Social Network Enhanced Digital City Management and Innovation Success: A Prototype Design

Bih-Ru Lea
Wen-Bin Yu
Prashanth Kannan
University of Missouri – Rolla

ABSTRACT

Innovation is the process by which knowledge is transformed into products and services which in turn fuels economic development to create wealth and generates improvements in the standard of living. With the advance of technology, social networks that play a fundamental role as a medium for the spread of information, ideas, and influence among its members have taken a form of digital city to offer a range of online services, including access to social environments, community services, and e-commerce to its infohabitants. This study investigates how social network theories can be used to design and manage a web-based digital city that connects entrepreneurs to influential factors of innovation (e.g., supply factor, demand factor, industrial support activities, business strategies and structures) and consequently enhances the innovation process. A conceptual entity-relationship diagram is proposed; design principles and an implementation prototype are discussed and presented.

INTRODUCTION

With the globalization of economies and competition, innovation has become the most important factor in development, employment, and prosperity (Komninos, 2002). Innovation is defined as the transformation of science and technological knowledge into products, processes, systems and services (Luxembourg, 1996) that fuel economic development to create wealth and generate improvements in the standard of living. The process of transformation often follows a linear trajectory from generating intellectual properties/innovation ideas during the basic research stage to production and marketing stage with a feedback loop, as shown in Figure 1.

Although innovation is difficult to measure, commercial success of products, processes, or services from innovation could serve as an objective means to evaluate impact of innovation on economic development (Komninos, 2002). Unfortunately, only a very small portion of innovative ideas achieve commercial success as reported by Stevens and Burley (1997), as shown in Figure 2. This has greatly limited the potential for economic development, wealth creation, and living standards improvement.

A social network can be defined as a set of people, organizations or other social entities, connected by a set of socially meaningful relationships, such as friendship, co-working or relationships formed by information exchange and interactions. Social networks provide participants with opportunities of finding social support, establishing new social or business contacts (Hogg & Adamic, 2004), starting collaboration (O'Murchu, et. al., 2004), exchanging social capitals or resources (Garton, et. al. 1997), and enabling knowledge transfer (Argote & Ingram, 2000; Reagans & McEvily, 2003). With the advancements in communication technology, social networking model can be applied in developing a digital city. Starting from the conception of building social network based web sites in 1999, the focus on this area has increased significantly.

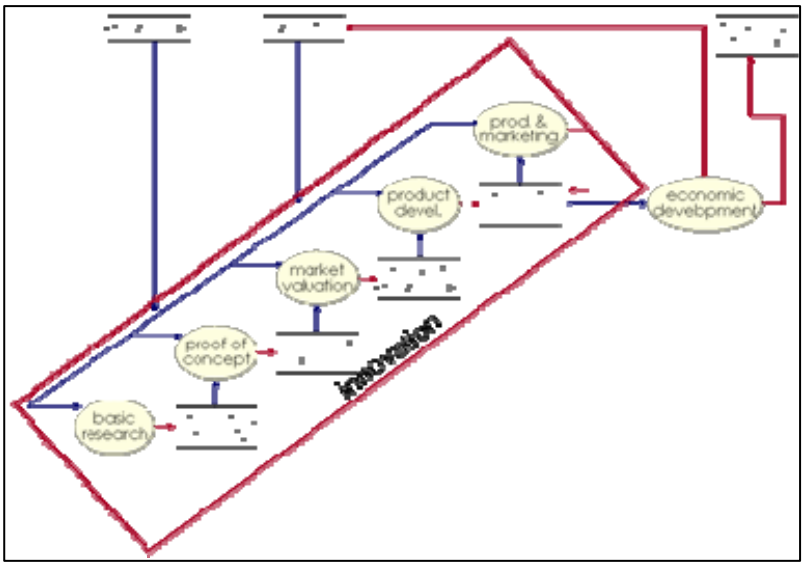


Figure 1: The Innovation Process.

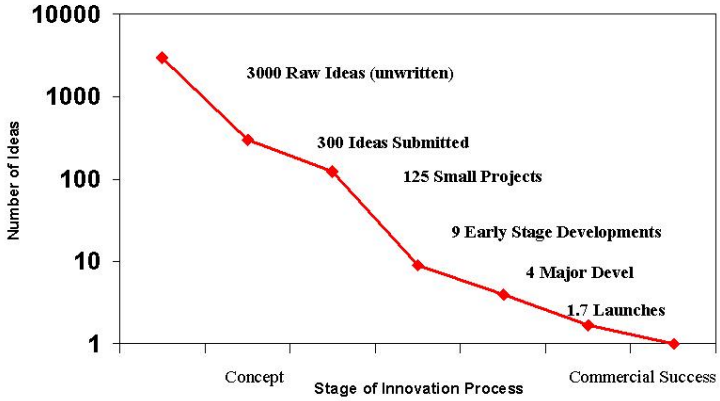


Figure 2: Innovation Stage: From Ideas to Commercial Success.

Source: G. Stevens and J. Burley, Research in Technology Management, May-June 1997

Although both digital cities and social networks could carry out major social and economic advancements (Ishida, 2002a & 2002b), limited research exists to apply social network concepts to design and construct a digital city to enhance innovation success. Therefore, the objective of this study is to apply theories from social network and digital city in designing a web-based digital city as a means of connecting individuals to influential factors of innovation and, consequently, improve probabilities of innovation success.

The structure of the paper is as follows: First, a brief literature review on influential factors for innovation success, social networks and digital cities is provided followed by the research methodology. Subsequently, a case study is used to provide insights on designing and managing a social network based digital city. This case study presents different means and designs to strengthen an individual's social network, to connect individuals to influential factors of innovation, and to obtain support needed during the innovation process. Finally, the implications and future research directions are presented.

LITERATURE REVIEW

Influential Factors of Innovation Success

Influential factors on the success of innovation include supply factors, demand factors, industrial support activities, and business strategies and structures (Reagans & McEvily, 2003). The supply factors include human resources, knowledge and information, and funding. The demand factors include existing and potential demands/needs, and local and international markets. Production, products, employment strategies and flexibility are part of the industrial support activities.

To translate a successful innovation into a commercial success, multi-dimensional supports, as shown in Figure 3, are required. Kraus and Schwarz (2007) reported that pre-start-up planning leads to ongoing planning and thus improved the success of business. Therefore, the dimension of specialist support includes pre-start-up planning such as technology application and management, demonstration, product evaluation, intellectual property advice, patent application, financial advice, and market research. The dimension of skills transfer includes finding liaison between research institutions/universities/individuals and industries, locating R&D resource, performing skill search, recruitment, and training and education. The technology transfer dimension involves research for products and processes, R&D technology audit, technology brokerage, and licensing issues. Funding is another support dimension critical to successful innovation and mediates all other dimensions.

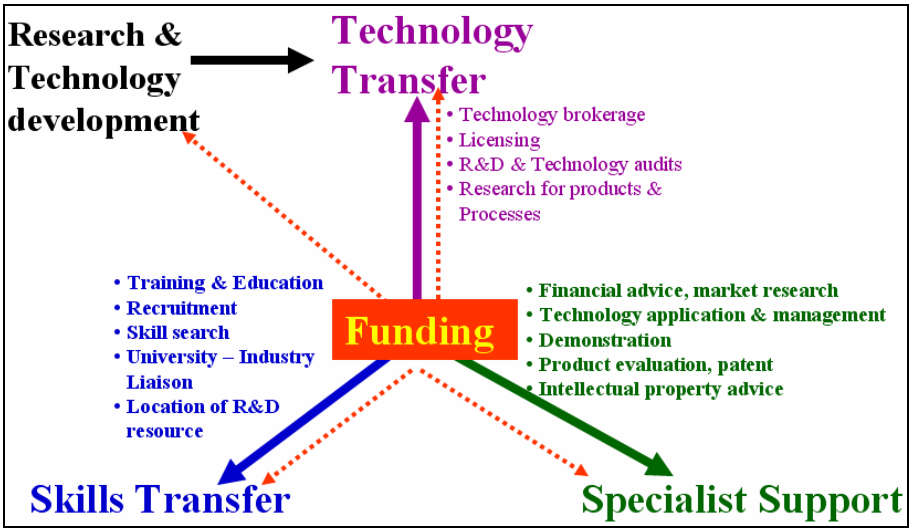


Figure 3: Dimensions of a Successful Innovation.

Social Networks

It is believed that innovation success is positively correlated with the opportunity to mobilize and direct resources/support to a solution from different support dimensions during the innovation process. However, an individual's opportunity to mobilize and direct resources is a function of the strength of his/her social network. Therefore, it is important for an individual to have a strong social network in order to establish and maintain connectivity to resources needed for innovation success. Consequently, strengthening an individual's social network leads to higher probability for innovation success.

A social network is a graph of relationships and interactions within a group of individuals (often called actors in social network literature) and plays a fundamental role as a medium for the spread of information, ideas, and influence among its members (Churchill et al., 2004; Wellman, 1997). Figure 4 is an illustration of relationships in a social network. In the figure, elliptical items represent individuals in a social network. For ease of understanding, only 3 levels of relationships have been depicted in the diagram and only individual 1 (ellipse 1) at

the top of the network is considered for indirect links illustration. The social network starts at individual 1 who has a direct social relationship with individuals 2, 3 and 4 (depicted as ellipse 1 that is linked to ellipses 2, 3 and 4 by solid lines with arrow heads). Each of the individuals 2, 3 and 4, has direct relationships with 5, 6, and 7, with 8, 9, and 10, and with 11, 12, and 13 respectively. As every individual (individuals 2, 3 and 4) known to individual 1 has a direct social relationship with other set of individuals, Individual 1 has indirect links with this other set of individuals, depicted as dashed arrow lines.

A social network can exist if an individual has an acquaintance that can form a social relationship and take the tree forward (as in the case of individuals 8, 9 and 10 in Figure 4). Because individuals 8, 9 and 10 are linked to individual 3 who is linked to individual 1 who is directly linked to individuals 2, 3, and 4 and indirectly connected to individuals 5, 6, and 7, individuals 8, 9 and 10 have an indirect link with those individuals connected by 1. So, they are still part of a social network. Though there is a link, it is not strong. These types of links will be considered as end nodes while breaking the network to form smaller networks with an administrator to manage each network.

Just as individuals can link to each other through a social relationship and form a social network, network groups (Garton et al., 1997) can be connected to other network groups (forming a network of networks) by individuals sharing membership in these groups, as shown in Figure 5. A, B and C are social network groups and ellipse 13 represents an individual who is not a part of any group. Although individual 13 is not a part of any group, he has a social link with individual 7 of group B and is part of this social network. Each social group has a set of individuals who have social links among them and the groups are connected to each other via shared members or social relations between members to form a cross group link. For example, a scholar, individual 3 in Figure 5, may belong to one network of computer technology researchers and also belong to a network of friends, so this scholar's membership in these two networks links the two social networks by forming a path between computer technology researchers and the scholar's friends.

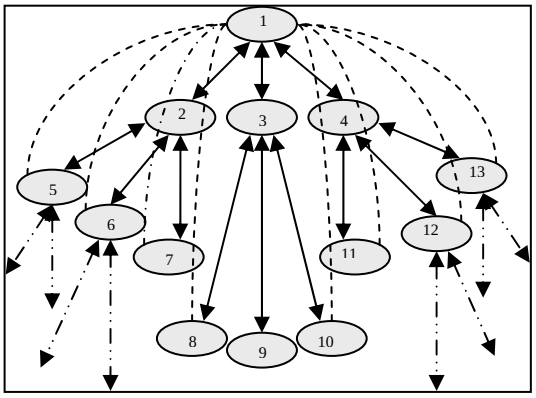


Figure 4: A Social Network Illustration.

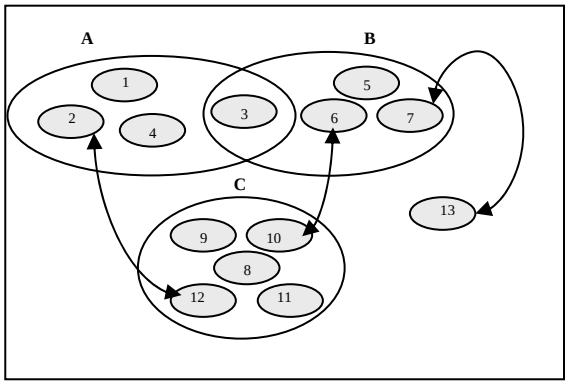


Figure 5: A Social Network Consisting Groups and Individuals.

The basic properties of social networks include size, density, degree, reachability (Hanneman, 2001), connectivity (Stocker, 2001), and multiplexity (Emirbayer & Goodwin, 1994). Size of the network is indexed by counting the number of nodes in the network (Stocker 2001). Density is the 'extent to which everyone of ego's contacts know each other' or 'the ratio of the number of ties actually observed to the number of ties theoretically possible' (Granovetter, 1976; Millen & Patterson, 2002). Density decreases as the groups get bigger (that is when the size increases). The number of connections a participant has is the degree of the network (Hanneman, 2001) or connectivity (Stocker, 2001). The sum of connections from the participant to others is the out-degree, which tells how influential a participant may be. In-degree specifies the number of other individuals that send information to the actor we are focusing on. An actor is 'reachable' by another if there are a set of connections that can be traced from the source to the target actor regardless of how many of connections in between (Hanneman, 2001). Multiplexity (repeated links) is the existence of two or more types of relations linking individuals (Emirbayer & Goodwin, 1999), or the degree to which relations between participants include overlapping institutional spheres. For instance,

individuals who are work associates may also be linked by family ties, political affiliations, or club memberships (Potes, 1995).

A social network provides a venue for storytelling or showcasing projects and best practices and could be leveraged to create new knowledge resources as social networks also allow interpersonal relations to cut across boundaries (i.e., neighborhood, workplace, and kinship or class). With application of information and communication technology, social networks become flexible and can be sustained over distance and are hence helpful in maintaining a community in a mobile society. Benefits of having a strong social network include opportunities of finding social support, establishing new social or business contacts for collaboration (Hogg & Adamic, 2004), exchanging social capital including financial resources, goods or services (Garton et al., 1997), and exploring and initiating knowledge transfer.

Digital Cities

A digital city applies information technologies and virtual spaces to urban functions and activities (Caves & Walshok, 1999) is a place where a group of people are drawn together by an opportunity to share a sense of community with like-minded strangers having common interest (Lea et al., 2006); is a large Internet-based site offering a range of online services, including access to social environments, community services, municipal information, and e-commerce to its infohabitants (Ferguson et al., 2004); and is an environment of learning and innovation on real and virtual level and is a center of knowledge, information management, technology, and innovation (Komninos, 2002). A digital city often provides three basic types of services including content services and information dissemination, communication and social services, and business transaction services (Lea et al., 2005).

The construction of a digital city is often built upon social network concepts including common interests or shared goals (Akahani et al., 2000; Blanchard & Markus, 2004; Churchill, et. al. 2004; Ferguson, et. al., 2004; Hiltz & Wellman, 1997; Kavassalis et al., 2004), facilitate social functions (Bucolo, 2003; Camp & Chien, 2000; Churchill et al., 2004; Ferguson et al., 2004; Hiltz & Wellman, 1997; Kavassalis et al., 2004; Sproull & Patterson, 2004), collaboration (Akahani et al., 2000; Blanchard & Markus, 2004; Churchill et al., 2004; Ferguson et al., 2004; Ishida, 2002b), and culture exchanges (Akahani et al., 2000; Igbaria, 1999; Ishida, 2002b). A conventional social network is built on people while a digital city is built on an online medium with participants consisting of human users and computer programs. Therefore, a social network based digital city is more flexible (Ishida, 2002b), has more multidimensional means for dissemination activities (Götzl et al., 2002), and provides more effective and efficient information integration than a traditional social network. Digital cities often apply technology to encourage public participation more effectively and efficiently than traditional forms of social network. As a result, the network growth rate of digital cities is much higher than traditional social networks. Without the physical boundaries, digital cities impart and enhance benefits of traditional social networks across time and space and accelerate and globalize the networking process (Lea et al., 2006). Furthermore, a digital city can easily support and maintain bigger networks more securely than conventional social networks.

RESEARCH OBJECTIVES AND METHODOLGY

Successful innovation is an important factor for economic development. Digital city has been used to stimulate and exchange ideas (Akahani et al., 2000; Argote & Ingram, 2000; Bucolo et al., 2003; Churchill et al., 2004; Ferguson et al., 2004; Ishida, 2002a) and both digital cities and social networks could carry out major social and economic advancements (Ishida, 2002a; Ishida, 2002b). However, limited research exists to address applying social network concepts to design and construct a digital city to support innovation process and, consequently, to enhance innovation success. Therefore, the objective of this research is to address how social network theories can be used to design and manage a web-based digital city that connects entrepreneurs to influential factors of innovation and consequently enhances the innovation process. This study provides sample designs that apply social network concepts to promote and structure social interactions among the users of a digital city and to stimulate commerce and collaboration activities needed for innovation success through initial deployment of a project called Innovation Information Infrastructure (I3) funded by the National Science Foundation (NSF).

The I3 is a social network built on an electronic medium to form a digital city that consists of an aggregation of people and computer programs. Because the process of establishing and maintaining a strong social network is time consuming and effort intensive, the objectives of the I3 project are to manage the network of users and resources in the system and to provide its users with opportunities for social support, business collaboration, communication with users having similar interests, resource sharing, information/knowledge exchange, and resources needed for innovation success without being physically presented in a social exchange process. The proposed system will include features to address following issues:

- Engaging individuals, groups, and communities to participate in social network activities (e.g. exchange of information, resources, or knowledge)
- Enabling users to learn best practices or propose new projects
- Generating, collecting and correlating social network data (e.g. degree, density, etc.) for innovation success
- Providing a framework for timely communication and distribution of experiences, contextual information, and expert insight to stimulate knowledge creation.

Researchers (Reagans & McEvily, 2003) stress the importance of having good user interfaces (Carthy et al., 2004), mechanisms for ensuring trust and security (Kippert & Swiercz, 2007; Garrison & Posey, 2006), easy-to-use environments, social computing, and services for collaboration and communication and how all these aspects of technology are needed to produce stable digital cities for everyone's benefit. For the implementation, Oracle 9i Forms (DS Release 9.0.2.9.0) was used because of its flexibility in reporting and displaying data and is used as the front-end tool for the application in conjunction with Oracle 9i database as the backend. Oracle 9i Reports Builder (DS Release 9.0.2.0.3) was considered in the implementation for generating reports. Oracle Forms is used as a tool to build and publish quality, dynamically generated content. Through data-driven tables of contents, Oracle Forms provides users with an easy interface to the information that is required. The application was tested and run on standard Intel Pentium 4 CPU 1.70 GHz Machines with 512 MB RAM, Windows XP professional OS.

PROJECT DESIGN AND DEPLOYMENT

Conceptual Model Design

The conceptual design for I3 system provides a useful setting for collaboration and information exchange, the essentials of a good digital city. The Entity Relationship diagram (ERD) in Figure 6 represents the data modeling of I3. The figure represents the organization of data into entities and the relationships between the entities in I3. Although the actual system includes both user modules and administrator modules, only the administrator modules that focus on the management of a social network based digital city is discussed in this study.

The ERD is segmented into four regions, as shown in Figure 6, with each region broadly categorizing the entities based on the four management tasks in I3. User Management region (the top left corner of the figure) provides the administrator with complete control over the management of users in the system. The Company Management region located on top right corner of the figure includes detailed company information. Resource Management region (bottom right corner) covers the resource entities (i.e., financial, equipment, space and intangible resource except human resource which is part of the user management scheme) and facilitates collaboration. The Request Management region (bottom left corner of the figure) is tied with the Resource Management segment as resource requests are served in I3's request management module.

All four management functions illustrated in the ERD are interlocked and operationalized as I3's administrator's menu, as shown in Figure 7. Furthermore, as the administrator is responsible for updating the database to ensure that the data in the system is updated and true at all times, the main menu also provides administrators with tools to enter and manage all meta-data and other pre-conditional data required for the system. These include metadata pertaining to user, company, resource or request management like Education level, Occupation list, Ethnic group, Expertise areas, NAICS code, Non-profit type, Occupation type, Session type, Milestone, Counties, zipcodes, regions, contact method etc. The subsequent sections will discuss how the ERD for the various management tasks has been designed and how it has been operationalized and implemented.

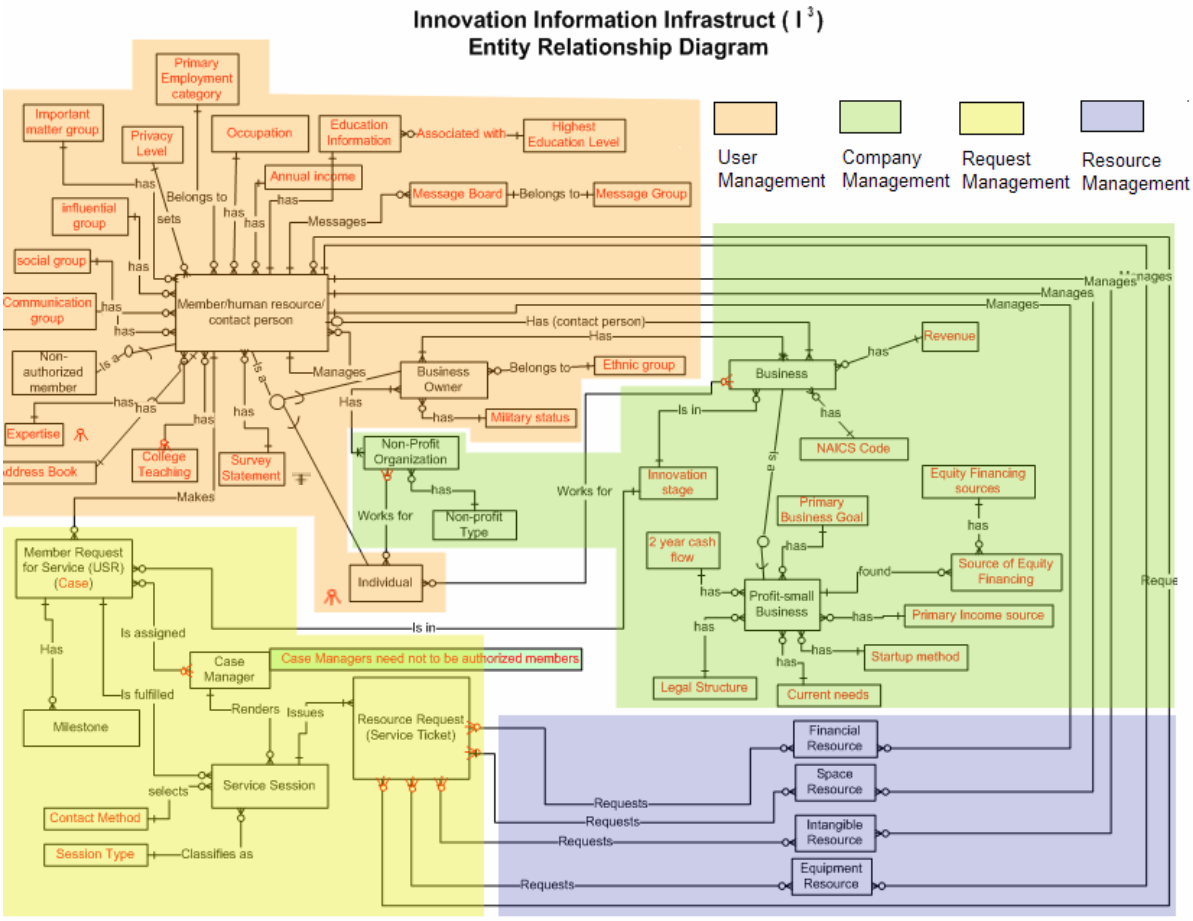


Figure 6: Entity Relationship Diagram.

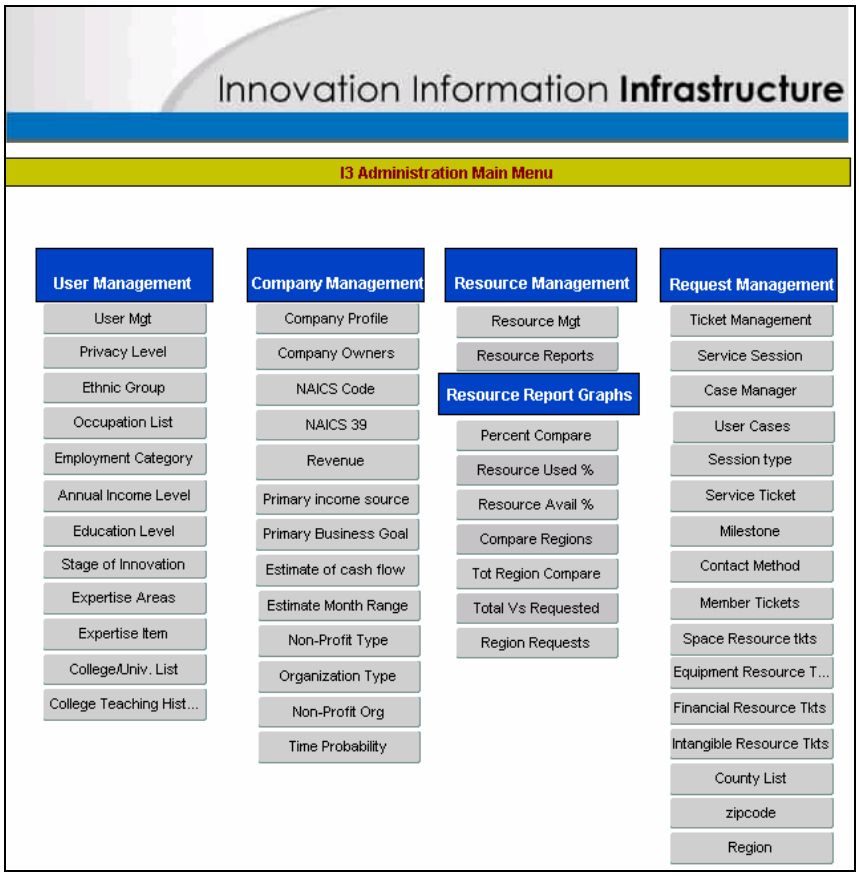


Figure 7: Administrator's Menu.

User Management

Identity and social interaction foster cooperation and should be supported via social, technical, and socio-technical means (Ishida, 2002b). User profiles and preferences must be captured to facilitate collaborative and cooperative environments and to give the user a sense of belongingness in the community (Ferguson et al., 2004). User registration and profiles are created through an initial registration process and data (e.g., occupation, education information, college teaching, highest education level, privacy level, etc.) for the user management entities are captured during this registration process.

The human resource entity is subdivided into four sub-entities - USERS, MEMBER, INDIVIDUAL, and BUSINESS_OWNER. The USERS entity forms the bounding box for all other entities. Every participant in I3 is defined as a user, which forms the outermost layer of the entity diagram. The MEMBERS entity inherits attributes from the USERS entity and defines additional attributes for an authorized member (AM). An authorized member will have a profile once the user completes the registration process and can own businesses (the BUSINESS_OWNER entity) or can operate as an individual (the INDIVIDUAL entity). The INDIVIDAUL and BUSINESS_OWNER entities inherit attributes from MEMBERS entity and have additional attributes. A business owner will have an additional business profile as part of company management.

As illustrated in the ERD, the human resource entity is tied to other entities that collect demographic information of a user (e.g., annual income, education information, occupation, expertise areas, ethnics, etc.). The information for these entities is acquired during a user's registration process (refer to Lea et al., 2006, for details), but can also be gathered by an administrator using a personal detail form, as shown in Figure 8. The form has navigational and search capabilities that allow the administrator to retrieve specific user information for modification or deletion.

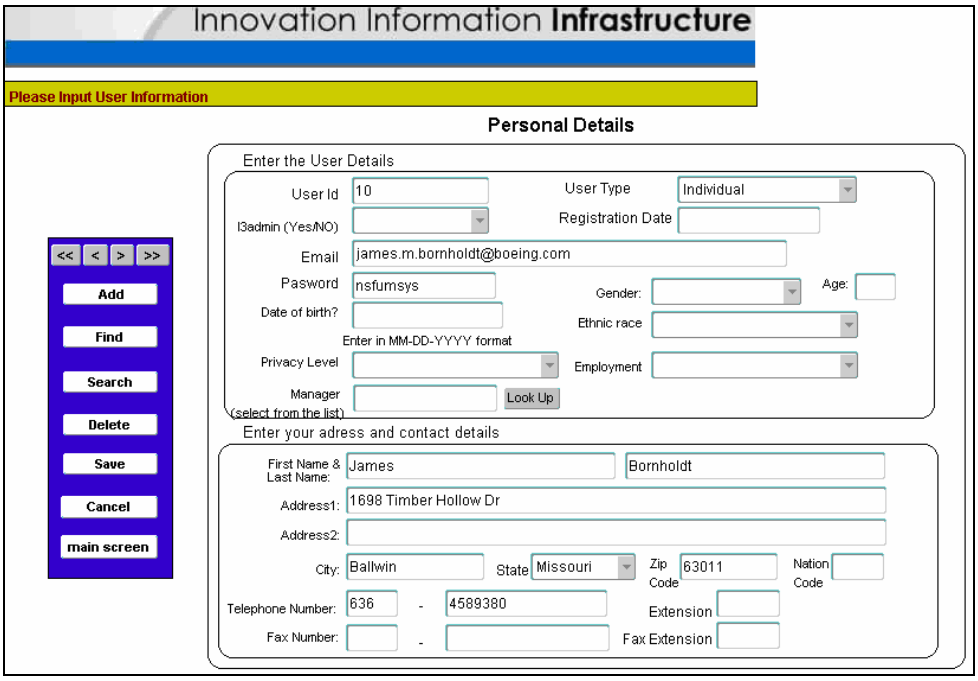


Figure 8: Sample of User Management Screen – User Profile.

It is important to track social network evolution for every user at all times(Hanneman, 2001) as social interaction can form influential circles that transform innovation into a successful business plan. The survey statement entity manages the 'who knows who' data collated from a survey deployed during the registration process and information collected is used to determine the user's initial social connectedness in the network. As illustrated in the ERD, a user's initial social network information is maintained by four entities including communication group, social group, influential group, and important matter group. All communication among users after joining the system are tracked and used to monitor changes in social network parameters and network evolution of users. The information maintained by the entities is used to calculate the network's key parameters like effective size of the network, density and redundancy, as shown in Figure 9. These social network measures are dynamically calculated and will change when new users are added to the system.

Company Management

I3's Company management fosters collaboration by providing company information to registered users. For example, if a company's objective matches that of a user's, a collaborative business could be in the process. Company management that is tied to the Human Resource entity emphasizes on the user's business. All information pertaining to the user's business (e.g., business goal, NAICS information, innovation stage, source of revenue and other financing, Income source, etc.) are captured as illustrated in the ERD. Figure 10 is the partial Company profile form which is used by the administrator to manage the company information, owner information, employee information, income and other financial information about the company. All the forms reachable from the administrator's menu have navigational and search features.

Resource Management

I3's critical resources identified from literature and verified by a panel of experts include human, financial, physical (equipment and space), and intangible/intellectual resources and are offered as part of the content services to registered users to improve innovations success (Lea et al., 2006). User management and resource management, function in tandem in I3. If a registered user (also human resource) requests a resource, the request is assigned to a case manager and the linkage between user management and resource management is established.

If the resources provided are all-encompassing, it is expected that more users would join the system and as a result of which, the general connectedness of the network will increase. Obtaining and maintaining information on the various resources available in the system and providing them to users are the objectives of resource management. Each resource entity in I3 stores and manages specific resource information. For instance, as shown in the Figure 6 ERD, the intangible resource entity would have information about intangible resources which could be patent, database, software, copyright materials or literature. The equipment entity manages equipment information like the type of equipment resource, restrictions, beginning and ending date for the resource, and service cost. Similar data is collected and managed for all resource types. Each resource is tagged to its owner (a registered user) and is classified into a resource type.

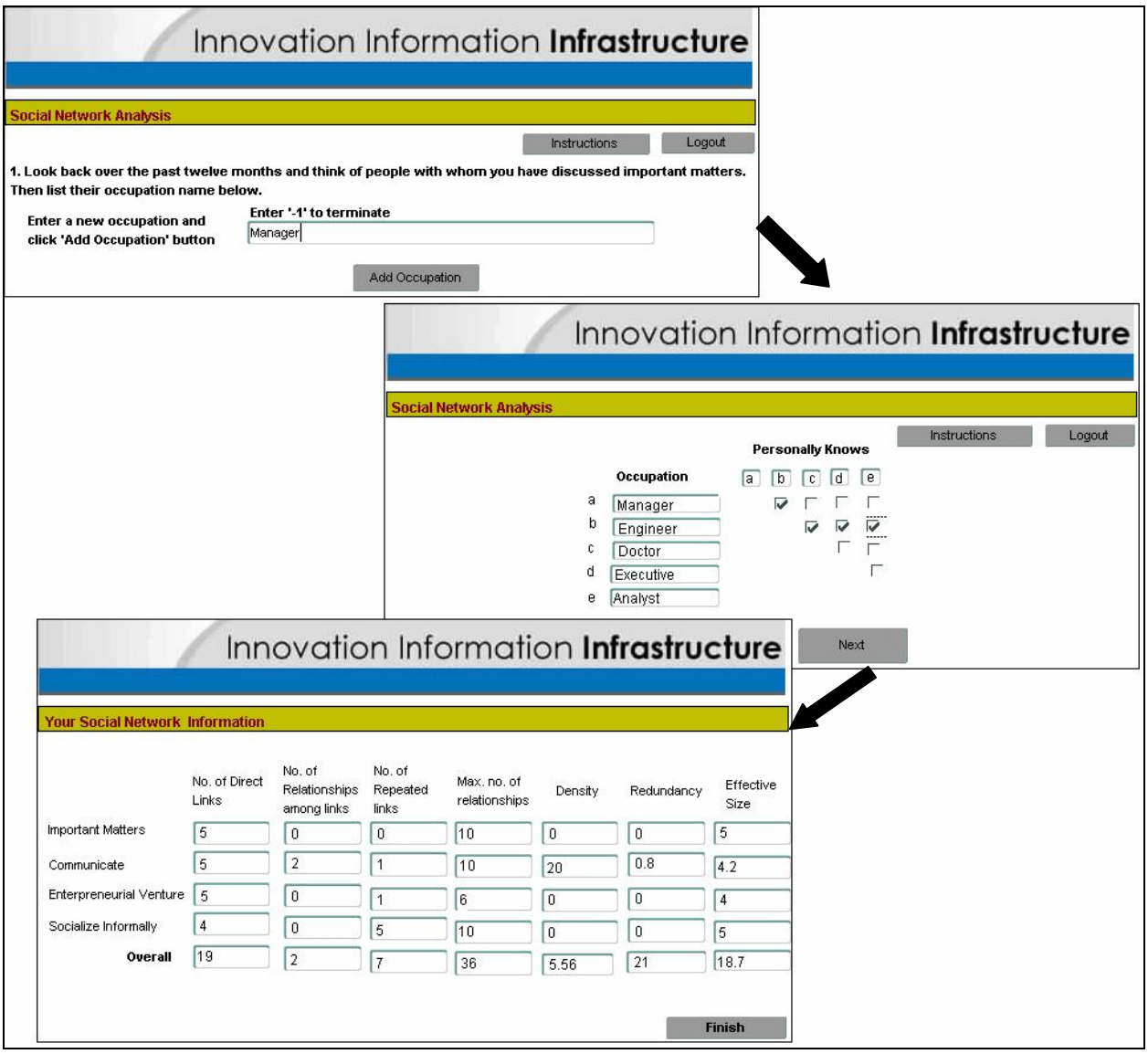


Figure 9: Partial User Social Network information Survey – Who Knows Who.

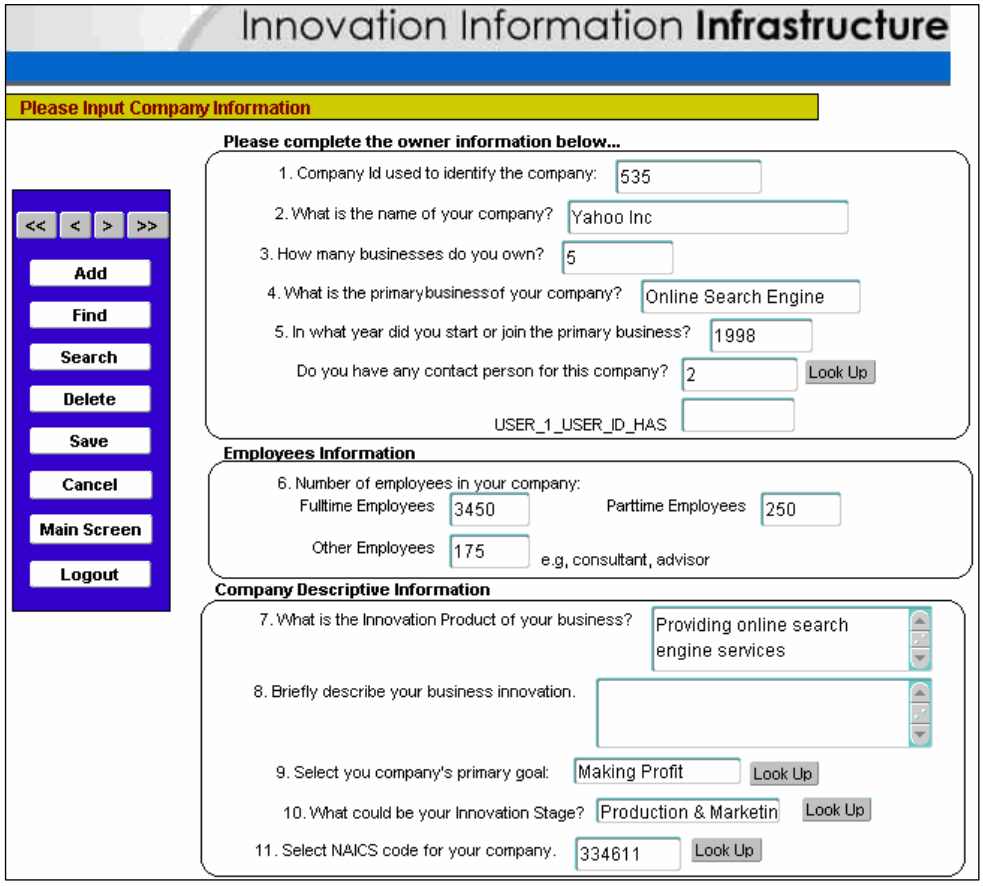


Figure 10: Company Profile (Partial).

The conceptual design of resource management is operationalized as the resource management in the administrator menu that consists of resource maintenance and reporting functions, as shown in Figure 7. As discussed earlier, successful innovations are correlated to one's ability to mobilize and direct resources during the innovation process. Therefore, having a strong social network is beneficial in finding social support, establishing new social or business contacts for collaboration (Hogg & Adamic, 2004; O'Murchu et al., 2004), and exchanging social capital (e.g., financial resources, goods or services) (Garton et al., 1997). However, access to sources of resources through person-to-person social networking is laborious, time consuming, and often unfruitful and is not efficient or effective because of geographic distance, topical distance, concept communication, potential advantage recognition, and individual bias. Therefore, one of I3's objectives is to facilitate communication between people in the scope of resource exchange, an important function of a digital city suggested by the literature (Akahani et al., 2000; Argote & Ingram, 2000; Bucolo et al., 2003; Churchill et al., 2004; Ferguson et al., 2004; Ishida, 2002a).

Lea et al. (2006) indicated that a virtual community should provide advanced content service for users, have advanced navigational/search capabilities for information retrieval, and should offer means of acquiring the resources. In I3, information on all types of resources can be accessed and managed from the administrator's menu. Although only the administrator functionalities are discussed, both administrators and users can view and search for resources.

Figure 11 is a sample resource screen designed based on the ERD. In all the resource screens, the administrator can search for resources on a combination of different search criterions - City, State, Zip code, Privacy level, Innovation stage, Name of the resource owner (First Name, Last Name), Name of the Resource, User ID, or Resource ID. The administrator can search and view resources posted by other users and can contact them for directing resources of interests to other users who may need it, as illustrated in

Figure 11. For example, an administrator can search people (i.e., human resources) who share the same goal/interest with other users and communicate with them to exchange viable information that could serve as a seed to developing an innovative business proposal.

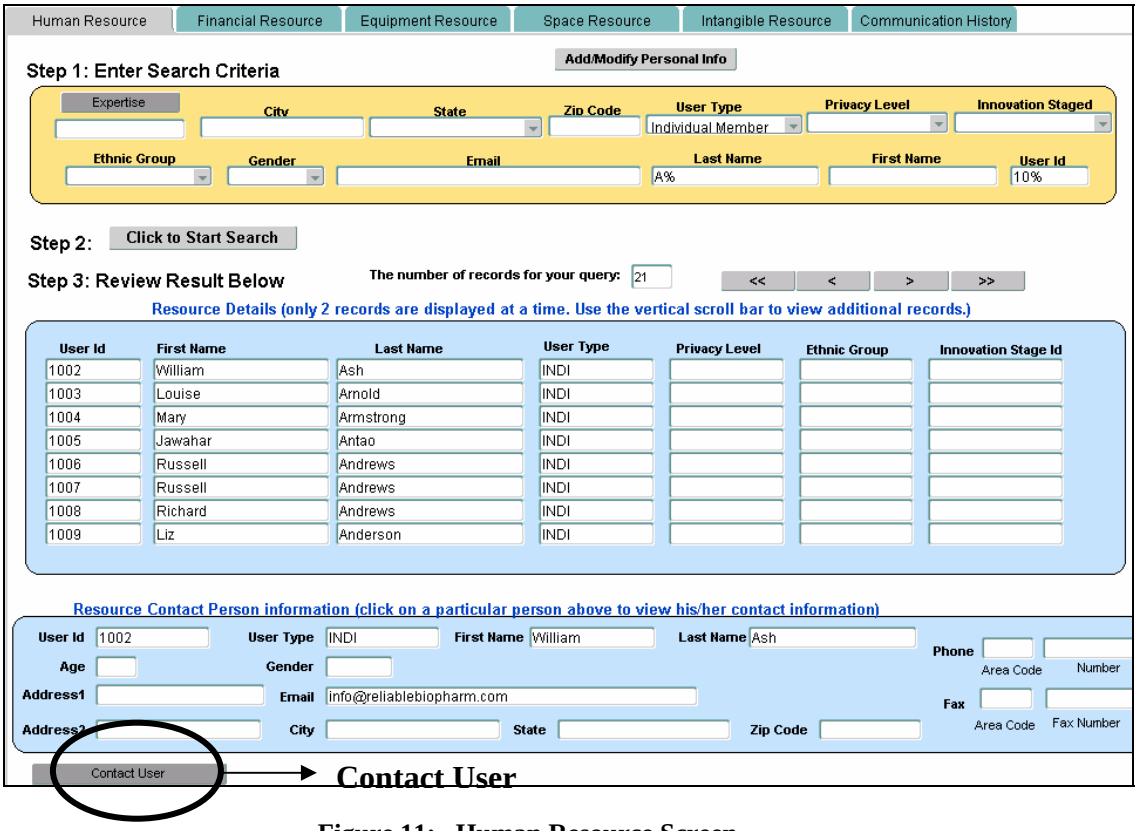


Figure 11: Human Resource Screen.

Other functions provided to the administrator include maintenance functions like addition, modification, deleting and updating user's resource entries. However a registered user will be allowed to manipulate only his/her own resource entries. All changes are processed in an on line real time manner and to improve usability, all data entry fields are enabled with smart tips to provide information (e.g., type, length, restrictions, or meanings of data) or helpful tips when a user moves mouse over a field, as shown in Figure 12.

Resource management promotes social and collaboration activities and enables users having similar business objectives to connect and work together towards developing a collaborative business. Millen and Patterson (2002) indicate that interesting content drives interaction based on their analysis in message board messages. To facilitate social interaction among users and improve the general connectedness of the system, I3 provides an internal email system that allows users to inquire resource or exchange ideas. As Kollock (1996) recommended, a system should not limit the length of a member's posting and should encourage users to read what has been said in the past about the subject at hand. Therefore, I3's email system is desgined to allow users to post messages on their needs or communicate a new innovative idea to another member without restricting the length or number of messages that can be posted by a member. Once the user logs into the system, the user can view new messages or all the messages received in the mail box. The user can reply to selected messages, retrieve the complete information on selected messages, or view all messages related to a particular message.

For the prototype, administrators focus on the threads of messages (chain of related messages), as shown in Figure 13, that are reasonably unambiguous. It is in the plan to utilize software agents to read and analyze contents of more complex messages for potential collaboration opportunities. For instance, a user may require 1000 sq ft. space resource and has emailed many users regarding the resource requirement, for which he has received many replies, but the user is not sure who to contact. To provide the right resource at the right time, the software agent could

review all resources available that match the requester's requirements and can direct the resource to the user (this process is currently done by the human administrator), so the user does not need to wait for a reply. Some room for error exists in the thread analysis because topic drift can occur and thread continuations are occasionally started over in a new root message. Nonetheless, the thread structures provide a reasonable approximation for the kinds of extended discussions that took place within the group of users involved in the discussion.

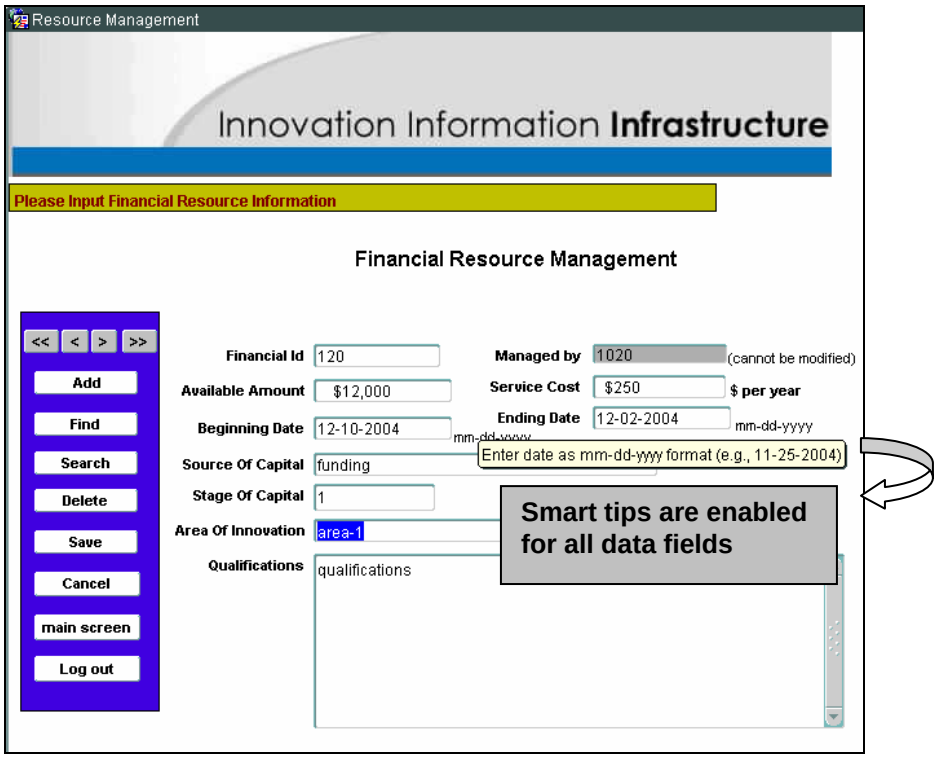


Figure 12: Resource Management – Smart tips enables.

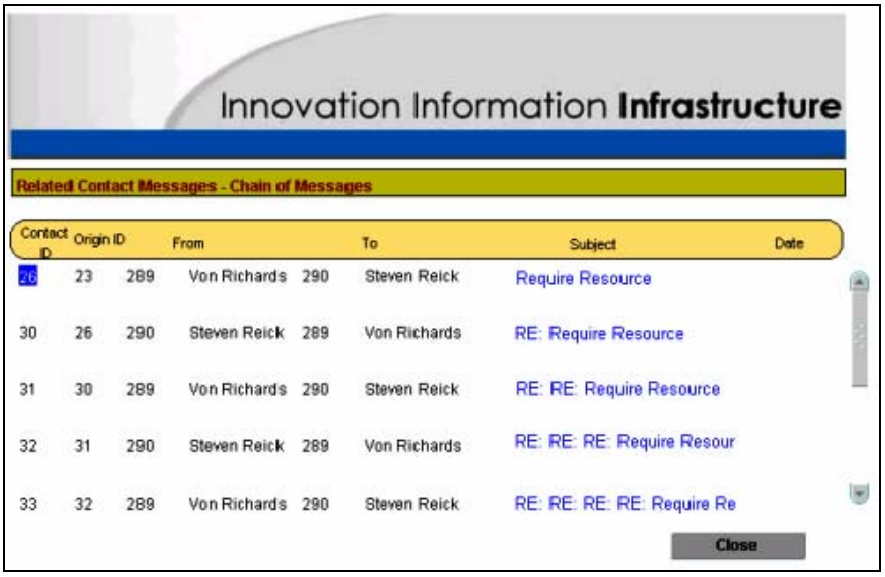


Figure 13: Viewing Related Messages.

The reporting system is part of the resource management functions in I3 and can be accessed from the administrator's menu. It provides resource information and key social network statistics, serves as a systematic mechanism to record and evaluate social network performance and knowledge, and provides leverage to the administrator in making important managerial decisions.

Six types of reports in I3 are provided to track resource usage in the system. The reports include region wide resource usage, county wide resource usage, county comparison, most and least used resource, and resource usage by type. The region wide report presents information on resource leaning for every region as well as resource usage and availability trends in a region, so the administrator can decide what resources are lacking and need to be made available in a particular region. The county wide report is similar to the region wide report but is a more focused analysis of resource leaning in a smaller area (as a region comprises of many counties). The county comparison report allows an administrator to compare two counties with similar resources to help an administrator identifies what resources need to be brought in or removed from counties that are comparable. The most used resource usage report allows the administrator to identify resources that are on demand or need more attention/proper actions (e.g., whether to bring in a specific resource to a region or distribute the resource evenly across regions). The least used resource report presents information on resources that are used infrequently and can help administrator analyzing why a resource was not used. Resource usage by type report, as shown in Figure 14, presents which type of resource is most used in the system.

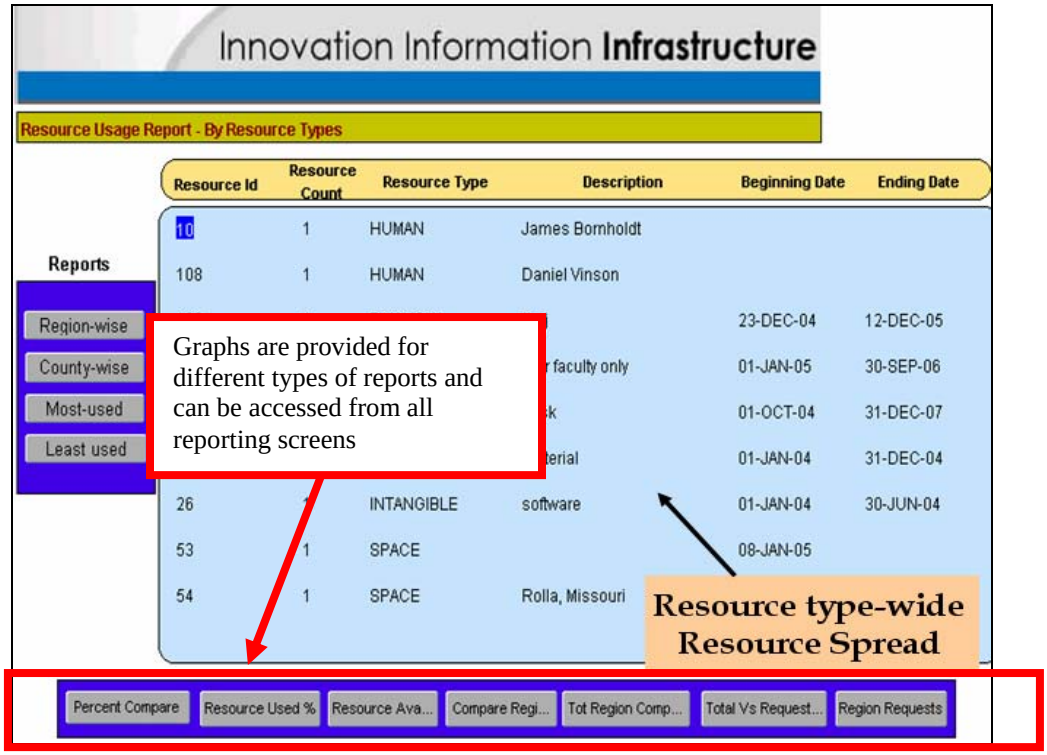


Figure 14: Reporting System – Resource Usage by Type Report.

A user-friendly graphical representation offers several advantages including providing a much richer picture and can provide equitable decision-making opportunities to the user. In I3 several graphical representations are provided with many reports to give the administrator a different direction for analyzing data. The graphs can be accessed from all the reporting screens. Figure 15 presents availability of human resources and intangible resource for every region. In a quick glance, the administrator can understand the resource spread across regions and can take proper action for resource allocation. Other graphs provided include resource availability by region and by type, resource usage by region and type, available resources vs. requested resources by region and type, and total resource requests by region.

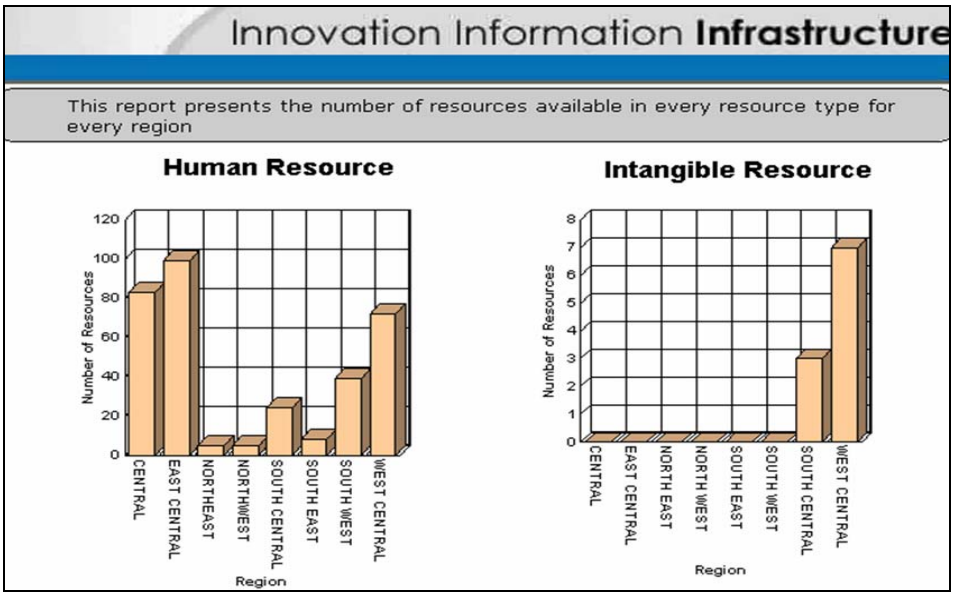


Figure 15: Graphical Representation of Region wide resource availability.

Request Management

Request management is presented in the bottom left corner of the Figure 6 ERD and forms a link between the user management and resource management systems. The request management process is shown in Figure 16. When an authorized member (the member entity in Figure 6) requests for resource (the Member request for Service entity in Figure 6), the administrator assigns a case manager (Case Manager entity in Figure 6) for the request. Case manager renders service sessions (Service Session entity) for any communication that the case manager might have had with the member requesting the resource. Significant events during the request-to-procure process are logged as milestones (Milestone entity). Finally, the case manager issues a service ticket (the Service Ticket entity) when a consensus is met on the resource.

Every case manager has a profile documenting his/her service center, specialty area, and contact information. The administrator can use a case manager profile form, as shown in Figure 17, to add, delete, or modify information pertaining to case managers. Both the user and administrator can view the request details (Request Information, Service Session, Milestones) in a hierarchical tree format, as shown in Figure 18. However, a user can view, search, delete, or modify his/her own request status while system administrators can view, search, delete, or modify all requests from different users.

Administrators and case managers monitor service requests to ensure that resources required by users are provided in a timely fashion. To improve efficiency of request management, a ticket status form is designed to displays status of a request for service (a ticket) managed by case managers, as shown in Figure 19. The administrator can select one or all case managers from a list and view the ticket information pertaining to a selected case manager or all case managers (a case manager can only view his/her own cases).

With the information on the number of resource requests handled by each case manager (i.e., number of new tickets that are assigned, number of in-progress tickets, and number of completed tickets), the administrator can ensure equal workload among case managers and identify tickets that might need additional actions. It is important that the requests are handled appropriately because most tickets pertain to resource requests and proper resource management facilitates collaboration and provides social support to improve opportunities for innovation success.

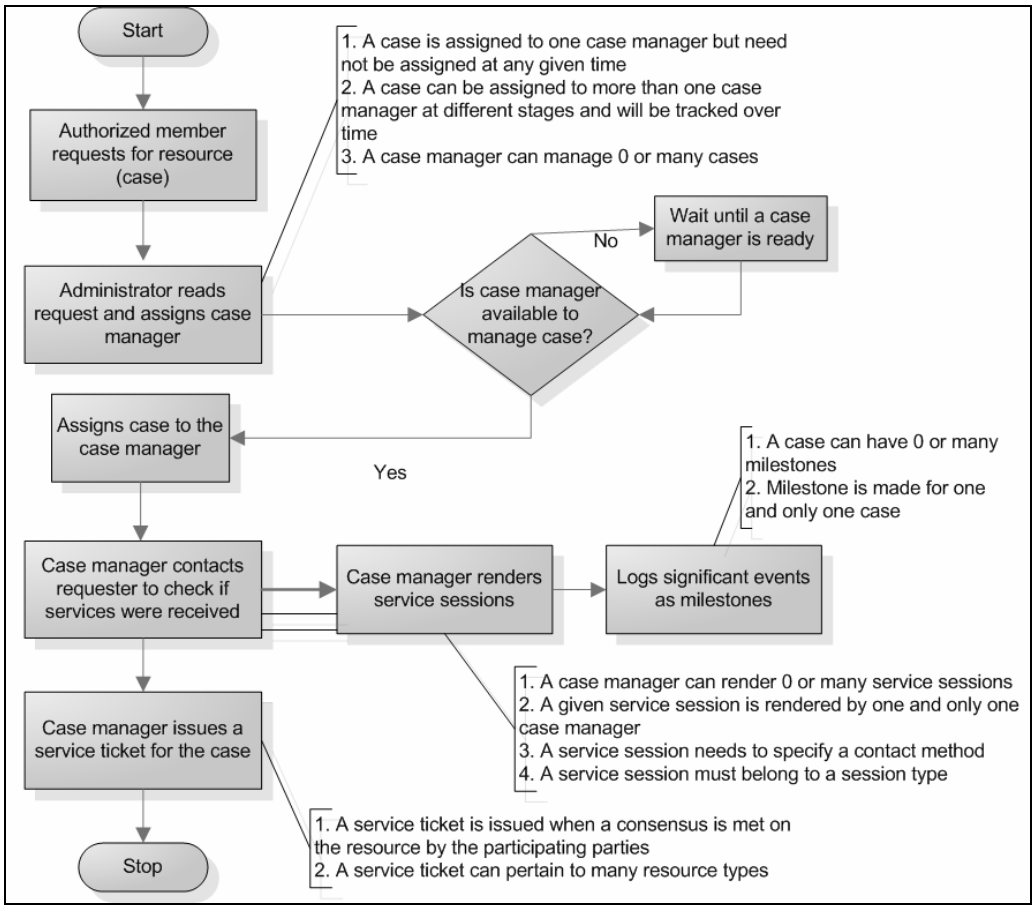


Figure 16: Request Management Process.

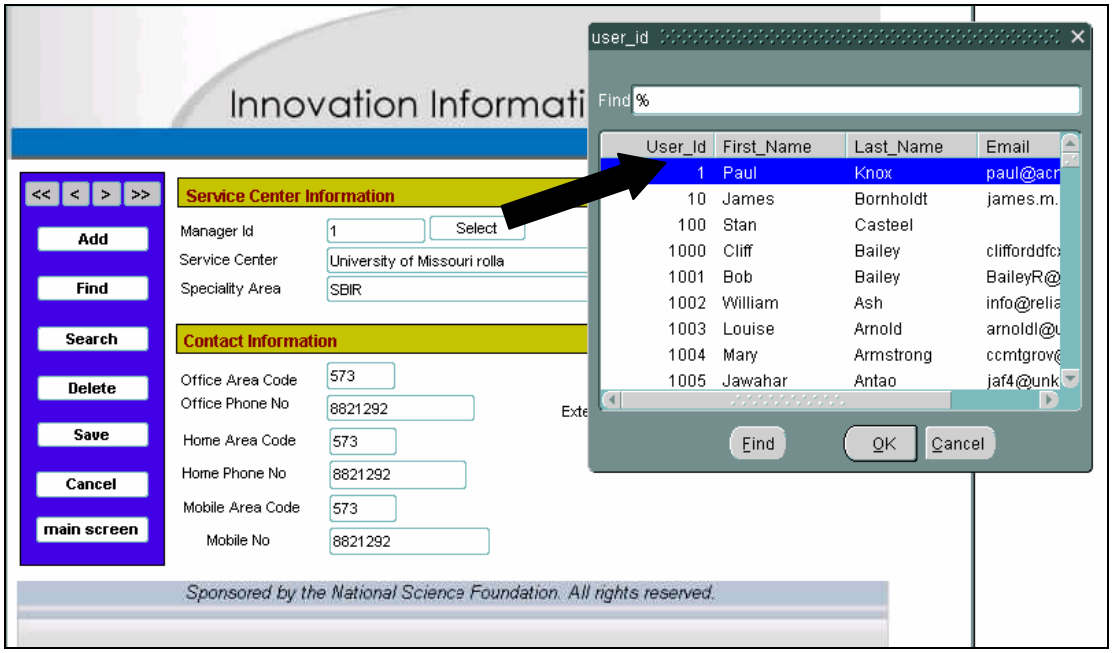
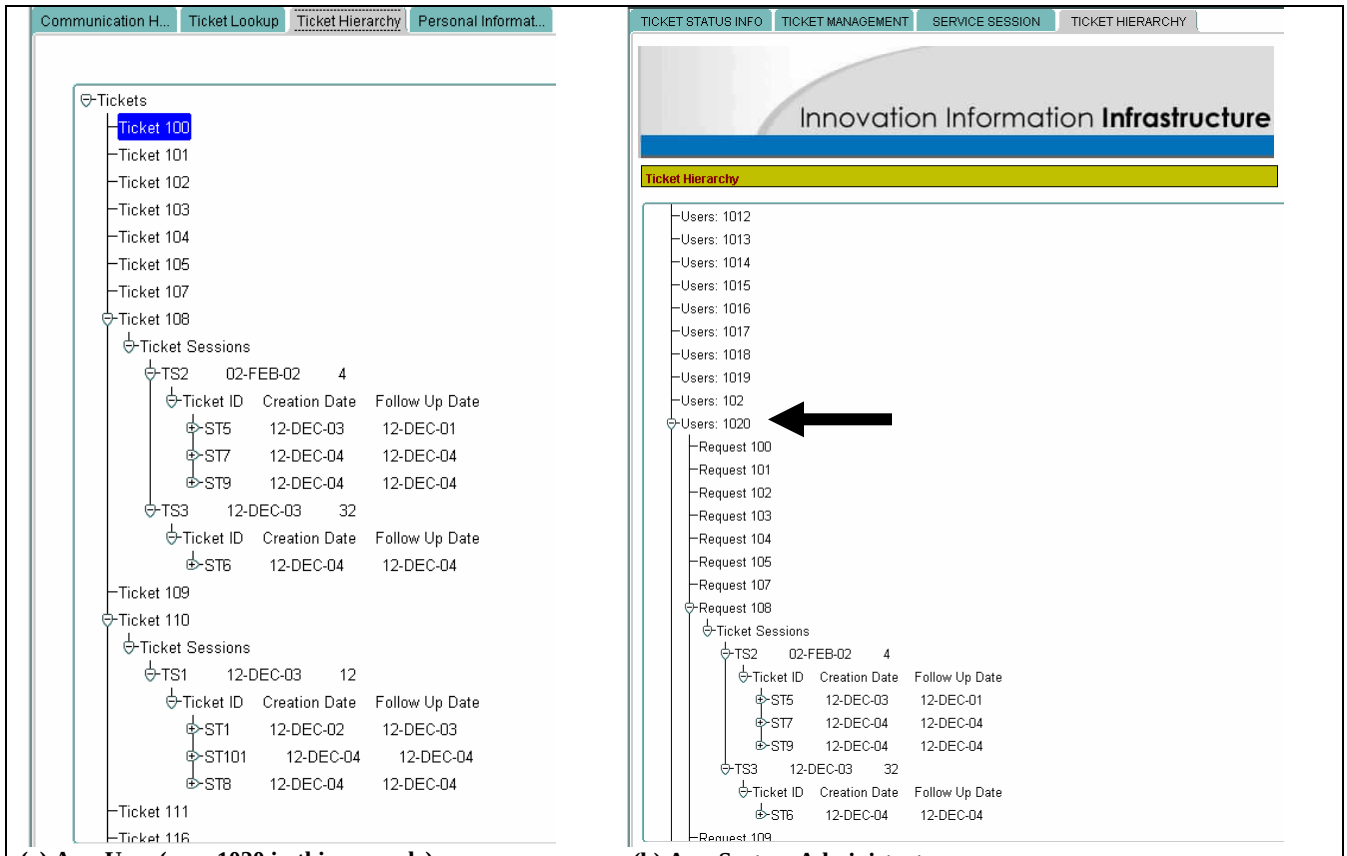


Figure 17: Case Manager Profile.



(a) As a User (user 1020 in this example) **(b) As a System Administrator**

Figure 18: Viewing Status of Tickets in Hierarchy Tree Form.

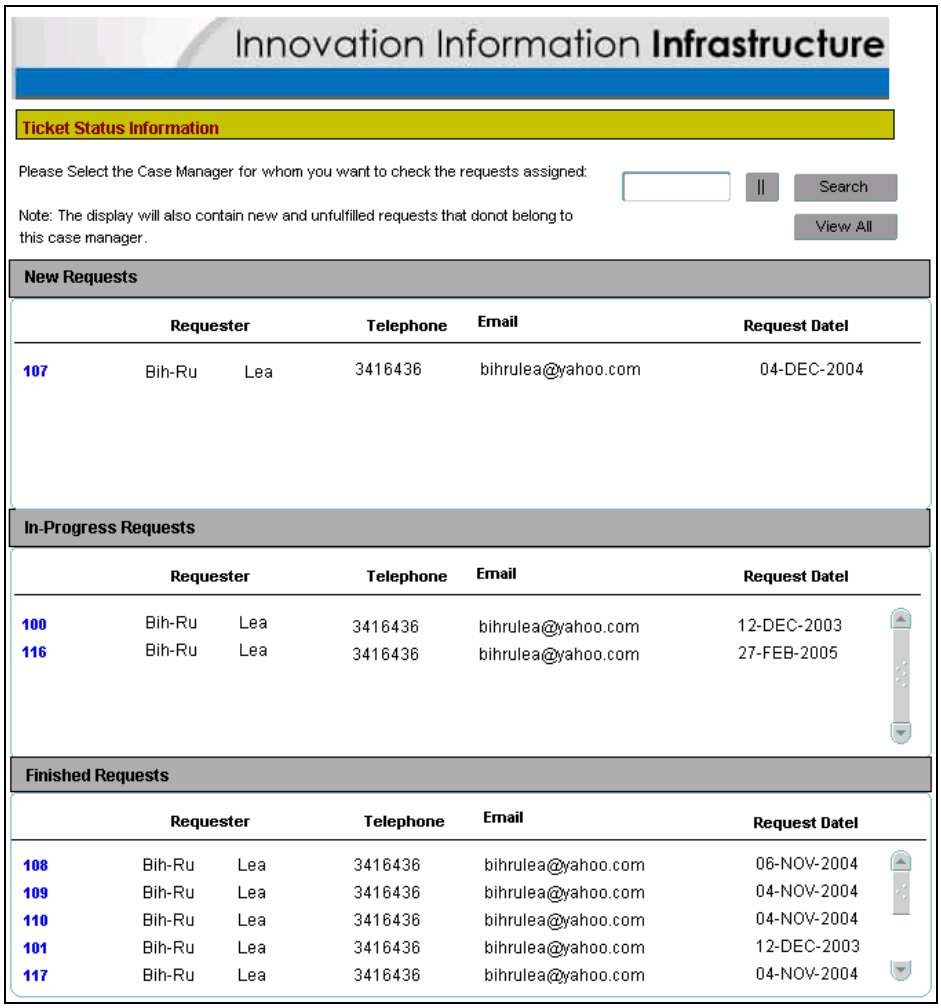


Figure 19: Ticket Status Form.

SUMMARY AND FUTURE DIRECTIONS

Social networks and digital cities go hand in hand and can positively improve the probability of innovation success. This study documents design and initial deployment of a digital city project 'Innovation Information Infrastructure (I3)' based on social network concepts to enhance success of innovation through promoting and structuring social interaction among the users of the network, stimulating commerce and collaboration activities, and creating the linkage between innovation discovery and societal benefits of new wealth creation.

An important feature that must be supported by a digital city is communication and collaboration among large groups of participants over computer networks and to encourage the participation of the key players of the digital city to improve cooperation and knowledge transfer (Götzl et al., 2002). I3 recognizes the need for communication and collaboration in digital cities and provides an internal email system and resource management that allows interactions among users and opportunities to access critical resources to support the innovation process. The communication and collaboration services in I3 enable users to develop their direct or indirect connectedness to improve his or her social network. Table 5.1 summarizes the key functionalities implemented in I3 and its effect in advancing Social Networking and innovation.

Although major functions needed to establish and maintain one's social network are in place, several essential functions are yet to be developed to improve efficiency and effectiveness of the proposed social network based digital city prototype. Personalization and intelligent interaction between digital cities and their users based on user

profiles are still challenges. Forums, chat rooms, and other discussion places need to be developed to provide better participation and collaboration for users. Business and transaction services are yet to be provided. Also as part of future enhancements, software agents can be developed and used to survey the threads of messages (in I3's email system) periodically to help the administrator in understanding the requirements of the users in the system and provide help (resource information or advice) whenever needed. For improving the connectedness in the virtual community, data mining techniques can be employed as part of future enhancements to provide credibility and integration of information as suggested by Lo and Hsieh (2003). In the entirety, I3 has been successful in implementing social networks but analyzing the data and building a knowledge base would help build a stronger digital community.

Table 1: Summary of Functionalities in I3.

Function	Objective	Features	How it Helps
User Management	Capture user profiles and preferences	Add, Modify, Delete, and Search User profiles	Facilitates collaborative environments and gives the user a sense of belongingness in the Information City
Company Management	Manage user's business information and provide the information to all the registered users in the system, as needed	Add, Modify, Delete, and Search Company Profile	Fosters collaboration, as the company information is publicly available
Resource Management	Obtain and maintain information on the various resources available in the system and provide them to users whenever needed	Add, Modify and Delete Resource information for users, Contact feature, Email System	Helps make successful business innovations as successful innovations in business are possible by mobilizing and directing resources
Request Management	Maintain requests for resource and to keep the resource request-to-procure process going by providing the users with resources on time	Add, Modify, Delete Case Manager, Milestone, Service Session, Case, View ticket status and history	Serves as a systematic method to record, evaluate and respond to social performance and knowledge
Reporting	Present key network (users and resources) statistics in Forms and Graphs	Resource usage report by Region, Resource availability report by Region, Total used Vs Total Available resource, Region wide and County wide resource split	Provides leverage to the administrator in making important managerial decisions
Social Network Analysis	Collect user perspectives on different issues of Social Network ing and forming influential circles through social interaction	Questionnaire/ Survey, Who Knows Who Data	Presents the user's social connectedness in the network and can help identify important nodes in the network

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About the Authors

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Social Network Enhanced Digital City Management and Innovation Success: A Prototype Design

Bih-Ru Lea is an Assistant Professor of Business Administration at the University of Missouri at Rolla. Dr. Lea conducts interdisciplinary research in the areas of Supply Chain Management, Enterprise Resource Planning, Management Accounting Systems, and Business Application of Software Intelligent Agents. Dr Lea has published in numerous journals including *International Journal of Production Research, International Journal of Production Economics, Industrial Management and Data Systems, Technovation, and Journal of International Technology and Information Management.*

Wen-Bin Yu is an Assistant Professor of Information Science and Technology at the School of Management and Information Systems, University of Missouri at Rolla. Dr. Yu received his PhD in Computer Science and Engineering from University of Louisville. His research interests are in the fields of data/text mining, business process simulation, software agent applications, and demand forecasting especially in a supply-chain environment.

Prashanth Kannan conducted research in the area of Social networking/ Digital Cities and business innovations and received his MS degree in Computer Sciences from University of Missouri at Rolla.

An Examination of Internet Effectiveness for Non-work Activities

Pruthikrai Mahatanankoon is an Assistant Professor of Information Systems at the School of Information Technology at Illinois State University. He received his Ph.D. in Management Information Systems from the Claremont Graduate University. He holds a Bachelor's degree in Computer Engineering from King Mongkut's University of Technology Thonburi, Thailand, a M.S in Management Information Systems, and a M.S. in Computer Science from Fairleigh Dickinson University. He has published various articles in academic book chapters, journals, and conference proceedings. His current research interests focus upon Internet behaviors in the workplace, mobile commerce, and management of IT professionals.

Tim Klaus is an Assistant Professor of Management Information Systems at Texas A&M University – Corpus Christi. He earned his PhD (Management Information Systems) from University of South Florida and his MBA (Finance) and MS (Computer Science) from Illinois State University. His research interests include User Resistance, ERP implementations, IT personnel, and Web Usage. He has published papers in journals such as Communications of the ACM and Human Systems Management.

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