistical Chi-Square test for dependency, which can be applied only to discrete variables. We form a grid of IV bins versus DV bins, calculate the proportion of each IV bin, within the DV bin, and compare it to the proportion of the IV in the population (Figure 4a). We then calculate the ratio between the proportion of the IV bin within the DV bin and the proportion of the IV bin within the entire population, and place the ratio number in the associated grid-cell.

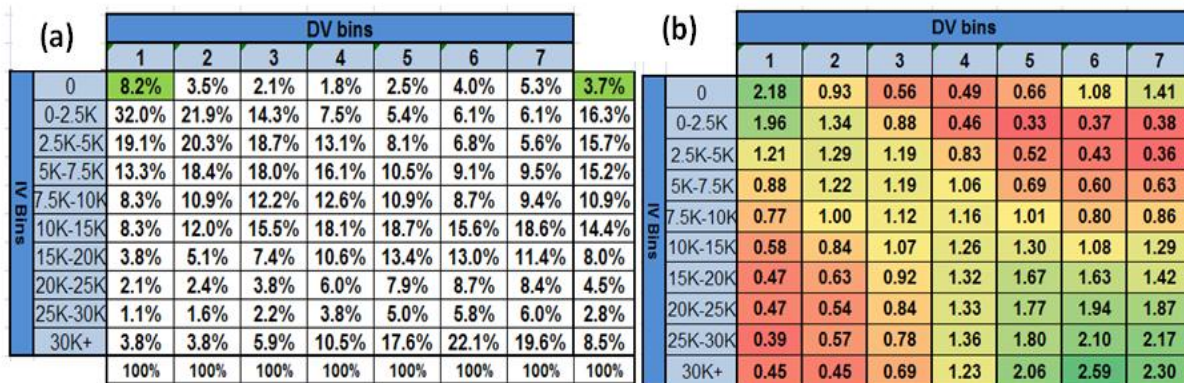


Figure 4. The Trend Test

To further emphasize the influence pattern – we turn the ratios into a color map (Figure 4b). A green cell reflects a proportion of the IV bin within the DV bin is much greater than 1, indicating strong positive impact. Similarly, a red cell indicates a strong negative impact (ratio much smaller than 1). A yellow cell reflects a ratio close to 1 - i.e., a case where the proportion of an IV bin within the DV bin is close to its proportion within the entire population.

## RESULTS

The results show a strong support for hypothesis H1, which argues for a positive effect of higher financial status on IB usage. Further, they also largely support hypothesis H2, which argues for a significant moderating effect of the level of IB novelty - the effect of financial characteristics is expected with a higher novelty. Notably, due to the large sample size, all the results were obtained with a very high statistical significance (a P-Value of 0.01 or less).

For query usage (low IB novelty), the delta test (Figure 5) shows significant and consistent increase in the ratio between usage proportion and population proportion, as the level of income grows (with the exception of the first income bin) – meaning that customer with high income tend to use the query utilities more often than low-income customers in a significant manner (an average delta per bin of 0.16). For transactions usage (medium IB novelty), the ratio still increases with income, but in less consistent and significant manner (and average delta per bin of 0.11). For analysis usage (high IB novelty), the ratio increases consistently only at low income level, but not at the higher levels (an average delta per bin of 0.1). Notably, the ratio-increase pattern is fairly similar between query usage and transaction usage – but both are fairly different from the pattern shown for analysis usage.

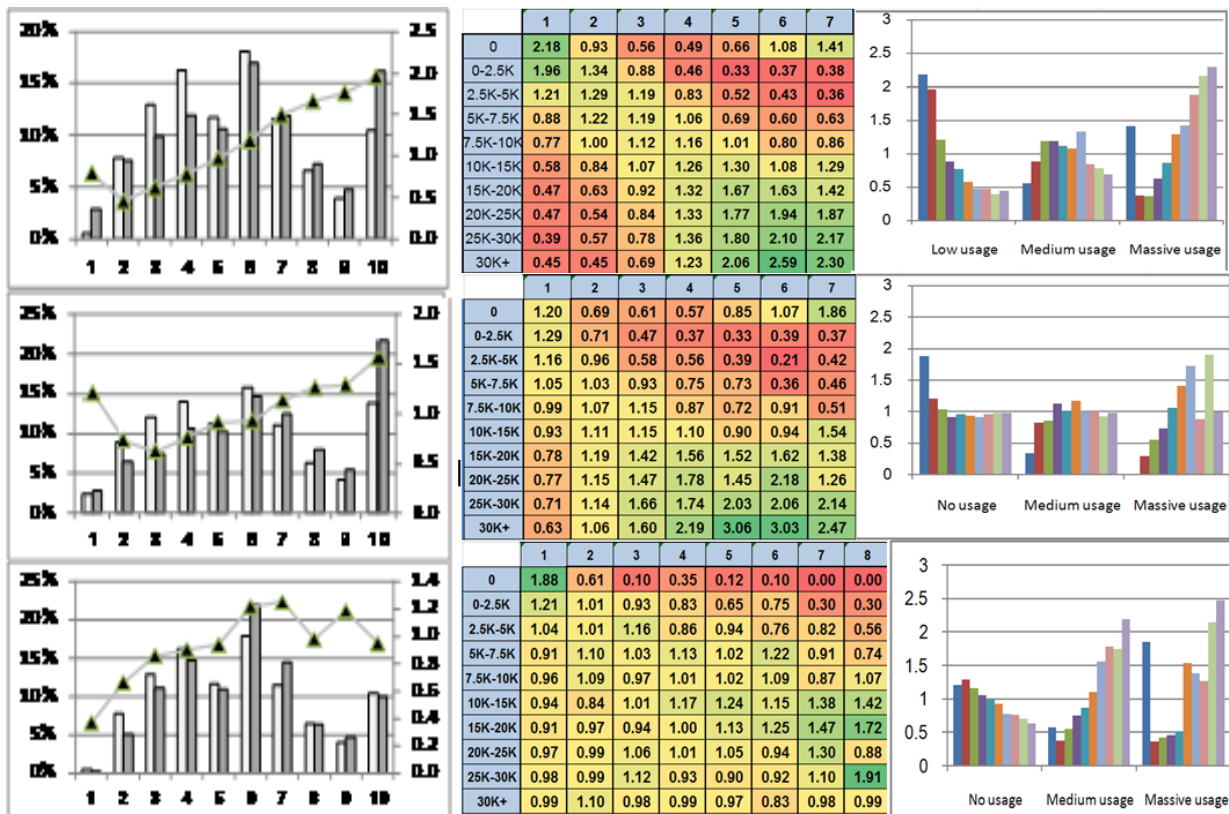


Figure 5. Usage Versus Income – Delta and Trend Tests

The trend-map for query usage (Figure 5a), shows a strong trend of "green" near the main diagonal, meaning relatively high ratios, and "red" near the top-right and the bottom-left corners (a ratio STDEV of 0.55). This implies a positive correlation between income and query usage. This pattern is further emphasized by the bin charts – a steep decrease in income for low usage (bin 1), a relatively "flat" pattern for medium usage (bin 4), and a steep increase in income for high usage (bin 7). Similarly, the trend-map generated for transactions usage (Figure 5b), also shows a strong and significant trend (a ratio STDEV of 0.61); however, the steep increase in ratio starts here earlier; at the medium usage range (bin 4 is shown).

For analysis usage (Figure 5c), however, the trend map is relatively "flat" – meaning nearly "yellow" for the most part (a ratio STDEV of 0.35 – much smaller than the two others). Only at the high-most usage bins, we see a significant increase of ratio, while in lower bins the increase is less noticeable. This results support the argument for a strong moderation effect of the IB novelty, as the effect of income of usage is much stronger with the less novel IB tools.

Some more insights were gained through a discussion with the bank's managers on the results. The high inequality in usage (i.e., the fact that a large proportion of usage is done by a relatively small group of users), and the strong effect of the financial attributes on usage patterns did not come

as a surprise – the managers were aware of the existence of a group of "power users" and have also estimated in advance that users who are financially in good shape, are more likely to use the IB services. However, the effect was not quantified previously in a manner that would let assessing its magnitude, as done in this study.

The moderation of IB novelty was surprising to an extent – particularly with the usage of the PFM tool, as the managers expected to see greater variability in its usage. While some managers were disappointed by these results, which probably point out lack of adoption, others have interpreted them as a sign for success. Those who were satisfied, have suggested that the results indicate that the PFM tool was designed correctly, such that it is equally important and useful to all customers - regardless their financial status.

## CONCLUSIONS

This research examined the trend and influence of characteristics on the use of Internet Banking (IB) services. The study shows that, generally, income has relatively strong and consistent effect on the usage. The study also highlights the level of novelty – the extent to which a certain IB utility is innovative and newly-introduced – as having a major impact. While some usage patterns have evolved around the more veteran IB utilities, no significant patterns have evolved yet around the newly-introduced PFM tool, which offers innovative BI capabilities to the bank's customers.

The study has some limitations, which ought to be further addresses and explore in future research. The study explores only a single financial characteristic, and only a limited subset of IB capabilities. Future research should look into extending the scope to examine the effect of these other factors – e.g., user demographics, level of education, etc. Further, the study evaluates usage over a period of three month, and was conducted when the PFM tool was relatively new. The usage ought to be evaluated again, in the future, over a broader time period, and after the PFM utility goes through some period of stabilization – an examination over a broader time-frame may help assessing whether or not some usage will evolved around the PFM, as it matures.

The bank's manager emphasized their "need to understand their customers better". An in-depth investigation of factors that affect IB usage may help classifying and segmenting the bank's customers, and understand their needs better. Finally, insights on usage patterns and the factors that affect them can guide the design of IB – e.g., utilities that can be customized to address specific customer needs and usage preferences. The banks managers have expressed a concern with today's "one size fits all" approach, which provides nearly all users with the same tool. Better customer segmentation, along their IB-services needs, may help designing customized and personalized versions of the PFM and possibly other IB solutions.

# EXPLORING MOBILE ACCESS TO A CORPORATE WEBSITE

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## INTRODUCTION

The evolution of mobile technology, particularly the emergence of the smart-phones, and the fact that people carry their mobile devices wherever they go, led to the use of information through handheld devices anytime and anywhere, and broadened the use of phones from phone calls to services accessed through the web. Many firms and organizations are aware of this trend, and chose to develop suitable mobile interfaces to their websites.

Some work has been done to reveal how people use the internet on mobile devices and what is the difference between the use of mobile and stationary web (Perry et al., 2001; Chae and Kim, 2003; Church and Smyth, 2008; Cui and Roto, 2008). The major purposes for using mobile internet are reading news, checking mail and information search. Although information seeking is used in both environments, there are differences in the way of usage, based on the devices used to access the web (Halvey et al., 2006a). Mobile information systems face problems originated from the uncomfortable devices (Gafni, 2008), because of their size, tiny screens and small keyboards. Hinman et al (2008) found that mobile web users access the same contents they are familiar with in the stationary web, but in a difficult and time consuming way. Nylander et al. (2009) found that sometimes users prefer the mobile web although they are near a computer.

The development of a mobile interface to an existing website involves reinvestments, additional to those performed for the stationary website. These investments are not yet proven as worthy for every kind of firm, because the technology is still new, and the consumers are in the first stages of adoption. This paper is a preliminary study for a wider research to examine whether the investments in mobile portals are worthwhile. One possibility to foresee the profitability is to check the tendency for adoption and use of these mobile portals, by users accustomed to getting the same information from the stationary site. This can be inspected according to technology acceptance theories, which examine the factors that influence the adoption of new technologies. Barnes and Huff (2003) collected the factors defined by other researchers (Rogers, Fishbein, Ajzen and others), and composed a list of factors that influence the adoption of a mobile phone browser. These factors are relative advantage, compatibility, complexity, trialability, observability, image, trust and intention.

The hypothesis is that the mobile web is accessed at different hours, days or situations, than the stationary, and although there are difficulties to use the mobile interface, customers are adopting this channel to get information; thus, there is a need to maintain both portals.

## METHOD

This research is based on the objective data collected using Google Analytics, during a period of thirteen weeks, from the website of a legal firm, which holds and updates an enormous knowledge base, enabling access to laws, verdicts and judgments' documents. The firm developed two different portals, a stationary one, developed at least fifteen years ago, and a new one for mobile devices. The clients of these sites are judges, lawyers, attorneys and law students, who subscribe annually to the knowledge base. Variables collected were number of visits, time and length of visit and number of pages visited, for both portals.

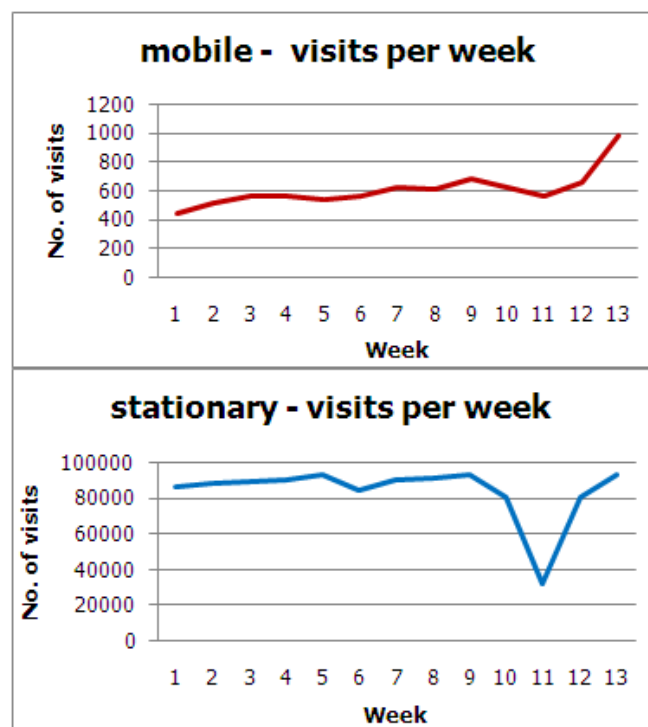
## RESULTS

According to the accumulated data, the differences between the usages of both portals and the degree of the mobile interface adoption can be identified. Table 1 summarizes usage data.

**Table 1. Differences between stationary and mobile portals' usage**

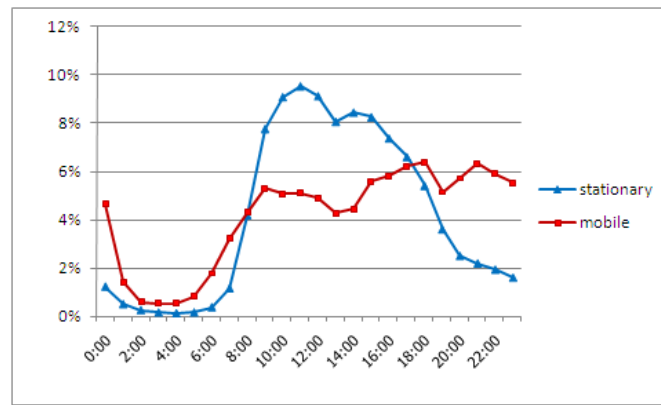
	Stationary Internet	Mobile Internet
Visits during examined period	1,200K	9,5K
Average percentage of new visits from total visits per day to site	13%	46%
Average pages retrieved per visit	7.3	4.0
Average time on site per visit	9:30 minutes	3:00 minutes

Although the number of visits to the mobile website is extremely low compared to the stationary one there is a significant growth of visits to the mobile portal, as seen in Figure 1 (week 11 was a holiday week).



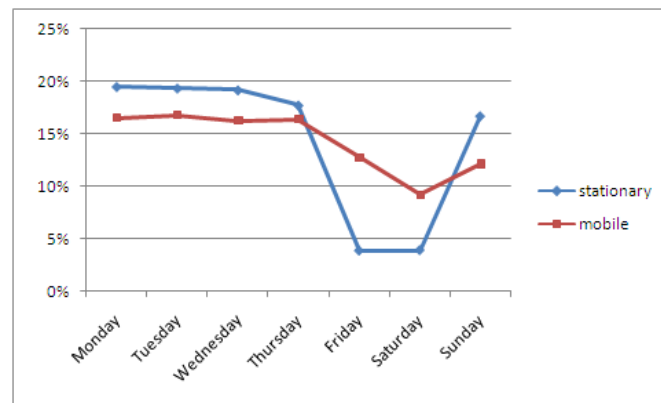
**Figure 1. Number of visits per week**

In order to check the differences in time, the percentages of use, for each type of portal, were calculated for each hour of the day and each day of the week. Most of the traffic, in both portals, as seen in Figure 2, occurs from 9:00 to 18:00 which are the regular working hours. However, the percent of mobile usage before and after work hours is greater than the stationary.



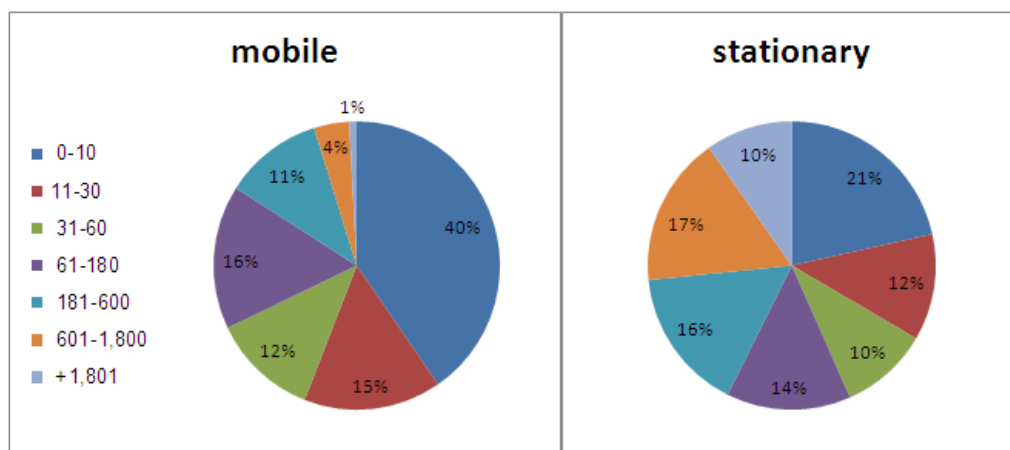
**Figure 2. Percentage of Hourly Visits**

When arranging the visits according to day in the week, as seen in Figure 3, the tendency to use the mobile portal is more uniform during the week, including weekends (Friday – Saturday) while the stationary internet is used homogenously during working days, but with little use on weekends.



**Figure 3. Percentage of Daily Visits**

The mobile portal is used for shorter sessions. The differences in durations of visits to the sites can be seen in Figure 4.



**Figure 4. Duration of visit [minutes]**

## DISCUSSION AND CONCLUSIONS

Despite the fact that both portals contain same data, the usage patterns of each are different, as shown. The results are examined according to the factors that influence the adoption of a new mobile technology:

**Relative advantage** - The mobile portal can be reached "anyplace – anytime", wherever the data is needed. This is a relative advantage for attorneys using the site while on court or in meetings out of office or after working hours (Figures 2 and 3), and complies with prior research (Karlson, 2009). Another support to this factor can be seen by the reduce effect of holidays in the amount of visits (Figure 1). Most of the traffic occurs during weekly working hours, 9:00-18:00, which is different to other researches in this area, who found traffic from 9:00 to 24:00 and weekends (Karlson, 2009; Halvey et al, 2006b; Beitzel et al, 2004). Prior works concentrated in general surfing, as email, entertainment, news, travel, etc.; while this site is focused in professional content, so naturally, it is mostly used during working hours.

**Compatibility** - The mobile portal content is compatible with the stationary one; the same data can be retrieved from both portals. The same search engine is used in both cases, with interfaces adapted to the relevant devices.

**Complexity** - The use of the mobile devices to retrieve large documents is perceived as complex, because the difficulty to read in small screens, and expensive, because of the need to download large amount of data using wireless networks. Therefore, the average pages per visit and the average time on site are significantly lower in the mobile environment (Table 1), and 40% of the visits are very short, while only 5% are over 600 minutes (Figure 4). Nevertheless, the increasing use of tablet devices (greater screens) and free Wi-Fi networks will change this factor.

**Trialability** - Each subscriber who owns a mobile device can freely try and experience the new mobile portal, and decide whether to use it. The subscription to the site facilitates both channels.

**Observability** - This factor does not influence in this case, because the data retrieved by mobile phones is not visible to others, unless the user exhibits it.

**Image** - People using their mobile phone to retrieve data, especially in public places, like in court, feel enhance prestige and image (Ong, Poong & Ng, 2008).

**Trust** – The use of the mobile portal is supported by two suppliers – the wireless network supplier and the content's supplier. Both suppliers are known to the subscribers from prior experiences and therefore trustworthy, otherwise they would have changed them.

**Intention** - The results demonstrate that although this new technology is in the first stages of adoption, the usage is continuously growing presenting the intention of customers to adopt the mobile interface, as can be seen by the percent of new visits per day (Table 1) and by the visits growth rate per week (Figure 1).

The results show that although the information offered by this site consists of large documents, commonly used by stationary internet with regular computers and displays, the adoption of mobile technology is growing. This indicates a need, especially in after work-hours and when out of office, to access the information ubiquitously. Furthermore, sites for other kind of information, which present smaller pieces of data, may be more attractive to mobile devices users' during these hours. The development of the mobile portal will be inevitable to gain competitive advantages and the adoption of mobile sites will grow over time, but will not abolish the need for stationary websites. This research is part of a larger research which examines different aspects of the use of mobile devices for browsing websites of firms, intending to find whether there are benefits in developing special interfaces for users of mobile devices. Further research will increase the amount of data collected, finding other viewpoints and comparing to other firms.

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# REDUCING FREE EXPOSURE IN SPONSORED SEARCH AUCTIONS<sup>1</sup>

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**Keywords:** information economy, attention economy, search engines, sponsored search, pricing of digital goods.

## INTRODUCTION

Sponsored search auctions are the primary vehicle for companies like Google and Microsoft to monetize their search engines, with Google's 2010 search revenues topping \$29.3 billion, with \$8.5 billion net income. Nevertheless, the currently used sponsored search auction Generalized Second Price scheme (GSP) does not charge advertisers for exposures. While this approach was well justified for a new unproven form of advertising, GSP still prevails in today's mature online advertising environment. In particular, GSP's predilection for free exposures has led impression-seeking advertisers (e.g. participants seeking brand awareness) to game the current scheme for free advertising.

Search auctions adhere to a relatively simple framework. Each advertiser specifies the keyword(s) s/he wishes to advertise on and submits a bid. Ideally, the advertiser's bid represents the maximum amount s/he is willing to pay for a click by a user who queried on the keyword. When a user enters a query, the system collects all of the advertisers bidding for the keyword and runs a GSP auction to determine both the winners and the prices that each would be charged. There are usually multiple winners, as there are multiple advertiser slots on the search results page, with higher slots valued more since they are seen by more users. Finally, the advertiser is charged only in the event of a user click on an ad, otherwise no money changes hands.

As search users overwhelmingly click on the first results that appear on a search results page gaming of the system for free-impressions is made possible by bidding low to receive placement in lower positions on the search result page.

It may seem that since the free advertising slots are not clicked on and hardly observed they have no true value to advertisers. However, a range of research has sufficiently established the value of these free impressions to advertisers (e.g., Ghose & Yang, 2009). From the end users' and search engine's point of view, though the low position ads created by impression-seeking advertisers are hardly ever clicked on they compose a block of content that is undesired, and can potentially be replaced by useful content.

In this work we present a solution that extends the GSP pricing scheme to charge for clicks as well as exposures. The solution leverages some of the advertisers' gain from clicks under GSP to charge for their expected exposures. This technique allows advertisers to participate without an expected loss, i.e. advertisers are individually rational. As Varian (2007) justified continued use of GSP by proving that it exhibits a Symmetric Nash Equilibrium (SNE), our analysis proves that a sponsored search auction implementing our new scheme exhibits a SNE.

## THE MODEL

We suggest a new extended Generalized Second Price auction for sponsored search auction with no free exposures that conducts a Symmetric Nash Equilibrium.

In our model, there are  $n$  advertisers, who bid for  $K$  slots on a specific keyword. For every advertiser the search engine observes the click-through rate of the advertiser when s/he is placed in slot  $j$ . We assume that the click-through-rate is non-increasing in  $j$  and is between 0 and 1.

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<sup>1</sup> Confidentially submitted for publication in ILAIS 2011 on June 29th 2011.

We also assume that every advertiser knows her true value for a click but the search engine does not know this information. An advertiser is charged a price-per-click that is bounded by his bid when his ad is clicked on, in slot  $j$ . The price charged is determined by the search engine's auction. We assume the advertisers to be risk-neutral and therefore if an advertiser is placed at position  $j$ , s/he obtains an expected utility per impression of the difference between her/his true value per-click and the price-per-click charged for slot  $j$  multiply by the click-through-rate of the advertiser in slot  $j$ .

### **Generalized Second Price Auction (GSP)**

For every user's web search, the search engine conducts an auction. At the first stage of the auction, the search engine picks the subset of advertisements to be displayed and matches them to slots based on the submitted bids. The matching criterion is the product of the advertiser's bid and the search engine's estimated click-through rate (or relevance) of her/his ad and is referred to as the matching score. The advertisers are ranked in the decreasing order of the matching score and the first  $K$  are allocated the  $K$  slots of advertisements. If an ad in slot  $j$  was clicked, the auction computes the price charged per click to the advertiser in slot  $j$  as the matching score of the advertiser in slot  $j+1$  divided by the click-through-rate of the advertiser in slot  $j$ .

### **Extended Generalized Second Price Auction with No Free Exposures**

Our extended GSP auction runs in an identical manner to the one presented above for the GSP auction with one difference. In the extended GSP auction, the price charged to advertisers has two components; one is the GSP computed price per click and the other is the new component, which charges the advertisers if an impression occurred and not a click. The impression price is computed from the expected gain from clicks (which is the difference between the sum of the values for clicks received and the price paid for them) and the expected exposures.

If an advertiser has value only for getting a click, it might be the case that the advertiser pays more than his value for the exposures and thus it may not be rational for the advertiser to participate in the auction. Nevertheless, the extended GSP scheme presented above maintains individual rationality by charging the advertiser less (or no more) money for his expected exposures than the utility s/he gains from the expected clicks. Indeed the logic behind the new scheme is that the search engine can tap into some of the advertiser's utility or gain from clicks and spread this gain amount among his expected exposures as a charge for (the currently) free exposures. To see that the new scheme maintains individual rationality we need to show that advertisers with zero value for exposures do not lose by participating in the auction. The fact that advertisers with value for exposures are individually rational immediately follows from the individual rationality of the advertisers with zero value for exposures.

**Claim.** Sponsored search auction that implements the extended GSP with no free exposures pricing scheme is individually rational

Though showing the individual rationality of our new auction is essential, one would also like to show that implementing the extended GSP scheme results in an equilibrium where no advertiser prefers the position of another. Such an equilibrium was shown for the GSP scheme by Varian (2007) and Edelman et al. (2007). To prove that the extended GSP pricing scheme satisfies SNE, we need to show that no advertiser can gain a greater utility by moving up or down in the slots from his original allocated position.

**Theorem 1.** The set of prices of the extended GSP with no free expositions satisfies SNE.

## **CONCLUSIONS**

Our extended GSP pricing scheme can potentially benefit search engines as it increases the revenue from impression-seeking advertisers (who currently receive free exposures) and also increases revenue from click-seeking advertisers (who are not currently charged for impressions). Our pricing scheme presents a potential revenue gain as it opens a new revenue stream from impression seekers, who would be fairly charged for impressions, and does not reduce click-seekers' valuation or payment for clicks, but only reduces their gain from clicks by the price they pay for impressions. An interesting question for future study is the affect of the extended GSP pricing scheme on the demand for search advertising as a whole. On the one hand, it is possible that the model may cause

a general increase in advertising rates as click-seeking advertisers will pay for impressions as well as clicks but on the other hand impression-seeking advertisers may withdraw from the search advertising market and reduce competition.

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# SUGGESTING A PRACTICAL AGENDA FOR GREEN IS – RECENT SOLUTIONS WITHIN A FRAMEWORK OF EFFICIENCY, INFORMATION, AND EFFECTIVENESS

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**Keywords:** Green IT, Green IS, Research Agenda

## INTRODUCTION

Awareness of environmental sustainability and ecological issues is growing, and different industry sectors are seeking ways to address them effectively. The Information Systems (IS) community is in a position to make a significant contribution to environmental efforts, not only by mitigating its own impact, but also by guiding the activities of other communities. To support environmental efforts, or to become more “Green”, several Green fields and research streams have emerged. Previous Green IT research focused on mitigating and reducing the impact of IT production and manufacturing, whereas Green IS research has the ability to re-design modern activities to support environmental efforts. This abstract reviews the state-of-the-art of Green IS research, and lists categories of IS solutions for environmental issues. A major contribution of this abstract is a suggested research agenda for Green IS.

### Definitions of Green IT and Green IS

The definitions of IT and IS vary, however it commonly accepted that IT includes hardware, software, data and telecommunication, whereas IS includes, in addition to these components, people and processes (Bernus & Schmidt, 2006). Green IT and Green IS build on these definitions, when Green IT focuses on mitigating the negative environmental impact created by production, usage, and disposal of IT components (i.e., software, hardware, and data/telecommunication).

In contrast, Green IS includes the impact of people and processes. It therefore has a greater potential to influence Green themes. The field does not only aim to mitigate the negative effects of IT operations, but seeks to create positive influences on the environment among non IS or IT communities (Boudreau, Chen, & Huber, 2008). Green IS focuses on “the design and implementation of information systems that contribute to sustainability of business processes” tackling a much larger problem, and seeking to add value, rather than only mitigate harm. In other words, while Green IT focuses on becoming more “eco-efficient”, that is, to reduce the negative environmental effects of IT operations, Green IS aims for “eco-effectiveness”: to create and support opportunities for mitigating negative environmental effects of other operations, with the use of IS (Watson, Boudreau, Chen, & Sepúlveda, 2010).

### Green IT research

Green IT research provides insight into its antecedents and outcomes. Antecedents were studies in the form of motives driving Green IT initiatives. Three groups of motives have been identified:

- (1) Economic and competitive - including cutting costs (Sayeed & Gill, 2008) and addressing consumer demand (Elliot & Binney, 2008)
- (2) Legal (Elliot, 2007) - including government reporting and regulation (Elliot & Binney, 2008)
- (3) Social responsibility (Kuo & Dick, 2010) - including ethical drivers (Molla, 2008)

Different cultures emphasize different drivers: while US organizations are driven by economic considerations, ethical considerations are the primary drivers of organizations in Australia and New Zealand (Molla, Pittayachawan, & Corbitt, 2009).

Consequences of Green IT have been studied aiming to measure the impact of Green IT on economic aspects of organizational systems (Velte, Velte, & Elsenpeter, 2008), e-business (Yi & Thomas, 2006) and across the supply chain (Rao & Holt, 2005). There is a debate as per the negative and positive impact of Green IT initiatives on the environment (Köhler & Erdmann, 2004) (Berkhout & Hertin, 2004), and on organizational outcomes (Fuchs, 2008).

The drivers and the consequences of Green IT need to be taken into account when Green IS initiatives are designed, as they are likely to apply to these initiatives as well.

## **GREEN IS RESEARCH**

Recent IS research has been concerned with identifying further questions to be studied in order to define the IS environmental agenda (Melville, 2010). In addition, Green IS research seeks to provide practical suggestions for supporting environmental sustainability. We categorize these practical suggestions according to the framework of Chen et al. (2008), into three categories:

- (1) Eco-efficiency efforts, which involve automation of existing functions
- (2) Eco-equity efforts, directed at information flow
- (3) Eco-effectiveness efforts, which transform organizations and societies.

Major practical suggestions are elaborated further in the abstract. All suggestions are summarized in Table 1.

### **Eco-efficiency**

Automation of existing functions using IT has been suggested as a way IS can support environmental efforts. This includes using ICT to replace paper, and virtualization of meetings and collaborative technologies.

#### **Really Going Paperless**

Despite the decades-old promise of the paperless office, ICT has greatly increased our use of paper in many areas (Sellen & Harper, 2002). Despite the popularity of e-business, online surveys, document readers, tracking facilities in word processors, e-books, online news, digital archiving, photo display devices and so on, research is still needed into increasing utility, usability and user acceptance of e-tools.

#### **ICT-enabled conferencing and collaborating**

Human interactions are necessary for the effective performance of human enterprises. Traditionally, face-to-face interactions have been preferred, requiring people physically arrive at work venues. Despite research showing the benefits and effectiveness of ICT solutions (see for example Hasan, 2005; Hasan & Crawford, 2007), the uptake of these ICT solutions is not sufficiently widespread. To encourage greater use of ICT tools, further research is needed to improve aspects like usability, effectiveness, and acceptance.

**Table 1 Three aspects of Green IS**

Aspect	Proposed Action	Proposed Research
<b>Eco-Efficiency:</b> <ul style="list-style-type: none"> <li>Using IT to automate existing functions</li> </ul>	<ul style="list-style-type: none"> <li>Going paperless (Hasan, Ghose, &amp; Spedding, 2009)</li> </ul>	<ul style="list-style-type: none"> <li>Increasing utility, usability and user acceptance of e-tools</li> </ul>
	<ul style="list-style-type: none"> <li>Virtualization of meetings and collaborative technologies (Dwyer &amp; Hasan, 2010; Hasan et al., 2009)</li> </ul>	<ul style="list-style-type: none"> <li>Further understanding the relationship between social issues and technology.</li> </ul>
<b>Eco-Information:</b> <ul style="list-style-type: none"> <li>Providing information to consumers and businesses about the ecological impact of various activities</li> <li>Disseminating information as a mobilizing force to influence decisions and policy makers</li> </ul>	<ul style="list-style-type: none"> <li>Network-centric advocacy (Hasan et al., 2009)</li> </ul>	<ul style="list-style-type: none"> <li>The process of transitioning into network centrality</li> <li>The social effects of network centrality</li> </ul>
	<ul style="list-style-type: none"> <li>Providing information for consumers and companies on environmental impact (Hasan et al., 2009; Watson, Boudreau, &amp; Chen, 2010)</li> </ul>	<ul style="list-style-type: none"> <li>Identifying effective information</li> <li>Identifying effective methods of information provision</li> </ul>
	<ul style="list-style-type: none"> <li>Guidelines for ICT procurement/purchasing (Dwyer &amp; Hasan, 2010)</li> </ul>	<ul style="list-style-type: none"> <li>Measuring environmental impact of ICT equipment and usage</li> </ul>
<b>Eco-Effectiveness:</b> <ul style="list-style-type: none"> <li>Creating positive impact by radically changing current, unsustainable behaviors</li> </ul>	<ul style="list-style-type: none"> <li>4U framework for IS design (Watson, Boudreau, Chen, &amp; Sepúlveda, 2010)</li> </ul>	<ul style="list-style-type: none"> <li>Applying the 4U principles to non-transportation fields</li> </ul>
	<ul style="list-style-type: none"> <li>Simulation modeling for sustainable enterprises (Hasan et al., 2009)</li> </ul>	<ul style="list-style-type: none"> <li>Development of simulation models to reduce pollution while supporting business financials</li> </ul>
	<ul style="list-style-type: none"> <li>Optimizations (Ghose &amp; Koliadis, 2007; Harvey, Chang, &amp; Ghose, 2006; Hasan et al., 2009)</li> </ul>	<ul style="list-style-type: none"> <li>Developing optimization tools to reduce pollution while supporting business financials</li> </ul>
	<ul style="list-style-type: none"> <li>Enhancement of holistic business processes (Dwyer &amp; Hasan, 2010)</li> </ul>	<ul style="list-style-type: none"> <li>Cultivating holistic views among business and IS graduates</li> </ul>

### **Eco-Information**

Eco-information is two-fold: on one hand, providing information to consumers and businesses about the ecological impact of various activities. On the other hand, eco-information efforts disseminate information as a mobilizing force to influence decisions and policy makers.

Informing individuals, groups, and organizations

Relatively simple IS tools (i.e., check lists, fact sheets, carbon calculators, and product labeling) (Watson, Boudreau, & Chen, 2010) can support individuals motivated to contribute to environmental sustainability. These tools are also good informants for organizations, groups, and governments driven by ethical considerations (Elliot, 2011). This is a low-cost way (albeit trivial) to empower individuals to be greener not only at home but also in small businesses and work units.

Research into what effective information is needed, as well as what methods of information provision are effective is required.

#### Network-Centric Advocacy and Government Policy

Supported by Web 2.0, the balance of power with respect to knowledge is now shifting from the 'official versions' in the hands of governments, big business, media moguls, formal libraries and publishing houses. Now, if anyone wants to 'know' they are more likely to go to Google or Wikipedia. This has democratized knowledge and provided a form of network-centric advocacy which is changing the political landscape. This phenomenon can be used to support the environmental movement, by leading changes in social norms with respect to environmental issues. The "marketing" of these issues using social media has shown effective in areas such as public health for almost a decade (Donovan & Henley, 2003), and can thus be harnessed for environmental issues. Transitioning into network centrality, and the effects of it are themes that need further research.

#### Eco-effectiveness

Going beyond reducing the negative impact of current activities on the environment, achieved by eco-efficiency, is the creation of positive impact by radically changing current, unsustainable behaviors. These radical changes are grouped as eco-effectiveness efforts to support the environment (Elliot, 2011). They include the 4U framework for IS design, optimization, the enhancement of holistic business processes, and systems for optimizing IT quality.

#### The 4U framework for IS design

Information systems developed based on four principles: ubiquity, uniqueness, universality, and unison, have been shown more effective for environmental efforts in transportation systems (Watson, Boudreau, Chen et al., 2010). Further research is required to the application of these principles to other arenas.

#### Computer-based simulation models

Building on the economic drivers of companies adopting green issues, companies with large carbon-footprint can be encouraged to support the environment through the use of computer-based simulations. These simulation models can demonstrate that environmental issues, such as reducing waste from the production stream, are closely associated with the production and economic aspects of the product, such as reducing costs. Simulation tools effectively demonstrate how environmental sustainability saves costs in the long run (see for example Hsien, Spedding, Bainbridge, & Taplin, 2006; Taplin, Spedding, & Khoo, 2006).

#### Optimization Information Systems

Optimizations of design and operational efficiencies have been shown to apply to climate change solutions (Ghose & Koliadis, 2007; Harvey et al., 2006). These optimizations utilize techniques which have significantly improved warehousing and manufacturing layouts, production and logistics schedules, and also highway networks and urban layouts.

Catering for limited organizational budget, Supply Chain Optimization Audit (SCOA) methodology under development (Hasan et al., 2009) helps organization identify optimal opportunities for carbon footprint reduction, which offer the best 'green return' on effort.

## CONCLUSION

This abstract examines Green IS research to date. It provides a definition of Green IS, which is distinguishable from Green IT, and highlights the extensive role IS can play in supporting environmental efforts. After reviewing current Green IT and Green IS literature, the abstract categorized Green IS efforts into three main categories: eco-efficiency, eco-information, and eco-effectiveness (Chen et al., 2008). Within this framework, the abstract categorizes practical suggestions recently proposed in Green IS literature, and respective research agenda. The breadth of these suggestions suggests that IS researchers and practitioners can play an important role in environmental efforts, by applying their expertise to a wide range of disciplines.

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# DISTORTION OF A MESSAGE PROPAGATED IN A SOCIAL NETWORK

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## INTRODUCTION

As a result of the Web 2.0 information revolution, vast numbers of organizations and individuals communicate by sending messages over social networks or in organizational communication networks. These messages, however, are subject to change as they propagate through the network. This paper calculates the distortion of a verbal message as it propagates in a social network, and compares a global measurement of the distortion in random, scale free and small world networks. We test a mathematical model that we created using a simulation of different types of networks and show that scale-free networks are the least sensitive to distortion of information compared to random or small world networks.

## LITERATURE SURVEY

Propagation in networks has been studied frequently in the social network community since Rapaport's pioneering study of influence of network characteristics such as transitivity of node linking on disease propagation (Rapaport, 1953a; Rapaport, 1953b). Propagation or diffusion refers to the transport on a network from node to node of some quantity, such as information, opinion or epidemics. The spread of socially-transmitted diseases is a canonical example (see Newman (2002) for a modeling approach from the theoretical physics perspective and Eames and Keeling (2002) for an up-to-date approach in bio-mathematics, together with references on their study of the propagation of AIDS).

There are many ways to assess a social network as an instrument for information exchange between individuals, groups or organizations. Haythornthwaite (1996) presented a "social network analysis", an approach and set of techniques to study the exchange of resources (information) among actors.

There are few works on the perceived quality of information sent by subjects through social networks. O'Reilly (1978) conducted several laboratory and field studies investigating antecedents to and consequences of the intentional distortion of information by senders in organizational communication networks. Laboratory studies were used to examine the impact of two interpersonal variables (trust in the receiver and perceived influence of the receiver over the sender) and directionality of information flow (upward, lateral, and downward) on senders' propensities to block or suppress information. Field studies were used to establish the external validity of the laboratory investigations and to relate information distortion by senders to job satisfaction and performance.

The results of these studies demonstrate that

- (1) A bias exists towards screening certain types of information from upward transmission;
- (2) Low trust in the receiver of a message results in significantly more suppression of information by senders, especially information which reflects unfavorably on the senders; and
- (3) A measure of information distortion is significantly and inversely associated with job satisfaction and individual and group performance.

These findings differ in several respects from previous studies on organizational communication. Their implications for decision-making are discussed and O'Reilly suggested a model relating antecedents and consequences to information distortion.

More recently, Ma et al. (2010) argued that when a piece of information spreads on a complex network, error or distortion can occur. Information explosion can occur where the number of distinct pieces of information on the network increases continuously with time, leading to high error probability. These authors constructed a physical model to address this phenomenon. They describe the transition to information explosion as the error probability increases through a critical value, and put forward a control strategy to maximize the robustness of the network against information explosion, which they then validate by both numerical computation and a mean-field based analysis.

## RESEARCH OBJECTIVES

We calculate the distortion of a verbal message as it propagates in a social network. Additionally, we compare the results of a global measurement of the distortion in random, scale free and small world networks, after propagation of the message in the network, to examine the robustness of each type of network against distortion of information.

## METHODOLOGY

In this paper we present a study of the robustness of a social network against distortion of information in the form of a verbal message. A message has the tendency to change when one person transfer it verbally to another person. Our assumption is that this change in the transferred message, or its distortion as we call it here, is usually reflected in different parts of the message, but some of the information remains unaltered in the original message. We compare a global measurement of the distortion of the propagated messages in random, scale free and small world networks using a simulation.

The simulation involved a model of the network and a model of the distortion process propagating on the network<sup>2</sup>.

A message  $m$  can represent a sequence of letters, words, or parts of sentences, and it represents a verbal message that a person sends to other individuals over a social network.

Initially, the message  $m$  is transmitted verbally by  $l$  different people in a given network  $N$ . These people forward  $m$  to some or to all of the people they know. At every transmission of  $m$  from a given person  $P_i$  to person  $P_j$  in network  $N$ ,  $m$  may mutate (be distorted) into  $\hat{m}$ , such that some of the letters in  $m$  (chosen randomly) will change value. The number of letters that change can differ from person to person in the network. The mutated message  $\hat{m}$  can continue mutating each time a person  $P$  receives a new message  $\hat{m}$  from another person in the network.

Two types of errors are measured: **relative error** and **absolute error**. The relative error  $E^i$ , for a person  $P^i$ , represents the number of mutations from the original message  $m_1^P$  that person  $P^i$  initially received. The absolute error  $EA^i$ , for a person  $P^i$ , represents the number of mutations from the original message  $m$  that was first propagated.

After the propagation of  $m$  in network  $N$  that contains  $n$  people, we can then calculate the average global relative distortion value  $N_R^D$  for  $N$  as

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<sup>2</sup> See our proposed mathematical details of the model in appendix I.

$$(1) \quad N_R^D = \sum_{j=1}^n E^j / n,$$

and calculate the average global absolute distortion value  $N_A^D$  for  $N$  as

$$(2) \quad N_A^D = \sum_{j=1}^n EA^j / n.$$

### RESEARCH HYPOTHESES

H1: Scale free networks are less sensitive to data distortion than Random networks.

The resulting two sub-hypotheses:

H1.1: The relative error will be lower in Scale free networks than in Random networks.

H1.2: The absolute error will be lower in Scale free networks than in Random networks.

H2: Scale free networks are less sensitive to data distortion than Small world networks.

The resulting two sub-hypotheses:

H2.1: The relative error will be lower in Scale free networks than in Small world networks.

H2.2: The absolute error will be lower in Scale free networks than in Small world networks.

Scale-free networks are less sensitive to data distortion than small worlds, or random networks.

The scale-free networks are characterized by a power law distribution of the number of links connecting to a node, and therefore, the existence of hubs. Our hypotheses are based on the scale free network structure, such that hubs and high degree nodes receive a message at an early stage of the propagation, and they deliver it to many people in the network (Rapaport, 1953a; Rapaport, 1953b; Barabási and Albert, 1999; Albert and Barabási, 2002). Therefore, the message path through a scale free network is shorter than the other types of networks, and as a result fewer message distortions occur in the propagation process.

### PRELIMINARY FINDINGS

At first, we present basic factual data after running the simulation on networks with 10,000 nodes, that were produced by the network analysis package NWB developed by Barabási's team at Indiana University (NWB Team, 2006), and self written software.

**Data Breakdown**

Tables 1-3 below show the descriptive statistics for each type of network with all research variables<sup>3</sup>.

	Degree	Mutations	Hub	Rel_Err	Abs_Err
Mean	4.00	.45	.00	.20	3.64
Median	3.00	.00	.00	.00	4.00
Mode	2	0	0	0	0
Std. Dev	6.031	.662	.010	.745	2.846
Range	1-225	0-2	0-1	0-7	0-10

	Degree	Mutations	Rel_Err	Abs_Err
Mean	9.98	.60	.26	4.22
Median	10.00	.00	.00	5.00
Mode	10	0	0	5
Std. Dev	3.120	.686	.865	2.22
Range	1-24	0-2	0-7	0-10

	Degree	Mutations	Rel_Err	Abs_Err
Mean	30.0	.64	.21	4.35
Median	30.0	1.00	.00	5.0
Mode	30	0	0	5
Std. Dev	1.699	.687	.747	2.16
Range	23-37	0-2	0-8	0-9

**Statistical Analysis Scale Free Network vs. Random Network**

Statistical analyses were performed using SPSS software. To test for differences in continuous variables between the two groups a t-test for independent samples (in Tables 4 and 5 below).

N	Relative Error (H1.1)				Absolute Error (H1.2)			
	Random Network (stdev)	Scale Free (stdev)	T-Test-value (df)	p-value	Random Network (stdev)	Scale Free (stdev)	T-Test-value (df)	p-value
10,000	0.26 (0.875)	0.2 (0.745)	5.529 (19568)	<0.001	4.22 (2.22)	3.64 (2.85)	15.866 (18879)	<0.001

<sup>3</sup> See the explanation of our research variables (Independent and dependent) in appendix II.

N	Relative Error (H2.1)				Absolute Error (H2.2)			
	Small World (stdev)	Scale Free (stdev)	T-Test-value (df)	p-value	Small World (stdev)	Scale Free (stdev)	T-Test-value (df)	p-value
10,000	0.21 (0.747)	0.2 (0.745)	0.967 (19998)	0.334	4.35 (2.163)	3.64 (2.85)	19.853 (18659.8)	<0.001

### Summary of the Results

We ran the simulation twice to increase the robustness of our results and obtained very similar results. The generality of our conclusions and their applicability to other sizes of social networks must be considered with the appropriate degree of caution.

In general, we found differences between the means of the three networks regarding both types of errors:

- The relative error is lower in scale free networks than in random networks (H1.1 accepted).
- The absolute error is lower in scale free networks than in random networks (H1.2 accepted).

The relative error is lower in scale free networks than in small world networks. However, the significance depends on the number of nodes in the networks. In the larger networks the difference was significant (h2.1 partially accepted, further research will be done).

The absolute error is lower in scale free networks than in small world networks (H2.2 accepted).

### PROBABLE CONCLUSION

Scale-free networks are less sensitive to data distortion because of the existence of hubs in scale-free. The hubs and the high degree nodes receive a message at an early stage of the propagation, and they deliver it to many people in the network. Therefore, the message path through the network is shorter than the other types of networks, and as a result fewer message distortions occur in the propagation process.

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## APPENDIX I: THE PROPOSED MODEL

Given:

A network  $N$  with  $n$  nodes

A message  $m$  can represent a sequence of letters, words, or parts of sentences. Without loss of generality in this model we chose to define  $m$  as is a sequence of letters  $\sigma_i \in \Sigma, i = 1, \dots, k$ , where  $\Sigma \in \{0,1\}$  is an alphabet. We define the length  $k = |m|$  of  $m$  to be number of letters in  $m$ . We can

refer to  $m$  as a Boolean vector  $\mathbf{v} = [\mathbf{v}_0, \dots, \mathbf{v}_k]^T$  of degree  $k$ , where  $\mathbf{v}_i \in \{0,1\}$ .

The message  $m$  represents a verbal message that a person sends to other individuals over a social network. Therefore, each letter  $\sigma_i$  represents a letter in a natural language message.

Initially, the message  $m$  is transmitted verbally by  $l$  different people in network  $N$ . These people forward  $m$  to some or to all of the people they know (adjacent nodes in the graph that represent  $N$ ).

At every transmission of  $m$  from a given person  $P_i$  to person  $P_j$  in network  $N$ ,  $m$  may mutate (be distorted) into  $\hat{m}$ , such that some of the letters in  $m$  (chosen randomly) will change value. The number of letters that change can differ from person to person in the network. The mutated message  $\hat{m}$  can continue mutating each time a person  $P$  receives a new message  $\hat{m}$  from another person in the network.

In order to create a mutated message  $\hat{m}$ , we need to consider all the following  $r$  messages received by person  $P$ .

$$(3) \quad (m_1^P, \dots, m_r^P),$$

For every mutated letter  $\sigma_i \in \hat{m}, i = 1, \dots, k$ ,  $\sigma_i$  is chosen to be the letter that has the maximum number of occurrences among all letters (the mode) at location  $i$  in  $(m_1^P, \dots, m_r^P)$ . In the case where we have an equal number of different letters the original letter in  $m_1^P$  is chosen.

Let

$$c^1 = \text{number of "1"s in all letters } \sigma_i \in (m_1^P, \dots, m_r^P),$$

And let

$$c^0 = \text{number of "0"s in all letters } \sigma_i \in (m_1^P, \dots, m_r^P).$$

We calculate

$$(4) \quad \sigma_i = \begin{cases} 1, & \text{if } c^1 > c^0 \\ 0, & \text{if } c^1 < c^0 \\ \sigma_i \in m_1^P & \text{if } c^1 = c^0 \end{cases}$$

For example, if we have the following four consecutive messages, the final mutated message will be:

Message $m_1^P$	0 1 0 1 0 1 1
Message $m_2^P$	0 0 0 1 1 0 1
Message $m_3^P$	0 1 1 0 0 1 1
Message $m_4^P$	0 1 0 0 1 1 1
Final mutated message $\hat{m}^P$	0 1 0 1 0 1 1
<b>Figure 1. Example for a Mutated Message</b>	

Since a person  $P$  can forward the message  $\hat{m}^P$  to other people and subsequently can receive additional messages that can affect his original message, the calculation of  $m_i^P$  at each such stage is done according to equation (4). This is shown in the following example:

Message $m_1^P$	0 1 0 1 0 1 1
Message $m_2^P$	0 0 1 1 1 0 1
$P$ sends message	0 1 0 1 0 1 1
Message $m_3^P$	0 1 1 0 0 0 1
$P$ sends message	0 1 1 1 0 0 1
Message $m_4^P$	0 1 0 0 1 0 1
Final mutated message $\hat{m}^P$	0 1 0 1 0 0 1
<b>Figure 2. Example for a Mutated Message</b>	

## APPENDIX II: OPERATIONALIZATION OF THE RESEARCH VARIABLES

### Dependent Variables

Two types of errors are measured: **relative error** and **absolute error (defined in the Methodology section)**. The relative error  $E^i$ , is calculated as follows:

Let  $\mathbf{u} = \hat{m}^P - m_1^P$  be the difference vector of the messages of a person  $P^i$ . We calculate

$$(1) \quad E^i = \text{Number of "1"s in } \mathbf{u}^4.$$

For example, take the messages in Figure 2. We calculate the difference vector:

$$\mathbf{u} = \hat{m}^P - m_1^P = [0101011]^T - [0101001]^T = [0000010]^T.$$

Therefore,  $E^i = 1$  which is the number of "1"s in  $\mathbf{u}$ .

The absolute error  $EA^i$ , for a person  $P^i$  is calculated as follows:

Let  $\mathbf{u} = m - m_1^P$  be the difference vector for person  $P^i$ . We calculate

$$(2) \quad EA^i = \text{Number of "1"s in } \mathbf{u}.$$

Example: Assuming that the original message  $m = [1101111]^T$  and by taking the final message in Figure 2, the difference vector:

$$\mathbf{u} = m - m_1^P = [1101111]^T - [0101001]^T = [1000110]^T.$$

Therefore,  $EA^i = 3$  which is the number of "1"s in  $\mathbf{u}$ .

After the propagation of  $m$  in network  $N$  that contains  $n$  people, we can then calculate the average global relative distortion value  $N_R^D$  and  $N_A^D$  defined in (1) and (1) respectively.

### Independent Variables

**Degree** - The degree of a vertex in a network is the number of edges attached to it. Degree is often interpreted in terms of the immediate risk that a node will contract whatever is flowing through the network (such as a virus, or some information).

**Type of network** – Three types of networks are analyzed in this paper:

Random networks (Erdős and Rényi, 1959; Gilbert, 1959), in which the nodes are randomly interconnected by a number of edges with probability  $P_{ER}$ .

<sup>4</sup> The vector  $\mathbf{u}$  can efficiently be created by using the logical operator AND instead of subtraction.

Small world networks (Watts and Strogatz, 1998), in which the nodes are initially evenly interconnected, with each node connected to its nearly adjacent nodes. The edges are then randomly rearranged with probability  $P_{ws}$ .

Scale-free networks (Barabási and Albert, 1999; Albert and Barabási, 2002), in which the network starts with  $m_0$  unconnected vertices, and at each time step  $t$ , another node is added with  $m$  edges ( $m \leq m_0$ ). The probability  $\Pi_i$  of existing node  $i$  being connected to the new node is proportional to the connectivity of that node.

$$(3) \quad \Pi_i = k_i / \sum_j k_j$$

Preference is thus given to "earlier" nodes, thereby forming hubs.

**Hub** – Scale-free networks characterized by a power law distribution of the number of links connecting to a node, and therefore include nodes which are often called "hubs", which have many more connections than others. In graph theory terms these nodes (vertices) have a degree that exceeds the average degree by an order of magnitude (e.g., Valente, 1996; Barabási and Crandall, 2003).

**Original Message** – The original message is the message that was first to propagate in the network.

**First Propagator** – Is a person (node) in the network that holds the original message and the first to propagate it in the network. There might be a number of First Propagators of the original message.

**Message-In-Memory** – Message-In-Memory is the message that a person in the network (node) holds. This message was formed in two possible ways:

It was initially received from one of this person's connections in the network, and therefore, will be identical to this initial message, which is called the "Person-Original-Message".

It already exists, but it is affected and changed by other messages that the person receives from his/her connections in the network. Every letter of the newly affected Message-In-Memory is calculated as the mode (most frequently occurring) of the letters at the same location in all the previous messages that this person received.

**Transferred message** – Before transfer of Message-In-Memory, the message will be distorted by the person and then it is transferred to some or all of his/her connections in the network.

**Mutation** – Every time a message propagates in a network, and is transferred from one person (the sender) to another (the receiver), it is distorted by the sender of the message. The receiver gets a mutated message and each such a message is called a mutation.

# USE OF QUALITATIVE DATA ANALYSIS SOFTWARE IN IS RESEARCH

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**Keywords:** Qualitative Analysis, Methodology, CAQDA, NVivo.

## INTRODUCTION

The use of traditional forms of analytical software, for example SPSS (Statistical Package for the Social Sciences) have long been dominant in Information Systems (IS) research. New forms of analytical software have been developed over recent years which add value to the field of IS research. Such software can reduce the cost and time of analysis, can improve research yield, and can aid data management. This paper considers the methodological value of using computer-assisted tools for qualitative data analysis.

Analysis of qualitative data is said to be demanding, repetitive and arduous (Basit, 2003, 143). This is because the objective of qualitative analysis, through its laborious deconstruction and reconstruction of discrete datum, requires more personal effort and diligence than do many other methods (Jones, 2007). Miles (1979) and Basit (2003) argue that qualitative analysis is among the most demanding and least examined areas of social research. This can be attributed to the relatively higher investments in time and effort that this research requires.

Qualitative data analysis involves a process of reduction to manage and classify data. Units of text are first de-contextualized by removing them from their source – with their meaning intact – and then re-contextualized by drawing from them a more robust, context independent, meaning based on an accumulation of evidence. Analysis, therefore, begins through an accumulation of contextually rich segments of datum. Analysis is then completed through a final process of abstraction which prescribes a level of meaning to the categorized data – this is known as coding.

The ability of the researcher to code is an important part of analysis (Basit, 2003, 144; DeNardo & Levers, 2002, 4). Miles and Huberman (1994) discuss two methods of code creation. The first is a method preferred by inductive researchers, this involves coding the data in the absence of existing, or *a priori*, knowledge and labeling the data, at least initially, using the data itself as the descriptor (Glaser & Strauss, 1967). This is often called *in vivo* coding. The second method utilizes a preconceived list of categories into which the researcher fits emerging data. While this list may expand or change over time, it enables a faster, though less emergent, beginning.

## QUALITATIVE DATA ANALYSIS SOFTWARE

Computer assisted analysis began with simple text searching tools in the form of word processors which allowed categories to be searched and text to be marked or edited (T. Richards, 2002). However, it was not until computer analysis packages were able to de-contextualize and re-contextualize that they were of any real value to qualitative researchers. One of the first computer programs to provide real assistance to qualitative researchers was NUD\*IST (Non-Numerical Unstructured Data by Indexing, Searching, and Theorizing) (L. Richards, 1999, 413). The fundamental purpose of NUD\*IST was to provide functions which would assist researchers in the retrieval of text from data, allow users to code that data, and to develop a system of relating codes to each other using a tree structure and a relational database.

The utilization of software to assist researchers in qualitative analysis has been controversial. The research community is divided regarding the benefits and deficits of digital intervention in what is fundamentally a human enterprise (Basit, 2003, 143; Crowley, Harré, & Tagg, 2002, 193). Opponents cite the befoulment of methodological purity which results from the transfer of data into a digital environment, and the resulting generalization through the intervention of binary logic. This can certainly be the case with plain text programs, where expression and emphasis are lost. However, today's rich text programs tend to mitigate this deficiency (Bourdon, 2002, 1; Crowley et al., 2002, 193). Also, computers are good at counting and producing numbers. Users can fall into the trap of turning qualitative accounts into semi-quantitative conceptualizations of analysis by enumerating the facts rather than interpreting them. While qualitative analysis software will often provide these facilities, it is not their strength and it detracts from their purpose (Crowley et al., 2002, 193; Welsh, 2002, 1). Software can also work to distance the researcher from their research by providing a buffer between the person and their data (Bourdon, 2002, 1; Welsh, 2002, 1).

Proponents see software as the genesis of a new age in qualitative research. Software assists researchers through better management of data, improved flexibility and greater time efficiencies. They see electronic data analysis as providing greater accuracy and greater transparency (Welsh, 2002, 3). Software can provide faster and more comprehensive methods of inquiring into the data, and more versatile and efficient systems of collecting, storing and reporting (Basit, 2003, 145; DeNardo & Levers, 2002, 5). Opponents often assume programs automate analysis, but this is not the case. The researcher must still collect the data, decide what to code, and how to code it. The software does, however, reduce repetition and complexity (Bourdon, 2002, 3). Where 'paper and pen' activities once thwarted the efforts of a qualitative researcher, software removes many of the less pleasant areas of research. Computer assistance is merely a tool which facilitates more effective and efficient analysis (Coffey & Atkinson, 1996). "Researchers who use the packages are often amazed that this kind of work, with its thousands of pages of data, could ever have been conducted by hand" (Basit, 2003, 145).

Despite these debates, computers are being increasingly employed in the use of qualitative data analysis (Basit, 2003, 145; DeNardo & Levers, 2002, 5). A number of notable qualitative theorists have encouraged the use of qualitative data analysis software within their research: (Berg, 2001; Denzin & Lincoln, 1998; Krueger, 1998; Merriam, 2001; Miles & Huberman, 1994; Morse & Richards, 2002; Patton, 2002; Silverman, 2000, 2001; Taylor & Bodgan, 1998; Tesch, 1990).

In summary, tools for computer assisted qualitative data analysis have both advantages and disadvantages. The advantages are the increased speed, density and accuracy of analysis, enhanced data management, and facilities for mining collected data. The disadvantages include a potential disconnect between the data and its interpretation, a tendency to enumerate rather than interpret data, and potential for users to over-analyzing their data.

This paper examines qualitative data analysis through the use of a software package developed by QSR, called NVivo. The paper will advance a discussion which will demonstrate the system's suitability for IS research, discussing the advantages and disadvantages of its use.

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# HCI MARKERS AND THEIR USEFULNESS IN MONITORING PERSONAL HEALTH

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**Keywords:** human-computer interaction, HCI markers, health

## INTRODUCTION

This conceptual work examines the possible medical value of information collected during human-computer interaction (HCI). HCI produces a stream of data, which can be analyzed for “HCI markers”. Similarly to biomarkers, which are used in medicine to indicate unusual physiological conditions such as illness, HCI markers can be used to identify changes in the cognitive, psychological, physiological and other states of users. This conceptual paper presents the concept of HCI markers, and examines the feasibility of using these markers for diagnostic purposes.

## HCI MARKERS

Users who interact with information systems create a constant stream of data. Data are created through the usage of keyboard and pointing device (mouse, touch screen, etc.) combinations, and via multimedia peripherals such as cameras, microphones and other sensors. Variables that can be collected during such interactions using a keyboard and pointing device include: (1) vocabulary; (2) typing speed; (3) spelling; (4) grammatical components; (5) response time and pauses; (6) usage of CMC (computer-mediated communication) cues such as emoticons, uppercase spelling, asterisks, etc.; (7) punctuation, and (8) flow and precision of pointing device use, to name a few. For example, in past research these variables have been used to study cognitive abilities, and were able to predict and detect the development of neurodegenerative illnesses such as Alzheimer’s disease (Garrard, 2009; Snowden, 2003). Other studies show that HCI markers can identify changes in emotional states. For example, Cohn and colleagues measured the significant influence of the shocking events of September 11, 2001 on the language used by American bloggers (Cohn, Mehl, & Pennebaker, 2004). Other variables such as personality and trust have also been shown to be reflected in the rhythm of online interactions (e.g. Kalman, Scissors, & Gergle, 2010). If the examples so far are based on information gleaned only from keyboard interactions, other sensors such as microphones, cameras and GPS receivers allow for the inclusion of many more variables (Cowie, et al., 2001). Finally, information can be gleaned from an analysis of the interaction between the users and the content they receive during the session: website visits, keyword searches, or their social correspondence using online media such as email, chat, or social networking sites (e.g. Brownstein, Freifeld, & Madoff, 2009).

## POTENTIAL USES

HCI markers can be collected while users are interacting with their workstations, laptops and mobile devices. The markers can then be analyzed either in real time, or in batches. The results of these analyses can be used for a spectrum of purposes, including the monitoring of the user’s emotional, cognitive, and physiological states and the detection of neurodegeneration, mental illness, and even conditions such as Parkinson’s or glaucoma. At the level of the individual, such monitoring systems can flag the emergence of a previously unknown condition, monitor the progress of an existing condition, or alert users when potential “red flags” are identified, similar to the emerging field of wearable physiological monitoring devices (e.g. Otto, Milenkovic, Sanders, & Jovanov, 2006; Wu, et al., 2008). These methods can also be used to study groups of people or even whole populations, in order to increase our understanding of the development of specific conditions in individuals as well as population-wide processes (e.g. Cohn, et al., 2004; Liehr, Mehl, Summers, & Pennebaker, 2004).

## POSSIBILITIES, RISKS, AND LIMITATIONS

HCI markers have the potential to provide rich information similar to that provided by ubiquitous standardized medical tests such as blood or urine tests. It is inexpensive to collect, and since all data are already digitized, there is no need for expensive transcription or digitization costs. The development of effective automated analysis tools will facilitate the creation of an end-to-end digital process that requires minimal human intervention only at junctures that require decision-making. This analysis can either be carried out in real time (for an example of real time analysis of such data see Leshed, et al., 2009), or at predetermined intervals, in batch mode.

Nevertheless, like other biomarkers and health-related variables, HCI markers too have limited reliability and validity (Diamandis, 2010), which have to be carefully assessed before the markers are implemented. In addition, the collection of HCI markers requires the monitoring and dissemination of private information. The ethics of such actions require careful consideration (e.g. Kerr, Steeves, & Lucock, 2009; McGuire, Caulfield, & Cho, 2008).

A responsible study of the potential uses of HCI markers requires extensive longitudinal studies in the general population, as well as studies of these markers in carefully selected populations with diagnosed emotional, cognitive or physiological conditions. The former category of studies would provide the baseline data required to build the diagnostic tools, while the illness specific studies would provide candidate variables for research. Ethical and psychological considerations need to be taken into account both during the research phase, as well as ahead of the implementation stage.

## CONCLUSION

This conceptual paper presents HCI markers, analogous to biomarkers used in medical fields. The paper reviews studies that have demonstrated associations between these markers and changes in emotional, cognitive, and physiological states. It suggests that HCI markers can be used to monitor individuals as well as groups and communities, while at the same time pointing to the significant technical and ethical challenges associated with using such markers. It recommends applying approaches learned in medicine, social science, and computer science to the development of effective HCI marker-based diagnosis tools. The promise of HCI markers is great, but it will only be fully realized through carefully controlled longitudinal studies.

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## MODEL OF OPINION SPREADING IN SOCIAL NETWORKS

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### INTRODUCTION

A computer mediated social network is a modern information system where data is generated ("crowdsourcing"), distributed, evaluated and accumulated. It is important to understand how the topology of the network affects the information cycle and to develop network algorithms accordingly. One of the intriguing processes in social networks is information and opinion spreading between actors. This paper attempts to define a proper model of opinion spreading between actors in social networks.

There are two main approaches for modeling information and opinion spreading. The contagion approach (Kitsak et al. 2010), which is based on the spreading of disease. It suggests that if a healthy person will encounter a sick person, there is a specific probability that the healthy person will get infected. The opinion spreading is just like the disease: if a person without a specific opinion about a topic (not opinioned person) will encounter an opinioned person, the first person will, with some probability, be opinioned.

The threshold model (Centola & Macy 2007) is another approach for opinion spreading. The model assumes that a probability of an actor to get opinioned is a sigmoid function of proportion of the actor's opinioned neighbors to total number of neighbors.

Both models contradict the opinion spreading mechanism as it is viewed in sociology (Kleinberg 2008; Centola & Macy 2007).

In our study, we distinguish between two types of information entities. One entity is un-debatable information. For example, facts, information or disease. When one is exposed, one may be infected, but the next exposure has approximately the same probability for infection. The second type is debatable information: when someone is exposed he or she can accept or choose not to accept the opinion. Examples include consumer tastes, ideas, decisions and so on. The contagion approach is relevant only to the un-debatable information, since in the case of debatable information, conformity is crucial.

In addition, in both approaches mentioned above, there isn't a significant difference in the opinion spreading time depending on which actors act as starting points (Watts & Dodds 2007). This is in contrast with sociology theories according to which there are key actors for opinion spreading in social environments (Katz & Lazarsfeld 1955).

For these reasons we propose a new model, which captures the main difference between information and opinion spreading.

### OPINION SPREADING

#### Model

The model is based on the assumption that the probability of a person to obtain an opinion is a function of the numbers of influencers that the person encounters. Jon Kleinberg called this the "0-1-2" effect, "in which the probability of joining an activity when two friends has done so is significantly more than the twice of the probability of joining when only one has done so" (Kleinberg 2008).

According to this we need to introduce two different probabilities, one if the person encounters one infector, and another probability when encountering two infectors.

For simplifying the situation, we assumed that the opinion may be expressed by Boolean value and there is a time interval on which each person can be exposed to an opinion from two of his friends. We suggested the following model of opinion spreading:

In each time interval for each not opinioned actor in the network we randomly select two of his friends:

If the two selected friends are not opinioned – the actor stay not opinioned.

If one is opinioned- the actor gets the opinion in  $p_1$  probability.

If two are opinioned- the actor gets the opinion in  $p_2$  probability.

In the case of opinion spreading with 0-1-2 effect  $p_2 \gg p_1$ , without 0-1-2 effect  $p_2 \sim 2 \cdot p_1$ .

### Simulations

Opinion spreading was simulated on different real world social networks (network of e-mail contacts (Leskovec, Kleinberg & Faloutsos 2005), network of scientific citation (Newman 2001) and social network of user community of tech news site (Leskovec et al. 2008)). Social networks, including the above datasets, obey the "Small World" properties and have power law distribution of actor degree. To distinguish the role of power law degree distribution from the role of Small World, we consider additional networks obtained from the source dataset by randomization the links with preserving nodes degrees.

For simulation we defined a starting actor whom which will influence the network. In each time iteration, according to the model probability outcome some not opinioned actor in the graph became opinioned. The spreading iterates until it reach target fraction of opinioned actor in the graph. Each simulation process was repeated until the standard deviation was low.

The average number of actors with opinion by time line was measured. The behavior of the spreading is characterized by a slow incline, until reaching a critical point or tipping point  $t_p$  on time line. For accurate definition, we assumed that  $t_p$  is reached when 10% of the actors are infected. Simulation shows that after reaching  $t_p$  the spreading speed is dramatically increases. Without the 0-1-2 effect the form of time dependence curve is similar to the one with 0-1-2 effect, however  $t_p$  value is significantly larger.

### Results

Main interest in the simulations is to understand if there's a difference between  $t_p$  for different starting actors of the network. Simulations show that for 0-1-2 effect the difference is significant, while without 0-1-2 the difference is small. In addition, in randomized social network with 0-1-2 effect the difference is small as well.

The actors with relatively small  $t_p$  we call influencers. From the simulation it is clear that not all actors with high link degree are influencers. Influencers in the case of 0-1-2 effect are not the same actors which have the smallest  $t_p$  value without 0-1-2 effect.

## DISCUSSION

In accordance with the 0-1-2 effect and as result of simulations data analysis it is clear that to be an influencer an actor not only has to have big number of followers, but these followers have to be linked between them. In social networks some "stars" have disconnected followers and as result they are not influencers.

In randomization process the Small World property is destroyed, but the stars continue to be stars as regarding to their degree. Simulation shows that influencers do not exist in this case, this points that influencer can exist only in Small World networks. Actually it means that the tipping point for network without Small World topology is not reachable.

Known characteristics of an actor in a network can not indicate if he or she is a potential influencer. It's clear that an influencer must not have a low degree and must have a high clustering coefficient

value. To become an influencer, a special position of an actor in the network is needed and this position is not a local property of the actor. Further investigations will be concentrated on accurate definition of this position together with the introduction of new topological metrics of a network.

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# A MEDICAL DECISION SUPPORT SYSTEM (DSS): THEORY AND APPLICATION TO PRENATAL DIAGNOSTIC TESTING

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## INTRODUCTION

Consider the following scenario: A patient diagnosed with a health problem must choose among alternative courses of action, including a treatment, a physician to administer it, and a medical facility in which the treatment is to be administered. In general, the alternatives to be considered are quite complex, involving assessment of risks and values, as well as financial and lifestyle considerations, and difficult to assess as wholes.

Shared Decision-Making (SDM) is a concept of treatment decision making. According to Charles et al. (1997) its key characteristics are both patient and physician involvement, information sharing, taking steps to build a consensus about the preferred treatment and their agreement on the treatment to implement. The idea behind the SDM concept is the recognition that the information patients have about their own values and preferences is as important for patient care as the research evidence that leads to medical decisions (Ruland, 2000).

In practice, however, it is not always easy to obtain the necessary information from the physician or to elicit the patient's preferences. Both may require some guidance on how to sort out and organizing the relevant information in a systematic manner, and identify the optimal course of action.

Decision Support Systems (DSS) have generally been defined as interactive, computer-based systems that utilize decision rules and models (Turban & Watkins, 1986). In the medical context, these models encourages patients' preference elicitation, externalization and communication, thus having the potential to facilitate SDM

Our study presents a procedure designed to aid physicians and patients in the process of making medical decisions, and illustrates its implementation to aid pregnant women, who decided to undergo prenatal diagnostic test choose a physician to administer it. The procedure is based on a medical decision making model of Karni (2009) which presented an axiomatic model of medical decision making that requires the elicitation and integration of the patient's preferences and the physician's risk assessment. The essence of this model is that patient preferences are represented as an outcome-dependent expected utility function, where each outcome is a possible post-treatment state of health, which includes the side effects of treatment, the associated pain and inconvenience, the direct monetary expenses, and the potential loss of income.

## OBJECTIVES

The main objective of this work is to study the possibility of using the model of Karni (2009) and procedures as model based DSS that help patients and physicians make medical decision.

The choice facing the women in this study is between undergoing a prenatal diagnostic test with an average physician and an expert physician (expert physician pertains to a physician that performs larger than average number of procedures per unit of time and, as result, has higher success rate than average physician but charge higher price than average physician). In other words, in this study we are looking after the tradeoff between the skill of the physician (expert/average) and the price that he/she charges for performing the test. The decision problem was chosen for its relative simplicity and the transparency it affords.

## METHOD

In this study we formulated questionnaires designed to prompt patients to reveal their evaluation of the medical consider, a pregnant woman who decided to undergo prenatal diagnostic testing, CVS or amniocentesis, and must choose between an expert physician and a average physician who is less expensive, but has a higher probability of fetus loss. We also use the responses to check whether they are consistent with basic premises of rational choice behavior.

The study was conducted through "LimeService", a survey service platform for running online surveys, in Hebrew, from December 2008 through December 2009.

The study includes two anonymous separate questionnaires, one for the CVS procedure and another for amniocentesis. Links to the CVS questionnaire were sent to doctoral and MBA students from Tel Aviv University by email. Links to the amniocentesis questionnaire were posted in four pregnancy and labor internet forums.

A total of 49 women participated in the CVS questionnaire and another 25 women participated in the amniocentesis questionnaire are included in our study. Most of the women were non-religious (41/49, 84%; 23/25, 92%) Jews (47/49, 96%; 23/25, 92%), aged 26-36 years old (40/49, 82%; 24/25, 96%). The marital status of most of the women was married (41/49, 84%; 20/25, 80%) with children (43/49, 88%; 14/25, 56%). Some were pregnant at the time of the study (12/49, 24%; 18/25, 72%), some had a health history including some kind of abortion (14/49, 29%; 5/25, 20%), and some were familiar with someone with birth defects (21/49, 43%; 11/25, 44%). As for financial characteristics, most of the women worked (44/49, 90%; 23/25, 92%) as salaried employees (37/49, 76%; 19/25, 76%), and most of them held at least a Bachelor's degree (45/49, 92%; 25/25, 100%).

\* First data refer to CVS participants and second to amniocentesis participants

## RESULTS

Examination of the responses shows that most of the participants (70% in CVS, and 76% in amniocentesis) are non-state dependent, most of the participants are rational (91% in CVS and 97% in amniocentesis) and most of the participants are risk averse (79% in CVS and 67% in amniocentesis). Irrational and/or risk seeking participants were excluded from the study.

To illustrate how our method works in this context, we describe one participant in the amniocentesis study who displays outcome-dependent risk attitudes or in other words displays different financial preferences in two different health states/possible outcomes  $\omega_0$  (continued pregnancy without complications) and  $\omega_1$  (involuntary abortion). Figure 1 present the graphs of two utility functions, corresponding to the two possible outcomes.

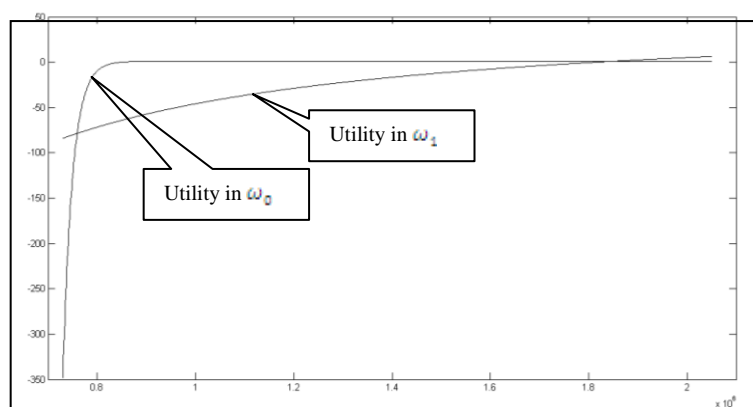


Figure 1. Utility functions of state-dependent participant

Table 1 displays the maximum price that a specific woman should be ready to pay to have the procedure done by an expert physician as opposed to an average physician is calculated based on her utility functions. This is followed by a recommended course of action, namely, a recommendation on whether to have the test administered by an expert or an average physician, given the prices charged by this physician. Throughout we assume that the price of having the test administered by an expert is 3500 NIS. We consider an alternative cost of having the test administered by an average physician with a full subsidy which means that the patient pays nothing.

**Table 1. Recommendation (based on utility functions)**

	Average physician Free	Recommendation
$p_{CVS}(\omega_1) = 0.25\%$	3197.76 NIS	Average physician
$p_{CVS}(\omega_1) = 0.01\%$	5894.37 NIS	Expert physician

This simulation which provides insights into the patient preferences should be discussed between patient and physician as part of the SDM process.

### CONCLUSIONS

The first main conclusion is that, for a large majority of the subjects participating in this study, the answers are not inconsistent with the basic premises of the decision model. This suggests that the subjects are capable to provide evaluations that can be used in the application of the model, and that, properly applied; the model is a useful instrument to help make medical decisions. For most subjects the risk attitudes do not depend on the outcome, and for those it does, it has no particular tendency. This suggests that, since involuntary abortion does not have long term physical health consequences, such as reduced earning ability, the attitudes towards risk are unaffected. Health-dependent risk attitudes may prove to be more important when the treatment alters the health state permanently, or for a significant period of time, with consequences for the earning ability. We also note that, in the cases studied in detail, the subjects displayed decreasing absolute risk aversion and increasing relative risk aversion.

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## INFORMATION LEARNING WITH KNOWLEDGE MAPS

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### ABSTRACT

Maps such as concept maps and knowledge maps are often used as learning materials. These maps have nodes as key concepts and links as relationships between key concepts. From a map, the user can recognize the important concepts and their interrelationships. To build concept or knowledge maps, domain experts are needed and the cost of map creation is high. This study developed a model which automatically builds a domain knowledge map (K-map) from a set of documents about a specific topic using text mining techniques. To build K-map, keywords are extracted from a set of documents using the TF/IDF algorithm and keyword pairs are ranked according to number of appearances in a sentence and number of words in a sentence. K-map was implemented to evaluate learning performance. The experiments analyzed both sentence recall and identification of important sentences, in comparison to document-based learning methods. The results show that K-map provides a mechanism with high recall and can distinguish the more important information, in comparison to document-based learning.

### INTRODUCTION

When people learn from text, they usually follow the order set by the author, as with reading books, in the most common method of text-based learning. However, text-based learning is not efficient in the following situations. First, in many cases people have different levels of prior domain knowledge. However, when they learn from textual material, they can only read it from beginning to end or use the table of contents to jump to a specific chapter. If a learner has a certain knowledge level, he can use the index to look for information on a certain concept, but the index usually contains hundreds of concepts listed alphabetically with no relational information between them. Second, in cases of learning under time pressure the learner can use the table of contents or index to identify main parts. There is no other specific way to distinguish important information. Furthermore, if a person wants to learn about a domain from a web search, the time limitation is more acute due to the huge amount of documents online. He will read documents from top-ranked ones down and will stop when the time is up. Third, if a document is complicated or long, a reader may find it difficult to recognize important concepts and their interrelationships.

Map-based learning can be useful in these situations. Key concepts and relationships can be identified directly from the map. Time can also be saved by shortening the amount of text. However, these maps are built by the manual effort of domain experts. This paper proposes a method of automatic map generation and presents an implementation example with real-world data.

### RELATED WORK

A concept map is a visuospatial representation of knowledge with text and graphical elements such as arrows, lines, ovals, and squares. It consists of nodes, containing a concept or item, and links connecting two nodes to each other and describing their relationship, where each node-link relation makes a proposition.

A concept map is taken from the theories of assimilation and subsumption in cognitive learning theory (Ausubel, 1968). A concept mapping tool was initially developed to search for

better ways to represent learner knowledge (Novak & Musonda, 1991). A topic map is an ISO standard for describing knowledge structures and associating them with their resources and contains basic concepts, such as Topics, Associations, and Occurrences (Pepper, 2000). An environment for e-learning, called TM4L, where people use topic maps for learning, was developed in (Dicheva & Dichev, 2006).

A way to construct concept maps automatically from academic papers was proposed in (Chen et al., 2008). They used author keywords as keywords after pre-processing and defined relations among them with four assumptions. While previous work dealt with constructing maps or using maps for learning, this study focuses on automatic map construction for learning.

### **MODEL OVERVIEW**

K-map is defined as a domain knowledge description map with nodes and links. Nodes are keywords considered important domain concepts and links are relations between two keywords. The present work developed K-map Tools, a learning environment where the user controls the number of keywords and relations, and thus the requested depth of information, that are used to automatically produce a K-map for a document. There is a concept search window that helps the user search for a specific concept. The system takes several documents related to a domain and generates a K-map. Figure 1 is an example of a K-map produced by K-map Tools, with 18 keywords and 30 relations, generated from a set of documents about John F. Kennedy. Each link has a different score and thickness, when a higher score yields a thicker link.

The K-map has a hyperlink on each relation. If the user clicks a relation, he will see all sentences having the two keywords at both ends of the relation. For example, if a relation between 'Kennedy' and 'president' is chosen, Figure 2 appears. In Figure 2, all sentences having the words 'Kennedy' and 'president' are shown. The user can read some of the sentences and acquire domain knowledge.

With K-map Tools, as the user handles the K-map, he searches and learns. In the searching and learning process with current search engines, the user first types in words he wants to know about; these can be considered the topic. Then the search engine shows him a list of documents related to the query. The user goes over the list, at some point choosing a document and reading. He repeats the process until he learns enough. With current search engines, there may be inefficiencies – the user may not understand important concepts, may miss key concepts, or may waste his time trying to find a right document.

However, with K-map the user doesn't have to find a right document, because the map already has extracted sentences, categorized by keyword pairs. He can recognize the key concepts and the strongly connected key concepts; he obtains a holistic view of the domain. Thus, K-map improves the searching and learning process.

### **IMPLEMENTATION AND EXPERIMENTS**

The K-map model was implemented as a system. The model consists of three parts: keyword extraction, relation extraction, and relation labeling. For the experiments 34 participants were divided into two groups: a document group which learnt from a set of documents and a map group which learnt from K-map using K-map Tools.

Three experiments were performed. The first experiment analyzed whether the K-map could identify the important sentences in a document. The results showed that the model can successfully filter out the sentences considered not important to the main idea. The second experiment analyzed in the two participant groups the recall - the number of important sentences identified. The results show that there was no statistical difference between the groups. The third experiment compared the number of significant sentences recalled between the two groups. The results showed that with K-map users learned information that is more important, in comparison to the information learned with documents.

The results showed that, contrary to the initial assumption, with K-map people do not read faster or recall more information compared to people who learn with texts. It is assumed that the

learning speed using K-map depends on previous experience and might increase as users become more experienced. Further studies can investigate the learning curve of using K-map and analyze K-map learning performance in different domains.

### DISCUSSION AND CONCLUSION

K-map offers multiple benefits. A user can see key concepts in a domain as well as strongly related concepts. As a user reads, he can directly access a document he wants from a certain sentence; in other words, K-map can function as a search engine. By exploring the map, a user can learn about the domain at some level of knowledge without accessing original documents. As a user explores a domain K-map, he can see the holistic/overall picture. Additionally, since a user can choose relations based on keywords, he can selectively learn about the domain, which is hardly possible when learning from text. Furthermore, experiments show that K-map provides a mechanism with which to distinguish the more important sentences.

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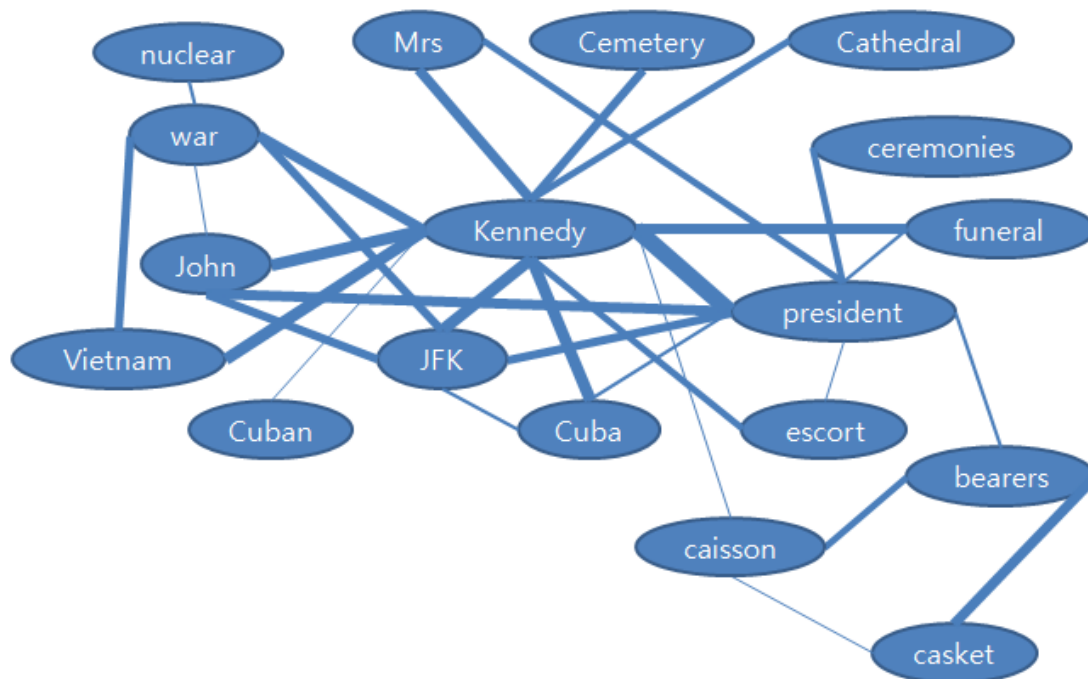


Figure 1. Knowledge map of John F. Kennedy

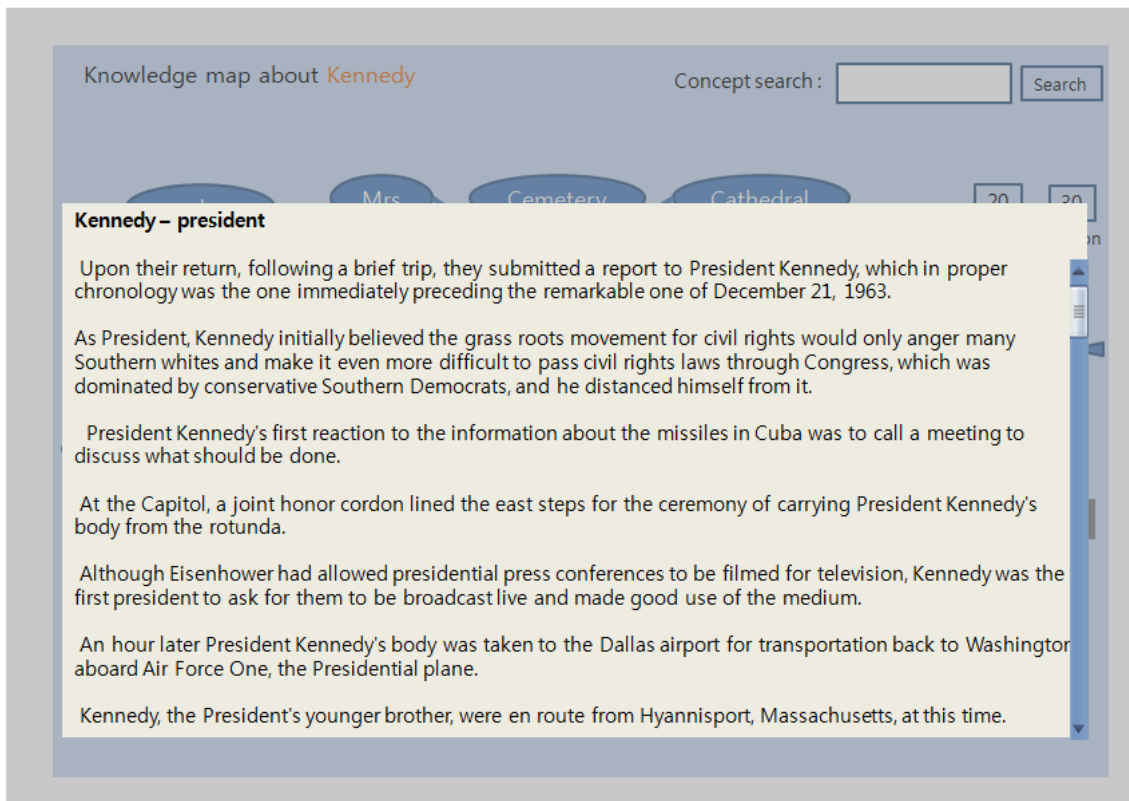


Figure 2. Screen shot of sentences containing 'Kennedy' and 'president' in K-map Tools

# EXPLORING THE IMPACT OF A PERFORMANCE MEASUREMENT SYSTEM IN THE ISRAELI POLICE FORCE

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**Keywords:** Performance Measurement System, Business Intelligence, IS Success.

## INTRODUCTION

The measurement of organizational performance is perceived as an important managerial tool. Effective measurement is often supported by dedicated information technology infrastructure, often termed as a Performance Measurement Systems (PMS). Such a system helps integrating and storing the performance-related data, processing it, and deploying it throughout the organization. To support these needs, PMS are often implemented today using Business Intelligence (BI) methodologies and technologies. PMS may assist implementing organizational strategy, align employees with the derived targets and goals, and act as an effective tool for control and surveillance. Studies have suggested that, in the long run, these important benefits will have a positive impact in organization's performance. However, even though PMS have received considerable research attention, the claims regarding their major impact on organizational performance are yet to be supported by rigorous evidence.

## OBJECTIVES

The study attempted to confirm the common claims for major impact on actual results, by exploring the impact of a PMS in a real-world setting. "MENAHEL", the PMS explored, was developed by the Israeli Police Forces and became operative in 2006. The system embeds a large number of performance metrics, each reflecting a key aspect of police activity. Using the system, which was implemented with advanced BI utilities, police commanders can view and analyze the measurement results for their own units, compare it to the overall performance, and get feedback on their success. Based on testimonies of police representatives, the system had major impact on work processes within the organization, and its contribution is well recognized. A main goal of this study was to assess these claims, through an in-depth evaluation of the data collected and presented in the system.

The study focuses on a comparative analysis of the metrics that the system collects and presents. The key assumption tested, which can be generalized beyond the specific context of this study, is that the use of a PMS will have a significant impact on the organization, and that this impact will be well reflected in the metrics that are measured. The diagram in Figure 1 describes the theoretical model that directed the study.

The dependent variable in this model is the organizational performance, as reflected in the set of metrics. The first hypothesis (H1) suggests that the use of the system will impact the overall organizational performance and improve it over time. This impact will be moderated by certain metric characteristics – the relative weight, and the category (Activity versus Outcome) – will moderate the impact of usage on performance (H2 and H3, accordingly). The study tested a few propositions, derived from these high-level hypotheses.

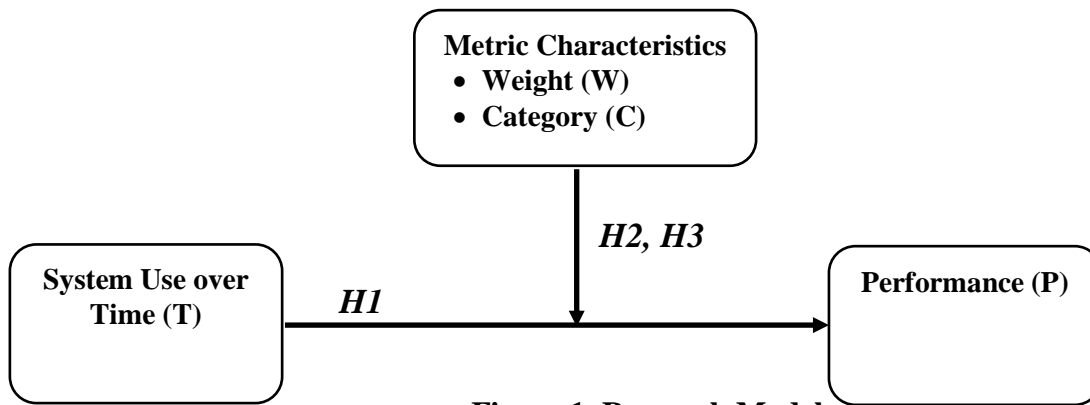


Figure 1. Research Model

## METHOD

Examining the impact of IS, and particularly PMS, on actual organizational performance is considered a great research-design challenge, due to the difficulty to control all possible parameters, as can be done in a laboratory experiment. This research was based on a comprehensive dataset provided by the Israeli Police that included monthly results for all metrics and units over a 5-year period (60 scores per metric and per police unit). The hypotheses in the model above were examined by assessing the behavior of each metric over time and the extent of performance improvement. The moderating effects of the relative weight and the category were confirmed by testing the goodness of fit to performance improvements over time.

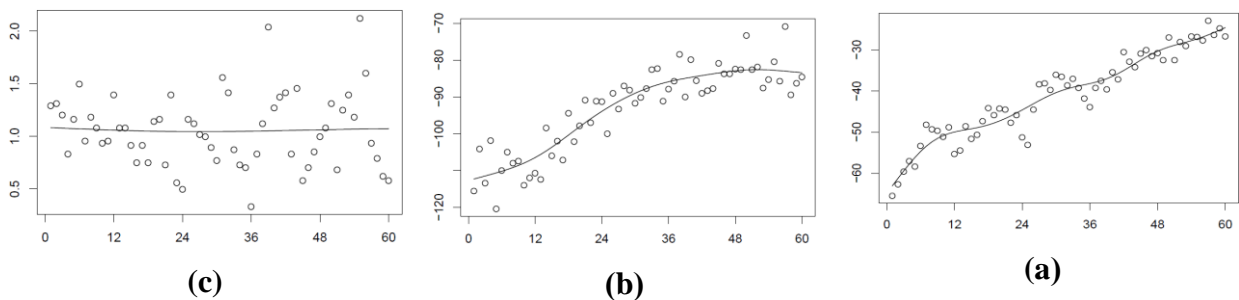


Figure 2. Typical Indicator-Behavior Patterns

Generally, the tested metrics are categorized into 3 groups, based on their behavior over time – as illustrated in the set of diagrams above (Figure 2). Some metrics improved consistently over the tested period (a), others have improved for a period of time, and then converged to a certain more-or-less fixed value (b). A few metrics have not improved consistently over time, but rather fluctuated or even decreased (c).

## RESULTS

Some of the analysis results are summarized in the following table (Table 1). The results show that with the majority of the metrics, the performance results have indeed improved over time; however quite a few of the metrics have improved only for a certain period and then converged. The general improvement rate is higher with outcome metrics, but so is the convergence. These assessments were supported by statistical tests, with a high significance.

**Table 1. Summary of metrics behavior over time**

	<b>Fluctuated</b>	<b>Converged</b>	<b>Improved</b>
<b>Activity</b>	23	8	18
<b>Outcome</b>	5	9	3
<b>Total</b>	28	17	21

A further investigation has highlighted that the expected link between activity and outcome metrics can be found only in a few police-performance aspects; however, in others the link was shown to be insignificant. The results also confirm the assumption that the relative weight of each metric moderates the improvement over time – this by showing a positive and significant correlation between the relative weight and the performance gain. Further, the analysis showed that below a certain point, the relative weight is no longer effective in driving performance improvements.

### **CONCLUSIONS**

The performance improvement that was found in most of the metrics demonstrated the strong impact of the "MENAHEL" on the organization as a whole – however, as expected, the analysis showed that not all metrics and not all units have improved in a similar manner. The fact that some metrics have converged may highlight the need to update the set of metrics, and possibly remove metrics that cannot promote organizational improvement anymore.

The findings regarding the moderating effect of relative weights indicate that, as expected, organization members indeed chose to focus on the more important metrics, those with the higher weights. The insignificant impact of lower weights on results raises the question whether the use of very low weights are beneficial at all. Another finding that requires further discussion and investigation is the link between activity metrics versus outcomes – a link that was found to be significant only in some aspects of police activities, but not in others.

# DISSATISFACTION DOES NOT MEAN REJECTION: A CONCEPTUAL MODEL OF MINDFUL AND UNFAITHFUL IT REINVENTION

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**Keywords:** IT satisfaction, reinvention, mindfulness, faithful appropriation, applicability.

## INTRODUCTION

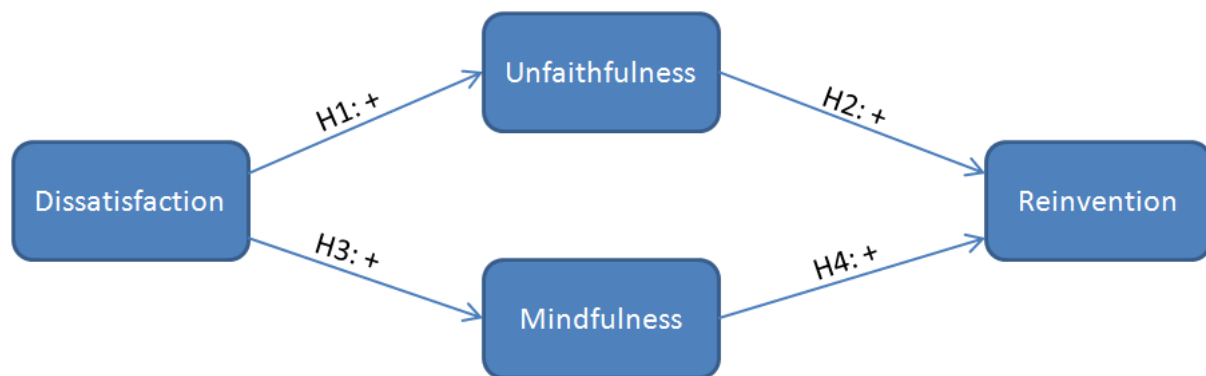
The objective of this paper is to propose a model that can guide post-adoption IS research by developing a set of propositions that jointly treat IT satisfaction (or lack thereof) not as the end point of IT implementation but rather as a first step in an ongoing process of technology reinvention as it is adapted to its local contexts and user needs as they unfold over time.

The dominant view in IS research considers reactions to technological innovations to be either positive (e.g., acceptance, use, or continuance) or negative (e.g., rejection, non-use, and discontinuance). That is, users are seen as having only two decisions to make with regard to a new technology: they either adopt it or they do not adopt it (Nambisan et al., 1999). Yet, as noted by Orlikowski (2000), “When the technology does not help [users] achieve [their] ends, they abandon it, or work around it, or change it, or think about changing their goals.” Indeed, increasing evidence, primarily from published case studies (e.g., Boudreau and Robey, 2005; Fedorowicz and Gogan, 2010; Orlikowski, 2000), clearly indicates that reactions to technological innovations are not an either/or phenomenon, but instead appear to reflect an underlying continuum that corresponds to a reality in which users neither wholeheartedly reject nor unquestioningly accept the innovation. Instead, users often partially and selectively adopt features of the technological innovation and/or actively modify certain functionalities to meet their unmet or changing needs. Therefore, we propose that rather than treating users of technology as largely passive recipients of such innovations, IS scholar should more explicitly recognize users’ ability to actively participate in the implementation process by continuously reinventing the technology – dynamically adapting it to their unique contexts and emergent needs.

## INFORMATION TECHNOLOGY SATISFACTION

In this paper, we focus our effort on what is generally deemed a close proxy for IT success – namely, satisfaction from IT (e.g., DeLone & McLean, 1992; Petter et al., 2008). Since IT satisfaction is treated as a strong indicator of successful innovations with IT (indeed, numerous models present satisfaction as their ultimate dependent variable), it is also apparent that dissatisfaction from IT is treated as a strong indication of failure, often equated with, or is considered a direct antecedent of, rejection, non-use, or abandonment (e.g., Bhattacharjee & Premkumar, 2004; Limayem et al., 2007). In this paper, we challenge this view based on two observations. First, the use of organizational IT (e.g., BI, ERP, and GSS) is often mandatory (e.g., Boudreau & Robey, 2005; Lapointe & Rivard, 2005), thereby making the nonuse, rejection, or discontinuance of IT unlikely user behaviors. Second, irrespective of the previous point, we argue that the use/nonuse perspective is too narrow and does not aptly reflect the nature of newer forms of IT, which are often loosely-bundled sets of components with built-in flexibility (DeSanctis & Poole, 1994; Rogers & Allbritton, 1995). In light of this malleability, organizational IT need not be abandoned (even when abandonment is permissible) when users experience dissatisfaction with the technology’s current performance but, instead, they are reinvented as users improvise (Orlikowski and Hofman, 1997), modify (Majchrzak et al., 2000), or tinker (Ciborra, 1992) with the technology

to identify and selectively appropriate its affordances (Markus & Silver, 2008). Therefore, we propose that IT dissatisfaction, instead of resulting in technology rejection or discontinuance can, in fact, lead to the reinvention of the technology (see Figure 1 below).



**Figure 1. The Dissatisfaction—Reinvention Model (DRM)**

### REINVENTION OF IT

Reinvention is defined as “the degree to which an innovation is changed or modified by a user in the process of adaptation and implementation (Rogers, 2003; pg. 17).” Reinvention can be measured as “the degree to which an individual’s use of a new idea departs from the core or ‘mainline’ version of the innovation promoted by a change agency (Eveland et al., 1977 as quoted by Rogers, 2003; pg. 17).” Several researchers have noted that innovations are often reinvented during their implementation, especially when users recognize misalignment between their needs and the technology’s features (e.g., Leonard-Barton, 1988; Lewis & Seibold, 1993; Rice & Rogers, 1980; Rogers, 2003). However, we propose that the path from IT dissatisfaction to reinvention is not a direct one. Instead, we argue that a dissatisfied user of an IT engages in reinvention behavior to the extent that two conditions are met – namely, the user enters a state of *unfaithfulness* toward the current spirit of the technology, and is *mindful* of his/her own dissatisfaction as well as the possibility of adapting the technology.

### Unfaithfulness toward IT

In IS research, the main stream of literature to recognize the existence of reinvention draws on adaptive structuration theory (AST), which acknowledges that technological innovations are not fixed but rather are continuously changed over time as they are interpreted and adapted to local contexts (e.g., DeSanctos & Poole, 1994; Orlikowski, 2000; Swanson, 1994). As such, AST uses concepts such as adaptation and improvisation to explain departures from the spirit of the technology. “Spirit is the general intent with regard to the values and goals underlying a given set of structural features. [It] is the official line which the technology presents to people regarding how to act when using the system, how to interpret its features, and how to fill in gaps in procedures which are not explicitly specified. [It] provides... ‘legitimation’ to the technology by supplying a normative frame with regard to behaviors that are appropriate in the context of the technology (DeSanctis & Poole 1984).” According to AST, departures from the technology’s spirit are considered unfaithful appropriations of the features, and although the literature does not explicitly treat such unfaithfulness as “bad,” it does seem to imply that faithful appropriations are desired in that they are more likely to lead to positive outcomes (e.g., DeSanctis & Poole, 1994; Thomas & Bostrom, 2010). In this paper, we argue that unfaithful appropriation of the IT can be a desirable action by users when the technology proves to be unsatisfactory in its current form. To see this, consider that if faithful appropriation resulted in IT dissatisfaction then unfaithful appropriation (i.e., using the technology in a manner inconsistent with the intended use prescribed by the designers or sponsoring agency) may lead to improved outcomes. This is particularly the case if the spirit of the technology is incompatible with the task for which the technology is used (Dennis et al., 2001) and/or the context in which the technology is used. Researchers have noted that users are

less likely to be faithful toward the technology's spirit if they experience unexpected and undesired discrepancies such as unsatisfactory performance (e.g., Lewis & Seibold, 1993; Majchrzak et al., 2000; Orlikowski, 2000). Thus, IT dissatisfaction appears to be a significant factor capable of affecting a user's faithful disposition toward the technology. In turn an unfaithful user appears to be more likely to act upon the source of the negative attitude (i.e., dissatisfaction) by modifying it, thereby engaging in reinvention of the IT. Therefore,

H1: The greater the user's dissatisfaction with an IT, the greater his unfaithfulness toward the technology's spirit.

H2: The greater is a user's unfaithfulness toward the technology's spirit, the greater the extent of technology reinvention behavior.

### **Mindfulness toward IT**

Researchers have noted that when individuals are mindful – i.e., open to novelty, alert to distinction, sensitive to different contexts, aware of multiple perspectives, and oriented in the present (Langer, 1997) – they are more likely to apply innovations in new ways and in alternative contexts (Butler & Gray, 2006). Entering a state of mindfulness means that an individual is attending to innovations with reasoning grounded in organizational facts and specifics, critically examining local validity, and looking for context specific rationale to justify use of technology (Swanson & Ramiller, 2004). In contrast, mindlessness is associated with habitual behavior, where users of technology apply the same features and functionalities automatically and unconsciously (Butler & Gray, 2006), thereby appearing less likely to reinvent an IT. Researchers have noted that satisfied users of IT are expected to develop habitual use, which stems from their tendency to repeat the same pattern of use again and again (Limayem et al., 2007). Therefore, we suggest that IT dissatisfaction interrupts such automatic and habitual behavior, prompting users to mindfully pay attention to the source of the dissatisfaction – namely, their current appropriation of the technology. Thus, a dissatisfied user of IT is more likely to become mindful about the technology, thereby gaining heightened awareness of the technology's affordances (Markus & Silver, 2008). In turn, when juxtaposing the recognition of the technology's applicability (e.g., Dearing & Meyer, 1994; Nambisan et al., 1999) against its unsatisfactory performance, which stems from the features and functionalities presently used, we can expect a dissatisfied user to become mindful about the technologies affordances and engage in its reinvention. Hence,

H3: The greater the user's dissatisfaction with an IT, the more likely his/she is to transition to a state of mindfulness vis-à-vis the technology's affordances.

H4: Mindfulness with regards to an unsatisfactory IT is positively linked to its reinvention.

### **SUMMARY**

The proposed model views IT dissatisfaction as an occasion for reinvention rather than an indicator of a failed technological innovation, which is an important shift in IS research considering the applicability of new organizational IT and the mounting anecdotal evidence. Such a reorientation of the perception of IT dissatisfaction allows organizations to take the actions needed to support IT reinvention and salvage technological implementations that would otherwise be deemed as failed.

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## TRADING FEDERAL DATA

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**Keywords:** USA Federal Government, e-Government, Public Management Information Systems, Information Economics.

### KEY DEFINITION

Improving Information sharing within the American federal government is defined as the objective of erecting a decentralized, comprehensive, and coordinated environment for the sharing and integration of electronic data across all federal agencies. This environment is built on existing federal government policies, standards, procedures, programs, systems, and architectures and used to leverage those resources to the maximum extent. The new information sharing environment also aspires to create a culture of information sharing within departments or agencies by assigning personnel and dedicating resources to the goal of information sharing, by reducing disincentives to such sharing, and by holding senior federal managers accountable for improved and increased sharing of such information. This definition is based on the common definition of information sharing but expands the original definition beyond its original counter-terrorism context (Bush, 2005).

### BACKGROUND

Federal information sharing failures threaten lives and waste government funds. The 9/11 investigation committee declared federal agencies' resistance to share counterterrorism information as the biggest impediment to averting similar events in the future (National Commission 2004, p. 416). The failure of USA intelligence agencies to share information about the terrorist who boarded a flight from Amsterdam to Detroit on Christmas Eve 2009 serves as another reminder that information sharing problems continue to haunt the federal government (White House, 2010). This information sharing failure is not limited to the security domain. For example, parents of sick students in Marion, Ohio labored for years to discover that valuable data regarding a contaminated former military site on which the local high school was built existed in disparate federal databases. Information sharing failures also waste billions of dollars annually of American taxpayers' money. For example, the federal government recovers pennies on the dollar when agencies first pay fraudulent claims and then attempt to re-claim these funds (GAO 2010a; U.S. Government Accountability Office, 2010b, 2010c).

### RESEARCH QUESTION

Why do USA federal agencies frequently fail to exchange electronic data and how can this exchange be improved?

### OBJECTIVES

Discuss four theoretical approaches (political, archeological, utopian and managerial) that address the research question but fail to offer solutions to improve electronic information sharing. Next, the paper proposes a fifth marketplace approach which suggests that federal data is a contested commodity (i.e., a commodity whose insertion into the marketplace evokes an ethical debate) and should be traded as such (Radin, 1996). The paper further proposes to erect an internal Federal Information Marketplace (FIM) to incentivize agencies to exchange data via trade and provides detail on how FIM might work.

## METHOD

Since a federal data marketplace has never before existed, the histories of thirty other contested commodities are examined to detect lessons that can assist in understanding if and how to commoditize federal data (See, for example: Basu, 2007; Becker & Elias, 2007; Cohen, 1989-1990; Cooper & Culyer, 1968; Kaserman, 2001; Sowell, 1981; Stanley, 2004).

## RESULTS

The following three key lessons are gleaned from these thirty histories:

1. A 'cresting moment' exists in the life span of a contested commodity, at which point dire scarcity of a product meets a promising solution-technology. Jointly, the scarcity and the new technology overcome ethical concerns and erect a new contested commodity marketplace.
2. Contested commodity marketplaces are more successful if they are subjected to trade limitations at their inception. Such restricted arrangements ban advertisement, curb market rhetoric, limit the number of potential buyers, decouple demand and supply, mandate non-monetary payments or set terms for the future removal of a contested commodity from the marketplace. The thirty histories suggest that full commoditization and non-commoditization are but end points in a commoditization continuum. The interesting questions are found in between these two extremes: what limits will be set on trading? How effective will these limits be?
3. Finally, the thirty histories teach that contested commodity marketplaces ingeniously overcome problems that once appeared insurmountable including the tough challenges of black markets and fraud. Quickly, new contested commodity marketplaces gut out black market trade.

The above three lessons are applied to Federal data as a contested commodity. The paper then uses insights from these histories to tackle four critical FIM challenges: curtailing the Freedom of Information Act, wasting taxpayer dollars, expanding greed in governmental work, and creating a Big Brother Government.

## CONCLUSION

This paper argues that marketplace-based exchange is an effective and scalable solution to increase electronic information sharing within the federal government. Utilizing thirty histories of contested commodities, the paper proposes that FIM will bloom because marketplaces encourage greater trade volumes as the most effective way to increase profits. Trading agencies will develop the knowledge to identify "information gems" buried in their data heaps. These agencies will harness data integration techniques to detect interesting relationships between data that they own and data that they purchase. Successful agencies will make it easy to interact with their information assets and in the process will simplify the internal structure of their computer systems.

Still, in the wake of the 2008 global financial crisis it is naïve to base all hopes on a marketplace mechanism. Three problems call for further scholarly investigation before a FIM prototype is developed and empirically tested. First, if a large volume of federal data is exempted from trading (due to alleged security, privacy or other concerns) there may be too small an amount of interesting data that agencies will want to buy. To address this problem, we must further investigate the following questions: what kind of federal data is fitted to become a contested commodity? Should the criteria for deciding which information to trade be based on the data's inherent features, on the data's intended use or on the character of the traders? Second, if successful, FIM will change the

internal federal information eco-system, begging the question: what might be some of the unintended negative side effects of a successful federal information marketplace? After FIM is launched, what will count as "information power" within the federal sector? Which agencies will benefit and which ones will lose from this new information ecology? Thirdly, how will FIM affect the balance of power between the federal government and both state and local bureaucracies, and the private and non-profit sectors? Will FIM contribute to or damage the prospects of closing the digital divide between bureaucracies at different levels of the federal government and between the federal government and non-government sectors? Scholars have warned (based on the experience of the British Empire in the 19th century) that new information technologies can tilt the balance of power within the state in favor of government and at the expense of other non-governmental sectors (Parry, 2004).

Yet, despite these challenges, FIM's promise to solve the internal federal information sharing problem is momentous. Faced with insurmountable problems, federal agencies have twice re-invented computer science. In 1890, the Census Bureau practically invented the modern computer when it launched a competition to automate manual processing of census surveys (Austrian, 1982). In the late 1960s, DARPA led to the invention of the Internet in a project designed to ensure the survivability of communication systems after a nuclear strike (Belfiore, 2009). Today, the federal government is faced with a critical problem: poor information sharing mechanisms that cost lives and billions of dollars. FIM can become the third and most significant federal IT innovation in history.

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# THE VALUE OF INFORMATION AS AN EXPERIENCE GOOD IN THE AMAZON MECHANICAL TURK MARKETPLACE

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**Keywords:** information market, Amazon Mechanical Turk, crowdsourcing.

## INTRODUCTION

The purpose of this work is to investigate the value of information in one information market, the Amazon Mechanical Turk. The value of information may depend on external influences such as market structure but it is mainly subjective, meaning that value perception may vary among people and may be affected by the social environment, personal preferences, the passage of time or with the accumulation of experience (Raban, 2007).

This latter point is the focus of the present research, namely, investigating the value of information as an experience good. Experience goods are items of commerce that can be fully evaluated by the consumer only after purchase and use (Nelson, 1970). Information is an experience good, the full value of which is revealed only after use (Shapiro & Varian, 1999; Van Alstyne, 1999). One must experience information personally in order to form a value judgment of it. Therefore, standard market pricing norms such as are applied when selling books, for example, are not uniquely suitable for information. One must pay the full price of a book up-front before receiving and reading it. Possibly, the experience gained while reading could make one think the book was a bargain, or, alternatively, that the book was disappointing. In both cases payment was transferred, cannot be changed, and does not reflect the value of the book to the reader.

A newer influence on the experience value of information may come from the development of the web 2.0 with its easy writing and publishing technologies. Nowadays every individual can take part in the information economy by being both a producer and a consumer of information. The introduction of decentralized, distributed, user-generated content to the information market raises new questions regarding the value of information. Now that users can be found on both sides of the fence they may assess information differently (Raban, 2007). Previous research informs us that taking different roles in information markets changes the value perception considerably (Raban & Rafaeli, 2006). That research considered market participants who were either buyers or sellers. Current participants may be both.

Information has been bought and sold since ancient times. The concept of a marketplace for information work is relatively recent and presents an intriguing research opportunity. The marketplace in the current research, the Amazon Mechanical Turk, is based on the notion of crowdsourcing in which work needed is published outside the corporation, on the web, inviting the general public to participate in doing the work. Each assignment is divided into small tasks which

are then performed by individual, unrelated, workers. The crowdsourcing model deals with the question whether and how financial incentives can be used to motivate workers performance.

The Amazon Mechanical Turk<sup>5</sup> (AMT) is a popular crowdsourcing information marketplace, established by Amazon in 2005. Originally, The Mechanical Turk was a fake chess-playing machine invented in the 18th century, which was beating the best players in chess games. The secret of the Turk machine was a human chess master, hidden inside the machine.

The idea of the AMT system is that there are many information-related tasks that people can do more effectively than computers. Moreover, it can be extremely difficult (if not impossible) for computers to perform certain tasks such as rewriting translated sentences, transcribing, or tagging.

The AMT service gives businesses or individuals, called Requesters, access to a diverse group of workers and gives workers a selection of thousands of micro-tasks that require human intelligence, called HITs (Human Intelligence Tasks).

The AMT marketplace boasts more than 400,000 workers in over 100 countries (Ross, Irani, Silberman, Zaldivar, & Tomlinson, 2010). This enables requesters to have work done 24 hours a day, 7 days a week, and to get work done by a more diverse group of workers than they could by staffing workers locally.

Workers are sometimes referred to as “Turkers”. Requesters determine the amount that they will pay for each completed HIT, called Reward. The Rewards can be low as \$0.01 per HIT. Each HIT can be completed by multiple Turkers, which allows the requesters to choose higher quality performance. The Requester can require that all workers meet a particular set of qualifications or a minimum percentage of previously accepted tasks. In addition, the Requester can reject a submitted work.

AMT provides two methods for paying workers: fixed rates (rewards) on each HIT and bonuses to individual workers for especially good work. Sometimes the bonus amount is explicitly mentioned in advance and sometimes it is not. This study tries to better understand bonuses as a motivational mechanism and as a pricing mechanism to support the experience value of information.

Mason & Watts found that raising the reward for each HIT increased the quantity of individual works but not the quality and accuracy of the work performed. The implication is that paying high rewards results in faster, but not better performance (Mason & Watts, 2010).

The general question driving this study is as follows:

What is the relationship between rewards and bonuses in AMT HITs? Can this relationship inform the experience value of information?

## METHOD

We use a web crawler written in Python to gather all available information from Amazon Mechanical Turk and store that information in PostgreSQL.

We started gathering data on March 17, 2011 and till May 18, 2011 we collected 47,967 HIT groups from 3,079 requesters with a total \$47,549 reward (without bonuses). These numbers do not include HITs that were posted and disappeared between our crawls. Nevertheless, they should be good estimation of the activity of the marketplace. We crawled all available HITs on AMT and

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<sup>5</sup> <https://www.mturk.com/mturk/welcome>

stored the data of each available HIT group (groupid, requester, title, description, keywords, rewards, number of HITs available within the HIT group, qualifications required and time of expiration). We also stored the HTML content of each HIT. This method enables finding the new HITs posted over time, and the reward and bonus, if such exist, offered for each HIT. Amazon Mechanical Turk groups similar HITs together based on their common properties, such as title, description, reward, keywords and time.

At the AMT site the bonus does not appear as a separate field, but as a part of a HIT title or description. Moreover, the bonus presentation isn't uniform: verbal, numerical, mixed. In order to examine the relation between the reward and bonus variables we isolated the bonus. This was done by filtering the data, categorizing and patterns identification. In some cases, bonus identification and separation was done manually.

### FINDINGS AND FUTURE WORK

During data analysis we found out that a surprisingly high rate, 42%, of total collected HIT groups include a bonus offer. We discovered that there are three major commercial requestors who regularly use the bonus mechanism as part of the total payment: CastingWords, SpeechInk and QuestionSwami. Table 1 shows the frequencies of HIT groups by requestors and bonus offer.

**Table 1. Number of HIT groups**

	QuestionSwami	SpeechInk	CastingWords	Other requestors	Total
<b>With Bonus</b>	478	2423	17114	312	20327
<b>No Bonus</b>	91	6970	4614	15965	27640
<b>Total</b>	569	9393	21728	16277	47967

The total dollar value of HITs is presented in Table 2.

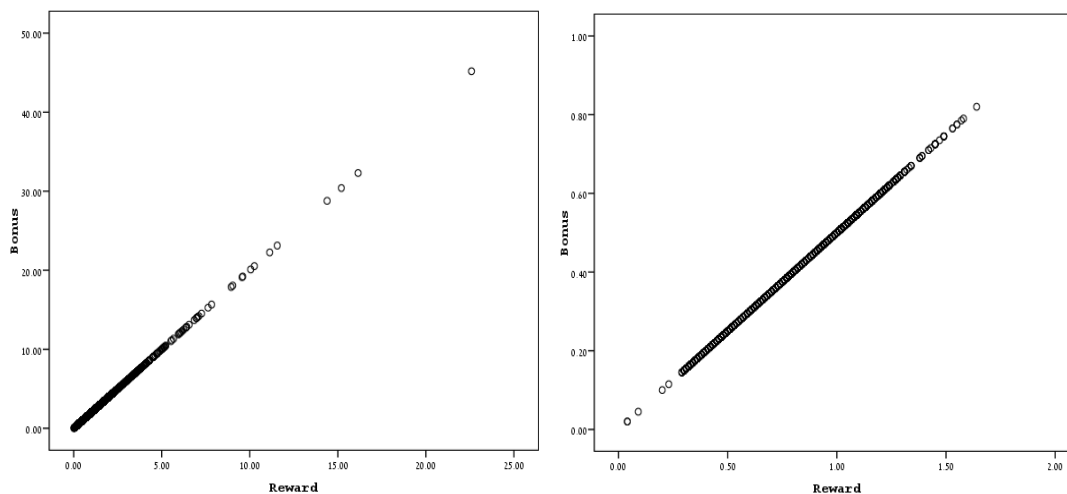
**Table 2. Total value of HITs (\$)**

	HITs with Bonus			HITs without Bonus
	Bonus	Reward	Total	Reward
<b>QuestionSwami</b>	150.18	1188.9	1339.08	5.48
<b>SpeechInk</b>	1115.85	2231.7	3347.55	5022.05
<b>CastingWords</b>	26994.96	13497.48	40492.44	13585.11
<b>Other requestors</b>	838.775	110.45	949.225	11909.11
<b>Total</b>	29099.765	17028.53	46128.295	30521.75

Table 3 shows the percent of CastingWords HITs in each cost level.

**Table 3. Distribution of CastingWords HITs per cost**

\$	Reward %	Bonus %
0-1	67.6	39.26
1-2	28.7	28.42
2-3	2.58	20.38
3-4	0.47	8.4
4-5	0.2	2.27
5-30	0.45	1.23



**Figure 1. Pearson correlation between Reward and Bonus ( $r = 1$ ,  $p < 0.01$ ), CastingWords (left) and SpeechInk (right).**

By analyzing the collected data we can learn about risk preferences of the major requestors. For example, CastingWords uses the ratio 1:2 between reward and bonus, SpeechInk uses 2:1, as presented in figure 1. We assume that this is an attempt to reduce financial risk and at the same time to raise the quality of work using contingent incentives. Since information is an experience good, its uncertainty level is high, hence the high risk when payment is guaranteed in advanced, as is commonly used in standard markets. Therefore, to reduce the risk and uncertainty, we see the tactics of the “big requestors”.

In the next phase of this research, we are planning to conduct a series of controlled experiments at the AMT site with different relationships between reward and bonus.

We hope that the findings will help to better understand the experience value of information in a digital marketplace.

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## HARNESSING THE POWER OF GAMES TO ENHANCE ORGANIZATIONAL KNOWLEDGE SHARING

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### ABSTRACT

This paper addresses the issue of scores in crowd based serious games. We unpack these terms in the following. Recent research on games focused on social and intrinsic motivations for playing games, game flow and learning, yet, relatively scant research is available on the effect of game scores on player behavior and motivation. Our research proposes to improve the understanding of the relation between game behavior and accumulated game scores (points) as indicators of motivations. We posit that the score keeping system design and the shape of the mathematical function is likely to inform us regarding patterns of participation in games. This paper is currently a theoretical basis for designing a score keeping function that will motivate players at three stages of game playing: start, persist and to strive to win. We begin with a brief definition of games and the key factors that make games motivational. We expand on reward mechanisms and bring some theoretical approaches regarding reward purposes. Understanding game scores promises to offer interesting implications in various fields such as business, game design and education. We present an actual crowd based game and highlight some aspects and benefits of using a crowd based serious game to enhance knowledge sharing.

**Keywords:** score keeping function, crowd based serious game, feedback, scores, motivation

### INTRODUCTION

A game is a competitive interaction which is guided by rules and is intended to achieve certain objectives. Broadly, games can be divided into two large groups: serious and casual games. In serious games the primary goal is education and training more so than just entertainment which is the primary goal of casual games (Breuer & Bente, 2010). Serious games have been applied in military, government and NGOs, educational, corporate, healthcare, political, business, marketing and communication settings.

Serious games are developing rapidly in recent years while generating academic and business interest (Breuer & Bente, 2010; DeKanter, 2004). The worldwide online game market is forecasted to reach over \$13 billion in 2011, almost four times the \$3.4 billion sales of 6 years earlier in 2005 (Intelligence, 2006).

Game playing is fun, attractive, engaging, and provides immediate feedback. Games create intrinsic motivation through fantasy, challenge, curiosity and competition (Crawford, 1984; Crawford, 2003; Garris, Ahlers, & Driskell, 2002; Leemkuil, Jong, & Ootes, 2000). Accelerated development of serious games over the past decade in academia as well as in the education and business sectors sprouted a wealth of academic research covering aspects such as education, learning, game flow and motivation for playing games. The prominence of scores in game interfaces and the large variety of available score keeping schemes creates an intriguing research opportunity that has received little attention so far. The present research offers to narrow this gap by gaining a deep

understanding of game motivations and linking them to game behavior and outcomes via novel score keeping functions. The focus of our research is on the game score keeping function, which is the shape of the game progress curve.

We focus on players' motivations in a new game environment called crowd based serious games. These games were born from the combination between the concept of "The Wisdom of Crowds" and serious games. Consequently, crowd based games are a computerized and networked games played in order to fulfill productive tasks. The crowd fills a purpose while each player individually is intrinsically and extrinsically motivated.

### **FEEDBACK, REWARDS AND SCORES**

In the following we briefly distinguish among three related terms: feedback, reward and score.

**Feedback** is any message generated in response to a player's action, usually after an action (Mason & Bruning, 1999). It implies that there is an interactive flow between the player and the system, based on information generated by the player and coming back to him as an output after some processing (Burgos, Van Nimwegen, Van Oostendorp, & Koper, 2007). Feedback provides useful and immediate information about performance (Burgos et al., 2007; Garris et al., 2002), and it informs the user about whether or not their intended actions resulted in the expected outcomes (Rieber, 1996). Contextual and instant feedback based on goal commitment increases the effort, the performance and the motivation (Burgos et al., 2007).

**Rewards:** One way of providing feedback is by rewarding the player during or at the end of a game. Rewards have several purposes such as enticement to enter or continue the game, to provide frequent/ immediate game feedback, to reach the final game goal, to encourage learning (Kolo & Baur, 2004; Rettberg, Corneliussen, & Rettberg, 2008; Sweetser & Wyeth, 2005). Rewards create a forward looking environment and therefore they encourage players to sustain in the game play. They also help to create a competitive environment. Some types of rewards include treasures, items, gold pieces or badges (Kolo & Baur, 2004).

**Scores:** One form of reward includes a numeric score accumulated during a session until the end of a game. Score refers to an abstract quantity measured in points that is associated with a player or team (Crawford, 1984). Events in the game can raise or lower the score of different players. The score during the game reflects performance; score indicates completion or failure of missions. Performance feedback and score keeping allow the player to track progress towards desired goals (Garris et al., 2002). Not only does a score assist in telling the player where they stand, it is a form of feedback that encourages mastery of the game (Federoff, 2002). Final outcome measures reflect the learner's overall performance in the game. Outcome measures document the final status of events, or may specify a relative scaling of performance in relation to others (Leemkuil et al., 2000). Using points increases motivation by providing a clear connection between effort in the game, performance and outcomes (points) (Von Ahn & Dabbish, 2008). Different score strategies are used to keep players engaged: extra bonus points, dividend points, points deduction for using hints (Hacker & Von Ahn, 2009; Von Ahn, Liu, & Blum, 2006).

### **CROWD BASED SERIOUS GAMES AND ORGANIZATIONAL SETTING**

Large enterprises often need to generate datasets for research, maintenance, and optimization purposes. Gathering the relevant information is both costly and time consuming and it also raises the problem of motivating people to participate. Using a game mechanism is suggested to encourage large numbers of users to participate. Scores are an important game incentive and play a role in making games motivational and engaging (Hacker & Von Ahn, 2009). Von Ahn and Dabbish first suggested the use of games as an attractive mechanism to attract the crowd to perform tasks that are hard for computational engines to cope with (Von Ahn & Dabbish, 2008; Vukovic,

Kumara, & Greenspan, 2010; Vukovic, Laredo, & Rajagopal, 2010). Vukovic presented virtual points as an incentive mechanism for achieving desired outcomes in an enterprise crowdsourcing service for IT Inventory Management (Vukovic, Laredo et al., 2010). Using points makes the enterprise crowdsourcing platform challenging and competitive (Vukovic, Laredo et al., 2010). Virtual points and user ranking also encourage secondary contributions such as engagement of lurkers through ratings and comments (Vukovic, Laredo et al., 2010). When a game is implemented in a corporate environment the incentive to play better is important in order to achieve the organizational purposes.

## GuessWho

We consider the crowd based computer game GuessWho. The game prompts players with names of people they are likely to know based on a recommender system. The player's task is to provide related people and tags to those individuals. The game results indicate that the game rapidly collects large volumes of valid information that can be used to enrich and complement the existing social network information. The advantage of using a game, rather than a tool such as questionnaires, is that it rewards participants for contributing valuable information while having fun. The player can see the time progression and how many other players are currently playing which adds pressure and a competitive environment to the game. The score keeping function includes dividend points and a dynamic update of the player's total score. In order to motivate the player to engage in more rounds of GuessWho the application sends updates to the player includes the total points, current ranking, and a tip shows the number of points required for moving one ranking up on the leader board. Different score keeping functions define different leader boards, and hence affect the competitiveness and motivation of the player.

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# ATTENTION IN CMC: INFORMATION-OVERLOADED KNOWLEDGE WORKERS

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**Keywords:** attention management, information-overload, email triage.

*"The most valuable asset of the 21st century institution (whether business or non-business) will be its knowledge workers and their productivity" (Drucker, 1999).*

## INTRODUCTION

Knowledge workers now account for more than half of the Western labor force and these figures are rapidly growing. Along with this growth, the nowadays organizational environment is IT-driven, rapidly changing and information-overloaded. Information-overload (Jones, Ravid, & Rafaeli, 2004; Zeldes, Sward, & Louchheim, 2007) is considered to be a major hindrance for organizations and is severely affecting the efficient work and productivity of organizations. The objective of increasing organizational productivity, despite the above impeding factors, can be accomplished through understanding the behavior of knowledge workers, and the interaction between them and their work environment. In our research study we explore Computer-Mediated-Communication (CMC), mainly organizational email, as a characteristic of the IT-driven work environment, and examine coping strategies of knowledge workers through this medium. As organizational productivity involves attention economy (Davenport & Beck, 2001), we focus our research on the organizational attention (Ocasio, 1997; March, Schulz & Zhou, 2000) of the individual knowledge worker to organizational needs, as expressed in organizational email.

## OBJECTIVES

We apply cognitive psychology literature, mainly bounded-rationality, prospect theory, heuristics and dual-process theories of thinking, to explain individual knowledge worker attention allocation. We assume that individual level attention allocation to the needs of the organization is illustrated in triage strategies of organizational email. The two main triage techniques are serial and prioritized: serial technique applies a sequential approach, usually chronological order like First In First Out (FIFO) or Last In First Out (LIFO), for viewing or replying to messages in the email inbox; in prioritized technique users view or reply to messages by the order of the perceived importance of messages. We postulate that serial triaging implies no allocation of organizational attention, while prioritized triaging implies some organizational attention allocation (by selectively and consciously reciprocating to other organizational players). Due to the fact that prioritized prompt replying is not always based on the organizational importance of a message (e.g., Dabbish, Kraut, Fussell, & Kiesler, 2005), we therefore assume that prioritized triaging doesn't imply full organizational attention allocation, but manifests only an upper limit to attention allocation of the individual knowledge worker to his organizational environment and organizational needs. As the triage technique implies organizational attention allocation, understanding the balance and utilization of each triage technique may suggest some measure of organizational attention allocation. This understating is quite novel and may promise some initial direction for measuring the illusive-natured organizational attention. We thus pose three research questions:

1. Is serial (i.e. chronological) triaging more frequent than prioritized triaging?

2. Is there a difference in the above frequencies between email reading and email replying?
3. Is there a difference in the above frequencies between the intended behavior and the actual behavior of the individual knowledge worker?

## METHOD

In order to answer the research questions, we defined and derived 4 variables: intended percentage of prioritized read emails (relative to all read emails), intended percentage of prioritized replied emails (relative to all replied emails), actual percentage of prioritized read emails (relative to all read emails), and actual percentage of prioritized replied emails (relative to all replied emails). Several methods were employed to derive these different facets of email triaging:

1. Intentions:
  - a. Variables: (I) Intended percentage of prioritized read emails (relative to all read emails). (II) Intended percentage of prioritized replied emails (relative to all replied emails).
  - b. Population: 338 participants from a large military logistics organization that employs about 1450 employees.
  - c. Design: an online web-based survey using an organizational intra-net to elicit triaging (both reading and replying) intentions (a response rate of 23.3%).
2. Actual reading:
  - a. Variable: actual percentage of prioritized read emails (relative to all read emails).
  - b. Population: 14 individual knowledge workers employed in another but smaller military logistics organization with about 300 employees.
  - c. Design: an analysis of actual reading triage strategies of individual knowledge workers, after applying an activity capturing background software.
3. Actual replying:
  - a. Variable: actual percentage of prioritized replied emails (relative to all replied emails).
  - b. Population: 27,714 emails retrieved from the publicly published Enron Email Dataset.
  - c. Design: An analysis of organizational emails chronemics to elicit actual replying strategies.

## RESULTS

**Table 1. Results**

	Reading	Replying
Intended prioritized triaging	21.3% - 34%	47% - 76%
Actual prioritized triaging	15.5%	29.6% - 46.1%

## DISCUSSION

The result, that 47%-76% of organizational email users intend to reply more organizationally-inclined rather than reply chronologically, may imply that users wish to allocate attention to organizational needs and expedite workflow of perceived important matters. The lower result that only 21.3%-34% of organizational email users intend to read more organizationally-inclined, rather than read chronologically, may be explained by the fact that reading acts as a basic filtering mechanism, which applies the simplest, fastest and most straightforward heuristics: the chronological ones. Moreover, chronological sorting is very common as part of the basic default interface of most email applications. The result that only 29.6%-46.1% of organizational email users actually reply more organizationally-inclined, rather than reply chronologically, and only

15.5% of organizational emails are read more organizationally-inclined, rather than read chronologically, implies that users actually allocate less attention to organizational needs than they intend to. Another point can be highlighted by the result that the percentage of prioritized reading is smaller than the percentage of prioritized replying; it may imply that organizational email users are less organizationally attentive when skimming through emails and mentally (or physically) prioritizing what needs to be processed later, while they are more attentive when execution is needed. As we refer to the percentage of prioritized triaged emails (relative to all triaged emails) as the upper limit of organizational attention one allocates through this medium, there are two straightforward meanings: (I) organizational actual attention of knowledge workers is far from optimal, and (II) that organizational email users mistakenly consider themselves as more organizationally attentive than they really are, thus their intention to be attentive is higher than their implementation. A literature review of measuring email triage techniques revealed only the study conducted by Neustaedter, Brush & Smith (2005). They used a survey to study sequential or prioritized email triaging, which resembles to our variables of intended reading and intended replying. Their results indicate that 19% of all participants triaged by priority only, 30% only sequentially and 15% used both (the remaining were indifferent to either strategy). In order to compare to our variables, we can view these results as intended prioritized triage of maximum  $19\%+15\%=34\%$ , and this result rather falls in the range of our results (Intended prioritized reading of 21.3% - 34%; Intended prioritized replying of 47% - 76). While Neustaedter, Brush & Smith (2005) studied email triaging techniques using only a survey, we used various methods, thus triangulating results, and received more attentional facets (i.e. intended or actual, differentiating between reading and replying).

It turns out that organizational knowledge workers often employ intuitive fast but sub-optimal heuristics, apparently framed by the user interface of email software, which decrease their attention to important organizational roles (e.g. customers) and needs, thus decreasing their organizational productivity and occasionally inadvertently impair organizational objectives, goals and revenues. One major implication is that in our information-overloaded organizational environment, attention allocation and attention management are crucial; attention may act as a filter for eliciting knowledgeable and organization-oriented actions and decisions, thus leading to better productivity.

## CONTRIBUTION

This study contributes to both theory and practice in several ways, just to name a few:

Theory contribution:

1. Contribution to information-overload literature, by further investigating and understanding coping strategies.
2. Expansion of organizational attention management research by referring to all kinds of knowledge workers and their personal level attention (while recent attention management studies mostly concern top management teams and organizational level strategic attention).
3. We apply cognitive psychology concepts (e.g., bounded rationality and heuristics) to study and explain individual level attention allocation in information overloaded CMC intensive nowadays organizations. Hence, while these concepts (mainly the observation that biases of judgment are systematic) were mostly recognized as relevant to the field of economics, our research study employs, quite innovatively, these underpinnings of psychological cognitive theories to the field of IT.

Practical contribution:

4. Understanding email coping strategies (and the framing effect of email software) enlightens better needs, features and designs for CMC and CSCW (computer supported cooperative work).
5. The study exemplifies that different knowledge workers have different coping strategies, needs and preferences. Therefore the need for personalization and more agile software applications is sharpened.

6. The study supplies support for the anchoring effect of basic application interface: users seldom explore application capabilities and hidden features, and achieve sub-optimal utilization and productivity. Thus, comprehensive assimilation processes for new software are of prime interest and necessity. The other (more marketing and economics oriented) side of the coin is the meager need for developing extra (and seldom used) features.
7. The study emphasizes the need for more creative and effective means for managing and better utilizing attention.
8. Better understanding of attention may help in building better decision support systems and mechanisms for email handling. The new generation email software should possess attention based abilities such as learning, filtering, sorting, archiving, recalling, prioritizing and alerting.

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# HARNESSING TEXT MINING AND BIBLIOMETRIC WEB COUNTS FOR MODELING IT ASSESSMENT FRAMEWORK AND AUTOMATED TOOL

Research in Progress – Abstract

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**Keywords:** technology assessment, bibliometrics, web mining, information extraction, co-word analysis.

## INTRODUCTION

In today's hyper-competitive business environment, in which Information technology (IT) innovations occur at increasing speeds with shorter life cycles, companies engage in technology assessment (TA) prior to IT investments. However, TA presents a tough challenge for decision makers due to their inability to manually process the abundance of data available about a specific technology on the Internet. This research-in-progress aims at responding to the TA challenge by modeling a TA framework for making sense of Internet data about a certain technology and developing automated decision support tool based on the model - Technology Assessment Software Kit (TASK).

This new TA approach, after fetching from the web a diverse corpus of unstructured textual data, draws on a unique and novel synergy of two well-established research fields:

a) information extraction (IE), also known as entity extraction, is applied to the corpus using a text mining (TM) technique based on natural language processing (NLP) to yield named entities and create a concept map in order to uncover in the corpus hidden patterns of relatedness proximity via co-word analysis and concepts relatedness algorithms; and b) bibliometrics is applied to the extracted concepts (i.e., semantic objects) to further fine tune the relatedness proximity through a series of bibliometric search queries using a search engine such as Google, amplifying silent information (e.g., tacit data) and reducing noisy information (e.g., outlier data).

Another novel feature of the research is the quantitative temporal operators, drawn on the basis of the Vector Space Model (VSM) and the cosine similarity measure, which are embedded in the concept map in order to establish temporal proximity and distinguish between emerging concepts and established concepts based on time dimension and temporal values. The combination of relatedness and temporal proximities yields a more accurate and augmented concept map.

## OBJECTIVES AND MODEL

The main objectives of the research are: (1) Modelling a new TA framework targeted at a specific technology, using the web both as a primary source of temporal textual data (e.g., PDF, Office documents, HTML files etc) and as a search space of web counts, and (2) Developing, implementing and validating the associated TASK tool, using a dashboard user interface as customary in business intelligence (BI) applications. To accomplish these objectives, full-text analysis, IE, co-word analysis and traditional bibliometric methods (e.g., number of publications) are combined with quantitative temporal operators, featuring relatedness and temporal proximities.

### Relatedness proximity: Applying bibliometrics web counts for improved concept maps

The novel idea behind the TA framework is to apply IE to extract the concepts (such as person, company, etc.) in the concept map constructed and then fine tune the extracted concepts through a series of bibliometric search queries using a search engine, such as Google, amplifying silent information (e.g., tacit data) and reducing noisy information (e.g., outlier data). The bibliometrics activity, in which numbers of related documents (i.e., bibliometric indicator) returned by the search set of bibliometric queries are combined with the traditional co-word cluster weighting analysis, affects only the weights assigned by the traditional co-word analysis, contributing no new concepts other than those extracted during the IE activity.

In the combined co-word process, described in Figure 1, the Similarity Link Value (SLV) calculation of co-occurrences is composed of three computational steps: in Step 1, using NLP-based TM tool, the IE activity extracts significant semantic concepts, yielding a-priori co-occurrence clustering indexes  $aSLV_{ij}$  for concepts  $i$  and  $j$ . In Step 2, the bibliometrics activity processes the extracted concepts, yielding the bibliometric co-occurrence clustering indexes  $bSLV_{ij}$ . In Step 3, both indexes are synthesized into combined co-occurrence clustering indexes  $cSLV_{ij}$ :

$$cSLV_{ij} = f(aSLV_{ij}, bSLV_{ij}) = f\left(\left(\frac{aC_{ij}^2}{aC_i * aC_j}\right), \left(\frac{bC_{ij}^2}{bC_i * bC_j}\right)\right) \sim \left(\frac{(aC_{ij} + bC_{ij})^2}{(aC_i + bC_i) * (aC_j + bC_j)}\right)$$

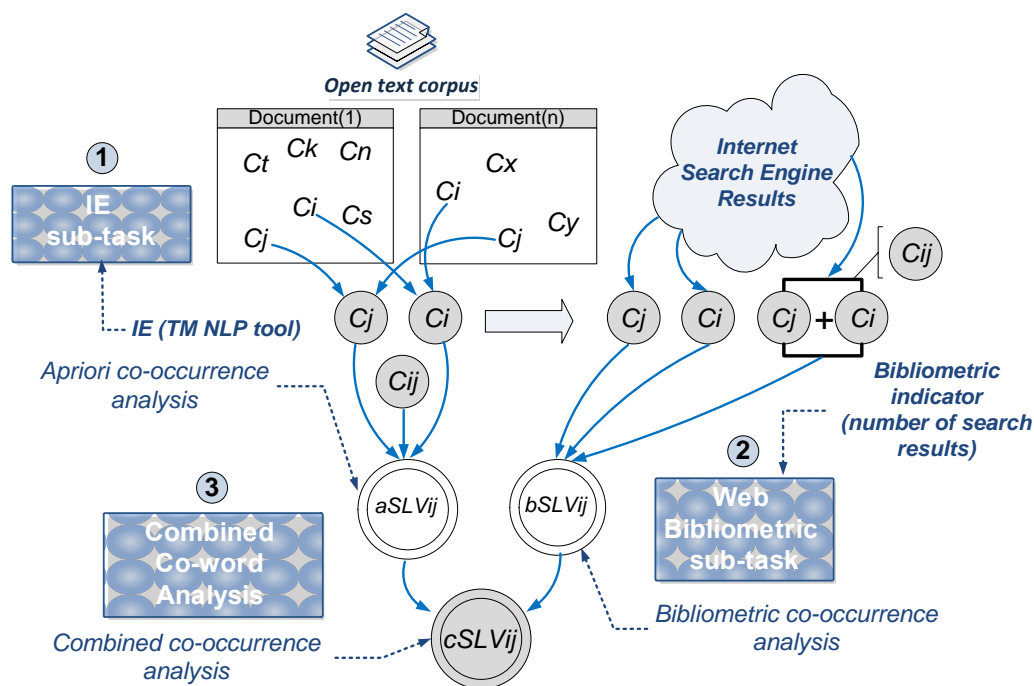


Figure 1: Combined co-word process

### Temporal proximity: Diagnosing emerging concepts using quantitative temporal operators

To present temporal values in concept maps in a novel way, describing the relatedness of two concepts on time scale, the modeled TA framework enhances the scalability of the Vector Space Model (VSM), also known as Vector Space Cosine Similarity method, by exploiting the cosine similarity measure for expressing the temporality value of the relationship between two co-occurring concepts in a concept map. The relationship can be described either as old (established) or young (emerging). If concepts  $i$  and  $j$  co-occur in  $n$  documents, a vector  $y$  with  $n$  dimensions is created, where each coordinate reflects the number of days since creation of each document. The

cosine similarity measure is applied to a reference vector  $\mathbf{x}$  with  $n$  dimensions, where all assume the value 1 to reflect 'fresh' temporal value (created today).

Four measures are proposed for assessing temporal proximity:

- Age of concepts relatedness -  $Age(x, y)$
- Publishing frequency rate (i.e., publication ratio or activity ratio) of relevant documents where concepts co-occur -  $Frequency(x, y)$
- Total range of publication dates of all relevant documents -  $DateRang$
- Average publication time value of all relevant documents -  $AverageDate$ .

The four measures are described in the following formulas:

$$Age(x, y) = \frac{\sum_{k=1}^n x_k y_k}{\sqrt{(\sum_{k=1}^n x_k^2) * (\sum_{k=1}^n y_k^2)}} , \text{ where } x_k \stackrel{\text{def}}{=} 1$$

$$Frequency(x, y) = \frac{\sum_{k=1}^{n-1} |x_k - x_{k-1}| |y_k - y_{k-1}|}{\sqrt{(\sum_{k=1}^{n-1} |x_k - x_{k-1}|^2) * (\sum_{k=1}^{n-1} |y_k - y_{k-1}|^2)}} , \text{ where } |x_k - x_{k-1}| \stackrel{\text{def}}{=} 1$$

$$DateRange \{ \min y_k \}, \{ \max y_k \}$$

$$AverageDate = \frac{\sum_{k=1}^n 1/y_k}{n}$$

This study has identified two major features -  $Age(x, y)$  and -  $Frequency(x, y)$  implemented with the cosine similarity measure that an emerging concept should possess. In order to classify a pair of concepts as emerging concepts, both should be semantically richer at a later time than they were at an earlier time. In addition, an emerging pair of concepts should co-occur more frequently as an increasing number of documents reference them. Thus, the relationship can be described either as old (established) or young (emerging), and active (progressive) or inactive (static) respectively.

## METHOD

TASK is a web-based tool being developed in order to automate the conceptualized TA model, including data collection from the web to create the textual corpus and a user interface to allow decision makers to interactively engage in technology assessment. The TASK architecture (Figure 2) features 15 steps, following on a functional level the general model provided by some classic data mining applications (e.g., CRISP-DM) and is thus roughly divisible into six main stages: (1) temporal domain-oriented text collection, (2) preprocessing tasks, (3) core processing operations, (4) post-processing analysis, (5) presentation layer components and browsing functionality, and (6) evaluation and refinement techniques.

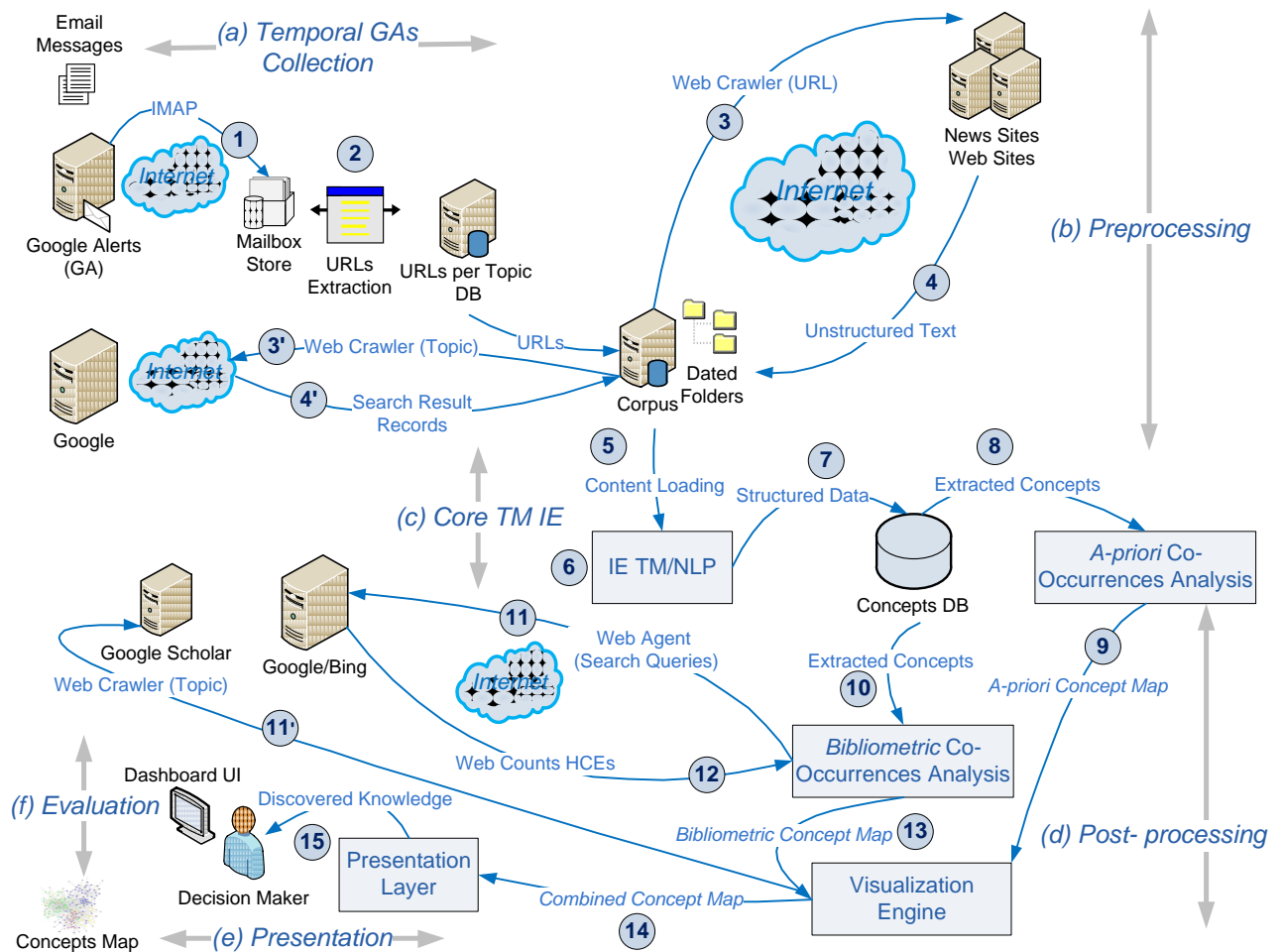


Figure 2: TASK Architecture

1) **Temporal GAs collection** involves collecting a repository of Google Alerts (GA) email updates which includes one or more URL links to domain-specific (e.g., grid computing) web documents (e.g., HTML, XML) in diverse web sites. This non-static process of gathering links over time facilitates in Stage 2 collection of documents into a *dynamic* and *temporal* corpus. Step 1 of the TASK execution plan in Figure 2 depicts Stage 1.

2) **Preprocessing tasks** include all routines, processes, and methods required for fetching the actual HTML files, using crawling techniques. A *crawler* web agent is applied in order to automate the execution of the actual textual data gathering, starting from a list of URLs stored in the repository created in Stage 1 that includes all links embedded in the GAs email messages received over time. Moreover, it is possible to enrich the corpus with a set of text documents which already exist as soft copies, or by generally executing a Google search query within an IT sub-domain (i.e., topic). The search result usually include up to one thousand URLs which are extracted and crawled accordingly (Steps 3' and 4' in Figure 2). Steps 2 to 4 of the TASK execution plan in Figure 2 depict Stage 2.

3) **Core NLP-based TM and IE operations** are routines and processes for concept discovery in the corpus intended to execute the IE sub-task. Two of several IE tools available are implemented; SPSS LexiQuest Mine and Alchemy API. In this stage, the document corpus yielded by Stage 2 is categorized, keyword-labeled and time-stamped, with extracted concepts and their relevant metadata (e.g., time stamp, total number of appearances, average concept distribution etc) stored for further analysis. Steps 5 to 7 of the TASK execution plan in Figure 2 depict Stage 3.

4) **Post-processing analysis** includes all procedures and methods required for executing the bibliometric sub-task. First, the *a-priori* co-occurrence analysis is calculated on concepts extracted in Stage 3, resulting in *a-priori concept map* and initial co-word weights and other properties. The *bibliometric* co-occurrence analysis implements a special *web client* that iteratively conducts search queries in Google (i.e., web bibliometrics sub-task). The name of the specific IT sub-domain (i.e., topic), is added accordingly to a specific search query for disambiguation, since ambiguity particularly affects named entities such as person with common names in different domains. Thus, the search result for each *search expression* is an HTML file. The HTML header frame includes the number of publications (results) retrieved for a specific search. Finally, the *combined concept map* is calculated by the  $cSLV_{ij}$  function. Steps 8 to 13 of the TASK execution plan in Figure 2 depict Stage 4. The visualization engine presents for each topic the most cited articles or books along with the list of authors from Google Scholar (Step 11' in Figure 2).

5) **Presentation layer components and browsing functionality** include graphical user interface and search capabilities. *Presentation layer* components display the *combined concept map* with references to co-occurrence weights calculated at each step. The browsing functionality provided by the *presentation layer* may include; simple filters of minimal support level on concept threshold parameters; query and search interpreter; graphing and GUI to dynamically present concept maps. Steps 14 to 15 of the TASK execution plan in Figure 2 depict Stage 5.

6) **Evaluation and refinement techniques** include the most fundamental iterative notion idea embedded in the knowledge discovery and the TM process. This stage is carried out by the decision maker, while valuating and interpreting the acquired results, and thus not depicted in Figure 2.

## RESULTS

Preliminary results point to accomplishment of the research objectives vis-à-vis: modeling a new TA framework and creating an automated decision support tool, both of which aid decision makers in assessing a specific technology. The novel TA paradigm goes beyond conventional NLP-based TM applied to closed textual corpus by acquiring all data from the Internet and by featuring robust concept mapping of significant concepts co-occurrence enhanced with bibliometrics. Moreover, the results demonstrate the feasibility of decreasing the number and the dimensionality of extracted concepts and displaying only significant key concepts, which improves the visualization of the resulting concept map and thus increases the its understandability by decision makers. Finally, inclusion of quantitative temporal operators in the concept mapping process can help in detection of emerging concepts.

## CONCLUSION

To improve concept mapping applied in the TA decision-making process, this research-in-progress presents a novel approach for applying concept relatedness measure to a concept map, using synthesized web counts with corpus level co-word analysis and quantitative temporal operators. While previous related work suffers from noise and information overload, the application of bibliometrics here improves concept mapping by selecting and presenting only the significant and important relationships between concepts. Moreover, the application of cosine similarity measure for expressing the temporality value of the relationship between two co-occurring concepts in a concept map adds value to the TA process by distinguishing between emerging and established concepts. Augmenting traditional concept mapping in this work with a method for evaluating concept relatedness based on estimates of bibliometric counts applied to web textual data, coupled with the temporal enhancement, can empower decision makers engaged in technology assessment. Future research will address issues such sentiment analysis and opinion mining on the concepts extracted from the corpus.

# EXPLAINING OVERSPECIFICATION IN SOFTWARE PROJECTS: AN EMPIRICAL INVESTIGATION OF BEHAVIORAL EFFECTS

Research in Progress

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**Keywords:** overspecification, software development, endowment effect, IKEA effect

## INTRODUCTION

One of the top ten risks in software development projects is the phenomenon of overspecification, also known as gold-plating, where the specifications of a product/service are beyond the actual needs of the customer/market. Once a project is launched it is very difficult, if not impossible, to cut its scope, even when some features are suspected as being the result of overspecification. In this work, we argue that overspecification is partially due to the emotional involvement of the developers with already-specified features, which seems to be associated with the endowment effect. Derived from prospect theory, the endowment effect leads people to place a higher value on objects they own than on objects they do not own. Research on the endowment effect has shown that the effect holds beyond physical goods and holds for imaginary possession rather than only for objects of real possession. Also noteworthy in this context is "the IKEA effect", reflecting the influence of one's putting his/her self into the object's production process on the perceived value of the object. The IKEA effect implies that when people construct products themselves, they come to overvalue their creations. Similarly, the "I designed it myself" effect, referred to here as the self-design effect, reflects the value increment one ascribes to a self-specified object. Other research noted that labor leads to higher valuation only when fruitful and that the IKEA effect dissipates upon failure to complete the product development. Early studies also address the time effect, arguing that ownership duration has a positive impact on product valuation.

## OBJECTIVES

While the existing literature does not address the above effects in the context of software development, the objective of this research is to study whether these effects are manifested in software projects, arguing that software developers get emotionally attached to their creation. Since even on non-software contexts there is lack of integrative studies that test more than one of the above effects in a single setting, the present study aims to explore whether the above three behavioral effects, endowment effect, self-design effect, and time effect, explain overspecification in software development. We hypothesize that putting one's ideas and cognitive effort in specifying a feature does change the feelings towards it. We suggest that this effect holds not only for essential features but also for nice-to-have features. However, we hypothesize that this effect holds especially when the developer feels that s/he has succeeded in the specification task. We further hypothesize that the more time and effort the developer spends specifying a software feature, the more emotionally attached to that feature s/he becomes. As a consequence, the perceived importance of the feature increases and the willingness to cut the feature from the project scope decreases. Another hypothesis is that the amount of one's cognitive effort invested in the process influences the magnitude of her/his feelings. Thus, when allowing higher specification freedom to the developer, a higher increment in perceived importance will be observed, compared to cases allowing lower freedom. In addition, we examine whether the employment position of the developer (an employee of the user organization versus an employee of a software company hired by the user organization)

or the contract status (ex ante versus ex post) influence the change in perceived importance. Our final hypothesis refers to the interaction among these factors.

## METHOD

To empirically test these hypotheses we applied a factorial design of  $2 \times 2 \times 2 \times 2$  as a result of four dichotomous independent variables – (1) specification duration, (2) specification freedom, (3) software ownership, and (4) contract status – and conducted a one-hour long experiment. To achieve the purpose of the study, i.e., to measure the change in the perceived importance of a certain software feature being specified by the participants, we designed a three-step experiment. The first step involved filling up Questionnaire A to set the stage for the experiment. Questionnaire A began with a case story about developing a software system for remote banking clients, provided in eight different versions for the purpose of manipulating the second, third, and fourth independent variables. After presenting the case story, Questionnaire A proceeded to ask participants to rank 16 different functional features according to their importance to the goal of the described system. The second step of the experiment was a specification process for one of the features mentioned in the first step. The feature to be specified was the same feature for all participants. This feature was chosen deliberately to be a nice-to-have feature. To manipulate the first independent variable, we defined two different time durations (10 minutes and 30 minutes) for separate experiment groups. The third step of the experiment involved filling up Questionnaire B to assess the change in perceived participant importance of the same feature list except for being introduced in a different order. Questionnaire B also included questions about participant feelings of accomplishment and satisfaction. The end of Questionnaire B included demographic and background questions such as gender, age, and previous experience. At the end of each step the filled-up questionnaire was taken and replaced by the questionnaire of the following step.

Advanced students in the Information Systems track at the Department of Industrial Engineering and Management at Ben-Gurion University were asked to participate in the experiment. Participants were randomly assigned to groups that performed the experiment in separate sessions. Data collection was recently completed, yielding 212 participants: 94 fourth-year students and 118 third-year students, with participation rates of 79% and 90% respectively.

## RESULTS AND CONCLUSION

We are currently at an early stage of data analysis. Our preliminary findings show that participants exhibit higher perceived importance toward the feature they specified, as measured by the difference between how they perceived the importance of this feature before and after the specification task. We intend to present our broader findings at the conference.