

P.L. Patrick Rau (Ed.)

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Cross-Cultural Design

Cultural Differences in Everyday Life

5th International Conference, CCD 2013

Held as Part of HCI International 2013

Las Vegas, NV, USA, July 2013, Proceedings, Part II

2
Part II



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P.L. Patrick Rau (Ed.)

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Cultural Differences in Everyday Life

5th International Conference, CCD 2013
Held as Part of HCI International 2013
Las Vegas, NV, USA, July 21-26, 2013
Proceedings, Part II



Springer

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Foreword

The 15th International Conference on Human–Computer Interaction, HCI International 2013, was held in Las Vegas, Nevada, USA, 21–26 July 2013, incorporating 12 conferences / thematic areas:

Thematic areas:

- Human–Computer Interaction
- Human Interface and the Management of Information

Affiliated conferences:

- 10th International Conference on Engineering Psychology and Cognitive Ergonomics
- 7th International Conference on Universal Access in Human–Computer Interaction
- 5th International Conference on Virtual, Augmented and Mixed Reality
- 5th International Conference on Cross-Cultural Design
- 5th International Conference on Online Communities and Social Computing
- 7th International Conference on Augmented Cognition
- 4th International Conference on Digital Human Modeling and Applications in Health, Safety, Ergonomics and Risk Management
- 2nd International Conference on Design, User Experience and Usability
- 1st International Conference on Distributed, Ambient and Pervasive Interactions
- 1st International Conference on Human Aspects of Information Security, Privacy and Trust

A total of 5210 individuals from academia, research institutes, industry and governmental agencies from 70 countries submitted contributions, and 1666 papers and 303 posters were included in the program. These papers address the latest research and development efforts and highlight the human aspects of design and use of computing systems. The papers accepted for presentation thoroughly cover the entire field of Human–Computer Interaction, addressing major advances in knowledge and effective use of computers in a variety of application areas.

This volume, edited by P.L. Patrick Rau, contains papers focusing on the thematic area of Cross-Cultural Design, and addressing the following major topics:

- Cultural Issues in Business and Industry
- Culture, Health and Quality of Life
- Cross-Cultural and Intercultural Collaboration
- Culture and the Smart City
- Cultural Differences on the Web

The remaining volumes of the HCI International 2013 proceedings are:

- Volume 1, LNCS 8004, Human–Computer Interaction: Human-Centred Design Approaches, Methods, Tools and Environments (Part I), edited by Masaaki Kurosu
- Volume 2, LNCS 8005, Human–Computer Interaction: Applications and Services (Part II), edited by Masaaki Kurosu
- Volume 3, LNCS 8006, Human–Computer Interaction: Users and Contexts of Use (Part III), edited by Masaaki Kurosu
- Volume 4, LNCS 8007, Human–Computer Interaction: Interaction Modalities and Techniques (Part IV), edited by Masaaki Kurosu
- Volume 5, LNCS 8008, Human–Computer Interaction: Towards Intelligent and Implicit Interaction (Part V), edited by Masaaki Kurosu
- Volume 6, LNCS 8009, Universal Access in Human–Computer Interaction: Design Methods, Tools and Interaction Techniques for eInclusion (Part I), edited by Constantine Stephanidis and Margherita Antona
- Volume 7, LNCS 8010, Universal Access in Human–Computer Interaction: User and Context Diversity (Part II), edited by Constantine Stephanidis and Margherita Antona
- Volume 8, LNCS 8011, Universal Access in Human–Computer Interaction: Applications and Services for Quality of Life (Part III), edited by Constantine Stephanidis and Margherita Antona
- Volume 9, LNCS 8012, Design, User Experience, and Usability: Design Philosophy, Methods and Tools (Part I), edited by Aaron Marcus
- Volume 10, LNCS 8013, Design, User Experience, and Usability: Health, Learning, Playing, Cultural, and Cross-Cultural User Experience (Part II), edited by Aaron Marcus
- Volume 11, LNCS 8014, Design, User Experience, and Usability: User Experience in Novel Technological Environments (Part III), edited by Aaron Marcus
- Volume 12, LNCS 8015, Design, User Experience, and Usability: Web, Mobile and Product Design (Part IV), edited by Aaron Marcus
- Volume 13, LNCS 8016, Human Interface and the Management of Information: Information and Interaction Design (Part I), edited by Sakae Yamamoto
- Volume 14, LNCS 8017, Human Interface and the Management of Information: Information and Interaction for Health, Safety, Mobility and Complex Environments (Part II), edited by Sakae Yamamoto
- Volume 15, LNCS 8018, Human Interface and the Management of Information: Information and Interaction for Learning, Culture, Collaboration and Business (Part III), edited by Sakae Yamamoto
- Volume 16, LNAI 8019, Engineering Psychology and Cognitive Ergonomics: Understanding Human Cognition (Part I), edited by Don Harris
- Volume 17, LNAI 8020, Engineering Psychology and Cognitive Ergonomics: Applications and Services (Part II), edited by Don Harris
- Volume 18, LNCS 8021, Virtual, Augmented and Mixed Reality: Designing and Developing Augmented and Virtual Environments (Part I), edited by Randall Shumaker

- Volume 19, LNCS 8022, Virtual, Augmented and Mixed Reality: Systems and Applications (Part II), edited by Randall Shumaker
- Volume 20, LNCS 8023, Cross-Cultural Design: Methods, Practice and Case Studies (Part I), edited by P.L. Patrick Rau
- Volume 22, LNCS 8025, Digital Human Modeling and Applications in Health, Safety, Ergonomics and Risk Management: Healthcare and Safety of the Environment and Transport (Part I), edited by Vincent G. Duffy
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- Volume 24, LNAI 8027, Foundations of Augmented Cognition, edited by Dylan D. Schmorrow and Cali M. Fidopiastis
- Volume 25, LNCS 8028, Distributed, Ambient and Pervasive Interactions, edited by Norbert Streitz and Constantine Stephanidis
- Volume 26, LNCS 8029, Online Communities and Social Computing, edited by A. Ant Ozok and Panayiotis Zaphiris
- Volume 27, LNCS 8030, Human Aspects of Information Security, Privacy and Trust, edited by Louis Marinos and Ioannis Askoxylakis
- Volume 28, CCIS 373, HCI International 2013 Posters Proceedings (Part I), edited by Constantine Stephanidis
- Volume 29, CCIS 374, HCI International 2013 Posters Proceedings (Part II), edited by Constantine Stephanidis

I would like to thank the Program Chairs and the members of the Program Boards of all affiliated conferences and thematic areas, listed below, for their contribution to the highest scientific quality and the overall success of the HCI International 2013 conference.

This conference could not have been possible without the continuous support and advice of the Founding Chair and Conference Scientific Advisor, Prof. Gavriel Salvendy, as well as the dedicated work and outstanding efforts of the Communications Chair and Editor of HCI International News, Abbas Moallem.

I would also like to thank for their contribution towards the smooth organization of the HCI International 2013 Conference the members of the Human-Computer Interaction Laboratory of ICS-FORTH, and in particular George Paparoulis, Maria Pitsoulaki, Stavroula Ntoa, Maria Bouhli and George Kapnas.

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Constantine Stephanidis
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HCI International 2014

The 16th International Conference on Human–Computer Interaction, HCI International 2014, will be held jointly with the affiliated conferences in the summer of 2014. It will cover a broad spectrum of themes related to Human–Computer Interaction, including theoretical issues, methods, tools, processes and case studies in HCI design, as well as novel interaction techniques, interfaces and applications. The proceedings will be published by Springer. More information about the topics, as well as the venue and dates of the conference, will be announced through the HCI International Conference series website: <http://www.hci-international.org/>

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Part I
Cultural Issues in Business
and Industry

Research Facing Interface Design of Android System Industrial Control System

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Abstract. This paper focuses on the UI interface in various forms of android system application. Based on comparative analysis for display interface of several typical industrial control system, summarizes the display design requirements for industrial control systems in industrial environments, with a view to the future industrial control system in android system how to carry on display design and interface design. Finally, based on the author's ongoing research project as an example, stage achievements as the research target, this paper analyzes the advantages and disadvantages of existing system interface design, and give the solutions of existing problems.

Keywords: Android, Industrial control system, Interface design.

1 Introduction

Android is the name of open source operating system which is announced by Google in November of 2007 based on Linux platform. With the feature of completely free open source code, it is sprung up in embedded field (1). Initially it is mainly used in mobile phones, and then gradually spread to tablet PC, and now in the field of industrial control system is get preliminary application which make requirements of users on the system interface design get more satisfy.

In the field of industrial control, a wide range of industry determines the high difference degree of industrial software type. Especially the software used in high technology and automation, must have more and more complex functions to meet the needs of the industry because of the particularity of the object dealing with and the complexity of the problems, so in the design of industrial software interface, its characteristics of software should be taken into consideration.

2 Main Principles of the Interface Design

System interface is the main bridge of man-machine interactive information. Industrial area, complicated operation, inconsistent layout and inappropriate information display will make the user frustrated. How to smooth completion of the human-computer interaction, let users through the simple operation, easy to complete the task, and feel a modern industrial equipment for quick and comfortable become the new proposition of interface design (2).

2.1 Concision

The most important principles of interface design is simple and straightforward. Program looks more complicated if application interface is very difficult, and a little depth to consider in the design, it helps to create the interface which is simple both in look and using. From an aesthetic point of view, the clean and simple design is more desirable.

2.2 Consistency

The coordination of the application will be reflected by the consistent appearance. The interface will be confusing and chaotic in the lack of consistency so that the application is also confusing rather than strict, failing to reflect the proper value. Then the user will feel inconvenient by operating the application even feel that the application is not reliable. Therefore, the design of the interface should be consistent with the current style of popular applications as much as possible. In Android system, you can unify screen and UI elements according to the style and themes, so that the entire application interface style will be consistent.

2.3 Focused

In the vast majority of the program interface design, not all content has the same importance. A good interface should be clear and tightly focused, with the more important and frequently used content placed in a conspicuous place and the secondary content in a secondary position. Putting content similar controls in a group is also very important. The controls which are put together in the light of the function or relationship, in the visual effect, is much better than dispersed throughout the screen. It makes the interface structured and clear.

3 Interface Design of Industrial Control System

In industrial control field, all data on the display and the distribution of function commands are achieved through the system interface. The interface design is good or bad is not only to take the aesthetic of information display into consider, convenience of its information to identify, interpret and understand is a prime consideration (3). Information can't be effectively displayed to the user if the interface design is unreasonable. This article focuses on interface color coding, shape coding, graphics coding based on the experimental analysis.

3.1 Different Color-Coded Visual Differences in Study

Today, people are accustomed to colorful software environment, but the requirements of industrial control system display interface is very different, on the contrary, gorgeous colors and dazzling graphics design will distract the attention of the operator.

Different colors, different reactions on the background of same color. This paper makes a comparative study of cognitive responses to different colors in the context of

the same color. Due to the existence of individual differences, some react more quickly and some react slowly to the same color in the same color as the background.

Through comparative experiments, it is obvious that people react significantly faster to yellow, red, white and green as the subject than the reaction of the other six colors as the subject. Thus, in the industrial control system interface design, such as the flag of tips and warnings should be used in bright colors of red, yellow, grass green which easier identified by users. In addition, all equipment, pipeline, character and static picture elements can be used in gray which make sufficient contrast to background color so as not be too eye-catching (3).

3.2 Different Graphics Coding

Graphics and icons can convey the information vividly that the text can't achieve the desired effect. Console man-machine interface converts a variety of data into graphics displayed in the graphics area through visualization technology, so we should select the icon which is Simple, standard and the preferred graphics and icons which is generally recognized by the public.

Figure 1 presents a monitoring interface of a dust removal system, but too much visual information confuse users when it is presented in front of the user. Display a lot of information on the page, you can let the page more detailed, but not appropriate layout and information presentation will cause visual confusion. We can categorize and integrate the information, display the information in several stages of page based on primary and secondary distribution of the information; We can also use the pop-up window to operate information (1); Additionally we can make the title of the similar information in the form of a list which is clarity, it will pop up the corresponding detailed information when we click on a title, avoiding visual confusion caused by too much information.

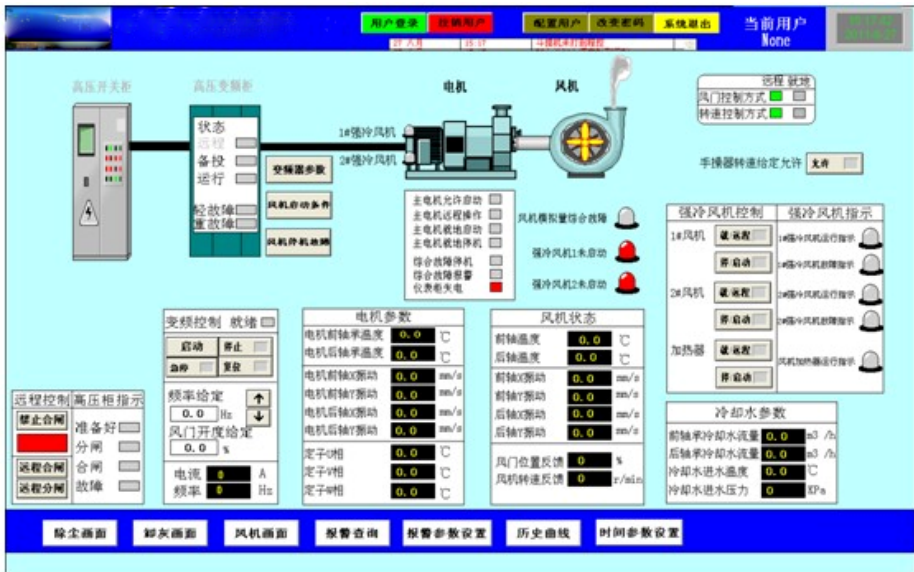


Fig. 1. A dust removal system monitoring interface

4 Introducing of Android Interface Development

Android can generate a screen in three ways: XML configuration generated; interfaces generated by the user interface; direct code generation. According to the MVC principles, the UI should be separated with the program logic, therefore, defining in the XML UI structure is highly recommended (1). In addition, a program adjust from one screen plan to another is also much easier. The basic functional unit of the Android application is Activity. Activity can do many things, but it not be shown on the screen, so we need to use the View and Viewgroup.

On the Android platform, you can use the View and ViewGroup hierarchical graph to define Activity UI.

The level of the tree can be simple or complicated as you wish. To show a view hierarchy tree on the screen, your Activity must call setContentView () method and pass it a reference of a root node. The Android system will accept this reference, and use it for the interface measurement. The root of the levels will require its child nodes to self-drawn, and each ViewGroup node is responsible for calling its subview for self-drawing (4).

5 Case Study

The author is conducting the development of a Android client relevant with teaching system, pre-interface design jobs have just been completed. The client consists of 3 main functions that each of the main functions correspond to several sub-functions shown in Figure 2. Taking into account the characteristics of the client hardware, the main interface uses TabHost layout which is user-defined, and puts the tab at the bottom of the page to switch on the interface, as shown in Figure 3. In addition, we use ListView at the top of the main menu to display the main function above the tab. Flexible use of the various controls in the Android system, we can easily solve the confusing interface layout problems mentioned above.

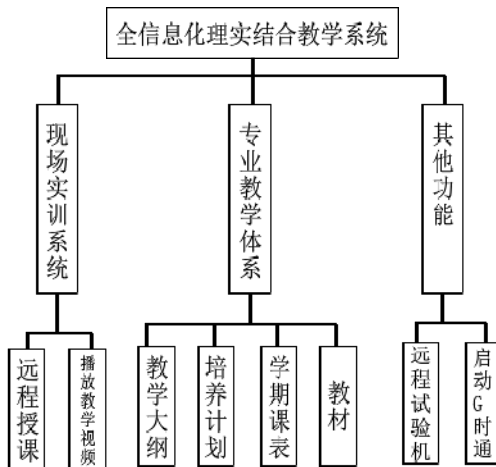


Fig. 2. Block diagram



Fig. 3. Case interface design

But there is an inevitable problem in the android system interface development, interface layout errors with different screen resolution. It is important to notice how to make the application to adapt to a variety of resolution as much as possible, how to be compatible of different platforms, and different screen in the development.

First of all, it should be sure how many resolution devices that the application will support; Secondly, it is need to be clear which resource files is wrong in the presence of different resolution devices; For the wrong resource files, we need to re-prepare the resource file and layout file which are adapted to the corresponding resolution device.

6 Conclusion

As is proved by the experimental research, Android system interface has some kinds of uncoordination, and the application interface is short of unified standard. Although the openness of Android provides the most possibility for applications free play, but it is not necessarily a bad thing that if system itself can provide the standard example. After all, there is no need for applications to create the interface originality. Under the Android system, in addition, the existing function controls provide little supports for industry control system interface development at present. It is necessary to do much secondary development to satisfy the needs of design.

References

1. Jin, Y., Yao, S.: Develop Introduction and Practice about Google Android. Posts & Telecom Press (2009)
2. Jianjun, O.Y.: Research Based on The Interface Application of Interaction Design. The Guide of Science & Education (2010)
3. Jing, Y.: Brief Talk About User Interface Design. Arts And Design (2009)
4. RongLi, L., Yan, H.: Users in the human-computer Interface Design Model Research. Changchun University of Technology, (02) (2006)
5. Leshan, L.: Human-computer Interface Design. Science Press, Beijing (2004)
6. Chao, H., Quan, L.: The Detail Explain of System Principle and Develop about Android, pp. 151–166. Electronic Industry Press (2010)
7. Bloch, J.: Effective Java Programming Language Guide. China Electric Power Press (2004)
8. Shicheng, Z.: Development and Research of Application based or Google Android. Computer Knowledge and Technology 5(10), 7959–7962 (2009)

Developing Customer Experience Ecosystem – Driving Business Results by Integrating Multiple Touch Points

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Abstract. Customers interact with brands and products through digital touch points such as websites and mobile apps as well as physical touch points such as brick-and-mortar stores and print materials. However, user experience professionals tend to treat digital and physical touch points separately and only focus on the digital channel. This paper analyzes the negative impact of such separation and proposes ways to re-integrate the touch points to support an effective customer experience ecosystem that drives revenues and customer loyalty.

Keywords: Customer experience, user experience, multi-channel.

1 Introduction

Traditionally, we think of user experience as something relating to digital platforms, including Web, mobile, and electronics UI, but not relating to physical-world experience, such as shopping at a brick-and-mortar store and reading a magazine. As a result, user experience and interaction design professionals mostly work on digital user interface, spending much less time on non-digital product designs.

The separation of digital and non-digital spaces is a curious one. On the one hand, consumers interact with a brand or a product across multiple touch points, be it digital or physical in nature. We walk into an Apple store to play with Apple's digital products. We make purchases on lowes.com and then pick up the items at a Lowe's local store. We watch movie trailers online to do some research before walking into a theater. From a true user-centered perspective, there should not be such a separation.

Then, where did this separation come from? One reason could be historical in nature. User experience design can find its root in the field of human-computer interaction. Many pioneering work in the field is related to the study of usability [1], focusing on how to better support user tasks by designing more effective digital-product user interface. There was little emphasis on the design of physical space and media. Another reason could be attributed to complexity. Human-computer interactions are typically more complex than physical-world interactions. For example, it could be very challenging for many of us to operate a digital camera or use Enterprise software. On the other hand, physical interaction – such as shopping at a brick-and-mortar store and reading a print magazine – is rarely baffling.

It is worth noting that the lack of integration does not only exist between the digital and physical spaces. Even within the same space, the lack of integration is often observed. For instance, many companies' websites and mobile apps are not well integrated to support a seamless experience – they are developed by different teams, have different visual branding, and function as separate channels that do not talk to each other.

The separation between the digital and the physical is but an artificial one that can greatly undermine our ability to deliver great user experience. To eliminate such separation, the first thing I'd like to do is replacing the term "user experience" with the term "customer experience" in the ensuing discussion. The former is traditionally associated with only the digital UI whereas the latter is used in a wider context that includes all touch points between humans and the brands/products they interact with.

Let us examine two real-life examples of failed customer experience as a result of such separation.

2 Why Do We Need to Integrate Customer Touch Points?

2.1 Costco: Could Better Integrate Its Offline and Online Channels

Costco is a great example. It has a multi-channel distribution model – customers shop at Costco in their brick-and-mortar stores as well as through costco.com. Both channels provide great customer experience. The warehouses are well designed to give shoppers easy access to a huge inventory and a number of affiliated services such as one-hour photo and pharmacy. On the other side of the table, Costco.com has a robust UI: clean, visually pleasing, easy to navigate, straightforward information architecture, and streamlined checkout process.

However, in light of a multi-channel distribution model, the two channels collaboratively fail to deliver their full value. There is little reference to Costco warehouses when you shop online, nor is there any mention of continuing your shopping journey online when you are in a warehouse. Below are some suggestions to better integrate the two channels.

Many in-store shoppers are not aware of the fact that Costco.com has a different and sometimes more comprehensive inventory relative to the warehouses. For example, there is a larger selection of laptops and home decor items online than in store. Many shoppers will just go to a warehouse and subsequently get disappointed by the limited options available there. To address the problem, there could be some in-store messaging that points shoppers to the website to look for additional items.

What can we do on the website? To integrate the two channels better, the website can market items based on the customer's in-store shopping history. For example, for customers that recently purchased a TV, the website can promote home theatres, blue-ray players, and game consoles. Another way to integrate is letting customers make purchases online and then pick up the items at the store. This way, Costco provides extra convenience through online purchases, while still driving customers to the stores to increase foot traffic.

Of course, there might be unknown business reasons behind the poor channel integration. It's hard to propose a specific integration strategy without knowing the full business picture. That said, the message is clear here: User experience is not just about the Web experience, the mobile experience, and the store experience – it's about all of these, integrated as a *customer experience ecosystem* or CXE.

2.2 Netflix and Blockbuster: The Negative Impact of Failed CXE

Many of us still remember the Netflix's customer experience fiasco – the company first abruptly raised the fees of its DVD services by more than 60% and then tried to split the streaming and DVD services into two separate websites to further inconvenience subscribers. Instead of integrating customer touch points to support a streamlined customer experience, Netflix decided to separate the two services completely. As a result, the stock price plummeted from around \$300 to less than \$80 within just a few months.

Blockbuster, the chief rival of Netflix, at the moment had a good shot at taking advantage of the series of missteps of Netflix. But Blockbuster also failed to integrate its online and offline channels despite an apparent effort.

Seeing the Netflix crisis, Blockbuster enhanced its existing Total Access package, which already included online DVD exchange and in-store exchanges (users can exchange their online rentals in the stores for other DVDs for free), by including video streaming in the package, and named the enhanced version Blockbuster Movie Pass [2]. All of a sudden, with three customer touch points integrated in one service package, Blockbuster looked like a superior alternative to Netflix, which didn't have the physical-store touch point.

The concept was great as it promised great convenience to customers, and that's why I signed up for Blockbuster Movie Pass and cancelled my Netflix subscription at the time.

BlockBuster Customer Experience Ecosystem – The Ideal

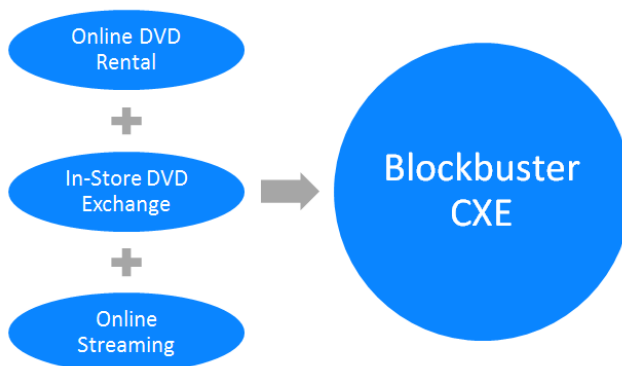


Fig. 1. Ideally, all three touch points should be well integrated in developing an effective CXE

Well, it turned out to be a far less satisfying experience due to the fact that Blockbuster had closed many of its stores in my neighborhood. That made in-store exchange a moot point. On the other hand, Blockbuster did have a few kiosks near my home, called Blockbuster Express. The kiosks work the same way as Redbox does – you can rent DVDs in a kiosk located in a local store - convenient to customers and less expensive for Blockbuster to own than a full store.

However, Blockbuster's Movie Pass package did not allow users to return DVDs rented online at those kiosks in exchange of other DVDs. Given that there're fewer Blockbuster stores around, not allowing users to take advantage of the kiosks as an alternative to the in-store DVD exchange was a big mistake.

BlockBuster Customer Experience Ecosystem – The Reality

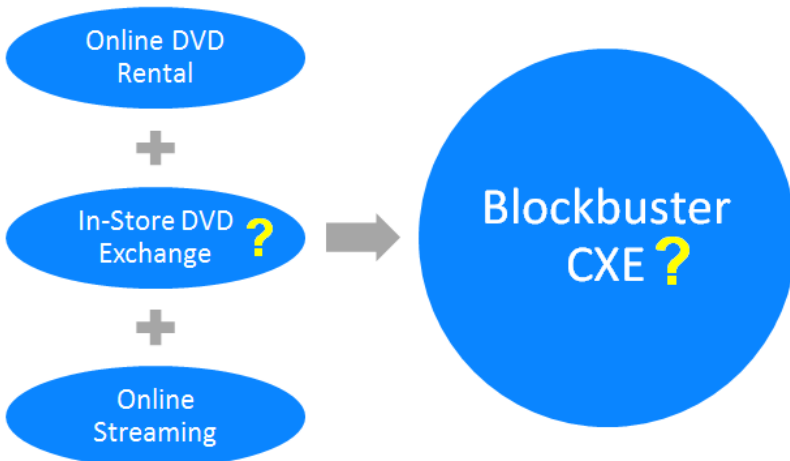


Fig. 2. In reality, the in-store touch point is poorly implemented, and the CXE breaks down as a result

This is yet another example of poorly managed CXEs. While the notion of those service packages is very promising, Blockbuster failed to provide a customer experience that truly bridges the online and physical worlds. A CXE failure like this will almost certainly further weaken the already failing business.

3 Improving CX Ecosystem: A Two-Step Process

Here is a two-step process that can be used to develop CXEs. Step 1: performing a thorough analysis of the current CXE to identify opportunities for improvement. Step 2: proposing solutions for those opportunities identified in Step 1. Figure 3 and 4 illustrated a hypothetical CXE developed based on the two-step process.

For this hypothetical business, there are three touch points, the website, the mobile app, and the sales reps. Depending on the business, additional customer touch points such as social media and physical stores can be easily integrated in the ecosystem.

3.1 Step 1 – Identifying Gaps

Let’s start with Step 1 – analyzing the current customer touch points and workflows. As we can see, the customer workflow starts at the very first stage of customers’ interaction with the company – a customer can learn of the company through venues such as marketing, friends and families, and search engines, before interacting with its websites and mobile apps.

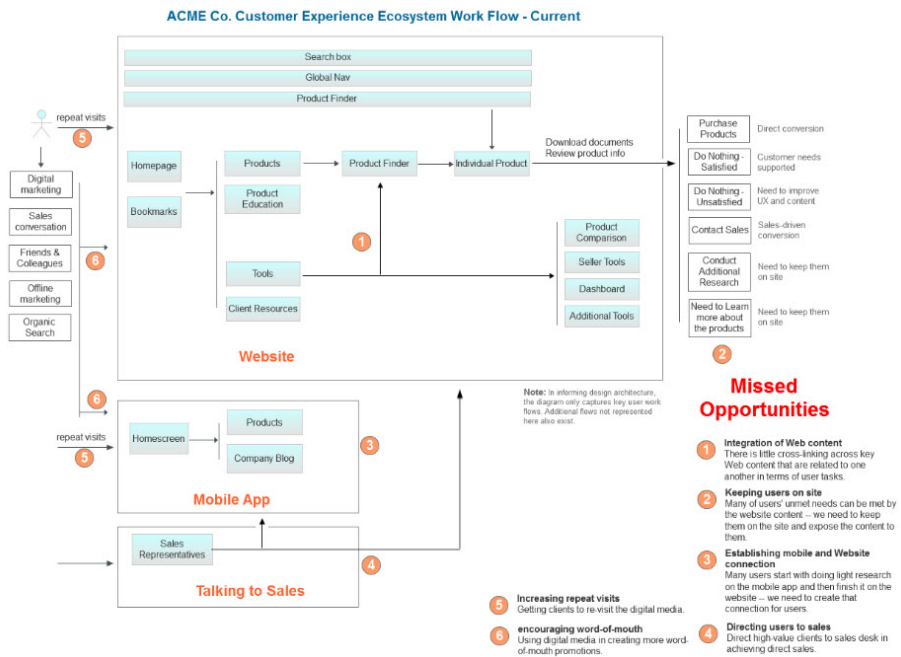


Fig. 3. Analyze the current customer ecosystem to identify missed opportunities

The ecosystem also does not end with customers leaving the touch points – instead, it ends with what they plan to do *next*, such as contacting the sales reps and conducting additional research before making a purchase decision.

Through a careful review of the diagram, coupled with a good understanding of the company’s business needs, we can identify a few key issues that undermine customer experience:

- The Web content and features are not integrated well
- The website does a poor job keeping users on the site
- There is little cross-talk between the website and the mobile app

- The website and the mobile device don't effectively direct users to talk to sales reps
- There is little incentive for users to re-visit the website
- The company needs to do something to encourage word-of-mouth as a marketing means to drive traffic

3.2 Step 2 – Proposing Solutions

Based on the gap analysis, we can propose solutions to those customer experience pain points, illustrated in the diagram below:

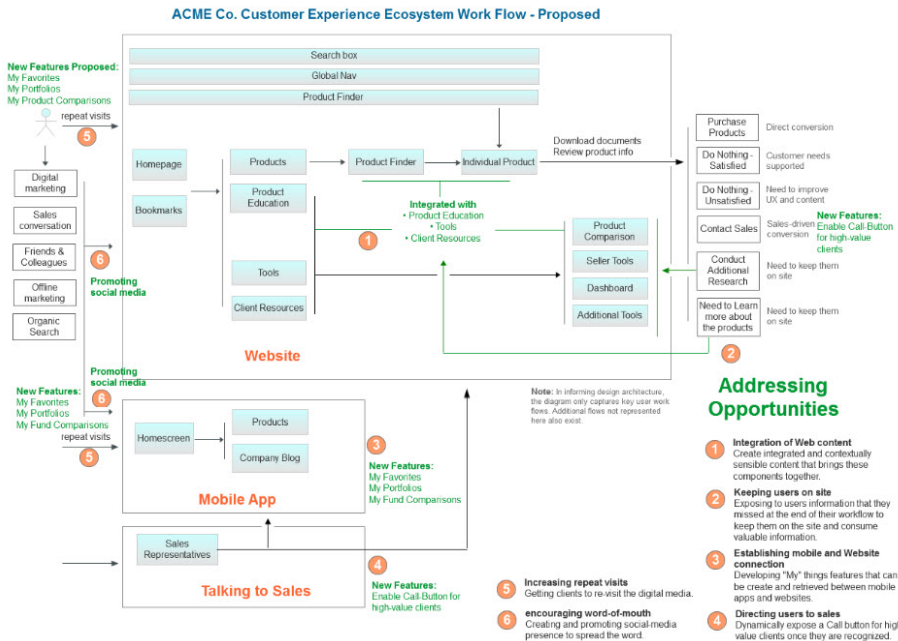


Fig. 4. Propose solutions to address the missed opportunities

Let me run down a few of those proposals:

To address Issue 1, the lack of content integration, we can redesign the website workflow and IA to combine multiple features in one module. To address Issue 4, the lack of support for sales conversation, we can propose to have a Call button implemented on the mobile app to send customers to the sales reps. To address Issue 5, encouraging repeat visits, we can propose to have a new feature suite that speaks to the personalization need of customers (e.g., my products, my product comparisons) that can bring users back to the site and the mobile app.

4 Leveraging CXE: A Case Study

Developing a robust CXE is key to driving revenues through customer engagement and loyalty. It is of great importance for a business to integrate CXE as part of its core strategy. This is especially true for start-ups in search of a profitable monetization model and mature companies that seek additional revenue growths. Let me talk about a healthcare start-up that I helped as a product strategy consultant, as a case study.

Before I start, here's some background about the company:

It is a commercial all-in-one remote health monitoring device and data integrator. Through remote data access and a digital client center that includes a website and a mobile app, it collects vital signs and full body composition biometrics and build online health and fitness communities based on the information collected. Patients and consumers of fitness and wellness services can engage in setting and tracking of health and fitness goals, playing online fitness/health games, and share information with friends, families, and support networks.

Here is a typical usage scenario:

Tom is clinically obese and has a slew of weight-related health problems such as high blood pressure, back pain, short of breath, and heart problems, which make him a frequent visitor to the doctor's office. He takes measurements of vital signs and full body composition biometrics through a Health Station manufactured by the company at his doctor's office, and he continues to track the measurements each time he visits his doctor. All of the data are remotely sent to the company's Digital Client Center, where he can share the information with friends and families, engage in fitness competition with like-minded individuals (e.g., those that also want to lose weight), and track his progress against a benchmark based on a target population that he wants to compare himself against.

Here is how the company builds a robust CXE into its business model.

4.1 Integrating Physical and Digital Customer Touch Points

In the medical-device industry, traditionally there is a lack of integration between measurements and digital records: The measurements, such as blood pressure, weight, and body mass composition, do not get pulled into digital records – caretakers or patients need to manually record the data. Fully aware of the issue, we made physical- and digital-space integration a key differentiator of the start-up:

Through remote access, the company's Health Station sends measurements to its Digital Client Center, where the customer can track and set goals based on the measurements as well as share such information with online health and fitness communities and friends and families. No manual data entry is needed. This saves time for end users as well as health professionals. By automatically feeding data into the Digital Client Center, customers will find it extremely easy to act upon the measurements and engage in health- and fitness-enhancing activities.

4.2 Integrating Web, Mobile, and Social-Media Touch Points

After discussing the integration of the physical and digital spaces, now let's take a closer look at the company's digital experience. In developing a digital CXE, we

designed the digital touch points, including Web, mobile, and social-media, in such way that we achieve seamless integration: Participants can retrieve and enter information on both the Web and mobile app interfaces, and the information can be shared through social-media sites as well as online health and fitness communities. This way, participants will use the company's Digital Client Center as an all-in-one platform to manage their health- and fitness-related goals and activities.

4.3 Summary

A big part of the business model of the start-up is about creating an all-inclusive CXE, leveraging a combination of hardware and digital product offerings. Whereas most players in the healthcare industry focus on a particular aspect of customer experience, the company's strategy is to integrate all aspects of the experience ecosystem to introduce stickiness and drive long-term loyalty.

5 Discussion

The user experience field went through multiple stages of evolution. At the very beginning, UX professionals go after usability refinement, helping companies develop products that are easy to use [1]. Later, the field realized that a big part of user experience management is about emotion and desirability [3], and therefore many of us expand our practice to improve digital marketing and visual identity. The progress made between the two states is a welcome one, as we expand our horizon and think of design in more holistic terms [4]. Still, user experience professionals are viewed as *digital-space* specialists that can only speak to Web and mobile UI design and marketing. That means we have much room to grow in terms of contributing to the overall business strategy.

Here is what I see as the next stage of the evolution. Starting from a place where the digital UI was the center of our practice, now we are ready to move forward – taking into consideration all the customer touch points as one holistic ecosystem and thus apply our expertise across the ecosystem to fundamentally shape customer experience and drive sustained business success.

References

1. Nielsen, J.: *Designing Web Usability*. New Riders Publishing, Indianapolis (1999)
2. Burns, M.: *Blockbuster Movie Pass: Dish Network's \$10/Month Answer To Netflix* (2011), <http://techcrunch.com/2011/09/23/blockbuster-movie-pass-dish-networks-answer-to-netflix-and-qwikster/>
3. Norman, D.: *Emotional Design: Why We Love (or Hate) Everyday Things*. Basic Books, New York (2005)
4. Guo, F.: *More than Usability: The Four Elements of User Experience, Part I*. UXmatters (2012)

Consumers' Evaluation and Perception within the Trend of Cultural Creative Design

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Abstract. During the process of the transformation and innovation of traditional cultural and localized characteristics, we can make old things fashionable through creative design. Therefore, the main purpose of this study is to investigate the effectiveness evaluation on cultural creative design of consumers' perception and preference. This study was implemented in two phases. First, we undertook a preliminary survey by means of literature review and opinions from a group of experts, and selected representative product samples and evaluation indices from the three categories: traditional culture, local elements and innovative fashion. The second phase was to give a questionnaire survey to 120 undergraduate and graduate students who voluntarily participated in this study in order to investigate consumers' perception and preference. According to the questionnaire survey and the analysis of the results, "Design Performance" is the most important factor for evaluating cultural creative products.

Keywords: consumer evaluation, consumer perception, cultural creative design.

1 Introduction

As the demands of life increase, the consumer market advances in an era of experience-focus and aesthetic economics. The distinctness of local culture and the structure of innovation-knowledge become the national core competency. It's seen within the trend of the promotion of cultural and creative industries as an important strategy for economic development in each country. For example, the manufacturers of pewter in the UK through its alliances with crafts-based designers have transformed their learning capabilities in order to add value to their products and create new organizational knowledge [1]. Furthermore, Fiji has increased the income of tourism to support national economic by holding folk cultural art-festivals and Oktoberfest in Munich of Germany aim to integrate their cultural assets in order to enhance the national image and improve competency of their industries. Expecting achieves the balance between economic output value and life quality by showing traditional culture and localized characteristics.

Because the influence of art and culture extends to the industry value chain, the industry must create aesthetic innovations on the basis of consumer culture [2].

Furthermore, the UNESCO [3] thinks that the cultural product possesses an economic and cultural nature and becomes a carrier of culture characteristics, values and meaning through the experience of use and keep cultural heritage. To be successful, innovative products must have clear and significantly different features that are related to market need. Therefore, creative design is considered to be one of the pivotal components in cultural and creative industries, and this will have a significant impact on consumer perception of innovation.

Li and Ho [4] discussed about the cooperation between the Taiwan National Palace Museum and Italian fashion brand Alessi and their inharmonic opinions of cultural creative products reported on various newspaper articles. In order to design “local features” into “innovative products”, we need to study how to link between local uniqueness and customers’ perceptions, and then the results can be transformed into cultural creative design. Therefore, this shows the importance of considering market factors and consumers’ needs during the innovation process of traditional cultural. Hence, the main purpose of this study is to investigate and analyze the effectiveness evaluation on cultural creative design of consumers’ perception and preference, and provides references for follow up cultural creative design and marketing.

2 Culture Elements and Cultural Creative Design

The design and development of cultural creative products help to improve life quality and the social culture level. Along with technology progress, designing “feeling” into products to present the emotional communication of user experiences became a design trend in the 21st century. Design should not only focus on function and elegant appearance but also on the heritage and connection of the culture concerning problems in our society in order to redefine people’s life style.

2.1 Exploration of Cultural Creative Products

Culture generally refers to styles of human activity and symbolic structures. Moreover, culture has been described as the evolutionary process that involves language, customs, religion, arts, thought and behavior. From the design point of view, Leong and Clark [5] developed a framework for studying cultural objects distinguished by three special levels: the outer ‘tangible’ level, the mid ‘behavioral’ level, and the inner ‘intangible’ level. Thanks to the improvement of technology, it is easier to implement innovation. In order to satisfy consumers’ demands, the design should be accomplished by the enhancement of investigation of the product and human-product interaction. Furthermore, Norman [6] suggested that a successful design should consider the suitability, practicability and aesthetics of the product in which emotion is the most important factor.

Based on previous studies [5], [7] and [8], a framework for studying cultural objects is summarized in Figure 1. As shown in Figure 1, culture can be classified into three layers: (1) Physical or material culture, including food, garments, and transportation related objects, (2) Social or behavioral culture, including human relationships and social organization, and (3) Spiritual or ideal culture, including art and religion.

Since cultural objects can be incorporated into cultural creative design, three design features can be identified as follows: (1) the inner level containing special content such as special meaning, storyline, emotion, cultural characteristics, (2) the mid level containing function, operation, usability, safety, Joint relationship, structure, and (3) the outer level dealing with color, material, appearance, pattern, lines, details, texture.

When designing cultural creative products, it is necessary to study and analyze their attributes to establish a reasonable transformation context between cultural characteristics and its product manifestation. The process of developing such a design concept is filled with uncertainties that are difficult for designers to control. "Transformational Thinking in Design" can facilitate understanding and exploration of cultural characteristics, and facilitate thinking about the different layers of cultural creative product application during the design process, resulting in culturally significant creative products (see Figure 1). In each layer of exploration, this figure can help to focus on the key point when we design a cultural creative product.

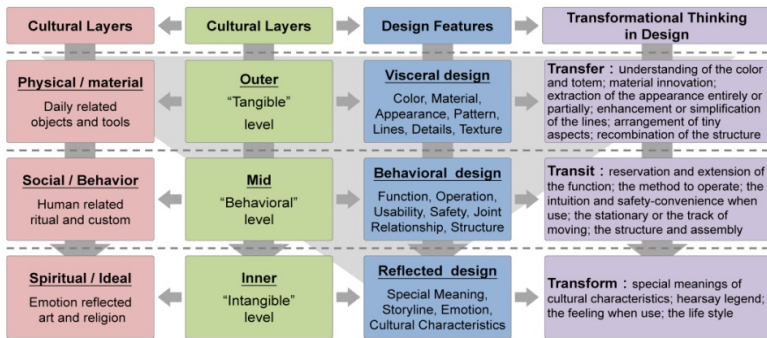


Fig. 1. Three layers and levels of cultural objects and design features

2.2 Fundamental Cultural Resources of Taiwan

Recently, Chinese culture has caught the attention of the world not only in the field of design application but also the style of arts. The multi-cultures and friendly people in Taiwan have been deemed as our characteristic, which bring potential application-value in the design field. However, most cultural creative products simply copy a form or are decorated with cultural totems. Products without the spirit of the culture will not help to upgrade the life culture [7] and [9]. Enhancing the quality and adding extra value to the product is necessary for the improvement of product performance. Taiwan has a strong potential to develop significant cultural creative design. Three fundamental resources for the development of cultural creative design are as follows: (1) the Taiwan Aboriginal culture, (2) the Chinese Southern Civilization originating roughly four hundred years ago, and (3) the Chinese Antiques civilization, with displays in the National Palace Museum, originating around four thousand years ago [10].

In addition, the character is the most important tool to record the history and culture. Recently, Taiwan dedicated itself to the promotion of cultural and creative industries. However, the design application for now is to transform mostly the concrete products

of traditional life into creative applications in industries. We can see prosperous characteristics of Chinese cultural materials in which Chinese characters are the most distinctive around the world. The Chinese character presents not only the heritage and development of the culture but also the symbol of the traditional esthetics. If we make good use of this precious Chinese character, the ideas of innovation and practical applications will be more prosperous and distinctive.

2.3 Project Results of Cultural and Creative Industries in Taiwan

Based on technology and with designs and innovations that have added value through culture and aesthetics, advanced countries already show their competitive edge. When facing the impact of economic globalization, traditional culture and local industries try to transform themselves, and through a process of innovation, let old things become new and fashionable.



Fig. 2. Website of cultural and creative industries in Taiwan [11], [12] and [13]

Starting in 2002, with the successive promotion of the policies “Challenge 2008: National Development Plan” and “Six Emerging Industries” and the action plan “Creative Taiwan – Cultural and Creative Industries Development Program”, Taiwan implemented policies for the advancement of cultural and creative industries [14]. Furthermore, all ministries implement relevant policies as well: for example the “Taiwan e-Learning and Digital Archives Program” for the digitalization of national collections of cultural relics by the National Science Council and the “OTOP – One Town One Product” counseling program to assist SMEs to use distinctive industries, supervised by the Small and Medium Enterprise Administration (SMEA) of the Ministry of Economic Affairs. In addition, the National Palace Museum turned to horizontal alliances through active brand licensing, thus making the National Palace Museum an industry cluster for domestic and international cultural and creative industries (see Figure 2).

3 Research Method

Cultural creative products are made for the global market, using materials and elements from traditional culture or with regional characteristics. With the development of technology, design and creativity, traditional culture can be maintained and local industries revived, and with the charm of traditional culture and local characteristics, economic output and life quality can be balanced. The literature discussed in the

previous section serves as the foundation of this research. It summarizes the plans for cultural and creative industries that were promoted by Taiwan in recent years and serves as case studies. It can be divided into three categories: (1) Traditional Culture: Using the traditional “cultural image” to reach product differentiation; (2) Local Elements: using “local features” to transform the industry by changing design; (3) Innovative Fashion: focusing on the global market and using “innovative design” to create characteristic products.

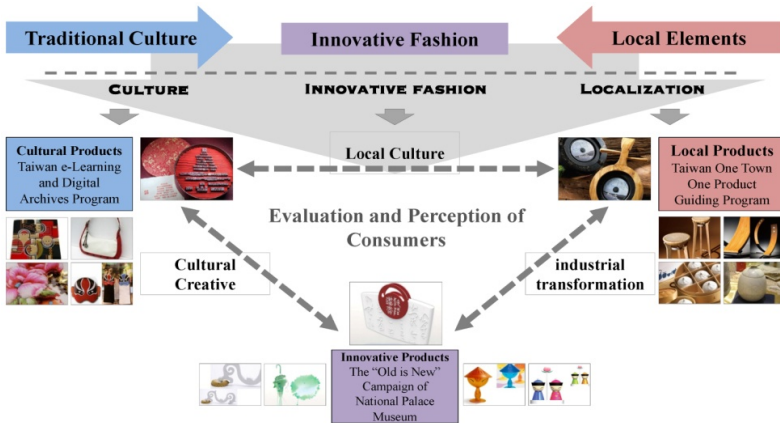


Fig. 3. The research framework

This research first undertakes a preliminary survey on the basis of the literature review and the suggestions of a group of 5 interdisciplinary experts from the fields of culture, creativity and industry. We selected representative product samples and evaluation indices according to the criteria of traditional culture, local elements and innovative fashion. Second, we carried out a questionnaire survey and analyzed the outcome of the research with SPSS Statistics 17.0. We used descriptive statistics and factor analysis to analyze the consumers' perception and preference of the participants. The framework of this study is shown in Figure 3.
















3.1 Participants

A total of 128 people participated in this study, with 120 valid participants (8 had to be excluded because their answers were not complete), consisting of 39 male and 81 female participants. Participants were undergraduate and graduate students from the National Taiwan University of Arts, the Chinese Culture University and the National Taipei College of Business with an educational background in Communication and Management related (68 participants) and Arts and Humanities related (52 participants).

3.2 Selection of Experiment Samples

We selected the product samples with the help of product images and design descriptions from related books, magazines and websites. Samples include the top three works of “Taiwan e-Learning and Digital Archives Commercial Application Competitions” (15 samples), works of “Taiwan One Town One Product Design Competitions” (24 samples) and selected products from the “Old is New Campaign of National Palace Museum” as well as top products from design competitions organized by the National Palace Museum (20 samples). In addition, we appointed a group of experts (5 experts from the fields of culture, creativity and industry). We defined the categories “Traditional Culture”, “Local Elements” and “Innovative Fashion” and selected 5 products for each category, with 15 in total (see Table 1).

Table 1. Three different categories of product samples

Cultural Products – From Taiwan e-Learning and Digital Archives Commercial Application Competitions				
P01	P02	P03	P04	P05
				
“Pinban Boat” handbag	“Beauty of the Mountains” cruet	“Domineering” towel rail	“Grandmother’s Fashion” brooch	“The Words of Love” wedding gift
Local Products – From Taiwan One Town One Product Design Competitions				
P06	P07	P08	P09	P10
				
“Tea-Flavored Egg” tea caddy	“Bamboo” table lamp	“Rush” chair	“Steamed Dumpling” cruet	“Recalling the Past” CD player
Innovative Products – From the “Old is New” Campaign of the National Palace Museum				
P11	P12	P13	P14	P15
				
“Dragon Claw” bottle opener	“Mr. & Mrs. Chin” Salt and pepper set	“Jadeite Cabbage” parasol	“The Writing Manual” briefcase	“Mandarin” Squeezer with goblet

3.3 Selection of Evaluation Indices

First, we compiled competition assessment criteria, integrated relevant research for the traditional culture evaluation index category [15], [16], the local elements evaluation index category [17], [18] and the innovative fashion evaluation index category [19], [20], and selected 16 items for each evaluation index. Second, the appointed expert group selected 6 representative items for each evaluation index (from the three categories traditional culture, local elements and innovative fashion), with 18 items in total.

3.4 Procedure

According to the previous survey, we selected 15 product samples and 18 evaluation indices and prepared the questionnaire and the explanation. Before the participants filled out the questionnaires we first explained the procedure to them. The first part of the questionnaire is “Personal Data”, followed by the “Design Evaluation” survey and the “Personal Preference” survey. The “Design Evaluation” survey shows 15 color images of product samples, with a short description of the design characteristics under each picture. This part consists of 19 questions, including the 18 evaluation indices as well as “Desire to Buy” the product. Participants rated the evaluation indices of the product according to their own experience and perception, or, in other words, indicated their degree of identification. We used a 7-point Likert scale and the subjects indicated their responses by circling the numbers; 1 indicates a low identification with the index, 7 a high identification with the index. In the last part, the “Personal Preference” survey, participants ranked the items “Personal Preference Product” and “Evaluation Index Importance” from 1 to 9; a smaller value indicates a higher personal preference.

4 Results and Analysis

We used this experiment to understand how the participants assessed the design of cultural creative products. 120 of the 128 collected questionnaires were valid, and we used SPSS Statistics 17.0 to evaluate the statistical data and investigate the potential factors of evaluating product samples and the design evaluation indices.

4.1 Factor Analysis of the Design Evaluation Indices

We used factor analysis to investigate the internal relationship between the items of the questionnaire and distill them into a few factors. The participants rated the design of the cultural creative products with the 18 evaluation indices; these ratings were reduced in number and given a new name for the factor analysis. In this way we tried to find the common factors that influenced the participants' ratings of the products.

The goal of this research was to find the factors of the cultural creative evaluation indices and to analyze the results. Before we implemented the factor analysis we first used KMO (Kaiser-Meyer-Olkin) and Bartlett's test to analyze the results from the questionnaires [21]. The KMO measure is 0.934, which is larger than the determined value 0.6 and the Bartlett's test of sphericity is statistically significant; hence, the results of the questionnaires are suitable for using factor analysis [21]. In this research we used the principal component analysis to extract two common factors. The value of the variance indicates the explanatory power of each factor. The explanatory power of factor 1 is 68.99% and the explanatory power of factor 2 is 9.08%. The cumulative explanatory variance is 78.07% (Table 2). The 18 items of the questionnaire can be distilled into two factors that influence the perception and judgment of cultural creative products. According to the statistical results, and after the arrangement of all factors and their included variables as well as the renaming of the factors, we distinguished the factors: “Design Performance” and “Cultural Elements”.

Table 2. The result of principal component analysis

Dimensions	Evaluation Index	Factor loadings	
		Factor 1	Factor 2
Design Performance	A09 Product Function	.850	.295
	A14 Texture	.836	.455
	A18 Overall Presentation	.830	.378
	A16 Fashion	.817	.227
	A10 Design Quality	.796	.488
	A13 Innovative Design	.787	.450
	A17 Environmental Sustainability	.781	.124
	A12 Unique Idea	.753	.480
	A15 Emotion	.735	.368
	A08 Innovative Materials	.719	.468
	A05 Aesthetic Image Form	.700	.531
Cultural Elements	A01 Special Meaning	.259	.845
	A04 Background Story	.326	.845
	A02 Cultural Characteristic	.288	.839
	A03 Evokes Feelings	.268	.817
	A11 Historic Origin	.434	.767
	A07 Local Features	.425	.767
	A06 Appearance Style	.624	.651
	Eigenvalue	12.42	1.63
	Variance (%)	68.99	9.08
	Cumulative (%)	68.99	78.07
	KMO	0.934	

4.2 Analysis of Participant's Personal Preference

Besides the analysis of the design evaluation indices of the products, we also investigated the participants' degree of personal preference. In part two of the questionnaire, we asked the participants to select 9 product samples they like best and 9 evaluation indices they think are important and rank both of them from 1 to 9. First place counts as 9 points, second 8 points and so on up to the ninth place which counts as 1 point. The product samples and evaluation indices not selected count as 0 points. Table 3 shows the participant's degree of preference for the 15 product samples and their perceived importance of the 18 evaluation indices.

In Table 3 we can see the ranking of the nine products the participants liked best. The ranking from one to nine is P07 "Bamboo - table lamp", P06 "Tea-Flavored Egg - tea caddy", P09 "Steamed Dumpling - cruet", P10 "Recalling the Past - CD player", P11 "Dragon Claw - bottle opener", P03 "Domineering - towel rail", P02 "Beauty of the Mountains - cruet", P05 "The Words of Love - wedding gift" and P15 "Mandarin - squeezer with goblet". This ranking also shows similarity to the "Desire to Buy" ranking.

Furthermore, in Table 3 we can also see the majority of evaluation indices on "Design Performance" factors by the factor analysis: The participants ranked A09 (Product Function), A13 (Innovative Design), A05 (Aesthetic Image Form), A10 (Design Quality), A12 (Unique Idea), A14 (Texture), A18 (Overall Presentation), A06 (Appearance Style) and A16 Fashion as the nine most important evaluation indices (see Table 2, 3) of cultural creative products. Therefore, "Design Performance" is an important factor for cultural creative products.

Table 3. Rank of Participant’s Personal Preference

High Rank		Rank of the “Item 19: Desire to Buy”														Low Rank		
Item	P07	P03	P10	P09	P06	P11	P02	P05	P13	P15	P12	P01	P08	P14	P04			
Mean	4.93	4.26	4.25	4.17	4.06	3.88	3.85	3.76	3.45	3.42	3.17	3.08	3.02	2.95	2.51			
High Rank		Rank of the Personal Preference Product (Personal Preference)														Low Rank		
Item	P07	P06	P09	P10	P11	P03	P02	P05	P15	P13	P01	P12	P14	P08	P04			
Mean	5.88	4.57	4.32	4.17	3.73	3.72	3.30	3.07	2.78	2.25	2.17	1.53	1.47	1.40	0.66			
High Rank		Rank of the Evaluation Index Importance (Personal Preference)														Low Rank		
Item	Index A09	Index A13	Index A05	Index A10	Index A12	Index A14	Index A18	Index A06	Index A16	Index A17	Index A01	Index A15	Index A02	Index A03	Index A08	Index A07	Index A04	Index A11
Mean	4.94	4.48	4.42	4.03	3.99	3.98	3.08	2.75	2.55	1.80	1.72	1.51	1.48	1.33	1.19	0.92	0.61	0.23

5 Conclusions and Suggestions

In Taiwan, the localized cultural elements, products and tours have gradually become an opportunity for animating the regional economy. Various types of souvenirs and the use of cultural creative design spring up all around. Currently, design development of cultural creative products is increasingly varied, but to satisfy consumer buying needs, most cultural creative products are reduced to an imitation of form, transfer of patterns or are limited to traditional crafts.

The results of the factor analysis that we used to evaluate the questionnaires suggest that we can extract two common factors that influence the participant’s perception and judgment: “Design Performance” and “Cultural Elements”. Furthermore, the “Design Performance” is the most important factor for evaluating cultural creative products.

Therefore, design application in cultural creative products is important for product development and innovations that can impart cultural heritage and present culturally distinctive aesthetics that are practical in daily life so that consumers can have new awareness of the characteristics of traditional culture. Moreover, the idea to transform local culture into creative design will enhance the innovation and originality of industries or even create the cultural and creative industries of Taiwanese style.

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References

1. Yair, K., Press, M., Tomes, A.: Crafting Competitive Advantage: Crafts Knowledge as a Strategic Resource. *Design Studies* 22(4), 377–394 (2001)

2. Shih, P.C.: Cipher of Aesthetic Economics. Business Weekly, Taipei (2009) (in Chinese)
3. UNESCO: Convention on the Protection and Promotion of the Diversity of Cultural Expressions (2005),
<http://unesdoc.unesco.org/images/0014/001429/142919e.pdf>
4. Li, J.C., Ho, M.C.: Rethinking about the Cultural Products of a Museum: Perspectives across Disciplines. *Journal of Design* 14(4), 69–84 (2009) (in Chinese)
5. Leong, D., Clark, H.: Culture - Based Knowledge towards New Design Thinking and Practice - A Dialogue. *Design Issues* 19(3), 48–58 (2003)
6. Norman, D.A.: *Emotional Design: Why We Love (or Hate) Everyday Things*. Basic, New York (2004)
7. Lin, R.: Transforming Taiwan Aboriginal Cultural Features into Modern Product Design: A Case Study of a Cross-Cultural Product Design Model. *International Journal of Design* 1(2), 45–53 (2007)
8. Hsu, C.H., Lin, R.: A Study on Cultural Product Design Process. *Journal of Design* 16(4), 1–18 (2011) (in Chinese)
9. Lin, R.: Creative Learning Model for Cross Cultural Product. *Art Appreciation* 1(12), 52–59 (2005) (in Chinese)
10. Wang, M.H.: Reviewed the Educational Policies for 40 Years of National Taiwan Institute of Arts. *Art Appreciation* 57, 59–72 (1995) (in Chinese)
11. Digital Taiwan - Culture & Nature, <http://culture.teldap.tw/culture/>
12. Taiwan One Town One Product, <http://otop.tw/>
13. Trends in Digital Life at the NPM,
<http://www.npm.gov.tw/hotnews/oldisnew/>
14. Council for Cultural Affairs: Creative Taiwan: Cultural and Creative Industry Development Plan (2009), http://cci.culture.tw/cci/cci/law_detail.php?sn=3838
15. Hsu, C.H.: An Application and Case Studies of Taiwanese Aboriginal Material Civilization Conferred to Cultural Product Design. Unpublished Master's Thesis, Chang Gung University, Taoyuan (2004) (in Chinese)
16. Liu, C.S.: A Study of Product Design Techniques for the Application of Cultural Elements. Unpublished Master's Thesis, National Taiwan University of Science and Technology, Taipei (2008) (in Chinese)
17. Wang, M.F.: The Research of Symbolism in Local Culture Commodity Developing Mode - A Case Study in Nantou County. Unpublished Master's Thesis, Tunghai University, Taichung (2007) (in Chinese)
18. Kuo, P.Y.: A Study of Marketing Mechanism of Locally Cultural Industry - the Consumer Psychology Analyses. Unpublished Master's Thesis, Chaoyang University of Technology, Taichung (2004) (in Chinese)
19. Bessemer, S.P., Treffinger, D.J.: Analysis of Creative Products: Review and Synthesis. *The Journal of Creative Behavior* 15(3), 158–178 (1981)
20. Shih, P.Y.: Exploring the Innovation of Product Design from International Design Award - Winning Products. Unpublished Master's Thesis, National Taiwan University of Science and Technology, Taipei (2006) (in Chinese)
21. Jung, T.: *SPSS and Research Methodology*. Wu-Nan, Taipei (2009) (in Chinese)
22. Hsu, C.H., Lin, J.Y., Lin, R.: A Study on Consumer Perception and Preference of Cultural Creative Products. In: *International Conference on Parading for Design Education*, pp. 221–226. National Yunlin University of Science and Technology, Yunlin (2012)

Introducing Human Performance Modeling in Digital Nuclear Power Industry

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Abstract. Human performance modeling (HPM) can be used to explain and predict human behaviors under certain situations, helping designers in the design stage through evaluating the interface, procedure, staffing, etc. This study discusses the feasibility of introducing HPM methods into digital nuclear power industry through 1) the new characteristics of human-system interaction/human performance in digital main control rooms (MCRs) of nuclear power plants (NPPs), 2) the simulating abilities of available HPMs on their latest progress. Based on the review of the two issues, we conclude that: 1) digitalization of NPPs changes operators' performance through the system, task, environment and human himself. 2) HPM is classified as human reliability modeling and cognitive modeling. The lack of performance data could be an obstacle for applying human reliability modeling in digital MCRs. The unclear underlying mechanism of human-system interaction in digital MCRs constrains the introducing of cognitive modeling.

Keywords: Digitalization, Nuclear power plants, Performance influence factors, Human performance modeling.

1 Introduction

Safe operation in NPPs can never be emphasized too much. While human performance act as a key component in this safe operation (O'Hara, Brown, Lewis, & Persensky, 2002; O'Hara, Higgins, Persensky, Lewis, & Bongarra, 2004), Much attention has been paid on this topic to enhance human reliability or error-tolerance of the system. Since it's difficult to obtain the real data of operators' performance in NPPs, especially under emergency conditions, introducing Human Performance Modeling (HPM) methods to predict operator performance seems to be important and necessary. What's more, the digitalization of NPPs changes the way of human-system interaction, which may cause new challenges for introducing HPM in such complex system. Meanwhile, methods for modeling human performance also got development during these years. Their powerful modeling ability impressed researchers very much. To identify the opportunities and challenges of applying HPM in digital MCRs, this paper presents a review on the new characteristics of human-system interaction/ human performance in digital MCRs first.

2 Digitalization and Human-System Interaction in MCRs

The shift from analog to digital NPPs changes the way of human-system interaction, mainly through four main aspects: system, task, environment, and human.

2.1 System

The digitalization in NPPs changes the system directly, reducing equipment volume, simplifying cabling, and supplying new functions (Cou, 1997). Three important trends of digitalization have been claimed: increased automation, computer-based information display and intelligent operator aids (O'Hara & Hall, 1992; Kim & Seong, 2009). They overlapped with each other in some extent:

- **Automation** means to allocate functions to machine agents instead of original operators (Parasuraman, 1997). Different levels of automation (LOA) differs from each other in their task allocation between human and machine under the four cognitive processing stages: monitoring, generating, selecting, and implementing (Endsley, 1999) or information acquisition, information analysis, decision selection, and action implementation (Parasuraman, Sheridan, & Wickens, 2000). The LOA needs to be considered carefully when deal with certain tasks: a higher LOA decreases operation time and workload in the shutdown reactor task but not in the reset alarm system task (Jou, Yenn, Lin, Yang, & Lin, 2009); an intermediate LOA (completely automatic in implementing stage but semiautomatic in other three stages) is better than a lower (action support) or a higher LOA (supervisory control) for one's SA in the procedure tasks (Lin, Yenn, & Yang, 2010). Beside, Automation in monitoring and implementing stage such as the pre-alarm system (Hwang, Lin, Liang, Yau, Yenn, & Hsu, 2008) and the auto-reset model alarm system (Huang, Hwang, Yenn, Yu, Hsu, & Huang, 2006, Huang, Lee, Hwang, Yenn, Yu, & Hsu., 2007) enhanced human performance and reduced operators' workload in monitoring tasks. On the other hand, automation may cause human errors due to poor feedback, inadequate transparency, or operators' over reliance on automation (Kim & Seong, 2009). What's more, lack of appropriate automation, misunderstanding or mistrust automation could cause accidents (Schmitt, 2012).
- **Computer-based information displays** indicate advanced display forms to provide new possibilities for information organization and presentation (Kim & Seong, 2009). Four types of information organization methods are used to design displays in MCRs (Andresen, 2011): Conventional process mimic display (organized by process flows), Task-based display (organized by predefined tasks), Ecological display (trying to make information easy to retrieve and utilize from the work environment), and Function-oriented display (refer particular to safety-functions). Ecological interface design (EID) is the most studied topic: Designers use the abstraction hierarchy method (AH, Rasmussen, 1985) to select and organize information, and present them in advanced configurational forms. A number of studies found that ecological interface improving operator's monitoring (e.g. Burns, et al., 2008) and diagnosing performance (e.g. Ham, Yoon, & Han, 2008), especially

under the novel and complex scenarios, and also enhancing operator's SA (e.g. Kim, Kim, Jang, & Jung, 2012), reducing their workload (e.g. Lau, Jamieson, Skraaning, & Burns, 2008), but taking more spatial resources of operators (Pawlak & Vicente, 1996).

Automation can coexist with computer-based information displays through one item — computer-based procedure (CBP). It's a digital method to support procedure management. There are four LOA of CBP: manual, advisory, shared, and automated (O'Hara, Higgins, Stibler, & Kramer, 2000). Integrated decision support information at the decision point in the CBP (the advisory level) and automation execution such as judging the current condition with the given standards (the automated level) are identified to improve one's performance and reduce the workload and behavior error (Huang & Hwang, 2009; Lee & Seong, 2004). Meanwhile, information presentation of CBP based on text or flowchart, two-column format or three-column has also been discussed. Xu and her colleges (2008) found that one- and two-dimensional flowcharts are better than two-dimensional flowcharts in skilled task.

2.2 Task

Tasks are "Procedures and characteristics" (Kim & Sung, 2003, P485) that operators need to implement. Since digitalization helped to complete many motor actions and supplied operator aids, less motor activities but more cognitive activities are required. Researchers believe that introducing computers to support the operation even changes operators' work roles. Sheridan (1997) postulated that planning, teaching, monitoring, intervening and learning are the new work roles of operators in this computer-supported supervisory control system. Monitoring, intervening and high level cognitive abilities such as decision making (to decide when and how to intervening) are regarded as the most important works (Kim & Seong, 2009; O'Hara & Hall, 1992).

Besides, operators in digital MCRs need not only to implement the primary monitoring tasks, but also to manage the interface itself to get the demanding information. This task called "interface management task" includes configuring, navigating, arranging, interrogating and automating, which compete with the primary task for the cognitive resources and may cause primary task performance degradation especially when the time pressure is high (O'Hara et al., 2002). Zhou, Jiang & Zhang (2012) declaimed that interface management task is one of the most significant impacts on operators' cognitive reliability to influence their performance.

Accordingly, the way researchers treat tasks is also in change. A systematic perspective has been used to consider the relationship between the underlying factors and task complexity. According to Liu & Li's summary (2011), not only the characteristics of task itself (such as steps, task types) affect task complexity, but also the task-related information display on the indicator, the time pressure while operators completing the task, even the characteristics of task doer are regarded as task complexity contributors. Besides, High-complexity task induces performance degradation and human errors (e.g. Hwang et al., 2008; Kim & Jung, 2003; Xu et al., 2008).

2.3 Environment

The physical working environment, leadership, team size, communication, etc. are all environment factors. Since digitalization made both Board operators (BOs) and Shift Supervisor (SS) obtaining higher level information from digital Human-system interfaces (HSIs) and controlling through the CBPs directly, they worked more independently from each other than in the traditional MCRs.

Communication amount and mode between operators have been changed: 1) The amount of communication decreased since many system information can get directly from the parameters on the interface; 2) More information-confirmation (know the content of wanted information, just ask for a confirmation) instead of information-identification (do not know the content of wanted information, ask for the detail contents) is used; 3) The asymmetric between SS and BOs has been compensated: SS needn't do as much integrate and disintegrate work as in the traditional MCR. 4) the variance of communication decreased, 5) communication is important for a crew to reach shared situation awareness (SSA) and cooperate based on the SSA. Since the total amount and frequency of communication decreased sharply, operators may need additional communication or operation to keep the status of each other (Chung, Yoon, & Min, 2009; Kim, et al., 2012; Min, et al., 2004; Roth & O'Hara, 1999).

Besides, training and team size have also been discussed under digital circumstance. Training level (familiar extent) and training interval affect operator performance (Dong & Li, 2011; Xu et al., 2008). The non-technical skills training, such as crew resource management training, improved crew coordination and reduced operators' mental workload significantly (Crichton & Flin, 2004; Kim & Byun, 2011); Huang & Hwang (2009) found that two operators can complete tasks as good as three operators when assisted with CBPs in the digital MCRs.

2.4 Human

Cognitive abilities, personal status (e.g. emotion), personality, etc. are all individual factors related to human. All the changes mentioned above: LOA, EID, CBPs, interface management tasks, work role, task complexity, new communication mode and amount, training and team size will influence operators' behavior, workload, SA and personal status, and may finally changes operator's individual characteristics (e.g. visual ability) in a long run.

To conclude, human-system interaction has been changed through the four main aspects. In addition, system, task, environment and human factors are also supposed to be the four big factors influence human-system interaction, under both digital and traditional conditions, also called performance influence factors (PIFs) (Kim & Jung, 2003). This means the changed and unchanged PIFs in the four aspects will influence human-system interaction collectively. But how these factors influence human-system interaction integrally is unclear. Moreover, these four aspects factors mentioned above are sometimes overlapped with each other: e.g. the task complexity related factors may overlapping with factors related to human. In fact, the ambiguous and overlapping in PIFs category is very common (e.g. Chang and Mosleh, 2007a).

Thus, the changes of the four big factors under digital condition, the unclear boundary among these categories and the unclear mechanism or manner of PIFs influencing performance could raise challenges to the application of HPM.

3 Human Performance Modeling

HPM methods use mathematical or computational abstractions to explain and predict human behaviors in particular domains or tasks (Byrne & Pew, 2009). According to Pew's (2008) taxonomy with a historical viewpoint, two ways of HPM are introduced in this section, roughly recommended on their modeling mechanism and simulating abilities.

3.1 Human Reliability Modeling

Human reliability modeling is developed from HRA methods. The whole modeling process could be viewed as an extension of task analysis, therefore human reliability model is also named as task network model or reductionist model (Laughery Jr & Corker, 1997).

Systems Analysis of Integrated Network of Tasks (SAINT) is a typical human reliability model. First, Tasks (that need to cope with) are decomposed into elemental actions (such as scan, read or other behaviors) until the time and success probability to perform these actions can be accessed from a particular database. Then the elemental actions are organized in network or series of network. The relationships among these elemental actions (e.g. operation order) are defined upon results from task analysis. Through define the input, duration (can be adjusted by PIFs such as stress, fatigue), essentiality, type, class and output of the tasks, SAINT generates quantification results such as time, accuracy, and workload (Pritsker, 1974). There, PIFs affect human performance as adjustment factors.

Improved Performance Integration Tool (IMPRINT) uses the same software of SAINT, but can execute tasks in parallel and generate more informative workload (Mitchell, 2003). Human Operator Simulator (HOS) introduces cognitive micro-models such as perceptual and mental computation to model human performance (Harris et. al., 1989). In fact, as the importance of cognitive factors is increasingly recognized, more cognitive factors are brought into human reliability models. The COGnition as a NETwork of Tasks (COGNET) model (Ryder, 1998) and the Information, Decision, and Action in Crew context (IDAC) model (Chang and Mosleh, 2007a) could be regarded as cognitive models already.

3.2 Cognitive Modeling

Cognitive models are developed on the findings and theories from cognitive science, especially the human information processing theory. The Adaptive Control of Thought-Rational (ACT-R) model is structured mainly with a perceptual-motor system, a goal module, a declarative memory module and a procedural memory module

(Anderson, Bothell, Byrne, Douglass, Lebiere, & Qin, 2004). With these modules and particular rules, ACT-R can model various functions such as perception, reasoning, decision making and learning (Anderson & Schunn, 2000). Other cognitive models are more or less like ACT-R. Most of them present sensory input, cognitive processing, and motor output as the major three stages of information processing, but differ with each other in many details, from basic cognitive structures to high-level functions. Characteristics of these models are discussed correspondingly with demands that digital MCRs put on operators in the following five aspects (adapt from Pew and Mavor's (1998) perspectives):

- **Basic cognitive structures and abilities:** indicating the structure of sense, perception, attention, memory and the corresponding functions. Since monitoring became one of the most important tasks in digital MCRs, a reliable and powerful modeling of human sensory and perceptual abilities could be necessary. Because of their outstanding theory base and well-constructed visual, auditory senses, attention (or cognitive resources) and memory, executive-process interactive control (EPIC, Kieras & Meyer, 1997), ACT-R (used the same perceptual module of EPIC) and Principles of Synthetic Intelligence (PSI) (Bach, Dörner, & Vuine, 2006) can meet the criterion.
- **High-level cognitive functions:** including reasoning, decision making, learning, planning (re-planning under a new condition), problem solving, etc. Decision making is important since operators need to decide when and how to intervene during monitoring. While the majority of the models make decisions directly based on the matching degree of goals and current conditions, The situation awareness model for pilot-in-the-loop evaluation model (SAMPLE) (Zacharias, Miao, Illgen, Yara, & Siouris 1996) and cognitive environment simulation (CES) (Woods & Roth, 1987) give more consideration of the inner condition that operators perceived, and make decision based on situation awareness (SA) and goals. Since SA is a popular concept in human factors studies, the use of SA made the modeling more directly to the results of human factor studies. In addition, ACT-R (Anderson & Schunn, 2000) and PSI (Bach et al., 2006) can model learning and planning abilities.
- **Team work:** As mentioned in section 2, communication, team size and training need to be considered when simulate crew operation. ACT-R, Man-machine Integration Design and Analysis System (MIDAS) (Gore and Corker, 2002), SAMPLE, and OMAR can simulate communication between crew members, but lack the information about other teamwork-related abilities. IDAC models teamwork though defining operator responsibility and communication rules (Chang and Mosleh, 2007a).
- **Influencing factors:** Factors affect human performance such as fatigue, emotion, motivation and age have been considered in some of the HPMs. Two ways are used to include these factors in modeling, one is to integrate the factors into the underlying mechanism (e.g. PSI), the other is to regard these influence factors as the successful probability of performing certain actions (e.g. IDAC). From section 2, we know that digitalization has changed many PIFs related to system, task and

environment and finally influence human performance. But the affecting mechanism or manner are still not clear.

- **Output or mediate output:** Plenty of useful outputs such as workload, situation awareness, timeline, accuracy of actions and even behaviors are generated for engineering application. MIDAS uses a virtual man “Jack” in 3D environment to present the behaviors, which makes the simulating process more impressing and understandable.

In summary, cognitive modeling can model a battery of abilities from perception to learning. Most of the abilities and functions required when operators work in digital MCRs can be modeled by cognitive modeling.

4 Conclusion

This paper focus on the new characteristics of human-system interaction in the digital MCRs to discuss the possibilities and challenges for introducing HPM into NPPs.

Since digital NPPs are not commonly in use, the lack of data support (i.e. the time and success probability to perform certain actions in a digital MCRs and how the influence factors adjusting the performance) could be the main obstacle for applying human reliability modeling in NPPs. Using data from other field like aviation or military (e.g. IDAC, Chang and Mosleh, 2007b) is a method worth trying. Thus, to consider the difference between different industries before using their database is necessary.

Meanwhile, cognitive models are good in modeling cognitive abilities and functions. Instead, the confusion of the mechanism that PIFs influencing operators’ information processing is the real problem in introducing cognitive modeling method in NPPs. Until now, studies are mainly concern the superficial relationships between single PIF and human performance. Researchers need to pay more attention to find out how these factors interact with each other and the underlying mechanism of PIFs influencing performance integrally.

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References

1. Anderson, J.R., Bothell, D., Byrne, M.D., Douglass, S., Lebiere, C., Qin, Y.: An integrated theory of the mind. *An Integrated Theory of the Mind*. Psychological Review 111(4), 1036 (2004)
2. Anderson, J.R., Schunn, C.D.: Implications of the ACT-R learning theory: No magic bullets. *Advances in Instructional Psychology* 5, 1–34 (2000)
3. Andresen, G.: Information Display Design: Three Attempts at Superseding the Traditional Process Mimic Display. *Simulator-based Human Factors Studies Across 25 Years*, 169–180 (2011)

4. Bach, J., Dörner, D., Vuine, V.: PSI and MicroPSI. A Novel Approach to Modeling Emotion and Cognition in a Cognitive Architecture, Tutorial at ICCM (2006)
5. Burns, C.M., Skraaning Jr., G., Jamieson, G.A., Lau, N., Kwok, J., Welch, R., et al.: Evaluation of ecological interface design for nuclear process control: situation awareness effects. *Human Factors: The Journal of the Human Factors and Ergonomics Society* 50(4), 663–679 (2008)
6. Byrne, M.D., Pew, R.W.: A history and primer of human performance modeling. *Reviews of Human Factors and Ergonomics* 5(1), 225–263 (2009)
7. Chang, Y.H.J., Mosleh, A.: Cognitive modeling and dynamic probabilistic simulation of operating crew response to complex system accidents: Part 1: Overview of the IDAC Model. *Reliability Engineering & System Safety* 92(8), 997–1013 (2007a)
8. Chang, Y., Mosleh, A.: Cognitive modeling and dynamic probabilistic simulation of operating crew response to complex system accidents. Part 2: IDAC performance influencing factors model. *Reliability Engineering & System Safety* 92(8), 1014–1040 (2007b)
9. Chung, Y.H., Yoon, W.C., Min, D.: A model-based framework for the analysis of team communication in nuclear power plants. *Reliability Engineering & System Safety* 94(6), 1030–1040 (2009)
10. Cou, N.R.: *Digital Instrumentation and Control Systems in Nuclear Power Plants: safety and reliability issues* (1997)
11. Crichton, M.T., Flin, R.: Identifying and training non-technical skills of nuclear emergency response teams. *Annals of Nuclear Energy* 31(12), 1317–1330 (2004)
12. Dong, X., Li, Z.: A study on the effect of training interval on the use of computerized emergency operating procedures. *Reliability Engineering & System Safety* 96(2), 250–256 (2011)
13. Endsley, M.R.: Level of automation effects on performance, situation awareness and workload in a dynamic control task. *Ergonomics* 42(3), 462–492 (1999)
14. Gore, B.F., Corker, K.M.: Increasing aviation safety using human performance modeling tools: an Air Man-machine Integration Design and Analysis System application. *Simulation Series* 34(3), 183–188 (2002)
15. Hallbert, B., Boring, R., Gertman, D., Dudenhoefter, D., Whaley, A., Marble, J., et al.: *Human Event Repository and Analysis (HERA) System, Overview* (2006)
16. Ham, D.H., Yoon, W.C., Han, B.T.: Experimental study on the effects of visualized functionally abstracted information on process control tasks. *Reliability Engineering & System Safety* 93(2), 254–270 (2008)
17. Harris, R., Kaplan, J.D., Bare, C., Iavecchia, H., Ross, L., Scolaro, D., et al.: *Human Operator Simulator (HOS) IV User's Guide* (1989)
18. Huang, F.H., Hwang, S.L.: Experimental studies of computerized procedures and team size in nuclear power plant operations. *Nuclear Engineering and Design* 239(2), 373–380 (2009)
19. Huang, F.H., Hwang, S.L., Yenn, T.C., Yu, Y.C., Hsu, C.C., Huang, H.W.: Evaluation and comparison of alarm reset modes in advanced control room of nuclear power plants. *Safety Science* 44(10), 935–946 (2006)
20. Huang, F.H., Lee, Y.-L., Hwang, S.-L., Yenn, T.-C., Yu, Y.-C., Hsu, C.-C., et al.: Experimental evaluation of human–system interaction on alarm design. *Nuclear Engineering and Design* 237(3), 308–315 (2007)
21. Hwang, S.-L., Lin, J.-T., Liang, G.-F., Yau, Y.-J., Yenn, T.-C., Hsu, C.-C.: Application control chart concepts of designing a pre-alarm system in the nuclear power plant control room. *Nuclear Engineering and Design* 238(12), 3522–3527 (2008)

22. Jou, Y.T., Yenn, T.C., Lin, C.J., Yang, C.W., Lin, S.F.: Evaluation of mental workload in automation design for a main control room task (2009)
23. Kieras, D.E., Meyer, D.E.: An Overview of the EPIC Architecture for Cognition and Performance With Application to Human-Computer Interaction. *Human-Computer Interaction* 12(4), 391–438 (1997)
24. Kim, J.H., Seong, P.H.: Human Factors Engineering in Large-scale Digital Control Systems. *Reliability and Risk Issues in Large Scale Safety-Critical Digital Control Systems*, 163–195 (2009)
25. Kim, J.W., Jung, W.: A taxonomy of performance influencing factors for human reliability analysis of emergency tasks. *Journal of Loss Prevention in the Process Industries* 16(6), 479–495 (2003)
26. Kim, S.K., Byun, S.N.: Effects of Crew Resource Management Training on the Team Performance of Operators in an Advanced Nuclear Power Plant. *Journal of Nuclear Science and Technology* 48(9), 1256–1264 (2011)
27. Kim, Y., Kim, J., Jang, S.-C., Jung, W.: Empirical investigation of communication characteristics under a computer-based procedure in an advanced control room. *Journal of Nuclear Science and Technology* 49(10), 988–998 (2012)
28. Lau, N., Jamieson, G.A., Skraaning, G., Burns, C.M.: Ecological interface design in the nuclear domain: An empirical evaluation of ecological displays for the secondary subsystems of a boiling water reactor plant simulator. *IEEE Transactions on Nuclear Science* 55(6), 3597–3610 (2008)
29. Laughery Jr, K., Corker, K.: Computer modeling and simulation of human/system performance. *Handbook of Human Factors and Ergonomics*, 1375–1408 (1997)
30. Lee, S.J., Seong, P.H.: Development of automated operating procedure system using fuzzy colored petri nets for nuclear power plants. *Annals of Nuclear Energy* 31(8), 849–869 (2004)
31. Lin, C.J., Yenn, T.-C., Yang, C.-W.: Automation design in advanced control rooms of the modernized nuclear power plants. *Safety Science* 48(1), 63–71 (2010)
32. Liu, P., Li, Z.: Toward understanding the relationship between task complexity and task performance. *Internationalization, Design and Global Development*, 192–200 (2011)
33. Min, D.H., Chung, Y.H., Yoon, W.C.: Comparative analysis of communication at main control rooms of nuclear power plants. Paper presented at the Proceedings of IFAC/IFIP/IFORS/IEA Symposium, Atlanta, GA (September 2004)
34. Mitchell, D.K.: Advanced improved performance research integration tool (IMPRINT) electronics technology test bed model development: DTIC Document. Document Number (2003)
35. O'Hara, J.M.: Human-system interface design review guidelines: Division of Systems Analysis and Regulatory Effectiveness, Office of Nuclear Regulatory Research, US Nuclear Regulatory Commission (2002)
36. O'Hara, J.M., Brown, W.S., Lewis, P.M., Persensky, J.J.: The Effects of Interface Management Tasks on Crew Performance and Safety in Complex, Computer-Based Systems: Overview and Main Findings (NUREG/CR-6690), vol. 1. Brookhaven National Laboratory, Upton (2002)
37. O'Hara, J.M., Hall, R.E.: Advanced control rooms and crew performance issues: implications for human reliability. *IEEE Transactions on Nuclear Science* 39(4), 919–923 (1992)
38. O'Hara, J.M., Higgins, J.C., Stibler, W.F., Kramer, J.: Computer-based procedure systems: Technical basis and human factors review guidance (No. J-6012). Brookhaven National Lab., Upton (2000)

39. O'Hara, J.M., Higgins, J.C., Persensky, J.J., Lewis, P.M., Bongarra, J.P.: Human factors engineering program review model: DTIC Document. Document Number (2004)
40. Parasuraman, R., Riley, V.: Humans and automation: Use, misuse, disuse, abuse. *Human Factors: The Journal of the Human Factors and Ergonomics Society* 39(2), 230–253 (1997)
41. Parasuraman, R., Sheridan, T.B., Wickens, C.D.: A model for types and levels of human interaction with automation. *IEEE Transactions on Systems, Man and Cybernetics, Part A: Systems and Humans* 30(3), 286–297 (2000)
42. Pawlak, W.S., Vicente, K.J.: Inducing effective operator control through ecological interface design. *International Journal of Human-Computer Studies* 44(5), 653–688 (1996)
43. Pew, R.W.: More than 50 years of history and accomplishments in human performance model development. *Human Factors: The Journal of the Human Factors and Ergonomics Society* 50(3), 489–496 (2008)
44. Pew, R.W., Mavor, A.S.: Modeling human and organizational behavior: Application to military simulations. National Academies Press (1998)
45. Pritsker, A.B.: SAINT: Systems Analysis of Integrated Network of Tasks: DTIC Document. Document Number, vol. I (1974)
46. Rasmussen, J.: The role of hierarchical knowledge representation in decision making and system management. *IEEE Transactions on Systems, Man and Cybernetics* (2), 234–243 (1985)
47. Roth, E.M., O'Hara, J.M.: Exploring the impact of advanced alarms, displays, and computerized procedures on teams. Paper presented at the Proceedings of the Human Factors and Ergonomics Society Annual Meeting (1999)
48. Ryder, J.M., Weiland, M.Z., Szczepkowski, M.A., Zachary, W.W.: Cognitive engineering of a new telephone operator workstation using COGNET. *International Journal of Industrial Ergonomics* 22(6), 417–429 (1998)
49. Schmitt, K.: Automations influence on nuclear power plants: a look at three accidents and how automation played a role. *Work: A Journal of Prevention, Assessment and Rehabilitation* 41, 4545–4551 (2012)
50. Sheridan, T.B.: Supervisory control. In: Salvendy, G. (ed.) *Handbook of Human Factors*, pp. 1295–1327. John Wiley & Sons, New York (1997)
51. Woods, D.D., Roth, E.M.: Cognitive environment simulation: An artificial intelligence system for human performance assessment: Cognitive reliability analysis technique: (Technical report, May 1986–June 1987) (No. NUREG/CR-4862-Vol. 3). Westinghouse Research and Development Center, Pittsburgh, PA (USA) (1987)
52. Xu, S., Song, F., Li, Z., Zhao, Q., Luo, W., He, X., et al.: An ergonomics study of computerized emergency operating procedures: Presentation style, task complexity, and training level. *Reliability Engineering & System Safety* 93(10), 1500–1511 (2008)
53. Zacharias, G.L., Miao, A.X., Illgen, C., Yara, J.M., Siouris, G.: SAMPLE: Situation awareness model for pilot-in-the-loop evaluation (1996)
54. Zhou, Y., Mu, H., Jiang, J., Zhang, L.: Investigation of the impact of main control room digitalization on operators cognitive reliability in nuclear power plants. *Work: A Journal of Prevention, Assessment and Rehabilitation* 41, 714–721 (2012)

Exploring Consumers' Responses to Delayed Introduction of a New Mobile Phone

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Abstract. This experiment investigates consumers' responses to postponement of the pre-announced introduction of a new product, and to the manufacturer's stated reasons for the delay(s), drawing upon the concept of trust violation and on attribution theory. A 2 (frequencies) \times 3 (reasons) between-subject factorial design tested the hypotheses. Two-way ANOVA analyzed the results, with purchase intention as the dependent variable. The study finds that the influence of the frequency of delays is contingent upon the reasons given. When firms announce that all or some of the causes have an internal organizational origin, while others relate to external influences, the frequency of delays has a negative impact on purchase intentions. If the reasons relate entirely to external factors, there is no significant negative impact.

Keywords: Product-introduction delays, Announced reasons, Trust violation, Attribution, Intention to purchase.

1 Research Background

When product life cycles are short, product competition is intense and the pace of technological innovation is rapid, it is essential to get a new product to market quickly, for the company that does so can typically demand a premium price, gain market share and earn higher margins (Nevens, Summe, & Uttal, 1990; Kumar & Motwani, 1995). Thus, it is important for marketing strategists to pay close attention to the pace of new product development and the timescale of commercialisation. Many companies have found the practice of 'pre-announcing' new products and services before they are available to be an effective marketing strategy (Lilly & Walters, 1997), the aim being to encourage current and potential customers to postpone any intention to purchase a competing product (Kohli, 1999). This tactic may have the secondary effects of: stimulating sales in complementary product lines; deterring competitors from entering the market segment; engendering positive attitudes to the firm and its business style among consumers, retailers and opinion leaders; and gaining access to efficient distribution systems (Robinson & Fornell, 1985; Lilly & Walters, 1997; Schatzel & Calantone, 2006).

In practice, however, pre-announced new product launches are often delayed, especially in technology-intensive markets. For example, Bayus, Jain, and Rao (2001) found that as many as 47% of 123 software products that were announced before introduction during 1985-1995 eventually reached consumers more than three months later. More recent examples of major delays in introduction include Apple's iMac desktop computer, Sony's PlayStation 3, and Microsoft's Windows Vista (Hendricks & Singhal, 2008). These are by no means unsophisticated or reckless marketers.

The phenomenon of introductions to the market being delayed beyond pre-announced deadlines has attracted the attention of management and policy researchers and commentators. A related stream of research has examined the reasons for such delays (e.g. Chrysochoidis & Wong, 1998; Rosas-Vega & Vokurka, 2000; Wu, Balasubramanian, & Mahajan, 2004) and the negative consequences of failing to fulfil promised introduction dates (e.g. Hendricks & Singhal, 1997; Hendricks & Singhal, 2008). Although previous studies have documented the negative effects on overall corporate performance, they scarcely address the central managerial question of how consumers respond to delayed new product introductions. Thus, marketing strategists are in the uncomfortable position of not knowing what to do to reduce the presumed negative consequences of the delay.

From the consumer's point of view, a company that does not release a new product on a pre-announced date has contradicted expectations, broken a promise and betrayed trust. The consequence is likely to be such negative behavior as abandoning the purchase, switching suppliers, incorporating additional controls, and expressing dissatisfaction (Rao & Lee, 2007). According to these same authors, the extent of the potential impact of trust violation, in the form of "disengagement behavior" of various kinds, depends on consumers' perceptions of its egregiousness. It also depends on the extent to which they attribute it to the firm's actions (Weiner, 2000).

2 Methodology

This experiment investigates consumers' responses to postponement of the pre-announced introduction of a new cellular/mobile telephone, and to the manufacturer's stated reasons for the delay(s), drawing upon the concept of trust violation and on attribution theory. A 2×3 between-subject experiment was employed. The frequency of delayed introductions was set as high versus low, and the reasons for delays categorized as internal, external, or a coexistent combination of the two. The dependent variable was intention to purchase.

The experimental scenario featured a hypothetical cellular/mobile telephone model, chosen as the focus because it is a mass-market product that has long been in widespread use in Taiwan, where the experiment took place, and belongs to a product class in which delays in the introduction of new products are common.

Participants were undergraduates enrolled in various management classes at one large university. All participants in the study were told to imagine that they had already made a decision to purchase a hypothetical phone model, but had encountered delays in its introduction to the market over a period of six months. Each was

presented with one of six scenarios containing a unique combination of the possible levels of the two manipulated independent variables. They were now to decide whether or not they would still buy the phone, or at least consider waiting for it. The eventual outcome was 583 usable data sets.

3 Results

Analysis of the mean scores calculated from the questionnaire returns suggested that the scenarios depicting the manipulations of the two independent variables were perceived as intended.

The effects of the frequency of introduction delays, and the announced reasons for them, were analyzed by ANOVA. Strong and significant main effects are indicated for both frequency ($F(1, 577) = 10.46, p < .01$) and reasons ($F(2, 577) = 3.96, p < .05$), though they are qualified by a significant interaction effect ($F(2, 577) = 5.55, p < .01$).

The results show that the higher the frequency of introduction delays, the lower participants' intention to purchase: the average scores on the 7-point self-rating scale were $M = 3.29$ for participants reacting to low frequency conditions versus $M = 2.91$ for those in the high frequency groups.

Purchase intentions were also significantly reduced when internal and external reasons coexisted in the experimental scenario ($M = 2.91$). When external reasons were presented alone, the average level of intention ($M = 3.28$) was only slightly more positive than when internal factors were the sole reason offered ($M = 3.14$). Comparison of these means showed that participants' intention to purchase was significantly higher in the external-reason circumstances than in the coexistent-reason condition ($F(1, 391) = 7.15, p < .01$). In contrast, there was no significant difference in purchase intention between participants reacting to the internal-reason scenario and those who were given an external reason ($F(1, 380) = 1.06, p = .30$), and likewise none between the internal-only group and those whose scenario evoked coexistent internal and external reasons ($F(1, 389) = 2.50, p = .11$).

Beyond these omnibus F test results, more significant conclusions are to be drawn from examination of the pattern of differences in purchase intentions across the high and low frequencies of delay for each category of announced reason. First, when delayed new product introductions were attributed to internal factors, high frequency generated lower levels of purchase intention than low frequency ($M = 2.92$ versus $3.34, F(1, 188) = 4.13, p < .05$). Similarly, when both internal and external factors were invoked, average purchase intention among the participants reacting to a high frequency of delays was significantly lower than that in the low-frequency group ($M = 2.49$ versus $3.30, F(1, 199) = 15.41, p < .001$). However, when the hypothetical manufacturer attributed all introduction delays to external factors, the frequency made no difference to the participants' purchase intentions ($M = 3.34$ versus $3.23, F(1, 190) = .41, p = .52$).

An even more meaningful picture emerges from examination of the way in which participants' purchase intentions varied as a function of the reasons they were given

for delayed introductions. In the case of low-frequency delays, there were no significant differences between the mean purchase-intention scores of participants assigned to internal-reason scenario versus those assigned to coexistent scenario, between those under internal-reason scenario and those under external-reason scenario or between external-reason scenario versus coexistent scenario. The respective descriptive statistics were: $F(1, 201) = .04, p = .85$, $F(1, 197) = .33, p = .57$, and $F(1, 200) = .16, p = .69$. These results show, in simple terms, that when a scenario set the frequency of delays in the introduction of a new product at two in the six-month period, no matter what factors were said to have caused those delays, purchase intentions were not significantly different across groups.

In comparison, in the high-frequency situation, participants given both internal and external reasons for the delays expressed purchase intentions significantly lower than those expressed by their counterparts who were told that the cause was only internal ($F(1, 186) = 6.29, p < .05$) or only external ($F(1, 189) = 17.20, p < .001$). Likewise, when the scenario set the frequency of delays at four in six months, participants who were given an internal reason for introduction delays expressed less inclination to purchase the delayed product than those told that the causes were external ($F(1, 181) = 4.90, p < .05$).

4 Discussion

The study reported here investigated the effects on purchase intentions of the frequency of product introduction postponements and the reasons given by manufacturers, aiming to offer important insights into the process for marketing strategists and planners. In so doing it raises the important issue of the ethics of delaying the availability of a pre-announced new product or service.

Such delays are relatively common, whether attributable to internal or external factors, especially in the high-technology sector. This study focused on prospective buyers of a specific mobile/cellular phone, who were confronted by announcements of its delayed availability, and the effect those had on their intention to purchase.

It was found that frequency of delays in the introduction of a new product had a significantly negative influence on a consumer's purchase intentions. A possible interpretation is that the delays are in effect violations of the trust of expectant consumers, who are unable to buy the product they want at the time they were told they would be able to, despite their investment of time and opportunity in a psychological contract. In the case of the mobile phone, more frequent delays can be expected to engender more severe perceptions of violated trust, which it is logical to assume would result in "disengagement behaviors" (Rao & Lee, 2007).

With respect to the moderating role of stated reasons for delayed introductions, the research results show that, when the manufacturer attributes all delays to internal factors only, or to a combination of internal and external, consumers' intention to purchase is negatively influenced by the frequency of the delays. By contrast, if the reason is claimed to be external factor in each case, the impact of frequency on consumers' purchase intention will be weakened.

This finding is consistent with attribution theory, which suggests that consumers will be less likely to exhibit negative behavior in response to delays believed to be due to external factors beyond the manufacturer's control and for which it therefore has no responsibility. If the cause of frequent delays is internal, however, the manufacturer has to accept responsibility, consumers will be more demanding, and negative responses will be more apparent (Folkes, Koletsky, & Graham, 1987). When delays in the introduction of a new product are attributed to both internal and external factors, consumers may doubt the manufacturer's ability to assess and control the contributing variables, and ask themselves if it may not in fact have made a pre-announcement simply to gain a pre-emptive competitive advantage. If they are right, the firm will have risked damage to its reputation and prejudiced consumer loyalty, but it may have done so in the belief that those long-term rewards were worth sacrificing in the pursuit of a short-term competitive edge. More frequent delays generate even stronger incredulity among consumers, and reduce the level of intention to purchase.

The study also found that, when the frequency of delays was low, and the violation of trust was therefore at a relatively low level, the role of attribution was also less; in other words, reasons for the delays had no significant influence on purchase intention. When frequency was high, however, attribution came into play and influenced consumers' behavioral responses. If the delays were said to be the result of external factors, they would be more patient than if the cause was seen to be either internal factors or a combination of internal and external factors. In the latter case, the level of intention to purchase was lowest of all.

4.1 Managerial Implications

A secondary aim of the research study was to improve practitioners' and researchers' understanding of the effects that delays in the introduction of new products to the market can have on consumers' behavioral responses, particularly in the form of intention to purchase.

Prospective purchasers' tolerance and patience in the face of such delays appear to wear thin the more often they recur within a given time period. Accordingly, if a manufacturer is uncertain that a new product can be released to the market on schedule, it will be wise to conserve some lead time, thereby avoiding unduly frequent delays and not squandering consumers' willingness to wait.

Acceptable reasons for delayed introductions can ease the negative impact on purchasing intentions. When the frequency is high, a manufacturer that explicitly attributes the delays to external factors, such as regulatory obstacles or some other uncontrollable forces, should find that consumers' readiness to wait for the arrival of the product is not significantly different from that when the frequency is low. If, on the other hand, a delay is overtly attributed to such internal factors as product quality problems, or to some combination of internal and external causes, consumers are likely to become impatient. From the strategic and ethical points of view, manufacturers would be well advised to assess carefully whether or not some internal factors may have the potential to interfere with the introduction schedule, or if there are external constraints capable of forcing delays, before making any pre-announcement of

future availability. They need to be especially cautious when the factors in question are likely to be difficult to manage, and the delay timetable therefore somewhat unpredictable. Otherwise, repeat delays will cause disengagement behavior on the consumer's part.

To sum up, pre-announcement of a new product should not be treated as a competitive tactic in isolation from questions of broader strategy and business ethics, and the negative impact of subsequent delays neglected. The consequence can be expected to be varying degrees of damage to corporate reputation, consumer attitudes, customer loyalty, and the market value of the firm.

4.2 Limitations and Suggestions for Future Research

The acknowledged limitations of the present scenario-based experiment suggest various opportunities for future research in the area.

First, the experimental sample was undergraduate students. Though a key target market for the product category on which the study was focused, they cannot be considered representative of all mobile/cellular phone users, and the generalisability of the findings is thus limited. Likewise, Taiwan is not wholly typical of Asian consumer markets in general, and certainly very distinct from those in the UK or USA. Therefore, future studies could usefully extend the geographic and demographic scope of the sample.

Second, the duration of each delay was not specified in the experimental scenario, and six months was chosen as a time horizon for recurring delays simply to provide commonality across all experimental conditions. In fact, duration will play an important role in determining consumers' intention to purchase. Their tolerance to it may be subject to such factors as product life cycle, marketplace competition, and substitute products, as well as to their own personality traits, such as innovativeness or variety seeking. These issues should also be further explored by future studies.

Third, when handling the experimental condition of coexistent internal and external reasons for delays, their level of occurrence was set equal, for simplification and the avoidance of variation, and internal reasons were always announced before external. The possible effects of the sequence and weighting of the two categories are worthy of methodological attention in future research.

Fourth and last, the experimental scenario instructed the participants to adopt a preference for the hypothetical 'A1' mobile phone. No real brand was named, to avoid potentially confounding influences. Thus, the experiment investigated only the negative influence of various kinds of delay on their intention to purchase a generic product, without measuring any decline in trust or increasing intensity of negative emotions. No scenario can be expected replicate the cognitive and affective complexity of the same situation in the real world, but future studies could at least incorporate named brands, and other influences on emotional responses, levels of trust and behavioral responses in the face of postponed gratification.

References

1. Bayus, B.L., Jain, S., Rao, A.G.: Truth or consequences: An analysis of vaporware and new product announcements. *Journal of Marketing Research* 38, 3–13 (2001)
2. Chryssochoidis, G.M., Wong, V.: Rolling out new products across country markets: An empirical study of causes of delays. *Journal of Product Innovation Management* 15, 16–41 (1998)
3. Eliashberg, J., Robertson, T.S.: New product preannouncing behavior: A market signaling study. *Journal of Marketing Research* 25, 282–292 (1988)
4. Folkes, V.S., Koletsky, S., Graham, J.: A field study of causal inferences and consumer reactions: The view from the airport. *Journal of Consumer Research* 13, 534–539 (1987)
5. Heil, O.P., Robertson, T.S.: Towards a theory of competitive market signaling: A research agenda. *Strategic Management Journal* 12, 403–418 (1991)
6. Hendricks, K.B., Singhal, V.R.: Delays in new product introductions and the market value of the firm: The consequences of being late to the market. *Management Science* 43, 422–436 (1997)
7. Hendricks, K.B., Singhal, V.R.: The effect of product introduction delays on operating performance. *Management Science* 54, 878–892 (2008)
8. Kohli, C.: Signaling new product introductions: A framework explaining the timing of preannouncements. *Journal of Business Research* 46, 45–56 (1999)
9. Kumar, A., Motwani, J.: A methodology for assessing time-based competitive advantage of manufacturing firms. *International Journal of Operations & Production Management* 15, 36–53 (1995)
10. Lilly, B., Walters, R.: Toward a model of new product preannouncement timing. *Journal of Product Innovation Management* 14, 4–20 (1997)
11. Nevens, T.M., Summe, G.L., Uttal, B.: Commercializing technology: What the best companies do? *Harvard Business Review* 68, 154–163 (1990)
12. Rao, V.S., Lee, S.J.: Responses to trust violation: A theoretical framework. *Journal of Computer Information Systems* 48, 76–87 (2007)
13. Robinson, W.T., Fornell, C.: The sources of market pioneer advantages in consumer goods industries. *Journal of Marketing Research* 22, 305–317 (1985)
14. Rosas-Vega, R., Vokurka, R.J.: New product introduction delays in the computer industry. *Industrial Management & Data Systems* 100, 157–163 (2000)
15. Schatzel, K., Calantone, R.: Creating market anticipation: An exploratory examination of the effect of preannouncement behavior on a new product's launch. *Journal of the Academy of Marketing Science* 34, 357–366 (2006)
16. Weiner, B.: Attributional thoughts about consumer behaviour. *Journal of Consumer Research* 27, 382–387 (2000)
17. Wu, Y., Balasubramanian, S., Mahajan, V.: When is a preannounced new product likely to be delayed? *Journal of Marketing* 68, 101–113 (2004)

The Impact of Workplace Gossip on Organizational Cynicism: Insights from the Employment Relationship Perspective

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Abstract. This study examined the effects of workplace negative gossip on organizational cynicism. Moreover, we explored the antecedents of workplace negative gossip based on the employment relationship perspective, tested the relationship between abusive supervision, psychological contract breach and workplace negative gossip. The data were collected from 455 employees in Taiwan. Three major findings manifest in the results. First, workplace negative gossip had a significant predictability for organizational cynicism. Compare to interpersonal-related negative gossip, the effects of task-related negative gossip on organizational cynicism were larger. Secondly, employment relationship (abusive supervision and psychological contract breach) had significant predictability for the employees' workplace negative gossip. Thirdly, we found that employment relationship affects organizational cynicism through its impact on workplace negative gossip. In summary, workplace negative gossip mediates the relationship between employment relationship and organizational cynicism.

Keywords: employment relationship, organizational cynicism, workplace negative gossip.

1 Research Background

Workplace gossip, defined as exchanges of personal information and judgmental opinions about other people while not in their presence (DiFonzo & Bordia, 2007; Forster, 2004), is frequently observed in workplace (Noon & Delbridge, 1993). Workplace gossip as part of the social interaction process, can provide employees an escape from work for social immobility. To explore the nature of workplace gossip can improve the understanding of informal communication within organization. In general, managers possess negative attitude towards gossips in work place and make gossips account for distrust among employees and decline of organizational morale (Akande & Funmilayo, 1994; Baker & Jones, 1996). Danziger (1988) considered that gossips have negative impacts in work place resulting in decreasing moral value, uncomfortable personal interactions, and damaging organization reputation.

The dysfunction of workplace gossip may attribute to its negative attributes (Burke & Wise, 2003). Negative gossip in workplace refers to the information received is other's bad news such as superior complaint, divorce, affair, or laziness of work. The content of negative gossip generates hostile work climate and implies the person in gossip of poor interpersonal relationship. Furthermore, having thought that it is likely for employees to suffer becoming the focal person in a negative gossip, their attachment to the organization will diminish gradually. Scholars tend to agree that there is more negative gossip in an organization, the more likely the individuals in this organization lose his or her organizational identification. When the cognition, interaction and affection toward the organization become negative and isolated, the organizational cynicism will be generated.

Kurland and Pelled (2000) categorized gossips into task-related and interpersonal-related. Task-related gossips focus on individual's work such as job performance, career development and interaction with others in workplace. Fiske and Taylor (1991) found that exchange of task-related gossips like compensation package, promotion, performance appraisal in workplace is more attractive and attentive to others compared with general gossips like plastic surgery and divorce. Accordingly, the influences are also different.

This study considers that the degree of negative gossip related to work will influence organizational cynicism. If gossip is task related, it belongs to instrumental ties (Grosser *et al.*, 2010). Instrumental tie originates from the degree of job accomplishment and function deployment, identifying responsibilities of individuals or groups. It defines how work group and work class interacts. Kueland and Pelled (2000) proposed that task-related gossip can form expert power and reference power. Negative task-related gossip will make employees feel less professional. If the gossip is not task related, it belongs to expressive ties. Expressive ties originate from socioemotional component. Social gossips such as divorce, having an affair, selling house, and illness are irrelevant to the role and responsibility that the organization assign. These can be seen as an expression of life but work. It is a way to relieve pressure from work. Interpersonal support and friendship may be obtained through these kinds of interaction and sharing gossips.

Dealing with negative gossip information, worker may consider every gossip has its own motivation and objective. This thought makes workers believe that the organization is strategically calculative and will betray integrity to achieve its goal. The organization will fail to meet worker's expectation. Due to the negative attribution for disappointment, negative emotion and behavior may occur as organizational cynicism. Particularly, when an individual receive task-related negative gossip, he or she may follow the clues to learn about the norm and regulation of the organization. These situational information can contribute to content validity and criterion-related validity, enhancing organizational cynicism. When an individual receive interpersonal-related negative gossip, he or she will take as an expression of emotion for work and like. This does not influence organizational cynicism.

Hypothesis 1 Task-related negative gossip has positive association with organizational cynicism. Interpersonal-related negative gossip has no significant influence on organizational cynicism.

Prior research indicated that if the employment relationship is not healthy, employee tends to show more attitudes against the organization such as intent to quit (Geurts et al., 1999). Hui, Lee, and Rousseau (2004) proposed two categories of employment relationship. One is employee-organization relationship. This can be described by psychological contract by Schein (1980). If employee believes in organization to keep promise, job security and promotion for example, employees will work hard and maintain loyalty as an exchange or reward. In the contrast, if employees perceive the organization intends to compromise, fail to meet individual expectation, or loss of justice, psychological contract breach may happen. Due to the negative attribution, worker gives special attention to negative gossip in organization. In particular, when facing task-related negative gossip, individual will use selective perception to verify the unfair treatment and feelings.

Hypothesis 2 Psychological contract breach is positively associated with negative task-related gossips but has no association with interpersonal-related gossips.

Employee-supervisor relationship is another category of employment relationship. Supervisor can be considered as the agency of organization, executing managing duties. Supervisors may humiliate employees in public just because they do not have appropriate personal characteristics and management skills. This kind of unfriendly management style usually contributes to an inferior relationship. Here we refer this as abusive supervision. When facing abusive supervision, employees may feel unfair, anxious, and nervous. They will seek emotional and psychological recovery. Therefore, according to social-information processing theory and self-fulfilling prophecy perspective, regardless of negative task-related or social gossips, employees can use them to justify the perceived inappropriate treatment and improve their perception on negative task-related and interpersonal-related gossips.

Hypothesis 3 Abusive supervision is positively associated with negative gossips (both task-related and interpersonal-related) in workplace.

Under poor employment relationship, either organization or supervisor can induce employees' negative attitudes. Employees will increase the tendency to participate in gossiping by social comparison in order to recover the negative emotion from poor employee-organization relationship. It is more likely to involve negative gossips, particularly task-related ones. Therefore, workers who perceived poor employment relationship will pay extra attention to negative gossips in workplace and generalize the information based on their own experience. They may consider others having the negative attitudes in the poor employment relationship as the same as they do. To have this thought can recover one's injustice feeling and negative emotions, but it

will reinforce the negative attitude toward organization, leading to organizational cynicism.

Hypothesis 4 Workplace negative gossips can mediate employee-organization relationship (psychological contract breach and abusive supervision) and cynicism.

2 Methodology

2.1 Sample and Procedures

We tested the hypotheses with data collected at two points in time. At time 1, surveys were distributed to 580 employees in several organizations in Taiwan. We assessed perceptions of workplace negative gossip, psychological contract breach, abusive leadership and demographic variables. At time 2, one month after time 1 data collection, we assessed organizational cynicism. 402 participants who completed the time1 and time2 surveys, 65 percent were female and 40 percent had marriage. The majority (67 percent) of the participants were within the 25-40 years age bracket.

2.2 Measures

Workplace negative gossip. We assessed task-related negative gossip ($\alpha = .89$) and interpersonal-related negative gossip ($\alpha = .83$) with measures developed by Kuo (2012). Twelve items assessed the perception of task-related negative gossip and six items assessed the perception of interpersonal-related negative gossip. Illustrative items are 'decrease the items of benefits', 'unfair system of performance appraisal' (task-related negative gossip), 'the poor quality of family life' and 'the traffic accident nearby' (interpersonal-related negative gossip). Participants rated their level of agreement with the items using a scale ranging from 1, not at all, to 6, a great deal.

Psychological contract breach. Psychological contract breach was assessed using a 9-item scale adapted from Robinson and Morrison (2000). This scale measures participants' overall evaluation of the extent to which the organization has fulfilled or breached its obligations to them. The example item is 'Almost all the promises made by my employer during recruitment have been kept so far'. The internal reliability of the scale was .92.

Abusive supervision. We used Tepper's (2000) 15-item scales ($\alpha = .90$) to measure participants' perceptions of abusive supervisory behaviors. This measure asks participants to rate the extent to which they agree or disagree with statements such as 'My boss is rude to me' and 'tells me my thoughts and feelings are stupid' on a 6-point scale (1= 'I cannot remember him/her ever using this behavior with me, 5= 'He/she uses this behavior every often with me').

Organizational cynicism. We used Kuo's (2000) 8-item scales ($\alpha = .89$) to measure participants' perceptions of cynicism about one's workplace. This measure asks participants to rate the extent to which they agree or disagree with statements such as

'I believe that my company lacks integrity' on a 6-point scale (1= 'strongly disagree, 6= 'strongly agree').

3 Results

3.1 Measurement Model

We assessed responses to the survey items using maximum likelihood confirmatory factor analysis (CFA) to examine the distinctness of the variables. The measurement model consisted of five factors: psychological contract breach, abusive supervision, task-related negative gossip, interpersonal-related negative gossip, and organizational cynicism. The results indicated that the five-factor model provided a good fit to the data, $\chi^2(1070) = 3,647.30$, $p < .001$, RMSEA = .08, SRMR = .07, NFI = .91, CFI = .93, IFI = .93 (Hughes, Price, & Marrs, 1986). We compared the five-factor model to (a) a four-factor model (where psychological contract breach and abusive supervision were combined into a single 'negative employment relationship' factor), $\chi^2(1074) = 5,989.50$, $p < .001$, RMSEA = .11, SRMR = .09, NFI = .87, CFI = .90, IFI = .90, (b) a four-factor model (where task-related negative gossip and interpersonal-related negative gossip were combined into a single 'negative gossip' factor), $\chi^2(1074) = 4,130.67$, $p < .001$, RMSEA = .09, SRMR = .07, NFI = .90, CFI = .93, IFI = .93, (c) a three-factor model (where psychological contract breach and abusive supervision were combined into a single 'negative employment relationship' factor, psychological contract breach and abusive supervision were combined into a single 'negative employment relationship' factor), $\chi^2(1077) = 6,442.81$, $p < .001$, RMSEA = .12, SRMR = .09, NFI = .86, CFI = .89, IFI = .89, (d) a single-factor model, $\chi^2(1080) = 15,545.57$, $p < .001$, RMSEA = .19, SRMR = .15, NFI = .79, CFI = .81, IFI = .81.

The five-factor model produced a significant improvement in chi-squares over the four-factor model, $\Delta \chi^2(4) = 2,342.20$, $p < .001$, and $\Delta \chi^2(4) = 483.37$, $p < .001$; three-factor model, $\Delta \chi^2(7) = 2,795.51$, $p < .001$; single-factor model, $\Delta \chi^2(10) = 11,898.27$, $p < .001$, suggesting a better fit than the other models (Schumacker & Lomax, 1996).

3.2 Structural Model

Psychological contract breach, abusive supervision and task-related negative gossip were all significantly correlated with organizational cynicism; psychological contract breach and abusive supervision were significantly correlated with task-related negative gossip and interpersonal-related negative gossip. The correlation of task-related negative gossip with interpersonal-related negative gossip is .54 ($p < .001$).

The proposed theoretical model exhibited good fit with the data. Even though the chi-square statistic was significant, $\chi^2(83) = 305.66$, $p < .001$, the ratio of chi-square to degrees of freedom was approximately equal to 4, indicated a good fit (Hughes et al., 1986). The other fit indices also indicated good fit between the proposed model and the data (RMSEA = .09, SRMR = .07, NFI = .94, CFI = .95, IFI = .95). Other than two paths (psychological contract breach to interpersonal-related negative gossip and interpersonal-related negative gossip to organizational cynicism), all paths in the

model were significant and in the expected direction. Hypotheses 1, 2, and 3 were supported. Psychological contract breach ($\beta = .20$) was positively related to task-related negative gossip. Abusive supervision ($\beta = .26$; $\beta = .27$) was positively related to task-related negative gossip and interpersonal-related negative gossip. Task-related negative gossip ($\beta = .45$) was positively related to organizational cynicism.

We performed the test of Hypotheses 4, the mediating role of negative gossip, by analyzing several alternative models. In each alternative model, a direct path was added from psychological contract breach and abusive supervision to organizational cynicism. Based on the chi-square difference, changes in fit indices, and path significance, we compared the alternative models against the proposed theoretical model. The direct path from psychological contract breach to organizational cynicism was significant and resulted in significant improvement in model fit. Abusive supervision had no significant direct impact on organizational cynicism. Hence, task-related negative gossip partially mediated the relationship of psychological contract breach and organizational cynicism, and fully mediated the relationship of abusive supervision and organizational cynicism. Therefore, Hypotheses 4 was partially supported.

4 Discussion

Previous research has established that workplace negative gossip can produce a number of dysfunctional consequences. However, the results of this study showed that task-related negative gossip and interpersonal-related negative gossip had the differential effects on organizational cynicism. In other words, not all workplace negative gossip has harmful effects in formal organization. It is clear that the relationship of workplace negative gossip with organizational cynicism emerged for task-related negative gossip but not for interpersonal-related negative gossip. Employees who perceived higher level of task-related negative gossip reported greater organizational cynicism. However, interpersonal-related negative gossip is not related to organizational cynicism. These results extend a growing body of evidence that suggests the various gossip attributes, such as positive vs negative, or task-related vs interpersonal-related, may play different roles in organization (Akande & Funmilayo, 1994; Burke & Wise, 2003; Danziger, 1988).

We found that psychological contract breach and abusive supervision were related to task-related negative gossip, but only abusive supervision was related to interpersonal-related negative gossip. Overall, our results suggest that task-related negative gossip mediated the relationship between two types of employment relationship and organizational cynicism, but interpersonal-related negative gossip had not the mediation effect. It indicates that employees' relationship with their supervisors or employers influenced their perception of the workplace negative gossip, especially task-related gossip, in turn influenced the job attitude. Therefore, the potential harm associated with negative employment relationship ought to serve as a warning to organization. It is important for managers and employers to have a proper appreciation of the nature and dynamics of the psychological contract breach and abusive supervision, and its impact on employee behavior and attitudes.

References

1. Akande, A., Funmilayo, O.: One more time- how to stop company rumours. *Leadership and Organisation Development Journal* 15(4), 27–30 (1994)
2. Baker, J.S., Jones, M.A.: The poison grapevine: How destructive are gossip and rumor in the workplace? *Human Resource Development Quarterly* 7(1), 75–86 (1996)
3. Burke, L.A., Wise, J.M.: The effective care, handling, and pruning of the office grapevine. *Business Horizons* 46(3), 71–76 (2003)
4. Danziger, E.: Minimize office gossip. *Personnel Journal* 67, 31–34 (1988)
5. Dean Jr., J.W., Brandes, P., Dhwardkar, R.: Organizational cynicism. *Academy of Management Review* 23, 341–352 (1998)
6. DiFonzo, N., Bordia, P.: *Rumor psychology: Social and organizational approaches*. American Psychological Association, Washington, D.C. (2007)
7. Fiske, S.T., Taylor, S.E.: *Social cognition*, 2nd edn. McGraw Hill, New York (1991)
8. Foster, E.K.: Research on gossip: Taxonomy, methods and future directions. *Review of General Psychology* 8, 78–99 (2004)
9. Geurts, S.A., Schaufeli, W.B., Rutte, C.G.: Absenteeism, turnover intention and inequity in the employment relationship. *Work & Stress: An International Journal of Work, Health & Organization* 13(3), 253–267 (1999)
10. Grasser, T., Kidwell-Lopez, V., Labianca, G.: A social network analysis of positive and negative gossip in organizational Life. *Group & Organizations Management* 35(2), 177–214 (2010)
11. Hui, C., Lee, C., Rousseau, D.M.: Employment relationships in China: Do workers relate to the organizations or to people? *Organization Science* 15(2), 232–240 (2004)
12. Johnson, J.L., O’Leary-Kelly, A.M.: The effects of psychological contract breach and organizational cynicism: not all social exchange violations are created equal. *Journal of Organisational Behavior* 24, 627–647 (2003)
13. Kurland, N.B., Pelled, L.H.: Passing the word: Toward a model of gossip and power in the workplace. *Academy of Management Review* 25, 428–438 (2000)
14. Noon, M., Delbridge, R.: News from behind my hand: Gossip in organizations. *Organization Studies* 14, 23–36 (1993)
15. Robinson, S.L., Morrison, E.W.: The development of psychological contract breach and violation: A longitudinal study. *Journal of Organizational Behavior* 21, 525–546 (2000)
16. Tepper, B.J.: Consequences of abusive supervision. *Academy of Management Journal* 43(2), 178–190 (2000)
17. Schein, E.H.: *Organizational Psychology*. Prentice Hall, Englewood Cliffs (1965)

A Study of the Effects of Display Atmospheric and Control Mode of 3D Virtual Store on Consumer Behavior in the Elderly

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Abstract. Online shopping has become quite popular since its first arrival on the internet. Some research has indicated that the older population is growing rapidly worldwide and is becoming an increasingly important demographic to understand. However, previous studies on cognitive aging have found that certain aspects of human information-processing abilities are negatively correlated with age. This study will discuss the effects of online store atmospheric collocating with control mode applied on 3D virtual store vision displaying for improving usability and acceptability in the elderly. The objectives of this study are to evaluate the cognition and emotion of the elderly on 3D virtual store atmospheric and control mode. It was found that the recognition and presence was positively related to emotion for the elderly, and then, emotion is positively and directly related to customers' behavioral intention. There was the best effect in recognition and presence by the central-cabinet layout.

Keywords: 3D virtual stores, Elderly, Atmospheric, Control mode, Cognition, Emotion.

1 Introduction

Online shopping has become quite popular since its first arrival on the internet. It lets us buy what we want, when we want at our convenience, and helps us to imagine ourselves buying, owning, and having positive outcomes by the goods available out there on the web [1]. Shopping has been a way of identifying oneself in today's culture by what we purchase and how we use our purchases. Although the percentage of older adults (i.e. silver tsunami) using the web is less than the percentage of younger individuals, surveys indicate that this may not be the case for long. The World Health Organization estimates that by the year 2020, 24% of Europeans, 17% of Asians, and 23% of North Americans will be over the age of 60 [2]. By 2020, the world will have more than 1 billion people age 60 and over. Along with elderly society's coming, many older adults (i.e., the "silver tsunami" generation) have problems performing daily tasks because of restricted mobility, lack of transportation, inconvenience, and

fear of crime [3]. Computers with an internet connection used at home can provide this population a new channel to access to information and services, and can also be used to manage internet shopping tasks. However, the traditional web shops introduce commodities only by two dimension (2D) pictures and descriptive catalogue, which fall short in terms of reality and the interaction with goods. This kind design with poor reality and interaction will influence customers' real shopping experiences; and what is more, they minimize customers' desire to shop. Therefore, the elderly may find the barriers so great to prevent effective communication and shopping taking place [4]. Nowadays, such problems can be solved utilizing the technology of virtual environments (VEs) [5]. One of the primary advantages of VEs technology applied in web shops is its ability to provide a three dimension (3D) perspective to customers for more real sense on goods and shopping environment. When the elderly is growing rapidly worldwide [6], for this population, the combination of VEs and internet would introduce a new mode in online shopping. However, previous studies on cognitive aging have found that certain aspects of human information-processing abilities are negatively correlated with age. Specifically, there are four basic mechanisms accounting for age-related decline in cognitive functions, including processing speed, working memory, sensory function and inhibition. Additionally, as the technology, hardware and software, improves, real applications become more feasible gaps in our knowledge about them become even more apparent. One need for better knowledge concerns the notion of recognition and presence. The recognition, in terms of perception, means that what we are seeing now puts us in mind of something we already know or are familiar with [7]. The presence is a desirable outcome of VEs participation, the existence of user predictable interactivity, degree of realism of the VEs and quality of fidelity of sensory input [8]. The emotion is a subjective feeling state within the individual such as pleasure, joy and excitement, and will be simulated by traditional retail store design [9]. Recognition and presence belong to perception level, emotion belongs to cognition level. Good recognition and presence will stimulate positive emotion. Furthermore, the atmospherics and control mode are important factors for designing 3D virtual store [10]. What types of atmospherics and control mode would induce better recognition and presence? Therefore, this study will discuss the effects of perception and emotion on atmospherics and control mode designed in 3D virtual store for improving usability and acceptability in the elderly.

2 Method

2.1 Hypotheses

In this study, the recognition and presence would be used to evaluate the effects of design factors of 3D virtual store on the elderly consumers' shopping decision. Related research hypotheses are described below.

1. Differences of 3D virtual store physical design factors will impact recognition of the elderly.

2. Differences of 3D virtual store ambient factors will impact recognition of the elderly.
3. Differences of 3D virtual store control mode will impact presence of the elderly.
4. Recognition positively affects emotion for the elderly.
5. Presence positively affects emotion for the elderly.
6. The elderly will be more easily accept the store shopping patterns in higher emotion.

2.2 Research Model

The research model, depicted in Figure 1, is based on literature review and resulting hypotheses illustrated in the previous section. The research constructs and corresponding interrelationships are shown in the research model.

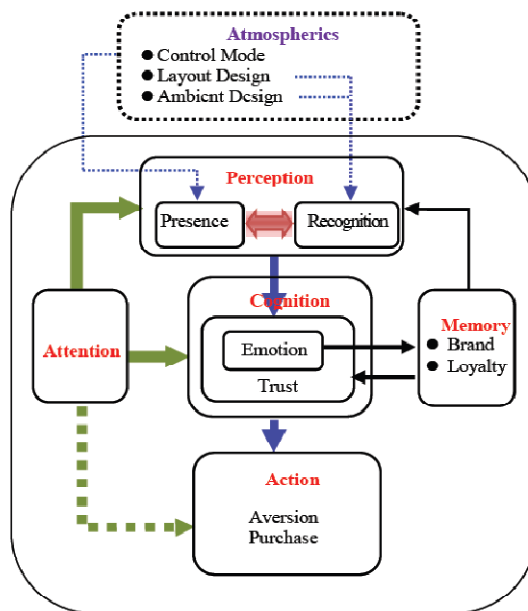


Fig. 1. Model of information decision on consumer behavior in 3D virtual store

2.3 Participants

There were 36 people (average age of 67.5 years) selected to participate in the experiment. They were paid a nominal NTD500 as compensation for their time. All participants were fully informed and had signed a consent form. Some researchers found that repeated exposure to the same virtual environment with separation of less than seven days could significantly affect the levels of cybersickness which would induce

participant's disorientation and nausea [11][12][13]. Therefore, the participants had not been exposed to the experimental VE in the previous 2 weeks.

2.4 Apparatus and the VE

The VE experiment was constructed using a virtual environment developing software (3DMax and Virtools) and presented on a 22" TFT-LCD display. The scene was designed as a retail store of automobile peripheral fitting for portable device. There are four commodity group designed in the virtual store: Brackets, Holders, Accessories and others. All objects are designed in 3D type (see Figure 2).



Fig. 2. A list of All merchandise presented in store

2.5 Experimental Design and Procedures

The study involved a 3 (Layout: central-arc type show, central-cabinet show and surround type show) \times 2 (Exhibition presentation: store plus arts billboards around and nothing and nothing) \times 2 (Control mode: operation in the role of "I" and "bystander") between-subjects experiment, resulting in a full-factorial design with 12 treatment conditions. Each participant was randomly assigned one of the 12 conditions to do the task of goods-finding. Therefore, there were three participants was randomly assigned to one of the 12 conditions.

1. Independent variables

- (a) Layout: the physical design factor to show overall layout of the exhibition area including: central-arc type show, central-cabinet type show and surround type show (Figure 1).
- (b) Exhibition presentation: the ambient design factor to show aesthetic presentation of the exhibition area including: (a) store plus arts billboards around; (b) nothing.
- (c) Control mode: operation in the role of "I" or "bystander." In the mode of "bystander," there is an avatar to be manipulated by the keyboard to find the designed goods in the virtual store.

2. Dependent variables

- (a) Recognition: Ahn et al (2004) services and commodities cognitive questionnaire was referenced to measure the elderly understanding of store and goods [14].
- (b) Presence: the ITQ questionnaire (Immersive Tendencies Questionnaire) and PQ questionnaire (Presence Questionnaire) was used to measure participant's presence of the store. ITQ questionnaire was used to measure the degree of integration into the virtual environment. PQ questionnaire was used to evaluate the sensitivity for the virtual environment [15].
- (c) Emotion: Mehrabian and Russell (1974) PAD (Pleasure, Arousal and Dominance) measurement questionnaire was used to assess the emotion during the virtual store [16].

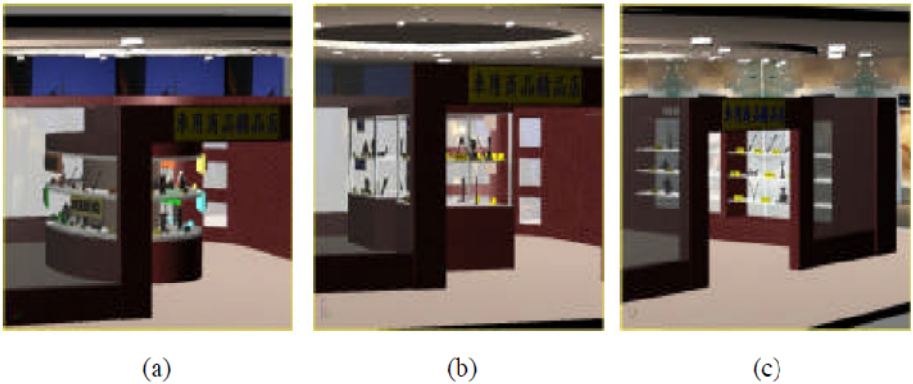


Fig. 3. Scene of the experimental 3D retail store: (a) central-arc type show; (b) central-cabinet show; (c) surround type show

3. Procedure

All participants were exposed to the same VE. During exposure, the VE was controlled by the program. First, the scene was rotated for one complete circle at the door gate along the vertical axis with a set rotating speed and angle. The scene was then moved forward along the fore-and-aft axis for 5 sec. at 0.2 units of translate vector per second before being rotated for one complete circle. Next, the scene was turned to the right and moved forward to the end of the showroom. The scene was then moved back to the door gate and rotated for one complete circle. It was then turned left and moved forward to the end of the showroom. Finally, the scene was returned to the door gate. The scene was halted for 5 sec. at each step. During the exposure period, participants were asked to search for and confirm eight goods in the store. When all eight target goods had been found, s/he was asked to complete the questionnaires.

3 Results and Discussion

3.1 Effects of 3D Virtual Store Design Factors

Via the variance analysis of 3D virtual store design factor for recognition and presence, the results showed that the main effects of physical design factor (i.e. layout) and control mode in recognition and presence are significant for the elderly, but the ambient design factor (i.e. aesthetic presentation) is not. These results provide support for hypothesis 1 and 3, but not support for hypothesis 2. Scheffe's post-hoc test, a multiple comparison statistical procedure, was used to identify differences between groups after a significant F ratio has been obtained in ANOVA (see Table 1 and Table 2). The findings indicate that there is the best effect in recognition and presence by the central-cabinet show. The reason may be that the central-cabinet show has better permeability compared with other layout; consumers could find and browse the merchandise in a short period of time. Additionally, the "I" control mode is better than "bystander" in presence. It shows that the sight will be impeded during operation in "bystander" mode, therefore, the sense of interactivity and control will not be gained to better the effect that people experience when they interact with the virtual store.

Table 1. Scheffe's post hoc tests for the effects of physical design factor on recognition

(I)Physical design factor	(J) Physical design factor	Mean Difference (I-J)	Standard Errors	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
Central-arc type	Surround type	-.938*	.261	.001	-1.457	-.418
	central-cabinet type	-2.031*	.261	.000	-2.551	-1.511
Surround type	Central-arc type	.938*	.261	.001	.418	1.457
	central-cabinet type	-1.094*	.261	.000	-1.614	-.574
Central-cabinet type	Central-arc type	2.031*	.261	.000	1.511	2.551
	Surround type	1.094*	.261	.000	.574	1.614

*p < 0.05 significant level.

Table 2. Scheffe’s post hoc tests for the effects of physical design factor on presence

(I)Physical design factor	(J) Physical design factor	Mean Difference (I-J)	Standard Errors	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
Central-arc type	Surround type	-.813*	.291	.007	-1.392	-.233
	central-cabinet type	-1.594*	.291	.000	-2.173	-1.014
Surround type	Central-arc type	.813*	.291	.007	.233	1.392
	central-cabinet type	-.781*	.291	.009	-1.361	-.202
Central-cabinet type	Central-arc type	1.594*	.291	.000	1.014	2.173
	Surround type	.781*	.291	.009	.202	1.361

*p < 0.05 significant level.

3.2 The Results of the SEM

Given the existence of multiple relationships between the dependent, mediating and independent variables, structural equations modeling (SEM) appears to be the most appropriate method for addressing the research question [17].The structural model designed in this study specified the physical objects design, control mode, layout design and ambient design as the exogenous constructs, while presence, recognition, emotion and behavioral intentions as the endogenous constructs, while presence, recognition, emotion and behavioral intentions as the endogenous constructs, while presence, recognition, emotion and behavioral intentions as the endogenous constructs.

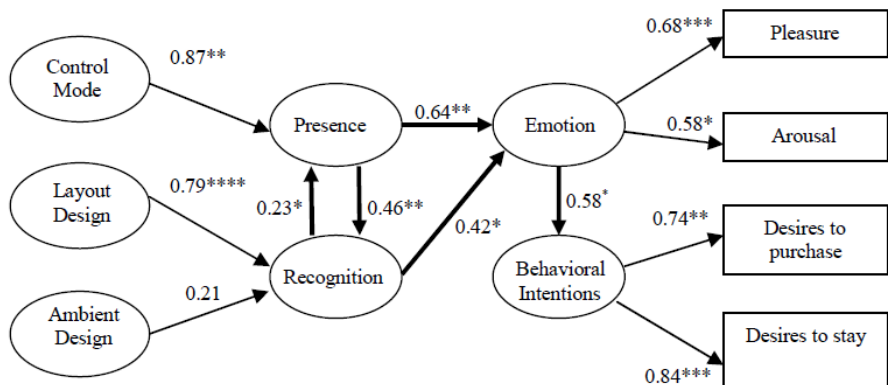


Fig. 4. The structural equation model of the full model

emotion and behavioral intentions were adopted as endogenous constructs as shown in figure 4. Hypothesis 4 posited that recognition positively affects emotion for the elderly. The analytical results, as shown in Figure 4 and Table 3, indicate that recognition is positively related to emotion for the elderly, with a standardized coefficient of 0.42 ($p < 0.01$). Thus, H4 is supposed. Additionally, presence also positively affects emotion for the elderly (i.e. Hypothesis 5 is supposed). Note that presence contributed more direct impacts to emotion than recognition toward the 3D virtual store. Finally, emotion is positively and directly related to customers' behavioral intention (i.e., desires to purchase and desires to stay), with standardized coefficient of 0.58 ($p < 0.05$). Hence, Hypothesis 6 is supported.

Table 3. The results of the full model

Measurement model				
Constructs	Type	Indicators	Loading	Critical ratios value
Presence	ξ_1	Control Mode	0.8725	31.273 ^{***}
Recognition	ξ_2	Layout Design	0.7873	22.459 ^{***}
		Ambient Design	0.2104	1.531
Emotion	η_1	Pleasure	0.6823	15.364 ^{***}
		Arousal	0.5774	11.741 ^{***}
Behavioral Intentions	η_2	Desires to stay	0.8351	4.379 ^{***}
		Desires to purchase	0.7435	2.983 ^{**}
Structural Model				
	Paths		Coefficient	Critical ratios value
Presence	→	Emotion	0.64	7.639 ^{***}
Presence	→	Recognition	0.46	4.372 ^{***}
Recognition	→	Emotion	0.42	2.643 ^{**}
Recognition	→	Presence	0.23	1.972 [*]
Emotion	→	Behavioral Intentions	0.58	2.152 [*]

4 Conclusion

The results of this study show that the main effects of physical design factor (i.e. layout) and control mode in recognition and presence are significant for the elderly, but the ambient design factor (i.e. aesthetic presentation) is not. The response of the participants in the experiment is in compliance with the proposed Model of information decision on consumer behavior in 3D virtual store, i.e. the recognition and presence was positively related to emotion for the elderly, and then, emotion is positively and directly related to customers' behavioral intention. Additionally, the "I" control mode is better than "bystander" in presence. It shows that the sight will be impeded

during operation in “bystander” mode, therefore, the sense of interactivity and control will not be gained to better the effect that people experience when they interact with the virtual store. Therefore, the central-cabinet layout combined “I” control mode designed in the 3D virtual world would produce the best effect in recognition and presence for the elderly.

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References

1. Davis, S.G.: *Culture Works the Political Economy of Culture*. University of Minnesota Press, London (2001)
2. World Health Organization, Press Release WHO/69, <http://www.who.ch/press/1997/pr9769.htm>
3. Czaja, S., Lee, C.: *Designing Computer Systems for Older Adults*. *The Human Computer Interaction Handbook* 21, 413–427 (2003)
4. Johnson, R., Kent, S.: *Designing universal access: web-applications for the elderly and disabled*. *Cognition, Technology & Work* 9, 209–218 (2007)
5. Sylaiou, S., Karoulis, A., Stavropoulos, Y., Patias, P.: *Presence-centered assessment of virtual museums’ technologies*. *Journal of Library and Information Technology* 28, 55–62 (2008)
6. Jones, S., Fox, S.: *Generations online in 2009*. Pew Internet & American Life Project Report (2009)
7. Sekuler, R., Blake, R.: *Perception*. McGraw-Hill, NY (2002)
8. Nichols, S., Haldane, C., Wilson, J.R.: *Measurement of presence and its consequences in virtual environments*. *Int. J. Human-Computer Studies* 52, 417–491 (2000)
9. Dennis, C.E.: *Objects of Desire: Consumer Behaviour in Shopping Centre Choice*. Palgrave, London (2005)
10. Held, R.M., Durlach, N.I.: *Telepresence*. *Presence: Teleoperators and Virtual Environments* 1(1), 109–112 (1992)
11. Stanney, K.M.: *Handbook of Virtual Environments*. Earlbaum, New York (2002)
12. Lathan, R.: *Tutorial: a Brief Introduction to Simulation Sickness and Motion Programming*. *Real Time Graphics* 9, 3–5 (2001)
13. Regan, E.C., Price, K.R.: *The Frequency and Severity of Side-Effects of Immersion Virtual Reality*. *Aviat. Space Environ. Med.* 65, 527–530 (1994)
14. Ahn, T., Ryu, S., Han, I.: *The impact of the online and offline features on the user acceptance of Internet shopping malls*. *Electronic Commerce Research and Applications* 3, 405–420 (2004)
15. Witmer, B.G., Singer, M.J.: *Measuring presence in virtual environments: a presence questionnaire*. *Presence* 7(3), 225–240 (1998)
16. Mehrabian, A., Russell, J.: *An approach to environmental psychology*. MIT Press, Cambridge (1974)
17. Zweig, D., Webster, J.: *Personality as a moderator of monitoring acceptance*. *Computers in Human Behavior* 19, 479–493 (2003)

The Difference of User Perception between Similarity and Dissimilarity Judgments

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Abstract. The similarity and dissimilarity is a corresponding relationship which is the base of cognitive judgments. The main purpose of this paper is to study the user perception by using similarity judgments. In this study, fifteen innovative products are used as the stimuli which divided into three groups: global, creative and local products. A total of 139 student volunteers participated in the various phases of the study. The feature measures are used to collect data under three different experiments: similarity judgment by random, similarity judgment by order, and dissimilarity judgment by random. In addition, the paper proposed an approach to confirm the effectiveness of collecting data. Then, MDS analysis was used to explore the difference of user perception between similarity and dissimilarity judgments. The results provide designers with a valuable reference for designing innovative products.

Keywords: multidimensional scaling, INDSCAL, similarity, dissimilarity, product design.

1 Introduction

Similarity judgment plays a critical role in cognitive capabilities such as memory, reasoning and decision making, especially, user preference and user experience in innovative product design [4, 15, 16, 32]. Traditionally, marketing researchers apply a variety of similarity judgment techniques, including MDS (multidimensional scaling) and its related programs (e.g. KYST, INDSCAL) to help them understand consumer perceptions of products or service alternatives [1, 3, 13, 20, 37, 38]. According to Norman's mental model [36], innovative products must be appreciated and recognized by the users. Several researchers have proposed different classifications for categories of innovative products based on the market insight and technological innovation [15, 16]. Recently, the design trend came from user-centered to user value and experience [2, 7, 36], and researchers of design field apply MDS analysis to explore the user perception in innovative product design [24, 25]. User emotional responses are derived from their perception expressed by products playing a significant role in their visual appearance [4, 15, 16]. Hence, the use of conventional multidimensional distance

model of similarity judgment is to understand users' perception and preference increasingly [18, 19, 20, 38].

However, marketing researchers have recognized that there is a limit to the amount of "effective" information that can be collected from respondents [20]. This has led to the development of procedures for reducing the number of required judgments, including the use of sorting tasks or categorization [14, 34, 37, 44]. The importance of studying user perception has been shown repeatedly in several studies in various areas of the design field [2, 4, 7, 15, 16, 26-28, 36]. Despite the recognized importance of user perception in innovative product design and creative design industries, industries lack a systematic approach to study user perception. Therefore, this study proposes an approach for illustrating how to transform "user perception" into "innovative products design." The approach integrates the difference between innovative products and user perception of global market into the design strategy of current service design practice.

2 Literature Reviews

When performing MDS analysis, for example, INDSCAL input data is generally of some type of similarity or dissimilarity data [1, 3, 5, 6, 24, 25]. For collecting similarity data, the researcher needs to determine which of the objects (products) are most similar to each other and which are the most dissimilar. The uncertainty in similarity measurement is the fundamental to compare all pairs of objects, then, what is the difference between similarity and dissimilarity data remains [8, 9, 10, 12]. In addition, when performing the comparison of paired objects, the researcher could choose the paired objects to compare randomly or to compare one by one orderly [1, 3, 13, 38, 39]. There is also a question about which one is better for collecting this type of data. Thus, several problems remain to be solved [6, 9, 12, 21, 35, 43].

The problems of identify the product features in cognitive science is determining the mental representations that underline human inductions [2, 4, 7, 18-20]. Solutions to this problem often rely on the analysis of subjective similarity judgments [10-12, 43-46]. Based on the assumption of recognizing "resemblance" between users, objects and events is crucial to everyday inference [33-35]. The question of what makes two objects psychologically similar has considerable significance for much of cognitive psychology. A variety of Models (i.g. categorization, memory, and learning theorists) have claimed to explore the questions [10-12, 32-35]. The models are related to factor analysis, multidimensional scaling and latent class models. The researches of similar theory and related models were widespread in many fields, For examples, Geometric model [1, 3, 13, 24-28, 39, 40], Feature Contrast Model [10, 12, 20, 41, 44, 45, 46], Alignment-Based Model [9, 11, 14, 34], Transformational Model [8, 35, 37], and so on [17, 29-31].

Spatial configuration approaches and feature-set approaches are the two of most influential approaches to deal with similarity judgments. Spatial configuration approaches define similarity as inversely related to the distance between stimuli in a dimensionally perceptual metric space, as exemplified by multidimensional scaling [39-42]. Feature-set approaches assume similarity increase as a function of the

common features and decreases as a function of the distinctive features of compared items [23], as exemplified by Tversky's Contrast Model [43, 44]. The contrast model of Tversky is a classic feature-set model of similarity that is applied to explore a range of fields in category-based [14, 18]. What makes category-based inductive reasoning on especially powerful is our capacity to project information from one category to another [14]. Multidimensional scaling provides a method of assigning a set of hidden features to a collection of objects, according to the observable similarities between those objects [34, 35].

Therefore, the purpose of this study is to propose an approach to study the differences of user perception between similarity and dissimilarity data of similarity judgments, and to explore the effect of randomly and orderly paired comparison. These results were discussed in terms of user perception and the likely psychological processes underlying similarity judgment [16, 17, 18]. Furthermore, results presented herein provide an interface for looking at how users recognize the innovative products, as well as illustrating the interwoven effect of user experience and perception in similarity judgments.

3 Research Method

This study involved using interviews, similarity ratings and MDS analysis [1, 3, 4, 24-27] to study the difference between similarity and dissimilarity judgments [8, 10, 18, 30, 43]. The study can be divided into three sessions. In session I, a literature review was used as a way to understand how the difference approaches influence the similarity judgment, and how to select stimulus products. In session II, three experiments, which are random similarity compared, random dissimilarity compared and sequence similarity compared, are performed to collect the similarity data. In session III, an MDS approach was used to study the difference between similarity and dissimilarity. The data were analyzed using descriptive statistics, MDS analysis and SPSS analysis. The framework of this study is shown in Figure 1 [15, 16].

3.1 Selecting Stimulus Products

Based on the previous studies [15, 16, 24-28], four professional designers and four design professors who are the experts from the fields of culture, creativity and industry served as the subjects for interviewing to select stimulus products for similarity ratings. The stimulus products came from three categories: cultural products, Alessi (global) products, and innovative products as shown in Table 1. P08 was chosen from "The Chin Family" [15,16] as the stimulus product representing the group of cultural products, and P01, 06, 10 &15 were chosen from different cultural product design competitions.

The innovative products stimuli were chosen from the 2011 iF gold award products because the German iF product design award is globally recognized and well known as the Oscar Award in the design industry. The iF design competition awards were awarded to encourage products with creative design elements to enter the global market. In Table 1, P09 was chosen from 2011 iF gold award products as the stimulus product representing the group of innovative products, while P02, 04, 11 &13 were chosen from different categories in the 2011 iF product design award competition.

For the global market, Alessi products were chosen as the stimulus products because the product is “glocal” and well-developed in the global market. Hence, in order to explore the concept of glocalization in Alessi’s design strategy, P14 known as Mandarin was chosen as the representing Alessi’s products because the Mandarin was designed by Stefano Giovannoni, and the idea also came from the portrait of Emperor Chien-Lung in the Chin Dynasty. In addition, P03, 05, 07 &12 were chosen from Alessi’s best selling global products as the stimulus products [15, 16].

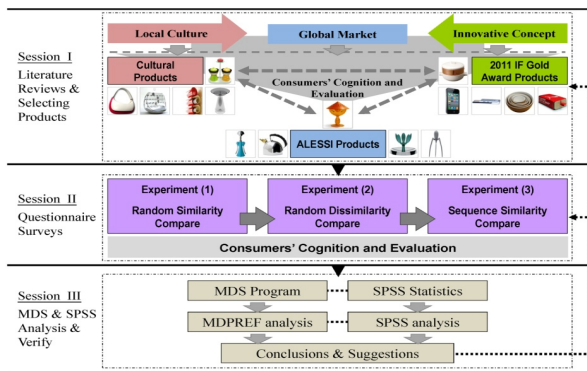


Fig. 1. The research framework

3.2 Procedures

The 15 stimulus products as shown in table 1 were used as the stimulus materials to collect the data. The stimulus materials of pairwise comparison are arranged by three different ways. Experiment 1 is to rate the similarity that arranged by the randomly paired compared (SR); experiment 2 is to rate the dissimilarity by the randomly arranged (DR); experiment 3 is to rate the similarity by the orderly paired compared (SO). The three experiments are conducted by every other week sequentially. After the experiments, the similarity rating data were applied to the analysis using linear regression to study the relationship among SR, DR, and SO.

The INDSCAL solution produced various multidimensional configurations which can be used to study the cognition of similarity judgments. Finally, the results were discussed to explore the difference between the similarity and dissimilarity judgments as well as the random and order pairwise comparison. The experimental procedures are

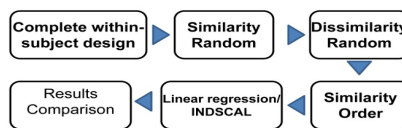

















Fig. 2. Experimental Procedure

shown as figure 2. A test book was given to the participants that contained a total 112 paired comparison for the similarity judgments. In general, the 15 stimulus products produce only 105 pairs for comparison. 7 pairs which include 14 stimulus products were selected from 105 pairs to confirm the “effectiveness” of the similarity judgment. Before the experiment, subjects were briefed on the purpose and procedure of the study. In a laboratory, a PC was used to project the stimulus materials on a screen. The subjects were first asked to compare the similarity of each product pair, and then they were asked to rate the extra 7 pairs to confirm their ratings. A 9-point Likert scale was used to rating the degree of similarity from 1 (Not similarity) to 9 (completely similar), and the subjects indicated their responses by circling the numbers according to their judgments.

Table 1. Three different categories of product samples

Cultural Products – From Taiwan e-Learning and Digital Archives					Commercial Application Competitions
P01	P06	P08	P10	P15	
					
“Ripple” martini cup	“Pinban Boat” handbag	“Mr. & Mrs. Chin” salt and pepper set	“Pearls Dropping on the Jade Plate” piggy bank	“Tile” magazine rack	
Innovative Products – From 2011 IF Gold Awards					
P02	P04	P09	P11	P13	
					
“iPhone 4” smartphone	“Family Bowls” tableware	“Clever Little Bag” shoe packaging system	“Steamer Set” steamer pot	“USB-Clip” USB flash drive	
ALESSI Products – From Italian fashion brand Alessi					
P03	P05	P07	P12	P14	
					
“Anna G.” corkscrew	“Fruit Mama” fruit bowl	“9091” kettle	“Juicy Salif” citrus squeezer	“Mandarin” Squeezer with goblet	

3.3 Subjects and Data Validation

A total of 139 student volunteers participated in the various phases of the study. The subjects comprised four groups with different backgrounds: 42 subjects with design-related background, 33 subjects with humanity related background, and 64 subjects with communication management related background. The subjects were between the ages of 20 and 40. As mentioned before, the extra 7 pair’s comparison was used to check the effectiveness of judgments. Based on the ratings of 7 pairs comparison, how to confirm the effectiveness of judgments are followings: (1) Using Likert scale 5 as the standard point, the extra 7 pairs with the same pair in 105 pairs must be in the same side as 1~4 or 6~9. (2) The deviation allows ± 2 , thus, if the one answer is 5, the other must be 3,4 or 6,7. (3) The combination of 4 and 6 also regard as

qualified. (4) There must be at least 5 qualified in the extra 7 pairs for regard as valid data. According to the confirmation of the data, 52 had to be excluded because their answers were not ineffective and 87 subjects were verified for the judgments consisting of 24 male and 63 female participants. Subjects were undergraduate and graduate students with an educational background in Arts and Humanities related (19 participants), Design related (32 participants) and Communication and Management related (36 participants) as shown in Table 2.

Table 2. The validation of subjects' judgments

Background	Subjects			Excluded
	Male	Female	Sub-total	
Arts and Humanities Related	5	14	19	14
Design Related	7	25	32	10
Communication Management Related	12	24	36	28
Total	24	63	87	52

4 Results and Discussions

The data were collected by three approaches including similarity judgments by randomly arranged (A-RS) and orderly arranged (B-OS), and dissimilarity judgments by randomly arranged (D-RD). Based on the previous researches, we got another three estimated data from three experiment data by: (1) estimated similarity data (C-EDS) = 10 – D-RD, (2) estimate dissimilarity data (E-ERS) = 10 – RS, (3) estimated dissimilarity (F-EOS) = 10 – OS. Then, the similarity data including A-RS, B-OS, and C-EDS and the dissimilarity data including D-RD, E-ERS, and F-EOS were applied to INDSCAL analysis. The MDS solution produced various multidimensional configurations for use in studying the difference between similarity and dissimilarity judgments.

INDSCAL analysis was used to transfer the similarity judgments data into a multidimensional configuration that can be used to study the cognitive space, to interpret the dimensions, and to analyze the individual difference of approaches. Figure 3 shows a two-dimensional perceptual space and the plot of three different approaches with the average correlation coefficient of .882. The correlation between computed scores and original data are .881, .873, and .892 for similarity judgments by randomly arranged (A-RS), orderly arranged (B-OS) and estimated similarity data (C-EDS), respectively. The stimulus products came from three categories: cultural products, Alessi (global) products, and innovative products. P08 was chosen from "The Chin Family" as the stimulus product representing the group of cultural products. P09 was chosen from 2011 iF gold award products as the stimulus product representing the group of innovative products, and P14 known as Mandarin design by Stefano Giovannoni was chosen as the representing global products. In figure 3, P11, P12 and P14 are separately away from the groups of P2,P3 and P13, P4, P6, P7 and P10, P1 and P5. Figure 4 shows a two-dimensional space of randomly arranged (A-RS) and orderly arranged (B-OS). Figure 5 shows a two-dimensional space of randomly arranged (A-RS) and estimated similarity data (C-EDS). Figure 6 shows a two-dimensional space of orderly arranged (B-OS) and estimated similarity data (C-EDS).

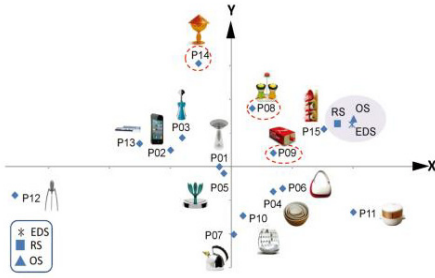


Fig. 3. Two-dimensional space of group stimulus of similarity judgments

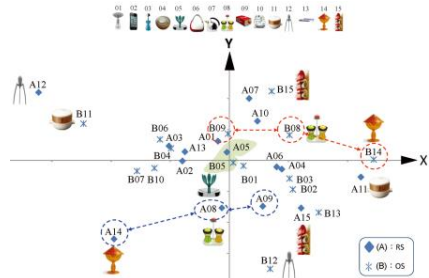


Fig. 4. The comparison of two-dimensional space of RS (Random Similarity) and OS (Order Similarity)

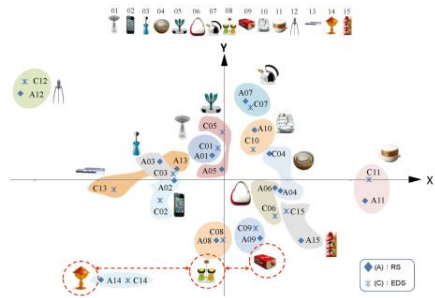


Fig. 5. The comparison of two-dimensional space of RS (Random Similarity) and EDS (Estimated Similarity)

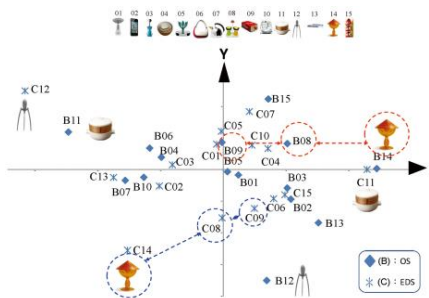


Fig. 6. The comparison of two-dimensional space of OS (Order Similarity) and EDS (Estimated Similarity)

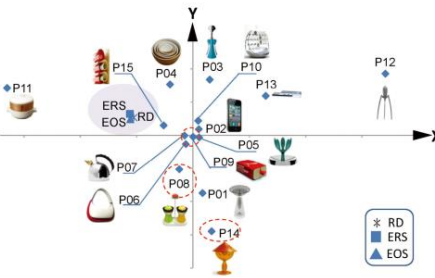


Fig. 7. Two-dimensional space of group stimulus of dissimilarity judgments

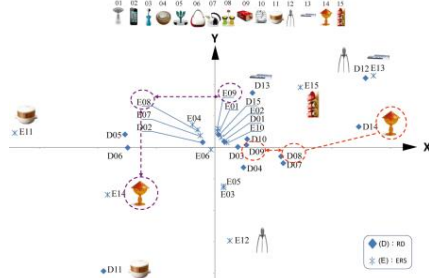


Fig. 8. The comparison of two-dimensional space of RD (Random Dissimilarity) and ERS (Estimated Random Dissimilarity)

Using the same way, the dissimilarity judgment data of different approaches including the dissimilarity data including D-RD, E-ERS, and F-EOS were subjected to INDSCAL analysis. Figure 7 shows a two-dimensional space of group stimulus of

dissimilarity judgments. In Figure 7, P2, P5, P6, and P7 grouped together with the P09 which represented the group of innovative products, while P11, P12 and P14 are separately away from the groups of P09 and other products. Figure 8 shows a two-dimensional space of dissimilarity judgment randomly arranged (D-RD) and estimated dissimilarity data (E-ERS). Figure 9 shows a two-dimensional space of randomly arranged (D-RD) and estimated dissimilarity data (F-EOS). Figure 10 shows a two-dimensional space of estimated dissimilarity data (E-ERS) and estimated dissimilarity data (F-EOS).

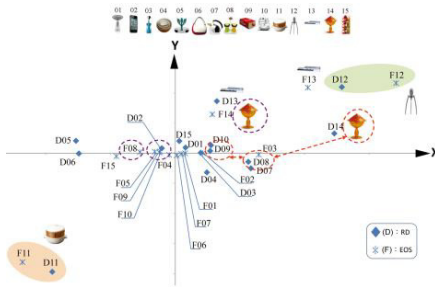


Fig. 9. The comparison of two-dimensional space of RD (Random Dissimilarity) and EOS (Estimated Order Dissimilarity)

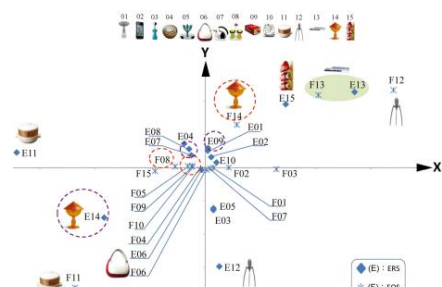


Fig. 10. The comparison of two-dimensional space of ERS (Estimated Random Dissimilarity) and EOS (Estimated Order Dissimilarity)

5 Conclusions and Suggestions

In this study, three groups of stimulus products including local cultural products, global market products, and innovative products are used to explore the user perception by similarity judgments. The similarity is one of the key factors to identify the user experience and value. The MDS analysis used in this study is a test of its utility as an approach to understanding the user perception in local design and global market. This study establishes a conceptual framework to provide designers with a valuable reference for studying user experience in cross-cultural product. The results of this study can be used as future reference for designers in the design strategy of the application of local culture for the global market. There are some tendencies for subjective interpretation in the foregoing context, so it is expected that more specific and rigid methodology will be conducted to verify these results in the future. Furthermore, while cross-cultural factors become important issues for product design in the global economy, the intersection of service innovation design and culture becomes a key issue making both local design and the global market worthy of further in-depth study.

References

1. Borg, I., Groenen, P.: *Modern Multidimensional Scaling: Theory and Applications*, 2nd edn. Springer, New York (2005)
2. Boztepe, S.: User value: Competing Theories and Models. *International Journal of Design* 1(2), 55–63 (2007)

3. Carroll, J.D., Arabie, P.: Multidimensional Scaling. *Annual Review of Psychology* 31, 607–649 (1980)
4. Clore, G.L., Huntsinger, J.R.: How Emotions Inform Judgment and Regulate Thought. *Trends Cogn. Sci.* 11(9), 393–399 (2007)
5. Navarro, D.J., Perfors, A.F.: Similarity, Feature Discovery, and the Size Principle. *Acta Psychologica* 133(3), 256–268 (2010)
6. Davenport, J., Keane, M.T.: Similarity & Structural Alignment: You can have one without the other. In: Hahn, H., Stoness, S.C. (eds.) *Twenty-First Annual Conference of the Cognitive Science Society*, pp. 132–137. Lawrence Erlbaum Associates, Hillsdale (1999)
7. Desmet, P.M.A., Hekkert, P.: Framework of Product Experience. *International Journal of Design* 1(1), 57–66 (2007)
8. Hahn, U., Chater, N., Richardson, L.B.: Similarity as Transformation. *Cognition* 87, 1–32 (2003)
9. Gentner, D., Markman, A.B.: Structural Alignment in Comparison: No Difference Without Similarity. *Psychological Science* 5(3), 152–158 (1994)
10. Goldstone, R.L., Medin, D.L., Gentner, D.: Relational Similarity and the Nonindependence of Features in Similarity Judgments. *Cognitive Psychology* 23, 222–262 (1991)
11. Goldstone, R.L.: Similarity, Interactive Activation, and Mapping. *Journal of Experimental Psychology: Learning, Memory, and Cognition* 20, 3–28 (1994)
12. Goldstone, R.L.: Hanging Together: A Connectionist Model of Similarity. In: Grainger, J., Jacobs, A.M. (eds.) *Localist Connectionist Approaches to Human Cognition*, pp. 283–325. Lawrence Erlbaum Associates, Mahwah (1998)
13. Green, P.E., Rao, V.R.: *Applied Multidimensional Scaling: A Comparison of Approaches and Algorithms*. Holt, Rinehart and Winston, New York (1972)
14. Heit, E.: Features of Similarity and Category-Based Induction. In: *Interdisciplinary Workshop on Categorization and Similarity*, pp. 115–121. University of Edinburgh (1997)
15. Hsu, C.H., Chang, S.H., Lin, R.: A Design Strategy for Turning Local Culture into Global Market Products. *Kansei Engineering International Journal* 12(2) (accepted, 2013)
16. Hsu, C.H., Chang, S.H., Lin, R.: A Design Strategy for Turning Local Culture into Global Market Products. In: *International Conference on Kansei Engineering and Emotion Research 2012*, pp. 124–131. National Cheng Kung University, Tainan (2012)
17. Joan, M.L.: Priming Effects on Product Judgments: A Hemispheric Interpretation. *Journal of Consumer Research* 16, 76–86 (1989)
18. Johnson, M.D.: Consumer Similarity Judgments: A Test of the Contrast Model. *Psychology & Marketing* 3(1), 47–60 (1986)
19. Johnson, M.D., Puto, C.P.: A Review of Consumer Judgment and Choice. In: Houston, M.J. (ed.) *Review of Marketing*, pp. 236–292. American Marketing Association, Chicago (1987)
20. Johnson, M.D., Lehmann, D.R., Horne, D.R.: The Effects of Fatigue on Judgments of Interproduct Similarity. *International Journal of Research in Marketing* 7, 35–43 (1990)
21. Johnson, M.D., Fomell, C.: A Framework for Comparing Customer Satisfaction Across Individuals and Product Categories. *Journal of Economic Psychology* 12(2), 267–286 (1991)
22. Kim, J., Novemsky, N., Dhar, R.: Adding Small Differences Can Increase Similarity and Choice. *Psychological Science* 24, 225–229 (2013)
23. Larkey, L.B., Markman, A.B.: Processes of Similarity Judgment. *Cognitive Science* 29, 1061–1076 (2005)
24. Lin, R., Lin, C.Y., Wong, J.: An Application of Multidimensional Scaling in Product Semantics. *International Journal of Industrial Ergonomics* 18, 193–204 (1996)

25. Lin, R., Lin, P.C., Ko, K.J.: A Study of Cognitive Human Factors in Mascot Design. *International Journal of Industrial Ergonomics* 23, 107–122 (1999)
26. Lin, R.: Transforming Taiwan Aboriginal Cultural Features into Modern Product Design: A Case Study of a Cross-cultural Product Design Model. *International Journal of Design* 1(2), 47–55 (2007)
27. Lin, R., Lin, C.L.: From Digital Archive to E-Business – A Case Study of Turning “Art” to “E-Business”. In: 2010 International Conference on E-Business. Athens (2010)
28. Lin, R., Chen, C.T.: A Discourse on the Construction of a Service Innovation Model: Focus on the Cultural and Creative Industry Park. In: Ifinedo, P. (ed.) *E-BUSINESS – Application and Global Acceptance*, pp. 119–136. InTech, Croatia (2012)
29. Medin, D.L.: Concepts and Conceptual Structure. *American Psychologist* 44, 1469–1481 (1989)
30. Medin, D.L., Goldstone, R.L., Gentner, D.: Similarity Involving Attributes and Relations: Judgments of Similarity and Difference Are Not Inverses. *Psychological Science* 1, 64–69 (1990)
31. Medin, D.L., Goldstone, R.L., Markman, A.B.: Comparison and Choice: Relations between Similarity Processes and Decision Processes. *Psychonomic Bulletin and Review* 2, 1–19 (1995)
32. Meyer, D.E., Schvaneveldt, R.W.: Meaning, Memory Structure, and Mental Processes. In: Coffey, C.N. (ed.) *The Structure of Human Memory*, pp. 54–89. Freeman, San Francisco (1975)
33. Murphy, G.L., Medin, D.L.: The Role of Theories in Conceptual Coherence. *Psychological Review* 92, 289–316 (1985)
34. Navarro, D.J., Lee, M.D.: Combining Dimensions and Features in Similarity-based Representations. In: Becker, S., Thrun, S., Obermayer, K. (eds.) *Advances in Neural Information Processing Systems*, vol. 15, pp. 67–74. MIT Press, Cambridge (2003)
35. Navarro, D.J., Griffiths, T.L.: Latent Features in Similarity Judgments: A Nonparametric Bayesian Approach. *Neural Computation* 20(11), 2597–2628 (2008)
36. Norman, D.A.: *Emotional Design: Why We Love (or Hate) Everyday Things*. Basic, New York (2004)
37. Rao, V.R., Katz, R.: Alternative Multidimensional Scaling Methods for Large Stimulus Sets. *Journal of Marketing Research* 8, 488–494 (1971)
38. Singh, R., YanHo, S.: Attitudes and Attraction: A New Test of the Attraction, Repulsion and Similarity-dissimilarity Asymmetry Hypotheses. *British Journal of Social Psychology* 39(2), 197–211 (2000)
39. Shepard, R.N.: The Analysis of Proximities: Multidimensional Scaling with an Unknown Distance Function: Part I. *Psychometrika* 27, 125–140 (1962a)
40. Shepard, R.N.: The Analysis of Proximities: Multidimensional Scaling with an Unknown Distance Function: Part II. *Psychometrika* 27, 219–246 (1962b)
41. Shepard, R.N.: Representation of Structure in Similarity Data: Problems and Prospects. *Psychometrika* 39, 373–421 (1974)
42. Shepard, R.N., Arabie, P.: Additive Clustering: Representation of Similarities as Combinations of Discrete Overlapping Properties. *Psychological Review* 86, 87–123 (1979)
43. Tversky, A.: Features of Similarity. *Psychological Review* 84, 327–352 (1977)
44. Tversky, A., Gati, I.: Studies of Similarity. In: Rosch, E., Lloyd, B. (eds.) *Cognition and Categorization*, pp. 79–98. Erlbaum, Hillsdale (1978)
45. Vanpaemel, W., Verbeemen, T., Dry, M., Verguts, T., Storms, G.: Geometric and Featural Representations in Semantic Concepts. *Memory & Cognition* 38(7), 962–968 (2010)
46. Zeigenfuse, M.D., Lee, M.D.: Finding the Features that Represent Stimuli. *Acta Psychologica* 133(3), 283–295 (2010)

Cloud Computing Adoption Journey within Organizations

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Abstract. Cloud computing is slated to create a paradigm shift in computing experience. Cost savings and control over employee access by the IT groups within corporate, government, and educational institutions are some of the major drivers for the adoption of cloud computing. However, there are limitations to the extent to which workflows are moved to the cloud. The major roadblocks to extending the adoption of some of the workflows to the cloud include concerns about control over the (critical) data, compliance across geographies, and security issues. The paper will explore cloud computing life cycle and concerns about cloud computing from interviews with IT decision makers.

Keywords: Cloud computing, security, networking, compliance, technology adoption, green technology.

1 Introduction

The adoption of cloud computing that has moved some of the activities and workflows from traditional computing have been termed a paradigm shift (Voas & Zhang, 2009). Cloud computing has been defined variously by different sources concentrating on specific sub-set of attributes. NIST has provided the most elaborate definition of cloud computing while acknowledging that is still an evolving paradigm. According to NIST, cloud computing is a model for enabling ubiquitous, convenient, on-demand network access to a shared pool of configurable computing resources (e.g., networks, servers, storage, applications, and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction. This cloud model promotes availability and is composed of five essential **characteristics**, three **service models**, and four **deployment models**. The five essential characteristics include on demand self-service, broad network access, resource pooling, rapid elasticity, and measured service. The service models include Software as a Service (SaaS), Platform as a Service (PaaS), and Infrastructure as a Service (IaaS). The four deployment models include private cloud, community cloud, public cloud, and hybrid cloud. For practical purposes, the industry recognizes private, public, and hybrid clouds (Mell & Grance, 2011).

The private cloud is deployed for only one organization, the public cloud is open for use by multiple tenants, and a hybrid cloud encompasses both the private and the

public cloud allowing data transference through connectors (Baars & Spruit, 2012). A community cloud is shared by multiple organizations with shared goals and managed either jointly or by one of the stakeholders on behalf of all.

The journey to cloud computing is complicated by various factors including perceived cost savings, security concerns, compliance, issues of management, and control over the data. These concerns are exacerbated particularly when there is a potential legal challenge that leads to subpoena of data where questions of ownership of the data can swing between the owner of the cloud and the creator or lessee of the cloud.

2 Methodology

We overviewed the landscape of cloud computing domain broadly and how this domain was perceived by savvy consumers from a variety of organizations. We interviewed 8 decision makers from the industry and educational institutions to obtain their perspectives about cloud computing. These stakeholders were invited to provide their input and their insights are integrated within the findings from a synthesis of the cloud domain. All the participants had adopted cloud computing solutions within their organizations.

3 Factors in the Cloud Adoption Journey

3.1 Terminology and Absence of Standards

Cloud computing is the new holy grail – companies are aspiring to attach this terminology to their product offerings. Interestingly, there is a significant diversity in the understanding of the phrase cloud computing. It is however associated with modernity and being in step with the future. Most of the key vendors have embraced the term *Cloud* without defining it. Underscoring the complexity in defining cloud comprehensively, the NIST definition that is considered as being holistic, is fairly extensive covering all the attributes that constitute it, with multiple service and deployment models.

One of the biggest factors in discussing cloud computing has been the general lack of agreement on what it means. Woo (2010) noted that McKinsey & Co. reported at least twenty-two different definitions of cloud computing. Some of the participants that had implemented virtualization solutions that met some of the requirements of the NIST cloud definition, considered that they had implemented cloud solution. Some of the organizations that had implemented cloud solutions in-house did not always turn on their metering or chargeback feature. When the participants were interviewed and asked to define cloud computing, their responses ranged from e-commerce including auction sites as being cloud solutions and any application that ran on the Internet as being a cloud-based solution, to the ability of an IT Administrator being able to provision virtual machines remotely and scale their capacities with agility as representing cloud computing.

3.2 Messaging and Branding

Advertising messaging of various cloud vendors emphasize the word Cloud. Since crystallizing the concept of cloud universally was difficult, the vendors found it easier to embrace the term cloud without defining it. Various offerings in the Cloud domain of IaaS, PaaS, and SaaS, include Google AppEngine (SaaS), VMware's vCloud Suite (IaaS), SpringSource (PaaS), Amazon's Elastic Compute Cloud (IaaS), Microsoft's Azure Services Platform (PaaS), Force.com (PaaS), Microsoft's System Center



Fig. 1. Messaging and Positioning of various vendors aimed at heightening the Cloud Brand

Configuration Manager (IaaS), Salesforce.com (SaaS), SAP's HANA (PaaS), and Workday (SaaS) although most of the advertisement messaging tends to focus primarily on the overarching Cloud brand. This tends to provide a halo effect of the cloud brand to the vendor and simultaneously exacerbates end-users bemusement about the concept of Cloud.

There is however significant consistency in the major vendors seeking to be attached to the cloud computing brand. Interestingly, most of the advertisement messaging appears to be interchangeable with the key differentiator being the name of the vendor. After being targeted with a multitude of messaging about various cloud offerings, customers' confusion on what represents cloud is understandable.

The term cloud has such high positive value proposition, that organizations that have deployed cloud solutions advertise that they are powered by the cloud. These include financial institutions like NYSE, airlines such as Southwest, and even cosmetics firms such as Revlon.



Fig. 2. Customers attaching the brand value of Cloud to obtain positive value proposition

3.3 Culture and Organizational Structure

Organizations that adopted cloud computing early tend to be more innovative and open to adopting or experimenting with new solutions. These organizations tend to either have decentralized pockets of power where a mid-level manager encouraged innovation or a centralized power structure where a key c-staff member embraced innovative solutions.

Although in both scenarios, cloud computing was adopted early, the extent to which it was deployed within the organization tended to be limited when the locus of control was at a relatively lower level. Unless cloud computing obtained the active approval of a c-staff member such as the Chief Information Officer or other c-staff officer such as the Chief Finance Officer that had the Information Technology (IT) group under its purview, the extent of proliferation of cloud computing to various workflows within the organization tended to be limited.

When IT departments are viewed as business units instead of cost centers, there tends to be greater innovation and speed in the adoption journey. Demonstrating value

proposition to the business is central to the degree new technologies are adopted and proliferated within organizations.

When organizations are unable to keep pace with the requirements of the consumers' computing needs within organizations, some employees have proactively found solutions without obtaining requisite permissions. When they are unable to wait for the bureaucratic process to obtain the hardware to meet their needs, they have sometimes circumvented the chain of approval and obtained computing resources from cloud vendors such as Amazon's EC2. This poses challenges especially when they are working on sensitive projects that need to meet the requirements of various contingencies. While cloud computing allows organizations to be agile and meet computing requirements expeditiously, it also allows employees to take initiative and circumvent checks and balances of data management that present potential challenges to the organization.

The speed of adoption of cloud computing within organizations, particularly large enterprises and mid-size companies depended on the effectiveness of the evangelizer's ability to demonstrate value, and the culture of willingness to adapt quickly to changes.

	IT - Business Center	IT - Cost Center
Technical knowledge of key Decision Maker is relatively high	<ul style="list-style-type: none"> • Early Adoption • Rate of Adoption tends to be fast 	<ul style="list-style-type: none"> • Early Adoption • Rate of Adoption tends to be relatively less fast
Technical knowledge of key Decision Maker is relatively low	<ul style="list-style-type: none"> • Moderate or late Adoption • Rate of Adoption tends to be relatively slow 	<ul style="list-style-type: none"> • Late Adoption • Rate of Adoption tends to be very slow

Fig. 3. Model of Adoption of Cloud Computing

Management of Computing Expenses. The metering ability or the chargeback for the resources consumed by specific cost centers within an organization makes the management of the expenses more efficient. The IT department can divest itself of some of its responsibilities of a cost center and instead play the role of an active business unit or an active partner of business units. However, when business units are the cost centers paying for computing resources, there is sometimes a tendency to inflate their requests for computing resources. There appears to be a challenge to shift from the paradigm of purchase from non-cloud computing where resources are planned on a three-year timespan to the new cloud paradigm where resources can be deployed in an agile manner on a need-by basis. Consequently, there is an inefficient hoarding of storage and networking resources unless the IT department is empowered to keep track of usage and reclaim unused resources for redeployment. Clearly, efficient

utilization of cloud adoption requires restructuring and political reorganization as well as clear setting of expectations.

3.4 Value Propositions

Cost of Real Estate to House Servers. Typically, being able to demonstrate value propositions such as savings in cost (Linthicum, 2010), and effectiveness of cloud solutions in being able to deploy computing requirements resourcefully were key to its proliferation. Cloud computing allows consolidation and efficient deployment of resources, thereby reducing the amount of space required to house servers that can translate into significant cost savings especially when the data warehouses are located in areas where the cost of real estate is high. These considerations are less important when the servers are located in low rent areas.

Cooling Costs. With consolidation of computing resources, there is a significant amount of savings (Boroujerdi & Nazem, 2009) in the maintenance of servers' cooling costs. Although for IaaS cloud computing, the consolidation ratios can be high, some of the organizations opt for a more conservative approach. Even when there is a consolidation ratio of 10:1, the amount of savings in cooling is down to one-tenth. It meets the standards of green technology by leaving a small carbon footprint. This in turn has a positive impact on the overall brand of the organization that can be perceived as being environmentally responsible.

Cost of Hardware. While cost savings *after* the adoption of cloud computing are significant, the cost of the adoption itself can be a determining factor (Lin & Chen, 2012). When organizations have already purchased significant hardware, the incentive to adopt cloud computing that could potentially reduce their costs through consolidation does not apply, whereas the software cost to deploy IaaS cloud can be relatively significant at least in the short term. However, when the hardware is obsolete and the cost for the purchase of new hardware is significant as can be the case in some educational institutions and small medium businesses (SMB) that are not focused on IT, the cost of adoption of IaaS cloud makes business sense.

Administrative Cost. The cost of managing IT departments can be reduced with the adoption of cloud computing. These are significant especially for organizations that are resource constrained. By placing workloads on the public cloud or through clouds managed by Internet Service Vendors such as Terramark, Savvis, and Bluelock, the number of in-house IT Administrators can be reduced and they can be reassigned to work on products and support.

3.5 Challenges to Cloud Adoption

Loss of Control. Perceived loss of control over the data is a major concern for organizations' adoption of cloud computing and if they have already adopted it, to extend it to workflows that have critical data. This is particularly applicable to the public clouds. When data has been deleted, there is crisis of confidence if the data continues

to reside in a backup server for disaster recovery. These have long term implications for both privacy as well as the lifecycle of the data itself.

Data Ownership and Legal Ramifications. When there is a legal issue and subpoenas are given out, it is not clear if the creator of the data and subscriber of the public cloud storage owns it or the vendor of the public cloud is responsible. In the recent Petraeus scandal involving the CIA director's indiscretions, the federal government asked Google to turn over the email accounts. Although in this case arguably, the Gmail account was free, a similar situation could prevail even in the existence of a paid subscription. Organizations that are functioning in the areas of confidentiality may want to protect themselves against such actions where they have little control over the situation.

Compliance. There are several issues with regard to compliance that pose challenges to the journey to cloud particularly the public cloud. The lack of absolute knowledge of where the data resides can raise auditability issues (Baars & Spruit, 2012). In addition, the requirements of privacy of data are different in various geographies and information on the cloud can complicate compliance with national laws. For instance, data privacy requirements are considerably more stringent in European countries than they are in the USA. In addition, there are various compliance standards such as HIPAA for Healthcare industry and PCI for Financial industry that can pose significant challenges to extending these workloads to the public or hybrid clouds.

Security. Security is the single biggest concern in cloud adoption (Chen et al., 2010). Even when organizations deploy workloads into the clouds, at least initially they are more likely to port relatively less critical data. Breach of data by hackers and the ability of public cloud vendor's administrators' ability to view the data are cause for consternation. Although security solutions by McAfee, Trend Micro, VMware's vShield, Neticitadel, and other vendors are working on security offerings to address consumers' concerns, there are real and perceived threats that negatively impact cloud adoption. The implementation of security solutions that can abate consumers' concerns is critical to their journey in porting mission critical workloads on the cloud.

Management. Managing and monitoring resources on the cloud can be challenging (Lee, 2012) particularly when organizations have solutions from multiple vendors. Suboptimal or absence of interoperability of cloud offerings poses challenges to managing resources. This is especially critical for monitoring CPU, I/O, storage, and network loads to ensure the workflows are running optimally and to set alerts of possible issues in a timely manner to enable troubleshooting and prevent or minimize loss of efficiency. Although there are a few widely used Management solutions, this area is still at a relatively infancy stage.

Current vendors that provide Management Solutions include BMC's Cloud Lifecycle Management, CA's Application Performance Management Cloud Monitor, HP's Matrix Operating Environment, Redhat's ManageIQ, Oracle's Enterprise Manager, and IBM's Tivoli.

User Experience. Given the relative complexity of these solutions, the user experience of the product can have an adverse impact on cloud adoption. This is particularly true for IT staff from small and medium businesses as they are already under significant pressure to manage the IT requirements within their organizations. The extra time required to educate themselves on cloud computing may not be available. A sub-optimal user experience when they explore cloud computing may lead to their re-commitment to the existing physical infrastructure.

3.6 Path to Cloud Computing

The journey to cloud computing from existing traditional infrastructure could either originate from public cloud to private cloud to a hybrid cloud or the reverse. When individuals within organizations take the initiative to obtain computing resources either with or without the permission of their management for a temporary period of time to fulfill their needs, their journey to the cloud can end there. When the decision to adopt the journey to the cloud is taken at an organizational level with a well-staffed IT department, there is a tendency to take a conservative approach. These organizations are likely to start their journey to the cloud with a private cloud in a sandbox environment and then extend their journey more extensively. Subsequently they may adopt the public cloud and hybrid cloud.

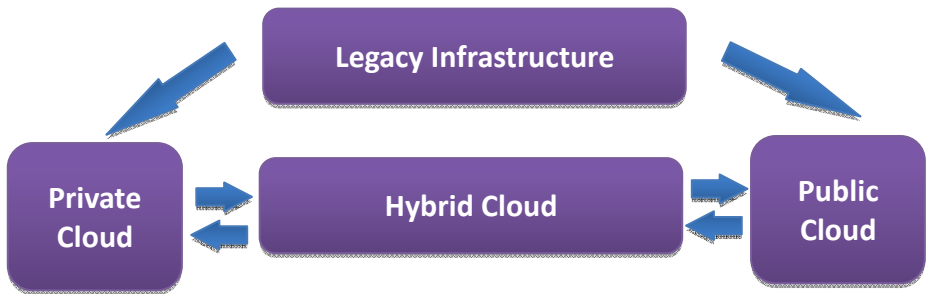


Fig. 4. Journey to the Cloud

For organizations with outdated hardware and skeletal IT staff, the first step to cloud computing could start with the public cloud. They may potentially add a private cloud when their resources allow such a deployment.

Typically, during early adoption phases, organizations tend to migrate non mission-critical workflows initially and progressively tend to migrate more important workflows on the cloud. However, even organizations that are mature in the lifecycle of cloud computing tend to keep some of their workflows in a non-virtualized environment. These include legacy applications, applications that require multiple authentications, and large workloads that do not accrue cost benefits by placing them on the cloud.

4 Conclusion and Future Directions

With the advantages of cost savings, scalability of deployment, and low carbon footprint afforded by cloud computing, it would seem that the journey to the cloud should be obvious. However, the various challenges such as security concerns, management of the computing resources both cloud-based and physical infrastructure, and compliance requirements prove to be roadblocks to the extensive adoption of cloud. Compliance and legal hindrances may be more difficult to overcome. In the areas of security and management of the cloud, innovations through research and development can potentially address significant issues of current and future cloud adopters. For instance, creating a Management solution that can effectively monitor both cloud computing and non-virtualized computing resources with a great user experience would accelerate the journey farther into the cloud.

References

1. Arinze, B., Anandarajan, M.: Factors that determine the adoption of cloud computing: a global Perspective (Report). *International Journal of Enterprise Information* 55(14) (2010)
2. Baars, T., Spruit, M.: Designing a Secure Architecture: The SeCA Model. *International Journal of Security and Privacy* 19 (2012)
3. Boroujerdi, M.M., Nazem, N.: Cloud Computing: Changing Cogitation about Computing, *World Academy of Science. Engineering and Technology* 58 (2009)
4. Buyya, R., Yeo, C.S., Venugopa, S.: Market Oriented Cloud Computing: Vision, hype, and reality for delivering it services as computing utilities. In: *Proceedings of the 10th IEEE International Conference on High Performance Computing and Communications*. IEEE CS Press (2008)
5. Chen, Y., Paxson, V., Katz, R.H.: What's New about Cloud Computing Security? *University of California, Berkeley* 20 (2010)
6. Lee, R.C.: Smart Systems Resource Monitoring. *Science Research* (February 2012)
7. Lin, A., Chen, N.C.: Cloud computing as an innovation: Perception, attitude, and adoption. *International Journal of Information Management* 8 (2012)
8. Linthicum, D.S.: *Cloud Computing and SOA Convergence in your Enterprise*. Pearson (2010)
9. Mell, P., Grance, T.: *The NIST definition of Cloud Computing: Recommendations of the National Institute of Standards and Technology*. National Institute of Standards and Technology, U.S. Department of Commerce, Special Publication 800-145 (2011)
10. Voas, J., Zhang, J.: Cloud computing: New wine or just a new bottle? *IT Professional* 11(2), 15–17 (2009)

Behavior Study of Traveling Chinese Businesspersons

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Abstract. China's growing economy has contributed to the emergence of an expanding, thriving class of traveling businesspersons. This paper investigates which factors affect these businesspersons' consumer behavior, as well as the role that each factor plays in their decision-making. In order to obtain a better understanding of consumer behavior in travel and the importance of each factor, a study was conducted in China on a group of frequently traveling businesspersons. The survey revealed that five main factors influenced the choices these businesspersons made. Within these factors, the two major factors were Novelty Seeking and Bandwagon Effect. The results of this study can pave the way for designing innovative goods and services that will enhance the travel experience of the typical businesspersons.

Keywords: Consumer Behavior, Traveling Businesspersons, Business Travel Psychology, Novelty Seeking, China.

1 Introduction

China's economy has witnessed a substantial development in both commerce and business over the past decade. This development has been accompanied by the rise of an expanding, thriving class of traveling businesspersons. Apart from frequently traveling for business matters, these businesspersons are also very interested in traveling for personal enjoyment, whether it is visiting novel tourist attractions, purchasing designer products, etc.

With the growth of online booking and planning, modern businesspersons find it much easier to control the entirety of their trips to both domestic and foreign destinations. In addition, they are now more than ever faced with a wide variety of travel options, packages, and combinations. An important aspect in researching the consumer behavior of these traveling businesspersons is to investigate how these people make their purchase decisions when presented with so many choices.

We can also observe a change in the current lifestyles among businesspersons compared to the past. Our traditional image of businesspersons is conservative, and somber. They dress in dark, formal suits, carry a black briefcase, and diligently work in towering office buildings. From this austere image has evolved a new body of businesspersons who are considerate of their appearance and carriage, as well as being sociable and in the spotlight. Instead of being solely dedicated to their work, many

businesspersons are now leaning towards a more material lifestyle, as well as displaying more interest towards their lives and health. Accompanied with a rising income level, many businesspersons have become enthusiastic consumers of quality goods and services. Many factors influence these businesspersons' consumer behavior, such as ego involvement or advice from family and friends [1].

In order to obtain a better understanding of consumer behavior in travel and factors that affect consumer behavior, a study was conducted in China among traveling businesspersons. This analysis focuses on their behavior both while planning the travel beforehand and during the actual journey. What factors affect these frequent travelers' behavior? Which factor plays the most important role?

2 Background and Hypothesis

As seen in Figure 1, based on results from MGI, the percentages of families in Chinese cities that fall under upper-middle class and upper class have been steadily increasing. It has been projected that the proportion of these families will continue to rise into the future. Among these families are those of traveling businesspersons, who not only seek to travel on quality vacations to novel destinations but also desire to purchase luxury or brand-name goods and services.

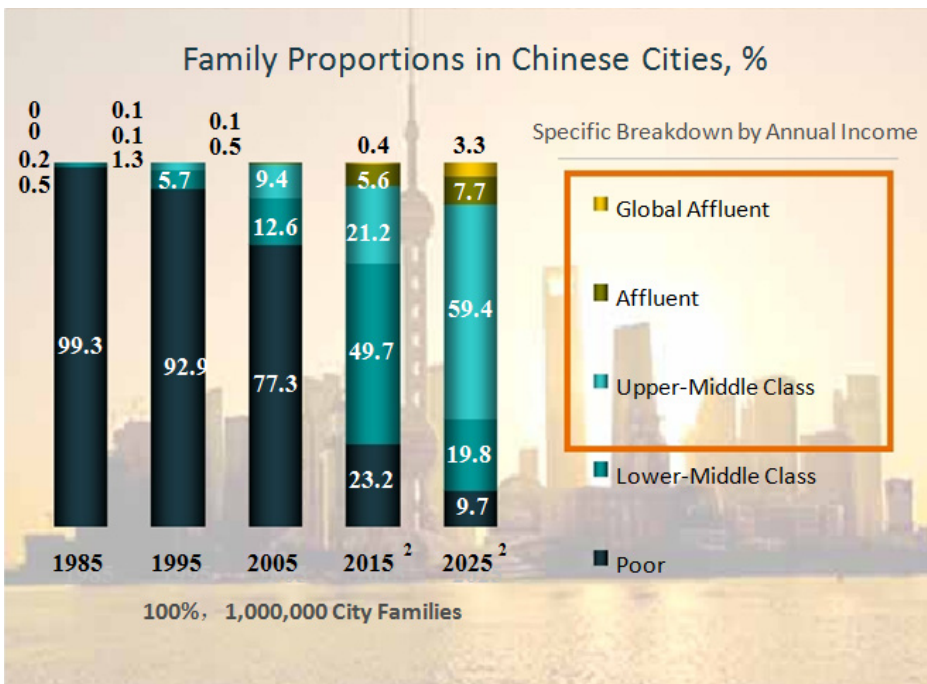


Fig. 1. % Breakdown of Families in Chinese Cities by Income Level [2]

In Figure 2 below, from CBES, we observe a decline in the percentages of businesspersons that were born during the 1950s and the 1960s (the 50's group and the 60's group on the graph), while the number of businesspersons in the 70's group remains steady. In comparison, the percentage of businesspersons born in the 1980s is steadily rising and has more than doubled over the span of four years, increasing from 11.8% to 24.5% in a span of three years. Overall, we observe a trend in which the population of Chinese businesspersons is becoming younger, Figure 1 shows the emergence of a growing class of businesspersons, while Figure 2 shows the increase of a younger age group within this class. On the basis of this research, we expect in conducting this study to find patterns of consumer behavior that reflect these observations. We hypothesize that the five main factors that may affect consumer behavior will be: Ego, Loyalty Programs and Benefits, Family and Friends, Bandwagon Effect, and Novelty Seeking. Out of these five factors, Novelty Seeking and Ego will likely play the most important role in consumers' decision making. The majority of businesspersons may desire to have greater control over their travels, while the growing group of younger businesspersons will likely seek the newest fashions and products.

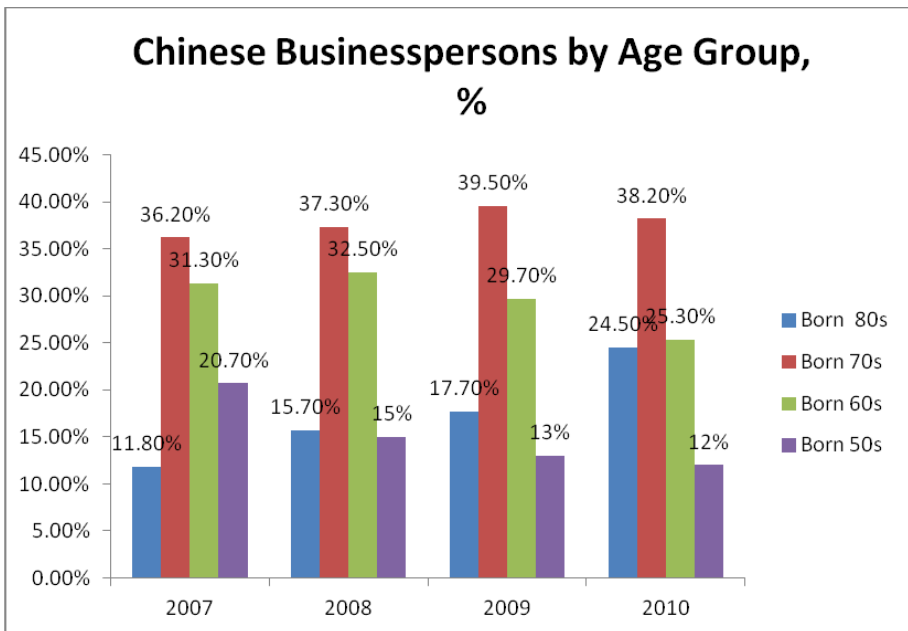


Fig. 2. % Breakdown of Chinese Businesspersons by Age Group [3]

3 Methodology

In this study, a web survey was designed and conducted to validate our research hypothesis. The survey included questions from each of the five main factors that affect consumer behavior: Ego, Loyalty Programs and Benefits, Family and Friends, Bandwagon Effect, and Novelty Seeking.

After designing the questionnaire, it was sent to a polling agency, where it was reviewed and proofread. The survey was then posted on a variety of different websites over the Internet. This was to ensure that we would sample a more random and diverse population. After prefixed, specific percentage ratios were recorded, the survey was closed. The results were compiled and data analysis was conducted.

For our survey, we chose a sample size of roughly 60 traveling businesspersons. In order to reduce bias, we strived to survey nearly equal numbers of males and females. We also tried to make sure each person surveyed was a frequent traveler, so he or she would answer from experience and ensure the validity of our results. We believe each of the responses should be independent because it is reasonable to assume that the answer of one respondent should not affect that of another respondent. We assume a sample population of sixty businesspersons should be a representative and large enough sample.

Table 1. Demographical Information of Respondents

	Male	Female
Northern China	13	14
Southern China	17	15
B.S. Degree or Above	19	18
High-Level Executives	7	4
Total	30	29

As shown by the table above, the surveyed population consists of roughly equal number of traveling businessmen and businesswomen. There are a slightly few more businesspersons from Southern China, most likely due to the rapid growth of major cities such as Hong Kong and Shanghai, both of which are hotspots for businesses. It can be seen that over fifty percent of both the businessmen and businesswomen group are college graduates.

The table below summarizes the factors included in the survey and some of the sample questions that fall under each factor.

Table 2. The Five Main Factors and Sample Related Questions in Study

Factors	Sample Related Questions
Ego	<ol style="list-style-type: none"> 1. I believe that I am well informed and make smart choices when making purchases. 2. I believe that I am not easily tricked by businesses' marketing strategies compared to the average person. 3. I want to be in control of the planning of my vacation, which includes extensive research and comparison of different options. 4. I pride myself in being able to find the best deals and prices. 5. I am highly involved in deciding my travel plans and use online booking such as Travelocity, Expedia, etc. 6. I often rely on my own instincts when making decisions.
Loyalty Programs and Benefits	<ol style="list-style-type: none"> 1. I always choose the best deal and price rather than sticking with the same brand. 2. I am part of a traveling rewards program because I believe it will benefit me even more in the long run. 3. If there's a difference in price, I may still choose the more expensive option because it is included in my rewards program. 4. I like to shop with my reward program points.
Family and Friends	<ol style="list-style-type: none"> 1. I often travel with my family or with groups of friends. 2. I often ask my friends or relatives for advice when planning for vacations. 3. I often respect my children's opinion when deciding on specific travel locations. 4. It is important to me that the attractions I visit have something for my children to do as well. 5. I may decide to join a group of friends when traveling to a foreign location. 6. I like to ask friends and family for their opinion before making purchases.
Bandwagon Effect	<ol style="list-style-type: none"> 1. I enjoy being part of the mainstream. 2. I often check what products my peers own before making purchases. 3. I reference products I've seen through advertisements on TV and the Internet before making purchases. 4. I will not easily switch from certain brands that I'm used to.
Novelty Seeking	<ol style="list-style-type: none"> 1. I like to travel to places that I have never been before. 2. I think it is more exciting to travel somewhere further away from my home, preferably out of country. 3. I often research to find the most unique destinations and attractions. 4. I like to keep up with the newest styles and trends. 5. I enjoy owning the latest products and advanced gadgets. 6. I enjoy being the center of attention. 7. I own or plan to own one or more imported, high-end car. 8. I wear a watch but do not use it to keep track of time.

4 Findings

The following findings are based on the compiled answers of the web survey. The figure below shows the order of which factor plays a more important role in businesspersons' traveling behavior based on our final results. Among the five factors, the two major factors observed were Novelty Seeking and Bandwagon Effect.

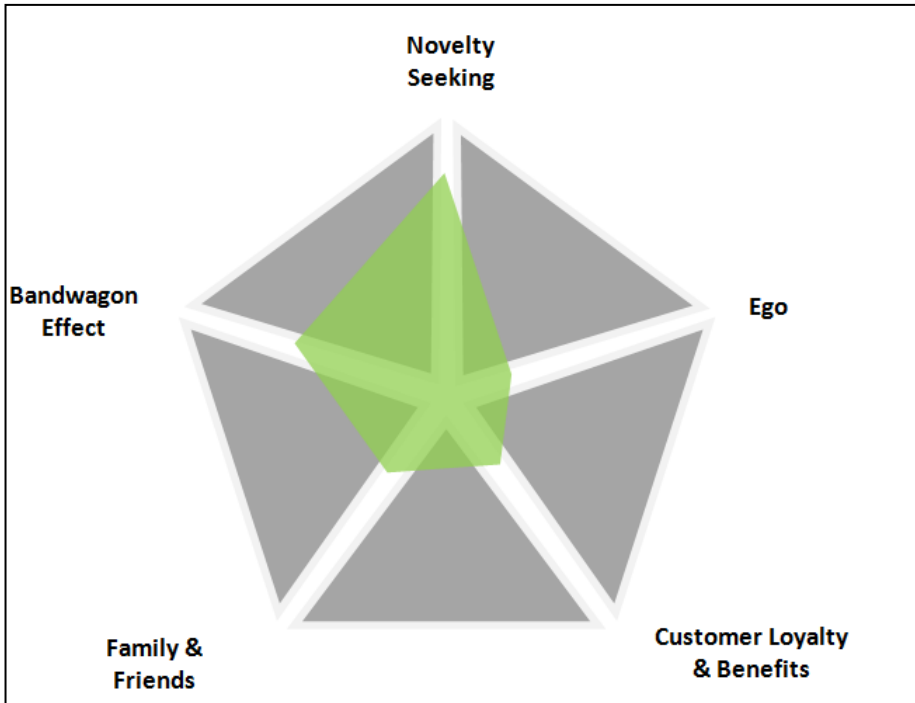


Fig. 3. Significance Proportion of Five Factors

In general, the respondents felt that the major factors that affected their decisions were Novelty Seeking and Bandwagon Effect. Within these factors, how does the factor specifically affect their choices?

4.1 Novelty Seeking

This factor refers to the search for new experiences, which is a key motivator for people who travel. These experiences can range from new regional landmarks of interest, entertainment, cultural activities, or shopping locations. In addition, people often spend more money when traveling to a foreign location than when visiting a place they have already been before. Even though they may not need to go new places for business, their willingness to travel to the new places is high.

Some of our results include:

- 91.5% of respondents like to travel to places they have never traveled to before
- 54.2% like to research unique destinations and tourist attractions before traveling
- 64.4% like to keep up with the newest style technology and trends
- 52.5% will reserve the latest products and advanced gadgets
- 59.3% own or plan to buy high-end/professional products, such as a Nikon camera
- 42.4% switch cell phones every two years or less
- 27.1% always use the newest style of cell phone
- 44.1% own an expensive watch, not to keep track of time but as a symbol of status
- 50.8% own or plan to own one or more imported/high-end car
- 49.2% enjoy being in the spotlight

4.2 Bandwagon Effect

The Bandwagon Effect factor is the tendency of businesspersons to follow the actions or beliefs of others they observe, usually those around them such as family and friends. They may also be persuaded by advertisements for products they see on the television or internet, or simply whatever product happened to be popular at the time.

Some of our results include:

- 62.7% of respondents enjoy being part of the mainstream.
- 66.1% purchase products after checking what their peers bought
- 83.1% refer to products on advertisements
- 30.5% will not easily switch from certain brands

4.3 Family and Friends

Advice and opinions from family members and friends are often an important influence in businesspersons' decision-making because of the trust. Their family or friends' suggestions will often be taken into heavy consideration. For example, if one of his friend had a prior bad experience with a certain product, that businessperson will also most likely refrain from buying the product.

Some of our results include:

- 45.8% of respondents often travel with family or groups of friends
- 61% ask family or friends for advice when deciding to travel
- 52.5% ask family or friends for opinion before buying a product
- 54.2% respect children's voice in deciding where to travel
- 62.7% will not purchase a product if someone they knew had a prior bad experience with said product

4.4 Customer Benefits and Loyalties

Many businesses related to travel offer reward programs for members, and this in turn influences whether consumers continue to choose one brand, agency, company, etc. Sometimes, two services are combined to further entice the consumer and garner loyalty, such as using one's credit card to accumulate mileage points for a specific airline. As such, some consumers may choose stick with a certain company, even if it is not the most economic choice, in the hopes of earning future benefits, such as exchanging reward points for a free airplane ticket.

Some of our results include:

- 44.1% of respondents are part of a traveling rewards program
- 45.8% like to shop with reward program points
- 32.2% choose the more expensive option when there's a difference in price because it is covered in the rewards program
- 78% prefer choosing the best deal and price rather than sticking with the same brand

4.5 Ego

In this case, the Ego factor refers to the current travelers' desire to show businesses that they are well informed, make intelligent decisions, and will not be fooled into buying unwanted products and services. The travelers want to research and compare all of their options, and then pick the best deal. They are active participants in planning their own travel experiences.

Some of our results include:

- 44.1% of respondents believe they are well informed and make smart choices when purchasing products
- 54.2% believe they won't fall into businesses' marketing traps
- 42.4% are highly involved in deciding their travel plans and will use online booking
- 39% want to be in complete control of travel plans, including research and comparison of different options, they would want some travel agency to take care.
- 42.4% pride themselves in finding the best deals or prices
- 40.7% sometimes rely on their own instincts when making decisions

5 Conclusion

Our results indicate that overall, the consumer behavior of Chinese traveling businesspersons is influenced by a combination of five main factors: Ego, Loyalty Programs and Benefits, Family and Friends, Bandwagon Effect, and Novelty Seeking. By observing our results, it can be observed that within these five factors, our

respondents have indicated that Novelty Seeking and Bandwagon Effect play the most important role in their decision making.

As indicated by our survey results, a majority of businesspersons like to keep up with the newest styles and trends, as well as being part of the mainstream. They seek to purchase or reserve the latest products, both because they seek the excitement of owning a novel product and because it is popular among their peers. These products range from the newest phone, a luxury watch, an imported car, to a quality Nikon camera for professionals. They also enjoy traveling and shopping at new or unique destinations, often out of country.

Our findings can be explained by several real-world observations. First of all, China has undergone a phase of rapid economic development. The standard of living has gone up, and many cities are experiencing a growth in the percentage of higher income families. With the growth of commerce and business, the income level of traveling businesspersons has also risen. The increase in available money to spend on consumer goods and desire to purchase these goods has altered the lifestyle of these businesspersons. There is now an emphasis towards consumerism and luxury spending, compared to an economic lifestyle that stressed the need to save money and compare prices. In addition, the overall population of traveling businesspersons in China is becoming younger. The group of businesspersons born in the 80's is steadily increasing. This group is more inclined towards following the most popular fashions and trends, as well as using the latest technology. They are less likely to present themselves in the traditional serious image of typical businesspersons; instead, they enjoy appearing sociable and being at the center of attention. They demonstrate more enthusiasm towards traveling to novel, exciting places and buying the most unique, innovative products.

To conclude, traveling businesspersons make up a unique consumer group with vast marketing potential. This study serves not only to investigate the actual psychology and factors behind consumer behavior, but also to pave the way for designing innovative goods and services that will enhance the travel experience of the typical businesspersons.

References

1. The Psychology of Travel, Strategic Travel Action Resource, National Tour Association (NTA) (January 2013)
2. McKinsey Global Institute (MGI), Q1 (2006)
3. CBES China Business Executive Survey (2007-2010)
4. Crotts, J.C., Fred, W.: Economic Psychology of Travel and Tourism. The Hawthorne Press (1994)

Part II
Culture, Health and Quality of Life

Moderating Effect of Culture on IT and Health Standard: A Country-Level Analysis

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Abstract. This cross sectional country level study inspects how the relationship between national eHealth initiatives and level of health standards are contingent on culture, education and infrastructure. Resource complementary perspective based on Resource Based View (RBV) and literature on culture and eHealth outcomes are used as the theoretical lens. Publicly available retrospective data from more than 50 countries are utilized to explore the moderating effect. Standard of health was gauged using Life Expectancy Rate (LER) at birth. The results indicates that culture and education moderate the relationship between eHealth spending and health standard. Theoretical and practical implications of the findings and future research are discussed in this paper.

Keywords: culture, eHealth, resource complementary perspective, life expectancy rate.

1 Introduction

Information Technology (IT) plays a significant role in healthcare outcomes as it allows introduction of high quality, low cost healthcare systems. According to Mithas et al. [1], IT expenditure would affect the overall life expectancy in a country. Information integration, workflow coordination and collaborative planning have been identified as the three main areas of health IT in that study and the authors have shown that, it is important to have a sound interactive system between users to achieve expected benefits of health IT, leading to better health standards measured using Life Expectancy Rate (LER). Though there are many country-level studies that have been carried out to recognize contribution of IT to economic growth [2], country level studies indicating the contribution of IT investments on better health standards are scarce. While, most of these authors have paid attention to overall IT spending of a country, they have not focused on investments on IT relevant to health care. However, in evaluating the relationship between IT and health standards, it is vital to pay attention to the IT expenditure specifically on healthcare related activities of a country.

Generally, IT initiatives are carried out within individual countries pertaining to their economic and technological capabilities. If a successful interaction between users and the eHealth system is to be maintained, it is important to consider the

cultural and other factors salient to that particular country in carrying out health IT initiatives [3]. Thus, studying the influence of moderating effect of culture, education and infrastructure can be considered as a key research gap to be answered in evaluating the relationship between health IT and health standards. With a high level of literacy among the population and higher availability of access to technology, eHealth interactions in a country too will be improved accordingly. For example, level of mobile health interactions is directly related to the facilities available and accessibility to such facilities (e.g. 3G).

Teece's [4] resource complementary perspective and literature on culture, IT and health standards are used as the theoretical framework in this study. Though there can be numerous factors affecting, we consider culture, education level and infrastructure as the key factors capable of affecting any development strategy and its standards in any country [5].

RQ: How do a nation's complementary assets (culture, education and infrastructure) interact with national health IT initiatives in predicting its health standards?

The rest of the paper is organized as follows. First, we present the theoretical framework that underlies our rationalization for the relationship between eHealth initiatives and LER with set of hypotheses developed based on them. The hypothesized model is tested using secondary data from 51 countries¹. Finally, this paper includes a discussion of the findings, contribution of findings, limitations and future research directions.

2 Theory and Hypotheses

According to Teece's [4] concept of complementary assets, to commercialize a new product profitably, an organization needs access to complementary assets in a favorable manner [6]. Complementary assets could be included in manufacturing or distribution facilities of the new product and they are resources or capabilities that enable an organization to get profits associated with a strategy, technology or innovation [7]. Even if a competitor duplicate and launch a similar product to the market, still they will not get a competitive edge if they do not have the competitive edge possessed by the primary producer. Resource Based View (RBV) discusses about having an explicit collection of resources and capabilities that can be used to attain a competitive edge over others [8, 9]. The complementary assets can be categorized into two different areas as resource co-presence view and resource channeling view based on RBV. Resource co-presence view (interaction perspective) clarifies that a resource can be considered to be a complementary asset if its presence increases the value or outcome of another resource. Resource channeling view clarifies that when resources are used in a mutually reinforcing manner, complementary assets are formed [10]. Accordingly, resource co-presence view can be applied in this study to understand why certain countries have better level of health standards compared to some other countries [11]. Complementary assets will assist in attaining high level of health standards from IS

¹ List of countries is not shown in this paper due to page limitation. Please email authors should you require further details.

innovations related to healthcare. Moderating variables (culture, education, ICT infrastructure) used in this study will be complementary assets that will enhance the relationship between eHealth development and health outcomes.

According to literature it has been found that IT investments could affect LER [1]. However, they have used overall IT expenditure of a nation rather than considering the ICT expenditure specifically related to healthcare and has identified it as a limitation in carrying out their research. They have demonstrated that use of ICT in the three mechanisms; namely, information integration, workflow coordination and collaborative planning can influence health outcomes. Therefore, sufficient investments on these three mechanisms and combined application of them (eHealth) will generate positive health outcomes [12]. It will be possible to meet the growing need of public for e-tools and e-services only if more and more investments are made to develop and sustain a quality ICT infrastructure in a country.

2.1 Moderating Effect of Culture

According to Geert Hofstede and others [13, 14], culture is the collective programming of the mind distinguishing the members of one group or category of people from others. Hofstede's national cultural dimensions (PDI-power distance index, IDV-individualism, MAS-masculinity, UAI-uncertainty avoidance index) distinguish countries from each other. These national dimensions had indicated to influence how people accept and utilize ICT systems [15]. PDI is the extent to which less powerful citizens accept and expect that power is distributed unequally. In high PDI, people will accept hierarchical level. Thus, they may prefer using eHealth systems due to existence of inequality. For example, mobile health had been successfully implemented in high power distance nations [16]. IDV considers the preference for a loosely-knit social structure where individuals are expected to look after themselves and their immediate families only. Thus, eHealth will be suitable under such contexts.

MAS describes inclination in people for achievement, heroism, assertiveness and material reward for success. That is people will be less caring for the weak and also for quality of life indicating the importance of having eHealth to manage and support personal health conditions. UAI explains the extent to which the people are uncomfortable with uncertainty. For example, since members of the society want to avoid risk, they may look for personal health management systems to understand danger and interaction of certain medication or supplements. Thus, we postulate the following hypothesis:

H1: The relationship between eHealth spending in a country and its Life Expectancy Rate is moderated by culture. The relationship becomes stronger when the cultural rating is high and becomes weaker when the cultural rating is low.

2.2 Moderating Effect of Education

With the public becoming more educated and knowledgeable, there will be an increased tendency towards their health care and taking precautionary measures against health related risks. A higher level of healthcare standing among the population can

be achieved with better educated and trained citizens. The education level and knowledge of public depending on an eHealth system can be considered as a factor promoting active engagement with eHealth activities. A higher level of education in general and a higher level of computer literacy in particular among the public will enhance the identification of web based healthcare systems and utilization of such systems in an advanced manner (e.g. group support systems, online discussion forums, e-channeling) to manage their health and protect themselves from diseases. Furthermore, such an educated public will provide feedback to improve the functioning of the systems too [17, 18]. Implementation of various new modern eHealth initiatives could be easily carried out only if there are educated and trained citizens in the healthcare sector. Thus, we postulate the following hypothesis:

H2: *The relationship between eHealth spending in a country and its Life Expectancy Rate is moderated by education. The relationship becomes stronger when the level of education is high and becomes weaker when the level of education is low.*

2.3 Moderating Effect of ICT Infrastructure

According to a United Nation's study [19], availability of reliable ICT infrastructure will allow better e-participation (better web presence) among citizens. The public will be actively involved in eHealth activities (e.g. personal healthcare management) with better facilities (e.g. broadband, mobile networks). Thus, we postulate the following hypothesis:

H3: *The relationship between eHealth spending in a country and its Life Expectancy Rate is moderated by ICT infrastructure. The relationship becomes stronger when the level of ICT infrastructure is high and becomes weaker when the level of ICT infrastructure is low.*

3 Research Design

To test the hypotheses a cross sectional analysis of 51 countries² are used. For dependent variable, 2011 is used as the base year and values for all the other constructs are captured in previous years [1, 11]. Archived data are used as it is impossible to collect primary data within resource constraints. Moreover, archived data will allow reproducibility with ease and are generalizable [20]. As data are collected from various sources, common method bias could be avoided [21]. The main data sources are (1) World Health Statistics 2011 [22]; (2) UN e-Government Survey report 2008 [19]; (3) Digital Planet 2008 [23]; and (4) Hofstede's cultural-dimensions [24]. These reports are considered to be reliable sources as these data collecting organizations follow rigorous procedures to maintain the reliability and validity of these data [25]. Also many authors have used these data in their research. For example, Digital Planet

² List of countries is not shown in this paper due to page limitation. Please email authors should you require further details.

Report is used by Mithas et al. [1], Ahangama and Poo [11] and Bankole et al. [12] to study the influence of IT spending on quality of healthcare system of a nation. Furthermore, many researchers have used Global Competitiveness Report and e-Government Survey Report in various research areas [11, 26, 27].

3.1 Operationalization of Constructs

Health standard will be measured using LER obtained from World Health Statistics 2011 [18]. The independent variable (IV) will be health IT expenditure (Digital Planet) for 2008. Hofstede's cultural-dimensions (power distance index, individualism, masculinity, uncertainty avoidance index) constitute the moderator culture. Education index is computed using adult literacy and gross enrolment and ICT infrastructure index is computed considering number of PCs, Internet users, main telephone lines, mobile phones and broadband users per 100 people. The education index and ICT infrastructure index are obtained from, UN e-Government Survey Report 2008.

Three control variables taken from World Health Statistics Report 2010 are used to explain the variance of dependent variable considered [1]. We controlled number of hospital beds, physician density and, nurse and midwife personnel density as they are indicators of quality of healthcare infrastructure and service. The control values are per 10,000 of the population.

4 Analysis and Results

4.1 Descriptive Statistics

According to descriptive statistics most correlations among variables are significant at $p < 0.05^3$. The correlation among independent and moderating variables are less than the threshold value of 0.8 [28, 29], thus indicating the lack of multicollinearity issue. Nevertheless, we performed the diagnostic statistical collinearity tests to measure Variance Inflation Factor (VIF) [18, 30]. Since VIF is below 10, then it can be considered as an absence of serious multicollinearity issue.

4.2 Hypothesis Testing

To test interaction effect as shown in Table 1, moderated multiple regression [31, 32], is used considering 51 countries. Standardization (Z-scoring) [31] of continuous variables is carried out to avoid the multicollinearity problem as if not IV and the moderators are highly correlated with the interaction terms [33, 34]. Furthermore, standardization makes it easy to use standard packages to compute moderation effects and to interpret the effect of interaction effects [34]. As indicated in Table 1, control variables, IV and the moderator variables and the product (interaction) terms are

³ Correlation table is not shown in this paper due to page limitation. Please email authors should you require further details.

entered into the equation in three steps (Hierarchical multiple regression equation). That is, ahead of interaction terms, all the individual variables used to create the interaction term will be included in the model [31, 33].

Table 1. Regression results

<i>Moderated Multiple Regression Steps</i>			
	β^b		
	Step 1	Step 2	Step 3
Controls			
Hospital_beds ^a	0.110	-0.060	-0.073
Physicians_density ^a	0.562*	0.389	0.465*
Nurses_density ^a	-0.012	-0.071	-0.055
Main Effect			
Health_IT ^a		-0.140	-0.231
Culture		0.030	-0.031
Education		0.430**	0.287
Infrastructure		0.239	0.332
Interaction Effect			
Health_IT* Culture			0.251*
Health_IT * Education			-0.434*
Health_IT * Infrastructure			0.239
R ²	0.424	0.616	0.684
Adjusted R ²	0.387	0.554	0.605
F	11.528***	9.866***	8.663***
R ² Change	-	0.192	0.068
F Change	-	5.390***	2.863*

^a Log-transformed variables; ^b beta values reported are based on standardised coefficients, N=51
 *p<0.05 **p<0.01 ***p<0.001 (2-tailed)

R² value of 0.68 and adjusted R² value of 0.61 (F=8.66, p<0.001) indicate that the overall model is useful in explaining the variance in LER. The change in R² value between step 2 and 3 as shown in Table 1, is 0.07 (F=2.86, p<0.05). Thus, it is possible to interpret the outcome in testing the moderation effects. Though, there is no direct effect of eHealth development on LER, it can be noted that there is significant moderating effect and eHealth development interact with moderator variables to affect LER. The relationship between eHealth development and LER is contingent on culture ($\beta=0.25$, p<0.05) and the direction of interaction pattern for eHealth development and standard of health is consistent with the initial prediction. Thus, H1 is supported. The relationship between eHealth development and LER is contingent on education ($\beta=-0.43$, p<0.05). However, the direction of interaction pattern for eHealth development and LER is contrary to our prediction. Hence, we can conclude that H2 is not supported. Then the relationship between eHealth development and LER is not contingent on ICT infrastructure ($\beta=0.24$, n.s.), hence, H3 is not supported. Although it was not anticipated, this interesting outcome will be discussed in greater aspect in the next section.

To find out whether the significant interactions verify to the proposed direction of interactions as hypothesized, we plotted interaction effects (Figure 1-a, b). To determine whether the gradient varies from zero, a slope analysis is done [31, 34]. Figure 1(a) presents the disordinal (crossover) interaction of culture on the relationship between LER and eHealth spending. When a simple slope analysis is performed on the effect

of culture on the relationship of LER with eHealth spending, it revealed that when the culture is high the relationship of LER and eHealth spending was not significant (slope=0.01, $t=1.39$, n.s.). When the culture is low, the relationship is negative and significant (slope=-0.02, $t=-7.6$, $p<0.001$). Figure 1(b) presents the crossover interaction of education on the relationship between LER and eHealth spending. According to slope analysis when the education is high the relationship of LER and eHealth spending was negative and significant (slope=-0.03, $t=-10.6$, $p<0.001$). When the education is low, the relationship is positive and significant (slope=0.02, $t=11.3$, $p<0.001$).

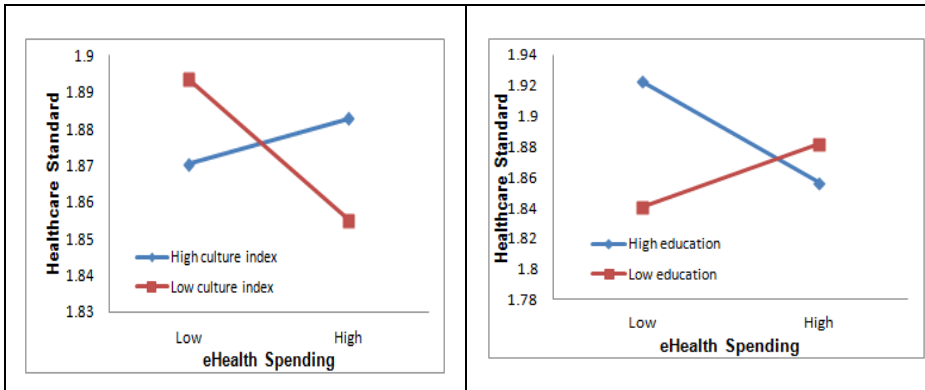


Fig. 1. Moderating influence of (a) culture and (b) education on relationship between eHealth spending and LER

5 Discussion

Through this study it was expected to understand the environmental factors that impact the relationship between eHealth spending and LER. Through the analysis performed, it is found that culture plays a significant role in improving LER in the presence of eHealth. Thus, a country having a high cultural index compared to another country will allow attaining better health standards. However, eHealth development may not affect LER, at higher levels of education (moderated in the negative direction). This may be due to the fact that there may not be a necessity for further increased investments on eHealth in such countries where a good health care system already exists [35]. Further in such countries people may be adequately knowledgeable in proper maintenance of their good health. However, the positive relationship found between the expenditure on eHealth and a low level of education on health outcomes, indicates that there is a necessity to increase the investment on a sound eHealth system in order to assist the less educated public. [16]. May be that, people with a lower level of education are not much concerned about their health specifically relevant to the adoption of preventive or precautionary measures. However, in the event that the governments initiate such systems with easy access even for the less

educated public, due to the lack of knowledge, they may not be concerned much about possible security and privacy breach in eHealth and they may depend on such systems for their health improvement activities without any hesitancy [11]. According to this study, the effect of eHealth spending on health development is not contingent on ICT infrastructure. This could be due to the fact that the effect of infrastructure may have been masked by stronger predictors (culture and education) [27].

6 Conclusion

6.1 Limitations

Dependence on secondary data obtained from various sources can be considered as a limitation in carrying out this research. Due to the resource constraints, it was not feasible to collect primary data from more than 50 countries. However there is no question about the validity and reliability of this data, since the data used are collected from reputable organizations such as WHO, WEF, UN who collect such data using stringent measures and statistical methods. Moreover, several researchers had used similar data for their studies [10, 20]. Only the countries having data for all the constructs were used in retrieving data for this study. Hence, in this cross sectional study we had to limit ourselves to only 51 countries. For instance, many African countries had to be ignored for this reason. In this study, 4 IVs (including mediator) were used and a sample size of 40 is adequate to detect fairly small R^2 values at a significant level of 0.05 [30].

6.2 Implications and Future Research

Theoretical contribution of this study are (1) Contribution made to theoretical discourse of RBV's resource complementary perspective. In previous studies, it is considered that IS innovation and deployment have direct effect on outcomes. However, our study maintains that having a specific resource can improve the outcome rather than having only the predictors (application of IS). (2) Contribution made to the knowledge base of IT-healthcare standard in assessing the influence of national level environmental factors on the relationship between eHealth spending and health standards (LER).

As practical contribution, this study assists practitioners, policy makers and administrators to understand the factors leading to various levels of health outcomes and to use these findings in policy planning and in management of complementary assets. In situations where negative interaction effects are indicated administrators are bound to pay more attention on these complementary resources and to avoid repeating the mistakes made.

As implications of our findings for future research, we would like to indicate the following. First; while we show that culture has an interaction effect on eHealth spending and LER, new complementary assets could be introduced to the model. For example, moderation effect of technological readiness and technological innovation can be examined. Second; panel dataset could be used to examine the

effect of leads and lags between predictors, moderators and dependent variables. Third; rather than using only LER to measure the health outcome, new combined measures could be introduced.

In conclusion, it is important to understand the influence of overall culture, education and infrastructure of a country when launching eHealth applications [35]. Based on individual countries' approach for health IT, different mechanisms may need to be introduced to attract and maintain stakeholders within the system.

References

1. Mithas, S., Khuntia, J., Agarwal, R.: Information Technology and Life Expectancy: A Country-Level Analysis (2009)
2. Kauffman, R.J., Kumar, A.: Impact of information and communication technologies on country development: Accounting for area interrelationships. *International Journal of Electronic Commerce* 13(1), 11–58 (2008)
3. Cyr, D., et al.: Exploring human images in website design: a multi-method approach. *MIS Quarterly* 33(3), 539 (2009)
4. Teece, D.J.: Profiting from technological innovation: Implications for integration, collaboration, licensing and public policy. *Research Policy* 15(6), 285–305 (1986)
5. Srivastava, S.C., Thompson, S.: E-Government, E-Business and National Economic Performance (2010)
6. Teece, D.J.: The Strategic Management. *The Oxford Handbook of Strategy*, p. 138 (2006)
7. Shaw, B.: Innovation and new product development in the UK medical equipment industry. *International Journal of Technology Management* 15(3), 433–445 (1998)
8. Barney, J.: Firm resources and sustained competitive advantage. *Journal of Management* 17(1), 99–120 (1991)
9. Barney, J., Wright, M., Ketchen, D.J.: The resource-based view of the firm: Ten years after 1991. *Journal of Management* 27(6), 625–641 (2001)
10. Ravichandran, T., Lertwongsatien, C.: Effect of information systems resources and capabilities on firm performance: A resource-based perspective. *Journal of Management Information Systems* 21(4), 237–276 (2005)
11. Ahangama, S., Poo, D.C.C.: Moderating Effect of Environmental Factors on eHealth Development and Health Outcomes: A Country-Level Analysis. In: Bhattacharjee, A., Fitzgerald, B. (eds.) *Shaping the Future of ICT Research*. IFIP AICT, vol. 389, pp. 143–159. Springer, Heidelberg (2012)
12. Bankole, F.O., Kweku, M.O., Brown, I.: Exploring the Impacts of ICT Investments on Dimensions of Human Development in Different Contexts: A Regression Splines Analysis. In: *Proceedings of SIG GlobDev Fourth Annual Workshop* (2011)
13. Hofstede, G.: National cultures in four dimensions: A research-based theory of cultural differences among nations. *International Studies of Management & Organization* 13(1/2), 46–74 (1983)
14. Hofstede, G., Bond, M.H.: Hofstede's Culture Dimensions An Independent Validation Using Rokeach's Value Survey. *Journal of Cross-Cultural Psychology* 15(4), 417–433 (1984)
15. Carter, L., Weerakkody, V.: E-government adoption: A cultural comparison. *Information Systems Frontiers*, 2008 10(4), 473–482 (2008)
16. Aldana, J.M., Piechulek, H., Al-Sabir, A.: Client satisfaction and quality of health care in rural Bangladesh. *Bulletin of the World Health Organization* 79(6), 512–517 (2001)

17. Wu, S., et al.: Systematic review: impact of health information technology on quality, efficiency, and costs of medical care. *Annals of Internal Medicine* 144(10), 742–752 (2006)
18. Bagchi, K., Udo, G., Kesh, M.: An Empirical Study Identifying the Factors that Impact eHealth Infrastructure and eHealth Use (2005)
19. United Nations, United Nations e-government survey 2008: from e-government to connected governance, UN (2008)
20. Kiecolt, K.J., Nathan, L.E.: Secondary analysis of survey data. Sage Publications, Inc. (1985)
21. Woszczyński, A.B., Whitman, M.E.: The problem of common method variance in IS research. *The Handbook of Information Systems Research*, 66–77 (2004)
22. World Health Organization, World Health Statistics 2011. WHO Press, Geneva (2011)
23. WITSA, Digital Planet 2008: The Global Information Economy. Arlington: WITSA (2008)
24. Hofstede, G., Hofstede, G.J., Minkov, M.: *Cultures and Organizations: Software of the Mind*, revised and expanded 3rd edn. McGraw-Hill, New York (2010)
25. Porter, M.E., Schwab, K.: *The Global Competitiveness Report 2008–2009* (2009)
26. Srivastava, S.C., Teo, T.S.H.: What facilitates e-government development? A cross-country analysis. *Electronic Government, An International Journal* 4(4), 365–378 (2007)
27. Krishnan, S., Teo, T.: *Engaging Citizens in Managing Electronic Government Service Quality: A Country-Level Analysis* (2011)
28. Gujarati, D.N.: *Basic Econometrics*, 4th edn. McGraw-Hill, New York (2003)
29. Gujarati, D.N., Porter, C.: *Basic Econometrics*, 5th edn., pp. 260–261. p. 338. McGraw-Hill, Boston (2009)
30. Hair Jr, J., Black, W.C., Babin, B.J., Anderson, R.E., Tatham, R.L.: *Multivariate data analysis* (2006)
31. Frazier, P.A., Tix, A.P., Barron, K.E.: Testing moderator and mediator effects in counseling psychology research. *Journal of Counseling Psychology* 51(1), 115 (2004)
32. Aiken, L.S., West, S.G., Reno, R.R.: *Multiple regression: Testing and interpreting interactions*. Sage Publications, Inc. (1991)
33. West, S.G., Aiken, L.S., Krull, J.L.: Experimental personality designs: Analyzing categorical by continuous variable interactions. *Journal of Personality* 64(1), 1–48 (1996)
34. Cohen, J., Cohen, P., Stephen, G.: *Applied multiple regression/correlation analysis for the behavioral sciences*, 3rd edn. (2003)
35. World-Health-Organization, Global Observatory for eHealth (GOe) (2006) under: <http://www.who.int/kms/initiatives/ehealth/en>

Predicting Mental Health Status on Social Media

A Preliminary Study on Microblog

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Abstract. The rapid development of social media brings about vast user generated content. Computational cyber-psychology, an interdisciplinary subject area, employs machine learning approaches to explore underlying psychological patterns. Our research aims at identifying users' mental health status through their social media behavior. We collected both users' social media data and mental health data from the most popular Chinese microblog service provider, Sina Weibo. By extracting linguistic and behavior features, and applying machine learning algorithms, we made preliminary exploration to identify users' mental health status automatically, which previously is mainly measured by well-designed psychological questionnaire. Our classification model achieves the accuracy of 72%, and the continuous predicting model achieved correlation of 0.3 with questionnaire based score.

Keywords: microblog, mental health, prediction, automation.

1 Introduction

The emergence of social media has been a highlight in the rapid development of the Internet, which attracts many users to express themselves through Social Media like Facebook, Twitter and so on. Users' online behaviors are fabricating a cyber-space, which reflects and interacts with the real world. Hence, users' online behavior can be an indicator of their psychological characteristics in real life.

Nowadays, more and more people are suffering from mental disorders like depression, anxiety, tension, etc., due to pressures, external environment and other reasons. These mental disorders may influence users' life severely and sometimes even may lead to suicides.

In the past, people with mental health problems may be advised to consult a therapist, or they may look for psychotherapy initiatively. People realize mental health disorders by intuition or self-reported questionnaires. Even if mental health problem is realized, psychotherapy may be unreachable due to lack of resources.

Nowadays, cyber-space is providing a new approach to change such situation. Since worldwide used SNSs have been a part of users' life, we propose to identify

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users' mental health problem through their online behavior and expression, and give them appropriate suggestions when necessary.

The rest of this paper is organized as follows. In Section 2, we introduce some related work. Section 3 will describe the experiment procedure and dataset in detail. Section 4 will talk about our modeling thought. In Section 5, we present the detailed algorithm. Experiment results will be discussed in Section 6. At last, we will give a conclusion in Section 7.

2 Related Work

The research of mental health has been a relatively ripe area in psychology, while recent researches have made exploration to migrate conclusions to cyber-space.

Personality, a stable psychological trait, is a fundamental research area in psychology. Therefore, early researches in cyber-psychology tried to identify and predict users' personality online. François et al. discovered that users' personality can be predicted through their linguistic cues [3], whose work is based on the corpus of essay and EAR. Jennifer [4], Yoram [5]. et al. tried to predict users' personality based on Facebook, took user's behavior into consideration. Their work is based on the assumption that users present themselves on Facebook profile in the way in accordance with their personality, while such assumption may not be applicable to other non-real-name SNSs. Daniele et, al have studied to predict personality with Twitter [6]. These works has proved that it is feasible to predict psychology trait through social media.

The difference between personality and mental health status is that, personality is a relatively stable trait while mental health status is much easier to change than personality. One's personality is shaped when he is grown up and doesn't change too much during his or her life, whereas one's mental health changes along with his or her mind, external environment and other reasons.

Fan et al. made a survey on the relationship between web behaviors and mental health [7]. It has been proved that, web behaviors like online time, instant messenger usage, browsing particular content, activity frequency etc., are closely related to mental health status. Dong et al. use web browser to predict users' mental health status and recommend content to alleviate mental disorders [7]. Their application proves the feasibility to predict mental health status through online behaviors. Yet it is notable that their approach record users' browsing data, which may leads to privacy concerns.

Michael et al. used "Weibo use intensity and motivation" as behavior factors to analysis the political efficacy among young Chinese citizens [9]. Their work reveals the relationship between Weibo behaviors and users' opinions, while the behavior features are measured in conventional questionnaire.

Our research goal is to find a way to predict users' mental health status through users' publicly accessible data or behaviors.

3 Experiment Design

Sina Weibo is a leading microblog service provider in China with more than 300 million users, and Weibo users post more than 100 million microblog publicly every day

[1]. Therefore, we conduct our study on Sina Weibo, as the platform to collect data. On Sina Weibo, people can pick their nick names instead of real name. Since the microblogs are in public, it is accessible to all Weibo users or crawler. However, each microblog is less than 140 characters, which makes it challengeable to analysis using conventional methods.

Predicting users' mental health status can be regarded as a typical machine learning problem. In this problem, feature space includes features extracted from users' Weibo behavior data, and the prediction variable is users' mental health statuses. To carry out the prediction task, we need to train a classifier based on labeled data, and apply the classifier on unlabeled data to predict the mental health status. In our case, labeled data refer to users' Weibo data labeled with the correspondent users' mental health statuses.

Users' Weibo data can be accessed publicly, since Weibo provides APIs to download users' data, including personal profile, microblogs, followings, followers and so on. We have implemented a Weibo crawler, which can download specified users' data conveniently. Whereas users' mental health statuses are costly to obtain. We use SCL-90-R, an influential and widely used psychometric instrument to assess users' mental health status [10], which consists of 90 questions. When a subject fills the questionnaire, it yields 9 scores correspond to 9 mental health dimensions: anxiety, depression, somatization, obsessive-compulsive, interpersonal sensitivity, hostility, phobic anxiety, paranoid ideation and psychoticism. We have published a Weibo app, *PsyMap* (<http://ccpl.psych.ac.cn:10002>), for users to fill the questionnaire and collect filling data.

When a Weibo user agrees to participate our experiment, he or she logs into our Weibo app by an OAuth2.0 based authorization interface provided by Sina Weibo. The user is instructed to complete our online SCL-90-R questionnaire. At the same time, Weibo crawler will download his or her Weibo data, ready for features extraction.

During modeling procedure, feature vectors, extracted from users' Weibo data, are dependent variables, and users' SCL-90-R assessments are independent variables. Our mental health predicting model is trained based on these data. The whole procedure is illustrated in Fig. 1.

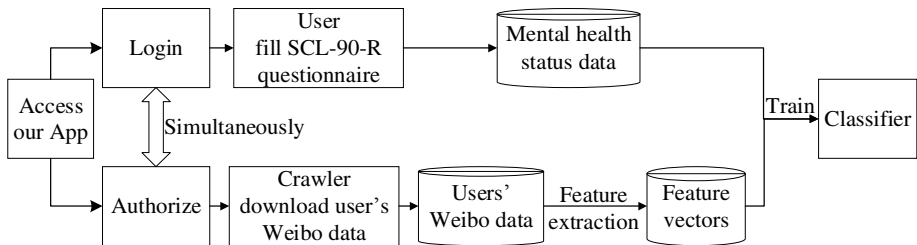


Fig. 1. Experiment Procedure

In June and July of 2012, we recruited 448 Weibo volunteers to take part in our study, and the recruitment is conducted randomly in order to get a normal user distribution. As a preprocess procedure, we scale 448 subjects' SCL-90-R scores by normalization $S_{scaled} = \frac{S_{original} - avg_{original}}{std_{original}}$, i.e. the scaled score S_{scaled} , ranges roughly from -1 to 4, has the average value of 0 and the standard deviation of 1. Higher score corresponds to poor mental health status. Fig. 2 shows the distribution of scaled 9 mental health dimension score of our dataset. We can see that most users' scaled scores are less than 1, in other words, most users have a good mental health status, while users scored greater than 1 tend to have poorer mental health status. In our dataset, users scored greater than 1 amounts for 15% roughly.

Additionally, SCL-90-R yields scores of 9 dimensions, so we build predicting model for each dimension separately following the same procedure, only the predicting variable needs to be changed in the training process.

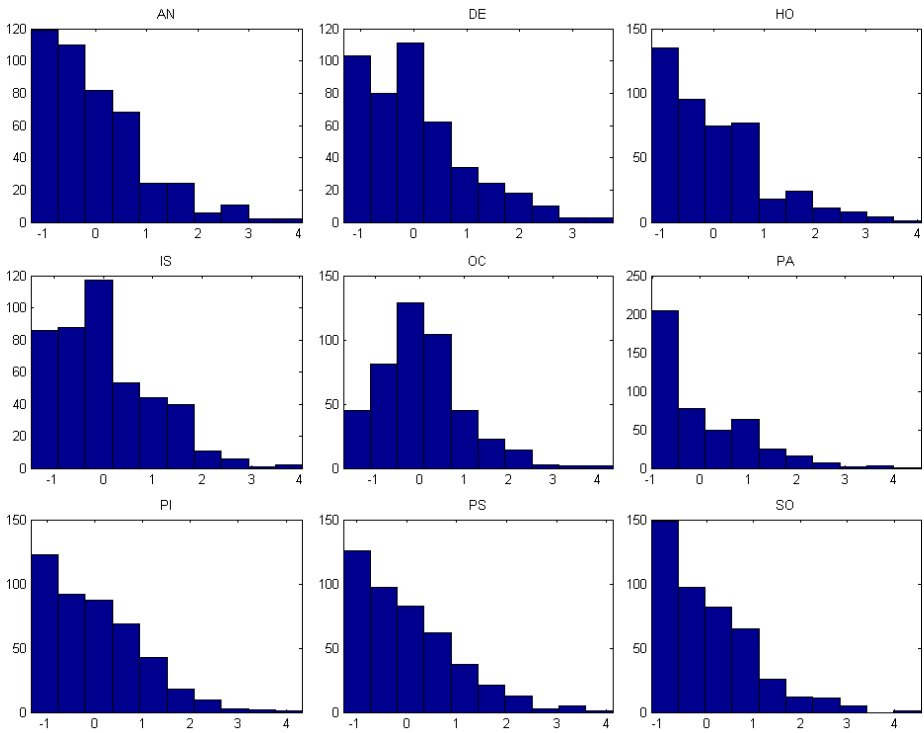


Fig. 2. Distribution of 9 mental health dimension score of our dataset

4 Modeling

4.1 Feature Extraction

Features are actually even more important than algorithms in modeling procedures. Obviously, features relevant to users' mental health status may leads to better prediction

results. We extract features from two perspectives, the first is users' microblog content, and the second is user's profile.

Generally, feature extraction needs particular domain knowledge from a different extent. In our study, we made two explorations to extract features. Firstly, we adopted little domain knowledge and establish model 1, which can be regarded as a "bootstrap" method. In this model, features are words that may be correspondent to mental health disorders. These words are discovered from the corpus by a vote whose core idea is based on Naïve Bayes principle. Secondly, model 2 introduced word dictionary, SNS profile and behavior features as domain knowledge. Different from model 1, in this model we are employing some psychological conclusions. Previous researches have proved that psychological traits or statuses are connected to linguistic expression and online behavior, so we extract features artificially in model 2. We also compare these two models at last.

4.2 Model Selection

Various effective machine learning algorithms have been developed in last decades, among which, SVM and neural network (NN) are thought to be best ones, yet it is worth to notice that, in practice they are both non-linear models. However, in psychological analysis, when a model is involved with multiple dependent variables, a non-linear model will be difficult to interpret, let alone complicated models like SVM and NN. The purpose of psychological analysis is to reveal the interpretable relationships between behaviors and psychology traits or status. Hence, SVM and NN are like black box, even if their prediction are nearly perfect, it will make little sense to understand the relationship between users' behavior features and mental health status.

As an exploring experiment, we choose to employ Naïve Bayes and linear machine learning algorithms, in order to generate models can not only predict in a fair accuracy but also easy to interpret. Naïve Bayes models are intuition-driven, and linear models can reveals the correlation between variables explicitly.

5 Algorithms and Prediction Models

In this part, we put our modeling ideas into practice. Model 1 employs the "bootstrap" feature extraction method and Naïve Bayes principle. Model 2 extracts linguistic features based on well-built dictionary, and extracts behavior features from user's profile. Model 2 uses linear machine learning algorithm, namely linear regression and pace regression.

5.1 Model 1 – Predictor Based on Naïve Bayes Predisposition Words Selector

Weibo users express their views, feelings, mood and so on by words, expression images, photos, etc. Intuitively, we believe that particular terms may link to particular

mental health status. Hence, we make our model to vote for predisposition words that low mental health status users use more, and apply these words to predict low mental health status.

Fig. 3 shows the procedure of building lexicon with mental health weights. As we mentioned, each user is labeled with a mental health status score, so we use this score to label the words used by this user.

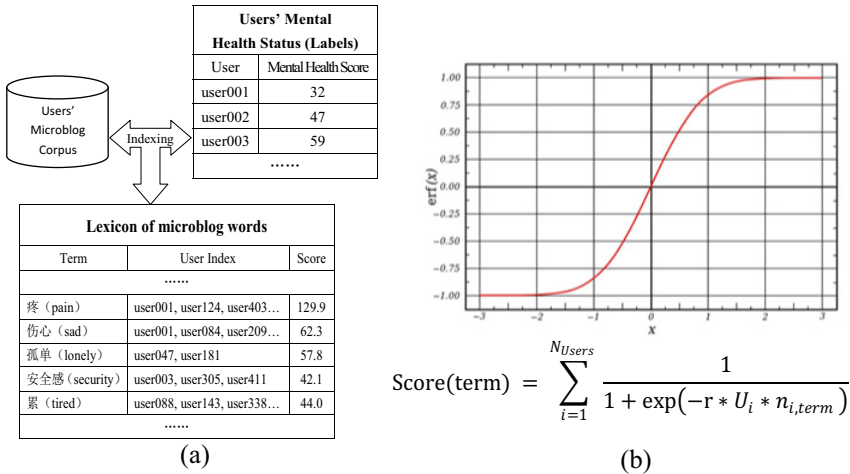


Fig. 3. Building Lexicon with Mental Health Weights

Firstly, for each user i with the mental health score of U_i , we pick up all this user's microblogs, and for each unique term in these microblogs, we label the term with a mental health score U_i and also record the term frequency $n_{i,\text{term}}$, in other words, user i use the term for $n_{i,\text{term}}$ times. So each term has several pairs of $(U_i, n_{i,\text{term}})$.

Secondly, we apply the formula in Fig. 3(b) to figure out the mental health score of each terms in the lexicon. Here, our formula use a sigmoid function, in order to eliminate affections caused by the situation where a term is used too many times by some users. The formula contains a parameter r , which adjust the steepness of sigmoid function. To a large r , terms score goes saturated when term frequency is not very high, whereas to a small r , saturation occurs only when term frequency is very high. In our case, we choose $r = 0.4$ as an empirical value. When applying the formula, we also set up a condition, that is only those terms used by more than 3 users are put in the lexicon. By doing so, we want the terms to have sufficient support.

It can be seen that, when a term is more often used by poor mental health status users, it will score high, when a term is more often used by good mental health status users, it will score negative, and when a term is often used by both good and poor mental health status users, its score will be eliminated to approach 0.

疼(pain)	破(bad)	对不起(sorry)	纠结(dilemma)	可是(but)	命(fate)
孤单(lonely)	久(long time)	贱(mean)	困(tired)	心里(in one's mind)	
只是(but)	伤心(sad)	心疼(sad)	鼻(nose)	面(face)	难受(sad)
讨厌(boring)	失眠(insomnia)	不好(not good)	头疼(headache)		
安全感(security)	闹心(worrying)	人家(a special form of first person pronoun)			

Fig. 4. Some top-ranked terms in the depression lexicon

After the lexicon with mental health weights is built, we can use it to predict unlabeled users' mental health status. Since the above procedure is based on the Naïve Bayes principle, we conjecture terms in the lexicon with high weights should indicate mental health disorders. This is supported by the experiment results, as we can see in Fig. 4, the listed terms are some top ranked in the depression lexicon. Their meanings are closely linked to poor mental health status by semantics and common sense.

In the prediction procedure, we adopted top 1000 out of more than 300 thousand terms, in the lexicon, since they are more closely related to mental health disorders. For an unlabeled user, we just pick up all his or her microblogs, and for all terms he used, we search it in our selected lexicon. To those terms occurred in our lexicon, we just add up their weights to get a total value as the prediction score P .

The prediction score P needs a threshold P_T to identify whether this users is suffering from mental health disorders. In psychometrics, subjects scoring higher than $avg + std$ (in our case, the value is 1) are tend to have mental health problems. To set the value of P_T , we use the prediction procedure to “predict” users that are already labeled, i.e. the training data. We choose 50 users whose labeled scores are closest to 1, and “predict” their mental health score using the above procedure. Thus we get their prediction scores $\{P_1, P_2, \dots, P_{50}\}$, then we set P_T to be the average of these scores.

At last, given a Weibo user's data, our prediction model yields user's prediction score P . When $P > P_T$, we say the odds this user has mental health problem is fairly high. This prediction model concludes as a two-class classifier. Our model implementation uses ICTCLAS [11] for Chinese lexical analysis and turn a microblog into terms.

5.2 Model 2 – Predictor Using Linguistic and Behavior Features

Model 1 is “bootstrap” since the features extraction is completed by discovering predisposition words from the corpus automatically, with little domain knowledge. In model 2, we are adopting domain knowledge and extracting features artificially.

Former research has introduced dictionary to predict psychology traits like personality. This is based on the idea that words occurred in the content is related to psychological traits or statuses. LIWC [12] is a widely used toolkit in psycholinguistics, which contains a dictionary that categorize words by psychological experiences. In our experiment, we use the simplified Chinese version of LIWC dictionary, translated from traditional Chinese version developed by Chin-Lan [13]. To assess users' emotional status, we also introduced a Chinese emotion word ontology dictionary, constructed by Linhong et al [14]. When applying dictionaries in feature extraction, we simply count the word frequency of each category occurred in user's microblog as the feature vector.

Table 1. Some features used in model 2

LIWC Features	Emotion word ontology Features	User profile and behavior Features
Swear	NA: 愤怒(Angry)	Count of Friends
Interjection	NB: 悲伤(Sad)	Count of Followers
Body	NJ: 失望(Disappointed)	Count of Bi-Followers
Money	NH: 疚(Regretful)	Count of Microblogs
Home	NI: 慌(Flurried)	Original Microblog Ratio
... (78 in all)	... (21 in all)	... (38 in all)

Apart from linguistic features, behavior features are also important because user's behavior patterns change along with his or her mental health status.

Then we are selecting from these 137 features, and applying linear machine learning algorithms using selected ones as independent variables, to predict the mental health status score. To select features, we applied stepwise regression algorithm to choose predictable variables. Then we use the selected features to fit the mental health score using linear regression and pace regression algorithm. In stepwise regression, the parameters of penter and premove are set to 0.05 and 0.10 respectively.

6 Experiment Results

To model 1, building the lexicon for each mental health dimension is time consuming. So in our experiment we only tried on the dimension of depression. The classification accuracy on training data is 72%.

In model 2, for 9 mental health dimensions, 4 to 12 variables are selected when using stepwise regression, and the results are listed in Table 2. In the table, RAE refers to relative absolute error, RRSE refers to root relative squared error, and Corr. refers to Pearson correlation coefficient

Table 2. Evaluation of regression results

Dimension	Linear Regression				Pace Regression		
	RAE%	RRSE%	Corr.	R^2	RAE%	RRSE%	Corr.
AN.	97.28	95.49	0.3012	0.13	95.70	94.03	0.3344
HO.	95.78	95.69	0.2883	0.11	94.39	94.41	0.3214
O.C.	97.77	96.40	0.271	0.11	95.45	94.57	0.319
I.S.	96.01	97.29	0.2504	0.11	95.81	98.85	0.2234
PS.	97.77	97.42	0.229	0.09	98.47	99.42	0.1793
SO.	96.91	97.99	0.2148	0.09	96.78	99.37	0.1823
DE.	99.00	97.99	0.2047	0.07	99.69	99.33	0.1613
P.I.	98.10	97.86	0.1926	0.05	98.00	97.75	0.1967
PA.	99.74	101.18	0.156	0.06	98.58	99.03	0.193

The current experiment results shows that our model performs not well enough. In psychological analysis, if two variable has a Pearson correlation from 0.3 to 0.4, it implies that these two variables are of low correlation. Here, in the dimensions of anxiety, hostility and obsessive-compulsive, the correlation between our prediction score and questionnaire based score have reach a weak correlation by using linear regression or pace regression. The evaluation is conducted by using 10-fold cross validation.

When applying Pearson correlation coefficient as the evaluation standard, we see that in 5 dimensions pace regression perform better than linear regression. This is because pace regression algorithm has introduced clustering analysis to evaluating the contribution of each variable. But this doesn't guarantee a better result.

7 Conclusion

Our study in this paper aims at predicting users' mental health status based on microblog. For this purpose, we built two models. Model 1 use little domain knowledge and can select predisposition words related to mental health disorders. The core idea of this model is a Naïve Bayes classifier, users classified as a positive class are identifeid as in poor mental health status. Model 2 introduced domain knowledge, as a typical machine learning problem, we extract features from users' microblog data, took both linguistic and behavior information into consideration, and then employ linear machine learning algorithm to the extracted features and predicting value. Model 1 is not good at contious value prediciton, while model 2 can turn into a two-class classifier simply by setting a thershold. Model 1 can also yield a lexicon with mental health status related weights, this can be generalized to other areas where terms are conncted to predicting variable.

Experiment results shows that these models can basically predict some mental health demisions such as anxiety. This paper presents our innovation in conventional psychology research, that is to take advantage of vast social media data and machine learning methods, to predict psychology trait or status, which can be a supplement of conventional psychometric tools - questionnaires.

As a preliminary exploration, major improvements are still to be made in our work. First, mental health status is time-varying, our models in this paper didn't take the time factor into condiseration and use all users' data since registration for prediction. This might be the reason why our expirment results are not good enough. Second, our feature extracion methods are heuristic and focus on users' static behaviors like profile, all microblogs posted by users. Time related behavior pattern features are not included in our model. Since mental health status affect behavior patterns a lot, such features should be introduced in feature works. Online microblog behaviors should also be defined more elaborately, which can be a guideline of extracting behavioral features.

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References

1. Meltzer, H., Rebecca, G., Robert, G., Tamsin, F.: Mental health of children and adolescents in Great Britain. *International Review of Psychiatry* 15(1-2), 185–187 (2003)
2. Xinhua News: Sina Weibo's registered user reached 300 millions (2012), http://news.xinhuanet.com/tech/2012-02/29/c_122769084.htm
3. François, M., Marilyn, W., Matthias, M., Roger, M.: Using Linguistic Cues for the Automatic Recognition of Personality in Conversation and Text. *Journal of Artificial Intelligence Research* 30, 457–500 (2007)
4. Jennifer, G., Cristina, R., Karen, T.: Predicting Personality with Social Media. In: *Proceedings of the 2011 Annual Conference Extended Abstracts on Human Factors in Computing Systems*, ACM (2011)
5. Yoram, B., Michal, K., Thore, G., Pushmeet, K., David, S.: Personality and Patterns of Facebook Usage. *WebSci 2012* (2012)
6. Daniele, Q., Michal, K., David, S., Jon, C.: Predicting Personality with Twitter. In: *2011 IEEE International Conference on Privacy, Security, Risk and Trust and IEEE International Conference on Social Computing* (2011)
7. Fan, Z., Tingshao, Z., Ang, L., Yilin, L., Xingguo, X.: A survey of web behavior and mental health. In: *6th International Conference on Pervasive Computing and Applications (ICPCA 2011)*, pp. 189–195. IEEE (2011)
8. Dong, N., Yue, N., Tingshao, Z.: Predicting Mental Health Status in the Context of Web Browsing. *Web Intelligence 2012* (2012)
9. Michael, C., Xuan, W., Yinqi, H., Rui, X., Tian, J.: Microblogging, Online Expression, and Political Efficacy Among Young Chinese Citizens: The Moderating Role of Information and Entertainment Needs in the Use of Weibo. *Cyberpsychology, Behavior, and Social Networking* 15(7), 345–349 (2012)
10. Derogatis, L.R., Savitz, K.L.: The SCL-90-R and the Brief Symptom Inventory (BSI) in Primary Care. In: Lawrence Erlbaum Associates (2000)
11. Huaping, Z.: ICTCLAS, Chinese Lexical Analysis System (2013), <http://ictclas.nlp.ir.org>
12. Pennebaker, J.W., Cindy, K.C., Molly, I., Amy, G., Roger, J.B.: The Development and Psychometric Properties of LIWC 2007 (2007)
13. Chin-Lan, H., Cindy, K.C., Natalie, H., Yi-Cheng, L., Yi-Tai, S., Ben, C.P.L., Wei-Chuan, C., Michael, H.B., Pennebaker, J.W.: The Development of the Chinese Linguistic Inquiry and Word Count Dictionary. *Chinese Journal of Psychology* 54(2), 185–201 (2012)
14. Linhong, X., Hongfei, L., Yu, P., Hui, R., Jianmei, C.: Constructing the Affective Lexicon Ontology. *Journal of the China Society for Scientific and Technical Information* 27(2) (2008)

Designing a Metal Hydride Actuator with Human-Compatible Softness and High Power-to-Weight Ratio for Future Quality-of-Life Technologies

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Abstract. Japan faces a rapidly growing elderly population that is unprecedented in the world. As a result, there are emerging needs for quality-of-life technologies, such as rehabilitation equipment, long-term care, and assistive devices. In particular, elderly people who are bedridden due to physical illnesses, such as cerebral stroke or bone fractures caused by a fall, may suffer awkward disuse syndromes (e.g., pressure ulcers, joint contracture, cardiac hypofunction, and mental depression). It is difficult for them to actively participate in rehabilitation exercises by themselves. Thus, to manage these disuse syndromes, we have developed a light and soft actuator device with metal hydride materials. This actuator device has a high power-to-weight ratio, adequate softness for human body support, noiseless motion, and a clean hydrogen energy system. The three apparatuses in which the metal hydride actuator is applied are a joint rehabilitation device for the hand, a seat lifter for a wheelchair or toilet, and a toe exercise apparatus for bedsore prevention.

Keywords: Super-aging society, long-term care, rehabilitation, soft actuator, metal hydride material, power assistance, quality-of-life technology.

1 Introduction

It is well known that older segments of the population within developed countries are expanding faster than younger segments. Longer life expectancies coupled with a

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general decline in the birthrate are leading to a dramatic shift in the proportion of people aged 65 years or over in the total population. By 2030, one in every three persons in Japan will be 65 years or over, and one in five persons will be 75 years or over. Reflecting improvements in health and the living environment after World War II, Japanese life expectancy at birth has become the highest in the world: 80 for males and 86 for females as of 2009 [1].

Demographic researchers, gerontologists, and economists in Japan have been attempting for several decades to alert the people of Japan to the fact that, collectively speaking, they are rapidly growing older. Population aging affects national and local economies in terms of healthcare services, pensions, and the long-term care system. The shortage of caregivers and nurses has led to the need to develop assistive devices and rehabilitation apparatuses to sustain several activities of daily life (ADL).

In particular, older patients who are required to lie down for long periods due to illness or injury may suffer disuse syndromes, including pressure ulcers, joint contracture, muscular atrophy, cardiac hypofunction, and mental depression. It is often difficult for these vulnerable older patients to actively exercise for physical rehabilitation and improved ADL. To help manage these disuse syndromes, rehabilitation equipment and assistive devices, such as compact apparatuses for continuous exercise of joints, power assistance devices to enable standing or lifting, and bedsore-prevention systems, are strongly needed at the bedside. These equipment and technologies demand soft and compact actuators to replicate the effort of human muscles.

Currently, there are no commercially available actuators that contain human-compatible softness for safety, noiselessness for comfort, and a high power-to-weight ratio similar to human muscles. These technical requirements present a large challenge to the development of rehabilitation engineering and assistive technologies. To solve these challenges, many types of artificial muscle-like actuators, such as pneumatic rubber actuators [2], shape memory alloy (SMA) actuators [3], and polymer actuators [4], have been actively studied by material scientists and biomedical engineers. Unfortunately, satisfactory results in terms of actuators that can actually contribute to rehabilitation, self-independent living, or long-term care have not yet been achieved.

We have been the first to develop a novel, soft and compact actuator using metal hydride materials [5]. A metal hydride (MH) actuator can produce a soft and powerful force even though it is small and light because the metal hydride materials can store hydrogen gas volumes in amounts that are over 1,000 times larger than its own volume by controlling its temperature. Moreover, the MH actuator has adequate softness and a noiseless motion for applications in rehabilitation and assistive devices. An additional potential merit is that hydrogen is a clean-energy carrier candidate, which contributes to a sustainable energy society [10].

The purpose of this paper is threefold: first, to overview the properties of metal hydride materials as soft and compact actuators applied in rehabilitation and long-term care apparatuses; second, to describe the fundamental structure of the MH actuator and its performance using experiments; and third, to show several applications of the MH actuators in rehabilitation and assistive technologies, including a continuous passive motion (CPM) device for joint therapy, a seat-lift apparatus for people with restricted mobility, and a compact foot-exercise apparatus for the prevention of bedsores.

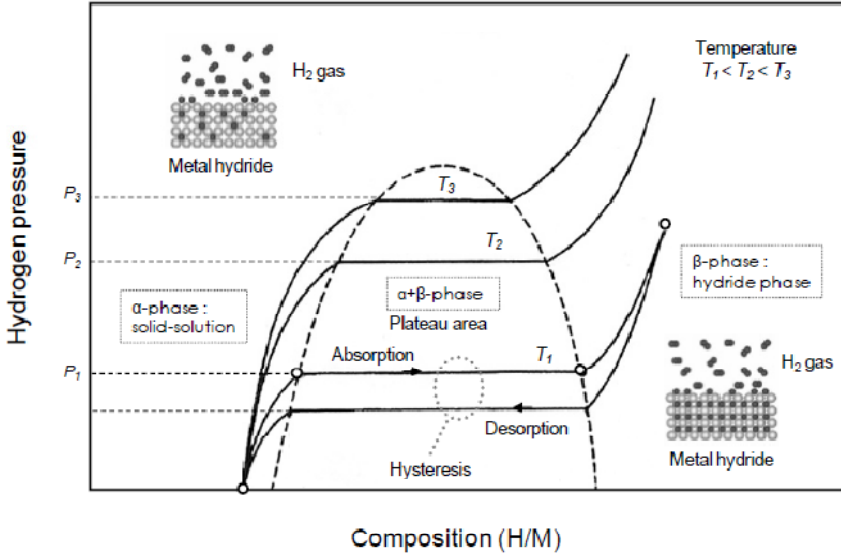


Fig. 1. Pressure-composition-temperature (PCT) diagram of a metal hydride material under hydrogenation.

2 Metal Hydride Actuator

2.1 Metal Hydride Materials

Metal hydride materials (i.e., hydrogen-storing alloys) have the ability to store a volume of hydrogen gas that is 1,000 times or more greater than the volume of the alloy itself. The compressibility of hydrogen in the MH material is higher than that of a high-pressure gas cylinder or liquid hydrogen storage.

The general hydrogen-absorbing and -desorbing properties of the MH material are described by the following reaction formula:



where M is the metal, H_2 is hydrogen gas, MH_x is the metal hydride, and Q is the heat of reaction. Thus, $Q > 0$ J/mol for H_2 .

Moreover, the hydrogen equilibrium pressure (P) is related to the changes in enthalpy (ΔH) and entropy (ΔS) as a function of temperature (T) by the Van't Hoff equation:

$$\log_e P = \frac{\Delta H}{R} \cdot \frac{1}{T} - \frac{\Delta S}{R} \quad (2)$$

where R is the gas constant. The logarithmic equilibrium pressure is proportional to an inverse function of the temperature. As shown in Fig. 1 (i.e., the PCT diagram), if

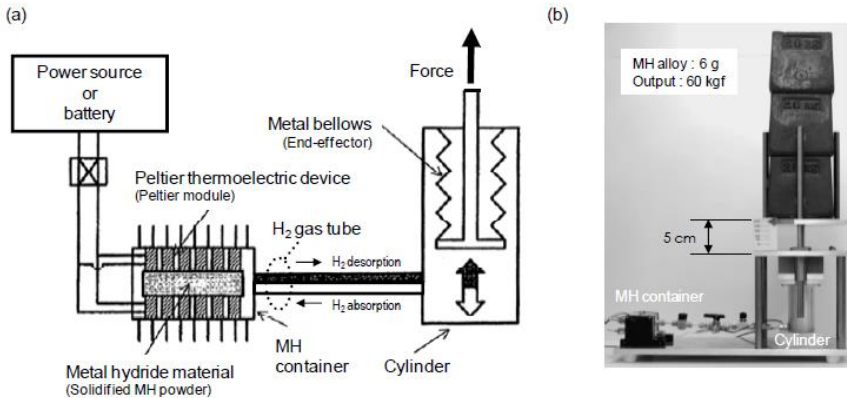


Fig. 2. (a) Basic schematic structure of an MH actuator system. (b) The prototype MH actuator with a metal bellows cylinder and a Peltier module in the MH container.

this reaction proceeds at a constant temperature, then it advances up to an equilibrium pressure, which is called the plateau pressure. As demonstrated in the PCT diagram, the plateau pressure can be regulated by changing the MH material temperature.

Fortunately, the MH material is not flammable, so it is safe as a solid hydrogen storage for a fuel battery in electric vehicles and mobile applications [6].

2.2 Power-to-Weight Ratio

MH materials can not only store a large amount of hydrogen gas efficiently but can also release the gas through temperature control. If this reversible chemical reaction is carried out in a hermetically closed container system, the heat energy applied to the MH material is converted into mechanical energy via an equilibrium pressure change inside the MH container. The MH actuator performs by using the hydrogen pressure generated by the MH material due to added heat energy, which can be controlled by, for example, an electrically heated wire, a Peltier module, or a solar thermal collector.

An MH actuator is composed of a solidified MH powder, a Peltier module, a temperature sensor, an enclosure for these elements, and an end effector to change the hydrogen gas pressure into a driving force, as shown in Fig. 2(a).

For example, the MH actuator system shown in Fig. 2(b) includes 6 g of metal hydride and a 36-mm-diameter metal bellows. This MH actuator can lift a 60-kg weight without any noise; this represents a high power-to-weight ratio of approximately 10,000. The power-to-weight ratio of the MH actuator is much higher than that of familiar industrial actuators, such as electric motors and pneumatic actuators. Because its mechanism involves direct heat-to-mechanical energy conversion, the MH actuator does not make any noise or vibration. In addition, the reversible hydrogen absorption and desorption in the metal hydride also produces a soft cushion effect, which

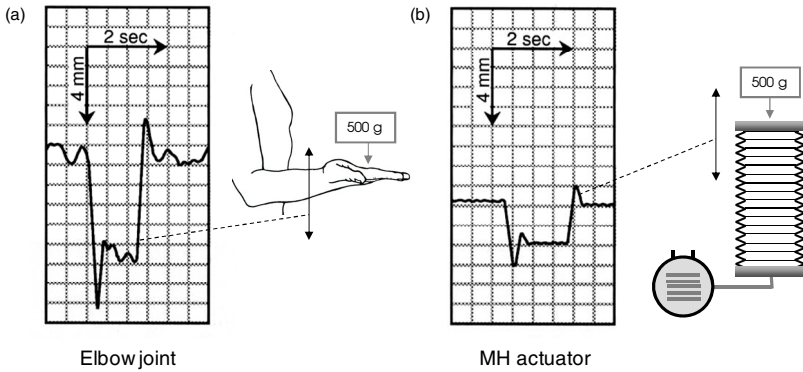


Fig. 3. Dynamic response of (a) the elbow joint and (b) the metal bellows of the MH actuator under step loading of 500 g.

improves the safety for the human and prevents mechanical overload of the device. Therefore, MH actuators are novel human-sized actuators that can be applied to rehabilitation systems and assistive devices requiring softness and quietness.

2.3 Softness Analogous to That of the Human Elbow

The human musculoskeletal system can make both gentle and powerful forces during various nursing and therapeutic exercises, which are needed for people with physical disabilities or vulnerable older people. However, it is difficult for state-of-the-art robots and machinery that use conventional actuators and mechanical parts to perform like humans.

To measure the elasticity (i.e., softness) of the MH actuator, the dynamic elasticity of both an MH actuator with a single metal bellows and the elbow joint of a healthy young subject were compared through the step response of dropping a 500-g weight. The displacement patterns of the step response were similar to one another as shown in Fig. 3.

The elasticity of the MH actuator with a metal bellows was also measured by a universal tester. The relationship between the stiffness and the inner pressure of the metal bellows for the initial inner parameters of the MH actuator is shown in Fig. 4. The stiffness increased with increasing pressure inside the metal bellows. Moreover, the range of stiffness of the MH actuator system when placed as a pair of antagonistic metal bellows, which replicates a musculoskeletal system, is compatible with that of the human elbow joint during voluntary movement [7]. Thus, this elastic feature of the MH actuator allows a technical solution for physical therapy and long-term care applications.

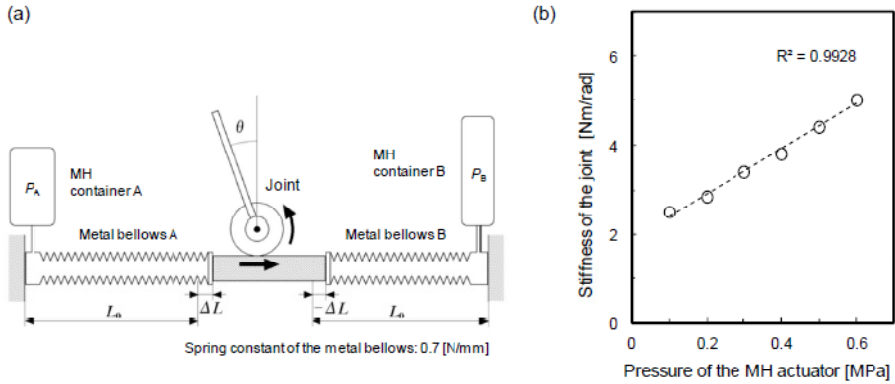


Fig. 4. (a) Schematic of the experimental setup used for the joint stiffness measurement of a double-acting MH actuator system. (b) Joint stiffness profiles of the MH actuator system at each given pressures: $P_A=P_B$.

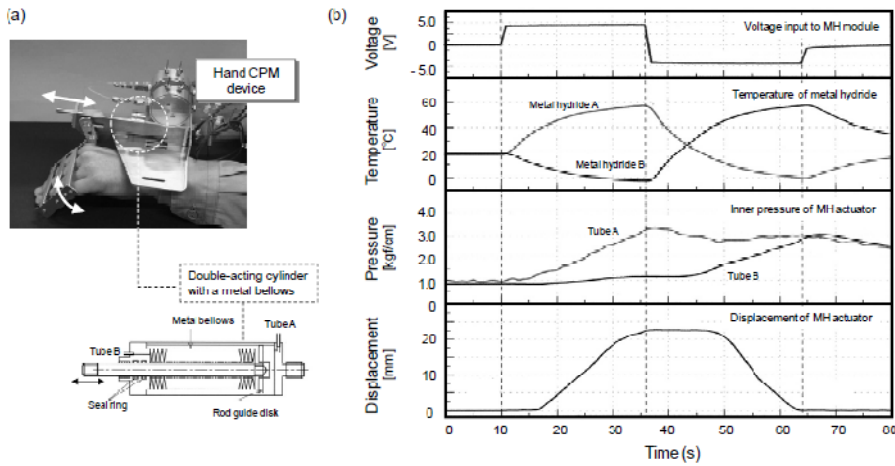


Fig. 5. (a) Photograph of a prototype hand CPM device that targets the finger joints. (b) Dynamic behavior of the compact double-acting MH actuator installed in the hand CPM device.

3 Joint Rehabilitation Device

Rehabilitation methods for joint therapy include manual therapy by a human (e.g., a physician, physical therapist, or occupational therapist) and range of motion (ROM) exercises using a CPM device. The therapeutic effects of CPM, which include the prevention of joint contracture, muscular atrophy, and ROM loss after joint injury,

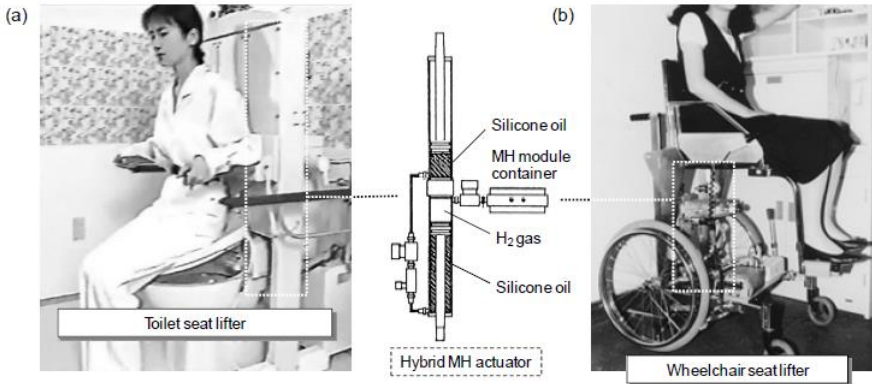


Fig. 6. Photograph of a seat lifter using the hybrid MH actuator having a hydrogen-hydraulic converter for (a) a toilet assembly and (b) a wheelchair.

have been shown in previous clinical studies [8]. Current CPM devices, however, have problems relating to stiffness, noise, and size. Thus, we designed a compact CPM device using MH actuators.

The CPM device for hand rehabilitation is shown in Fig. 5(a). This CPM device was installed with a compact MH actuator that includes a small push-pull metal bellows covered with a metal sleeve and a pair of MH containers with 3 g of MH powder and a Peltier module. The output force and stroke of the MH actuator were 100 N and 20 mm, respectively. The weight of the MH actuator was 250 g. The hand CPM device using the MH actuator was much lighter than conventional CPM devices, which are built out of an electric motor and many mechanical parts.

To evaluate the behavior of this hand CPM device, the MH actuator was driven by a voltage input in the range from -4 V to 4 V, and the responses were measured. Fig. 5(b) shows an example displacement pattern of the rod of the MH actuator. It was observed that the push-pull motion of the compact MH actuator was noiseless and smooth within the allowable bounds for a delicate ROM exercise for finger joint therapy.

4 Seat Lifting Apparatus

Assistive devices to support standing or lifting up of the human body must secure a smooth and long stroke motion for users (i.e., people with lower limb disability, vulnerable elderly people, and caregivers). For this purpose, a hybrid MH actuator that uses a long tandem piston cylinder with a hydraulic converter was developed. By applying this hybrid driving mechanism with a hydrogen-hydraulic converter, the stroke displacement is doubled compared with a common MH actuator driven by only hydrogen gas from metal hydrides.

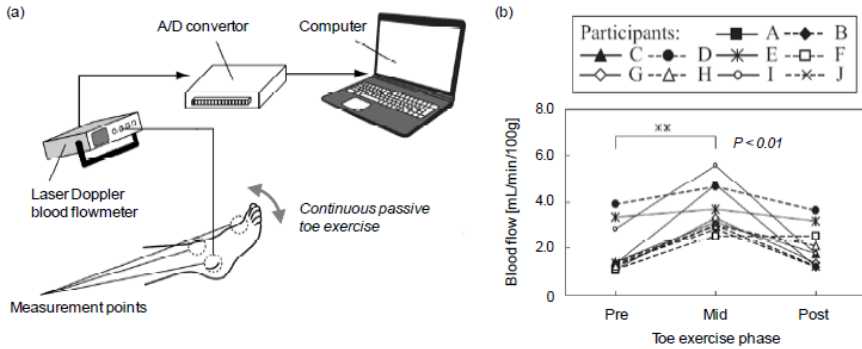


Fig. 7. (a) Experimental setup for the continuous passive exercise of toe joints and measurement site locations for subcutaneous blood flow in the foot. (b) Subcutaneous blood flow rate of pre-, mid-, and post-exercise at the base of the first toe.

The toilet seat lifter system featuring the hybrid MH actuator is shown in Fig. 6(a). The toilet-seat lifting function has a similar hybrid MH actuator system to that described above. This toilet-seat lifting system had 150 g of MH powder and could lift a 100-kg weight to a 35-cm height. The lifting speed was 10 mm/s. To heat and cool the compacted MH powder, we adopted an electric heating wire and a water jacket with cold in-house tap water, respectively, as a simple heat exchange system that also saves energy.

For wheelchair applications, a hybrid MH actuator with 40 g of MH powder can lift an 80-kg weight to a 40-cm height as shown in Fig. 6(b). The lift speed was 20 mm/s, and the total weight of the lifting unit including the MH actuator with the tandem piston cylinder was 5 kg.

5 Bedsore Prevention Apparatus

Pressure ulcers (i.e., bedsores) can arise when a prolonged mechanical load is applied to soft biological tissues. These sores interfere with quality of life, daily living activities, and rehabilitation and, in some cases, may prove life-threatening. To prevent pressure ulcers in the elderly and people with motor disabilities, it is important to maintain subcutaneous blood flow, to relieve the pressure on soft tissues, and to obtain proper nutrition [9].

Initially, we performed measurements of the subcutaneous blood flow at common sites where pressure ulcers arise during passive toe exercises. Subcutaneous blood flow was measured at the base of the first toe and at the lateral malleolus using a laser blood-flow meter. The blood flow rate data were acquired for 1 minute before exercise (pre-exercise), 2 minutes during exercise (mid-exercise), and 1 minute after exercise (post-exercise) in each trial. Ten healthy subjects aged from 20 to 80 years participated in this experiment after giving informed consent.

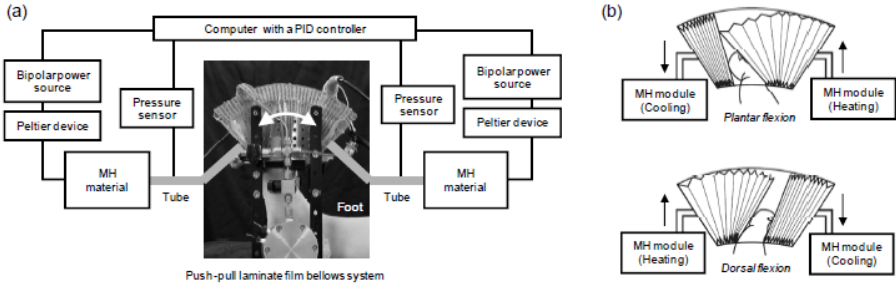


Fig. 8. (a) Block diagram of the prototype bed sore prevention apparatus. (b) Schematic of a motion pattern for controlling a pair of soft MH actuators with laminate film bellows.

From the experimental results, the blood flow rate at the base of the first toe during the exercise was significantly higher ($P < 0.01$, Wilcoxon test) than before the exercise as shown in Fig. 7. The blood flow rate at the lateral malleolus exhibited the same trend ($P < 0.02$, Wilcoxon test). The results suggest that the continuous passive exercise of toe joints can prevent bedsores and soft tissue contracture induced by ischemia.

We then developed a prototype of the bed sore prevention apparatus based on mild toe exercises using a fan-shaped soft MH actuator that has laminate film bellows [5] and can easily fit various foot forms as shown in Fig. 8. The extension and flexion motion of the toe joints was derived from a pair of laminate film bellows that spread out in sectors of the bed sore prevention apparatus. The motion of the subject's toes by using this apparatus was enough to increase subcutaneous blood circulation. During the operation of the apparatus, many subjects' toes (i.e., variable sized and shaped toes) could always fit into the space between the antagonistic laminate film bellows of a pair of the MH actuators.

The motion patterns for the joint exercises were produced by the regulation of the pressure combination of both MH actuators. Linear control over the flexion and the extension angle of the toes was obtained by altering the difference between the inner pressures of each laminate film bellows through the pair of MH actuators. The stiffness of the movable part inserted between both laminate film bellows was determined by evaluating the sum of the inner pressures of both bellows. Thus, both the angle and the stiffness of toe motion could be controlled independently.

6 Conclusion

In this paper, we described a soft and noiseless actuator using MH materials and its applications in assistive technology and rehabilitation engineering. The MH actuator has several unique features, including a high force-to-weight ratio, low mechanical impedance, noiseless motion, and a muscle-like actuation mechanism based on expansion and contraction that differs from conventional industrial actuators. Based on these distinctive features, we believe that MH actuators are suitable force devices for applications in human motion assistance, long-term care, and rehabilitation exercise.

Initial applications of the MH actuator were developed including a CPM device, a seat lifter for a wheelchair or toilet, and a bedsores prevention apparatus. Further works with an interdisciplinary approach among rehabilitation engineering, material science, medicine, and robotics should help these novel MH actuators become applicable to devices in which human-friendly motion is desirable for future quality-of-life technologies.

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References

1. World Health Organization: World Health Statistics 2012, pp. 51–61 (2012)
2. Kure, K., Kanda, T., Suzumori, K., Wakimoto, S.: Flexible Displacement Sensor Using Injected Conductive Paste. *Sensors and Actuators A-143*(2), 272–278 (2008)
3. Otsuka, K., Ren, X.: Recent Developments in the Research of Shape Memory Alloys. *Intermetallics* 7(5), 511–528 (1999)
4. Mirfakhrai, T., Madden, J.D.W., Baughman, R.H.: Polymer Artificial Muscles. *Materials Today* 10(4), 30–38 (2007)
5. Ino, S., Sato, M., Hosono, M., Izumi, T.: Development of a Soft Metal Hydride Actuator Using a Laminate Bellows for Rehabilitation Systems. *Sensors and Actuators B-136*(1), 86–91 (2009)
6. Schlapbach, L., Züttel, A.: Hydrogen Storage Materials for Mobile Applications. *Nature* 414, 353–358 (2001)
7. Bennett, D.J., Hollerbach, J.M., Xu, Y., Hunter, I.W.: Time-Varying Stiffness of Human Elbow Joint during Cyclic Voluntary Movement. *Experimental Brain Research* 88(2), 433–442 (1992)
8. Michlovitz, S.L., Harris, B.A., Watkins, M.P.: Therapy Interventions for Improving Joint Range of Motion: a Systematic Review. *Journal of Hand Therapy* 17(2), 118–131 (2004)
9. Hosono, M., Ino, S., Sato, M., Yamashita, K., Izumi, T.: A System Utilizing Metal Hydride Actuators to Achieve Passive Motion of Toe Joints for Prevention of Pressure Ulcers: A Pilot Study. *Rehabilitation Research and Practice* 2012(541383), 1–7 (2012)
10. Sato, M., Hosono, M., Yamashita, K., Nakajima, S., Ino, S.: Solar or Surplus Heat-Driven Actuators Using Metal Hydride Alloys. *Sensors and Actuators, B-156*(1), 108–113 (2011)

Design and Assessing the Usability of an Interactive Digital Game in Assisting the Older Adult's Prescriptive Medication Behavior

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Abstract. Taking prescriptive medicine has been a major daily routine for many older adults. However, misused medication behavior has been reported as a major safety issue for senior welfare subject to the well-documented decline in cognitive aging. Game-based learning has been demonstrated as an effective media in enhancing cognitive functions but mostly in the fields with young adults as the subject. The present study thus aimed to investigate the usability of digital games in improving the medication behavior for older adults. The results indicated that the older subject who received the game-based learning significantly outperformed the counterpart who received the traditional treatment. Implications for designing appropriate learning media for the older adult's medication behavior were raised.

Keywords: digital games, digital learning, human-computer interaction, cognitive aging, prescriptive medication.

1 Introduction

One of the most common problems facing older adults is the need to take prescriptive medicine due to chronicle diseases. The literature in aging has shown that age is normally associated with declined mental abilities such as working memory [1]. One frequently cited problem of the reduced cognitive abilities is the difficulty for older adults in accurately adhering to the often complex medical prescriptions. As medication behavior bears critical consequences to life safety, providing an assisting mechanism that can assure successful medication particularly for the cognitively disadvantaged older adults thus becomes an important issue [2-3]. Game-based digital learning, powered by computerized interaction technology, has become a major vehicle for the human to facilitate better mental processing of learning material [4-5]. Possibility thus exists where the older adult's challenge in accurately adhering to prescriptive medication can be resolved by learning the prescriptions through interactive procedures led by digital games [6]. The purpose of the present study is to investigate

the effect of game-based digital learning in assisting older adults in medication behavior as a function of prescription complexity. It is hypothesized that as compared to the traditional prescriptive presentation, the game-based e-learning would more highly motivate the older adult to obtain a deeper comprehension of the medication knowledge, and in turn result in more successful obedience of the prescribed medication behavior.

2 Methodology

2.1 Experimental Design

A 2x3 split-plot factorial experiment was conducted to verify the hypothesis. The learning media was defined as a within-subject factor which consisted of two levels of treatment, namely, game-based e-learning and traditional presentation. The prescription complexity was defined as a between-subject factor in which three levels of prescription matrix were manipulated. The prescription matrix consisted of 18 cells determined by six medication time zones (e.g., after breakfast) and three diseases (e.g., high blood pressure). According to the memory capacity of 5~9 chunks, the three levels of complexity was operationally defined as simple (5 cells of prescriptive information), medium (7 cells), and difficult (9 cells). The subject's medication behavior was measured by test scores concerning how well they were able to accurately assign pills to the associated time zone-disease combination, e.g., taking a green round tablet after lunch for high blood pressure. The subject was also evaluated by their subjective preference over the two learning media by a rating scale of 1 to 10 with 10 representing the most favorable.

2.2 Subjects

15 subjects aged over 65 participated in the experiment with each prescription complexity group receiving 5 subjects. All the participants were at least high school graduates with sufficient computer experiences. Each of the subjects was eye sight corrected, if needed, during the experiment.

2.3 The Learning Material

The game-based e-learning system was developed by Flash CS 5.5 and was presented to the user through a 21.5-inche touch screen (Dell ST2220T). The gaming system adopted a metaphor of railway traveling where the prescribed medicine (pills and tablets) acted as passengers boarding on a train departing at designated schedules (prescribed time zone) for particular destinations (disease-related organs).

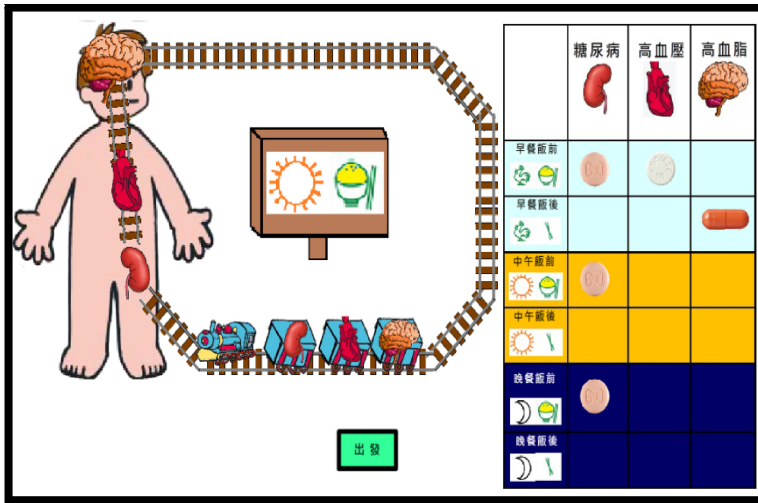


Fig. 1. A snapshot of the game-based digital learning where the prescription was exhibited on the right panel, from which the subject was instructed to drag pills/tablets to the corresponding train cars

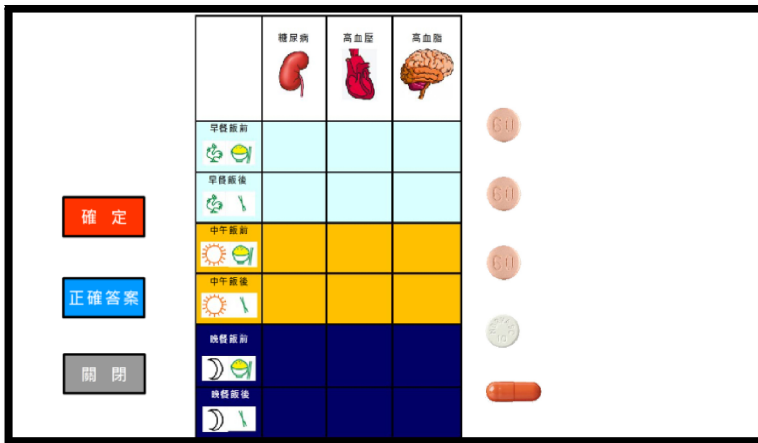


Fig. 2. A snapshot of the online test session where after the learning session, the subject was instructed to drag pills/tablets to the correct corresponding prescription cells

2.4 Procedures

The 15 subjects were evenly assigned to the three complexity groups at random. Following a warm-up exercise, the subject of each complexity group was instructed to interact with the game-based e-learning material and the traditional material whose prescription contents differed from each other but both with the same prescriptive

information load. Each subject was allowed a five-minute break between switching of the two learning media. The order of presentation of the two learning media to each subject was randomized. A 10-minute rest period was offered after completion of the experimental session.

Following the rest period, a test session was administered in which the subject was first asked to rate their preference concerning the two learning media with respect to a variety of user experiences. Immediately after the subjective rating session, the subject was then asked to assign given prescriptions to their associated prescribed time zone and the diseases/organs the prescriptions intended to deal with. The test scores and the time spent on solving the questions were recorded for each subject.

3 Results and Analysis

The descriptive results of the experiment were shown in Table 1. Analyses of data normality (Anderson-Darling test) and variance equality (Levene's test) were performed and the results showed that both prerequisites were satisfied for subsequent ANOVA analysis.

Table 1. Means and (standard deviations) of the hit rates under the manipulation of learning media as a function of medication complexity

Game-based media			Traditional media		
Simple	Medium	Complex	Simple	Medium	Complex
0.902	0.850	0.698	0.778	0.584	0.556
(0.104)	(0.072)	(0.062)	(0.105)	(0.085)	(0.091)

3.1 Performance

ANOVA results indicated that while there was no significant interaction between learning media and prescription complexity ($F[2,12]=3.00$, $p > 0.05$), the respective main effects were both significant. The subject who received the game-based e-learning scored significantly higher than the traditional counterpart when associating the prescriptive medicine with correct prescribed time zone and intended diseases ($F[1,12]=47.20$, $p < 0.000$). Meanwhile, the complexity effect indicated that the test scores decreased as the prescriptive information load increased regardless of which

learning media was employed ($F[2,12]=10.45$, $p < 0.002$). Further post-hoc pair comparisons ($\alpha=0.05$) revealed that the source of significance was derived from the difference between the simple and the difficult levels, with the differences between the simple and the medium, and the difficult and the medium being due to chance results.

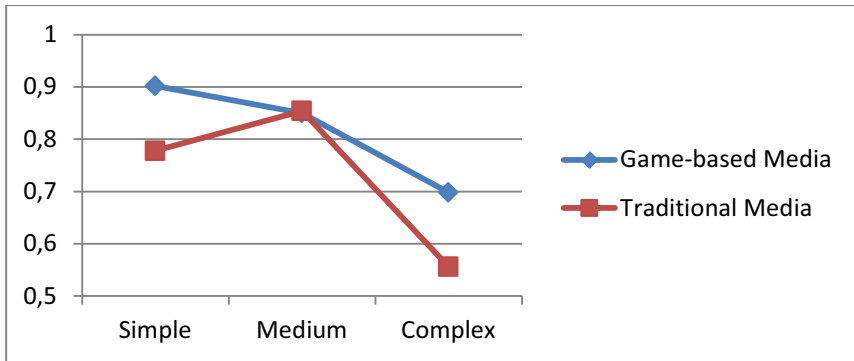


Fig. 3. Interaction plot of the test scores (hit rates) under the two media as a function of medication complexity

3.2 User Experiences

A paired t test ($\alpha=0.05$) was performed to differentiate the subjective preference over the two learning media with respect to the dimensions of pleasure, entertainment, ease of learning, attractiveness, confidence. The results indicated that all the subjects preferred the game-based e-learning to the traditional media, except on the dimension of confidence. It is possible that no learning feedback was provided in the present experiment so that the subject had no reference as to his/her learning performance despite the positive attitude towards the game-based learning materials.

4 Conclusions

It has been well documented that older adults are vulnerable to cognitive activities. As taking prescriptive medication requires mental resources such as memory, it is important that older adults are appropriately supported in this respect to avoid potentially dangerous consequences. The present study found that the older adult exhibited positive preference towards digital games, and significantly improved the medication accuracy after receiving properly designed game-based training.

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References

1. Park, D.C.: The Basic Mechanisms Accounting for Age-related Decline in Cognitive Function. In: Park, D.C., Schwarz, N. (eds.) *Cognitive Aging: A Primer*, pp. 3–21. Psychology Press, Philadelphia (2000)
2. Chen, C.H., Wu, J.R., Yen, M., Chen, Z.C.: A Model of Medication Taking Behavior in Elderly Individuals with Chronic Disease. *Journal of Cardiovascular Nursing* 22(5), 359–365 (2007)
3. Wu, J.R., Moser, D.K., Lennie, T.A., Peden, A.R., Chen, Y.C., Heo, S.: Factors Influencing Medication Adherence in Patients with Heart Failure. *Heart & Lung* 37(1), 8–16 (2008)
4. DeLeeuw, K.E., Mayer, R.E.: Cognitive Consequences of Making Computer-based Learning Activities More Game-like. *Computers in Human Behavior* 27(5), 2011–2016 (2011)
5. Prensky, M.: *Digital game-based learning*. McGraw-Hill, New York (2001)
6. Schutter, B.D.: Never Too Old to Play: The Appeal of Digital Games to an Older Audience. *Games and Culture* 6(2), 155–170 (2012)

Cultural Diversity - New Challenge to Medical Device Use Safety for International Markets

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Abstract. Medical device nowadays may be used by user groups with quite different cultural backgrounds. Cultural diversity may influence normal medical device use or even induce risks and hazards. Manufacturers are facing up to a new challenge to consider cultural diversities in design. This paper aims to formulate a systematic framework to handle medical device design for international markets. The standardized requirement specified in risk management standard of ISO 14971 is adopted as a basis. The cultural diversities that may induce risks and hazards are summarized. Medical device design issues that should be adapted are discussed. Many examples on these issues are presented.

Keywords: Cultural diversity, Medical device design, Use safety.

1 Introduction

Ongoing economic globalization has fostered increasing exchange of technical products worldwide. Statistics show that many medical products are aiming at global markets instead of national markets. Reports on medical device market in 2009 showed that the world's total exports in this area valued at a high level of 170.487 billion dollars, which was almost half of the total production. The biggest exporting countries are USA, Swiss, China and Japan. The important target importing countries are USA, Mexico, Ireland, Germany, China and Japan etc. These countries imported about 60% of the total medical device traded worldwide.

As the medical device market becomes more global and the user groups become more varied, design of medical device has evolved some new characteristics. Manufacturers nowadays should face up to additional design considerations posed in designing products for multiple cultures, user groups or markets. Cultural diversity – not only the thinking patterns, values, habits, beliefs of the target users, but also the level of economic development, political system, physical environment, etc. has

become a new influencing factor to medical device design. It is clear that under global circumstance, a well usable medical device in one culture might meet with serious problems in another culture. Cultural differences will influence effectiveness of medical device use, or even induce risks and hazards.

2 Cultural Diversity as New Factor to Hazards and Risks

According to the definition in the ISO 14971, hazard is the potential source of harm, and risk is the combination of the probability of occurrence of harm and the severity of that harm. Fig 1 shows the occurrence of the harm. If a person is exposed to a hazard, the harm may occur. In the medical device use, there are different kinds of hazards, such as the biological hazards, radiation hazards, and chemical hazards, etc. In order to avoid the occurrence of harm, the causes of (or contributing factors to) the hazards should be effectively identified, analyzed, and controlled.

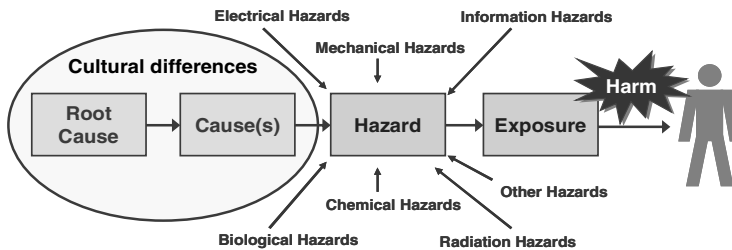


Fig. 1. Cultural differences as new contributing factors to hazards and risks

For medical device intended to be used in international markets, the cultural diversity has become an additional root cause for the hazards (see Fig. 1). As user groups or use context are changed, the existent operation attributes that certainly impact efficiency and safe use of medical devices have changed. Consequently, measures should be taken to analyze new influencing factors and adapt medical device design to the changed use conditions. However, at present, although there are many researches or even applicable results in the area of culture-/nation-specific design, most of them focus on the computer industry. There is not enough concern in the medical device design area. Many particularities in this area are still unknown both for the researchers and the manufacturers. Furthermore, previous experience gained from other application areas may not be suitable for design of medical device due to some particularities of medical device use

It is therefore necessary to consider the medical device design for international markets in a different way. New framework should be developed to define cultural influences and to incorporate these influences in design solutions.

This paper adopts a meta-culture model developed by Stewart and Bennett (1991) as a basis to formulate categories of cultural diversities to be considered in medical device design. The meta-cultural model classifies culture into two layers: *objective culture* and *subjective culture*. Objective culture comprises the institutions and

artifacts of a culture, such as its economic system, political structures and processes, social customs, arts, crafts and literature. Subjective culture comprises the psychological features of a culture, including assumptions, values, and patterns of thinking. In consideration of the requirements in EN 62366, which indicates that the user profiles, task profiles, context of use (organization, environment, technical, social, hygienic, etc.) should be addressed in medical device design, the cultural diversities that should be considered could be classified into three categories:

- National issues: language, unit system and format, regulatory issues;
- Culture-specific use context: use environment, professional traditions and work organization, technological environment, social context;
- Culture-specific operator profile: demographics, anthropometric characteristics, interpretation of colors and symbols, preference and expectation, attention, knowledge and experience.

These cultural diversities may probably induce hazards and risks for medical device use in international markets. They are similar to the other lists of cultural diversities of some researchers (such as Del Galdo EM) but are different to those in detail. The way of this classification also well reflects the understanding of the practitioners in medical arena. In the following sections, some examples on the detailed information of these diversities will be presented.

3 Framework of Factors for Safe Medical Device Design

As the risk management standard ISO 14971 is one of the most important standards for medical device design, it is rational to adopt its requirements as a basis to formulate the framework of factors concerned in medical device design for international markets. Fig 2 shows the risk management process specified in the ISO 14971. There are 4 steps for the risk management: risk analysis, risk evaluate, risk control, and post-production information.

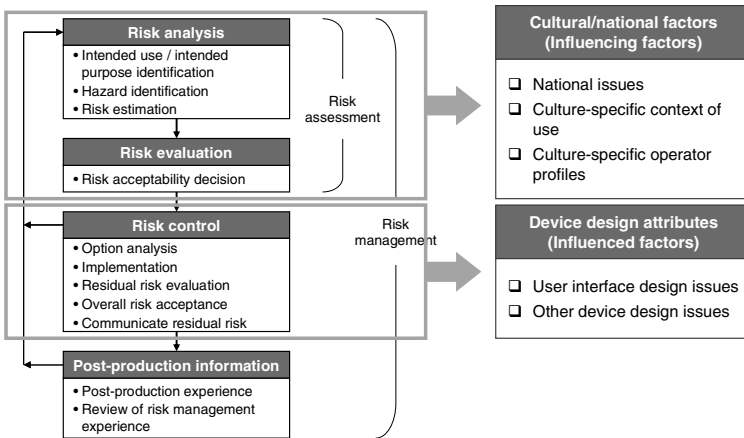


Fig. 2. Risk management and factors for cross-cultural design of medical device

If any cultural influencing factors may induce unacceptable risks for medical device use, in the risk control phase, corresponding design adaptations should be formulated as control measures. These issues can be referred to as the device design attributes (see Fig 2). The following two groups of factors should be addressed in the medical device design for international markets:

- Influencing factors: cultural factors.
- Influenced factors: device design attributes.

The relationship of these two groups of factors is shown in Fig 3. More detailed description of these factors is presented in the next sections.

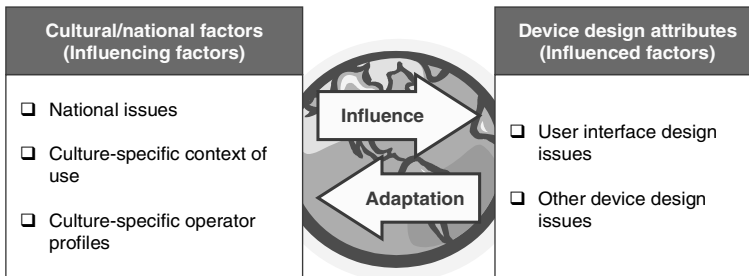


Fig. 3. Relationship between the two groups of factors

3.1 Influencing Factors

National Languages

Language is a key challenge for designers of products for international markets. Although many non-English speaking operator groups read and understand English well, a critical situation may result in high stress on the device operator. When required to use a non-native language, use errors could occur that are directly attributable to the requirement that the operator interacts with the device in a foreign language. So, the subset of preferred languages that manufacturers support should be chosen carefully otherwise it will become a potential source of harm.

Language issues which should be considered for the design of medical devices include: script, length of words, grammar, spelling differences, alphabetical order, reading/writing direction, different meaning of same words, homonyms, idioms, etc.

Unit System and Format

Units used in different countries are various. The use of the imperial units system in the UK and USA and the SI system used in many other countries is well known. Additionally, some countries continue to use unique traditional unit systems in some product areas (e.g., “Gauge”, “French” and “Charrière” as the diameter of needles or catheters ...).

Other national differences relate to the use of different formats for date, time, number, address, etc. that can confound the use of medical devices. For example the date format of 05/09/02 is unclear without any cultural context. Designers should be aware of these diversities and prevent them from inducing new risks.

Professional Traditions and Work Organization

The traditions for medical treatment and its workflow vary among different countries. The work organization (division of labor, responsibility, hierarchy, etc.) of health care practice also differs from country to country. This may result in differences in operators of medical devices in the same type of care area in different parts of the world. For example:

- In operating rooms throughout the world, patient monitors and anesthesia delivery systems are primarily operated by anesthetists;
- Outside of operating rooms, patient monitors are primarily operated by nurses or technicians in the United States and Canada, but by physicians in Europe;
- Intensive care ventilators are mainly operated by physicians in Europe, but by respiratory therapists in the United States.

Technical Environment

The general level of acceptance of technical devices in a target market influences that market's ability to support new technology and its acceptance of different technologies (e.g., new or obsolete technologies). For example, Korea tends to adopt new technologies more quickly than Ireland. The technological traditions of the target market include specific technical standards for mandatory design requirements (e.g. different "safe" levels of radiofrequency exposure for different countries). The existence of other devices already in use can influence the use of the medical device in question. Differences in the characteristics of the area's power system, as well as its quality (e.g., stability of power supply), should also be considered.

Social Context

Use of medical devices may involve more than just medically trained caregivers, possibly including the patient and their family members. The social context of the target culture (e.g., the relationship of different family members) can be quite different, exerting direct influences on the use of medical devices in that locale.

Anthropometric Characteristics

Body size and physical performance characteristics (e.g., strength) differ among different populations. On average, Asian people are smaller than Westerners. So anesthesia workstations designed for people who work in US hospitals may be too large for smaller operators in Japan, leading to reach and vision envelope-related problems. The design of the workplace, control elements and other components directly interfacing with people (both caregivers and patients) should consider differences in the anthropometric characteristics of target operators.

Interpretation of Colors and Symbols

In respect of color application, manufacturers should be aware of the possibility that a color will be interpreted differently, impacting the way people use a given medical device. An example is on the interpretation of colors red and green among different cultures. In Europe and the USA, people associate the color red with danger or stop and the color green with start (primarily because of how those colors are used on traffic lights). While in China and Japan, the color red is associated with prosperity and happiness. In a Japanese infusion pump, a red button is used for start and a green button is used for altering the settings. If such a pump would be used by users in Western cultures, it is foreseeable that use errors may be easily provoked under emergency (Fig. 4).



Fig. 4. Example on different design that may induce risks

Preference, Expectation and Attention

Operators in different cultures have different preferences and expectations, which can significantly influence medical device use. For example, in central Europe, the rotation directions for mechanical and electronic devices are typically different. Turning a knob clockwise reduces a setting by closing a pneumatic or hydraulic valve, but increases a setting on an electronic device e.g. the volume control. In contrast, in the United States, the rotation directions of hydraulic valves (e.g., water valves) may be different. Turning a knob clockwise might close a hot water valve, but open a cold water valve. These differences should be carefully addressed in device design, because in the presence of stress or lack of attention a user easily falls back into stereotypical behavior even though the task may require the opposite behavior.

3.2 Influenced Factors

A variety of medical device design issues are influenced by the cultural-/national-factors described above. According to ISO 14971, these design issues are taken as the control measures for risk control in international markets. Two groups of design issues could be classified:

- User interface design issues: hardware design issues, interface structure, navigation, dialogue system, information presentation, help information, warnings, etc.;
- Other device design issues: functional and technological features, technical documentation, operator support, training, etc.

Hardware Design Issues

One of the first points to consider in designing the hardware aspects is to adapt the workspace, size of control elements and other components to the anthropometric features of the target operators. Input and output (display and printing) should be considered to facilitate the operator's interaction with the medical device. This is especially important for languages (such as Greek, Russian, Chinese, Japanese, etc.) with many ideographical characters (e.g., a Chinese operator may prefer a writing pad to input the Chinese characters rather than a keyboard). The memory size required for the device's character set should also be considered.

Interface Structure

For a medical device, more than one operator is usually involved. If possible, the interface structure should be based on each operator's tasks, work organization and responsibilities. An operator usually only interacts with operating functions related to his/her area of responsibility. If the work flow, task completion and responsibility vary, the operator-device interface structure should be optimized to support all important operator needs to the greatest extent possible.

For example, the responsible operator for the intensive care unit ventilator is the respiratory therapist in the USA, but is a physician or nurse in Europe. If an ICU work station, being designed for use in the USA and Europe, incorporates both patient physiological monitoring and ventilation, then the structure of the user interface should take the responsible operator into account. It should also consider that in the USA different people may work with the integrated work station at the same time.

More significantly, the operation sequence is largely determined by the operator's work habits too. For example, the operation sequence for setting the infusion rate of a large volume infusion pump is quite different for nurses in Germany, Spain, Switzerland and UK, because the VTBI (volume to be infused) function is rarely used in Germany.

Language Issues

Translation of a device's user interface into the operator's native language is the most basic adaptation of a medical device to a particular country or region. The translation should be done by persons with experience using these medical devices; however, target operators may still have problems understanding the translated user interface. Several details have to be considered with respect to this issue:

- Display resolution: for example a higher display resolution is needed to display a Chinese character than is needed to display a Roman character.
- Text field (Character) widths: a paragraph of German text usually occupies more space than a paragraph of English text (general rule of thumb is 25-30% more space for German).
- Prioritized translation: if a complete translation of the user interface is unrealistic considering time and cost, at least the most critical labeling and indications should be translated. The hazard/risk analysis must be updated to address the non-translated parts, however.
- Country requirements: some countries require specific languages for device and their accompanying documents, other countries allow device to be in a foreign language, but require the accompanying documents to be in a specific native language. Manufacturers should also check with sales agents within the country because specific language requirements may exist in tender documents.

Technological Features

Foremost, the technical specifications of a medical device should meet the relevant regulatory requirements of the target market for the specific device. These can differ from country to country. For example, the US National and IEC standards have different requirements for chassis/enclosure and earth/ground risk currents, which should be addressed by the manufacturers.

Other differences in local power supply, radio frequency allocation, and electromagnetic interference and compliance (EMI/EMC), etc. should also be considered.

To ensure that medical devices function reliably wherever they are used, device design should incorporate special technical measures intended to mitigate the effects of possible environmental factors such as high humidity, high concentrations of acidic substances, fluctuations of temperature, electricity supply, etc. Changes to address these issues in the device's technological features may also affect the overall design of the user interface.

Operator Support

A device's working life may vary by country as well. For example, some countries replace anesthesia machines regularly while others continue using them for 20 or more years. Due to geographical restraints and possible shortages of qualified service personnel available in a specific area, support services such as maintenance and repair, spare part supply and operator training pose problems. Special measures such as using spare parts that are readily available on the local market should be considered to minimize dependence on manufacturer-provided support.

Not many design adaptation measures could be presented here, however, according to the ISO 14971, the design measures could be generalized into the following order with decreasing priority:

- Device design adaptations to avoid potential hazards (inherent safety by design);
- Protective design measures, such as alarms etc.;
- Information for safety, such as those described in user manual.

4 Guide to Cross-Cultural/-National Design of Medical Device

Once a manufacturer decides to enter a new market, they must decide how to adapt their product to the new market's requirements. Their decision making on cross-cultural/-national design is largely influenced by the following factors:

- How large is the expected market volume for the device?
- What is the scope of the changes required to modify the design for the new market?
- How complex is the work to implement the design adaptation?
- If design adaptations are infeasible, what is the risk for safe use of the device in target culture?

The decision on when and how to start a cross-cultural/-national design process can be based on a cost-benefit analysis. Manufacturers must consider their own design resources, experience, and the potential benefits gained through the design adaptation. The manufacturer's representatives in the target markets should provide adequate information. The final decision, however, will be based on the manufacturer's own circumstances.

The general development process of medical device considering cultural and national differences in the different markets is essentially the same as the HFE process defined in EN 62366 and ANSI/AAMI HE74. Recognition of cultural differences may, however, affect the specific characteristics of the analysis and specification (operator investigation), design and realization, and design evaluation.

5 Conclusions

As business is becoming more global and medical products are more globally accessible, the importance of the cross-cultural/-national design should be better recognized by the manufacturers. Looking into the future, it is clear that only manufacturers who are good at analyzing culture/-nation-specific requirements of each market's target operator groups and integrating these requirements into device design will be successful. At present, there is controversy with respect to affordability and safety, how far operators must adapt to technology and how far technology can adapt to operators. Manufacturers must assess the resulting risks and mitigate or control them as necessary. Unfortunately, some markets are not large enough to be treated independently, so their unique requirements may not be considered explicitly. Not selling medical device into those markets could put patients at risk by withholding necessary treatment. It is the manufacturer's obligation, via its risk management process, to make decisions on the acceptability of the remaining risks

and to establish methods to collect post-market data for feedback into the risk management process.

Globalisation may replace many local habits and values with internationally uniform habits and values. The internet, TV, news and literature together certainly have a strong influence on some operator groups. The result may be that the need for specific cross-cultural/-national designs of a human-machine-interface may gradually become less critical over time.

References

1. ANSI/AAMI HE74, Human factors design process for medical devices (2001)
2. Aykin, N.: Usability and internationalization of information technology. Lawrence Erlbaum Associates, Mahwah (2005)
3. Del Galdo, E.M., Nielsen, J.: International user interfaces. Wiley, New York (1996)
4. EN 62366, Medical devices - Application of usability engineering to medical devices (2008)
5. Fernandes, T.: Global interface design: A guide to designing international user interfaces. AP Professional, Boston (1995)
6. Hoelscher, U., Liu, L., Gruchmann, T., Pantiskas, C., Wilcox, S.: Design of medical devices for international market. In: Day, D., Evers, V., del Galdo, E. (eds.) Designing for Global Markets 7, 7th International Workshop on Internationalisation of Products and Systems (IWIPS), Amsterdam, Netherlands, pp. 113–128 (2005)
7. ISO 14971, Medical Devices - Application of Risk Management to Medical Devices. International Organization for Standardization, Geneva (2007)
8. Kalorama Information Report, The Global Market for Medical Devices, 2nd edn. (2011)

Technology-Based Medical Interpretation for Cross-Language Communication: In Person, Telephone, and Videoconference Interpretation and Their Comparative Impact On Limited English Proficiency (LEP) Patient and Doctor

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Abstract. Health care organizations face challenges in providing language services for Limited English proficiency (LEP) clients. Supported by a grant from the National Science Foundation, we have been working to develop a technology for proximate simultaneous medical interpretation. In an effort to understand the relative importance of physical proximity, audio cues and visual cues to effective interpretation, we conducted two controlled trials of the comparative impact on patient and provider satisfaction of four conditions which represent the interpretation circumstances with LEP patients and monolingual providers in hospital settings; a certified interpreter present in the consultation room (“In Person”); at a remote location mediated by audio only (“Telephone”); at a remote location mediated by audio and video (“Videoconference”), and no interpreter present (“No Interpreter). In study 1, dyads of a medical student and a standardized patient were randomly assigned to In Person or No Interpreter condition on a rotating basis, producing a total of 25 encounter sessions. In Study 2, four interpretation communication modes including Videoconference and Telephone condition simulated 25 encounters. Repeated measure one-way analyses of variance (ANOVA) showed preferences of patients and physicians for four different methods of interpretation. Patients expressed high satisfaction for their doctors regardless of the communication mode. Doctors’ perception of the interpretation quality was also as desirable in remote communication as onsite human interpretation. Patients reported significantly greater feelings of being guarded for their privacy and were more satisfied with the interpretation quality in the remote communication via telephone over in-person interpretation.

Keywords: Limited English Proficiency, Medical Interpretation, Controlled Trial.

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1 Introduction

Limited English proficiency (LEP) affects the health care of millions of Americans, many of whom are Hispanic/Latino. In 2000, 18 percent of the total population aged 5 and over, or 47.0 million people, reported they spoke a language other than English at home. This was up from 14% and 11%, according to census data from the 1990 and 1980 surveys, respectively. More significant is the fact that of the 21.4 million who had trouble communicating in English, 13.8 million were Spanish speakers.

There are serious consequences for health care when individuals with LEP do not have access to adequate translation. One undesirable side effect of the increasing diversity of the U.S. population is the presence of significant barriers to health care delivery and access for the LEP segment of the population, predominantly minority women, children and elders. Numerous clinical and public health studies have documented the multiple facets of this problem, including lack of regular primary care, limited or no access to preventive care, high incidence of medical errors, and poorer health outcomes. For example, Tchen, Bedard et al. (2003) found trends for LEP patients who did not receive interpretation or consultation from a bilingual provider to have less accurate understanding of their disease status and to be more unrealistic in expectations of a cure.

There have been regulatory efforts to improve access to health care for persons with LEP. Recognizing this problem, the U.S. Congress mandated establishing the Office of Minority Health (under the Department of HHS) in 1994, a part of which was the creation of the Center for Linguistic and Cultural Competency in Health Care in 1995 with a mission to develop and evaluate models, conduct research, and provide technical assistance to providers on removing language barriers to health care services. In 2003 an issuing guidance went into effect (Guidance to Federal Financial Assistance Recipients Regarding Title VI Prohibition against National Origin Discrimination Affecting Limited English Proficient Persons) addressing mechanisms and organizational practices that impact cultural and linguistic competence. Hispanic/Latino parents of cancer patients in California, for example, now have the right to an interpreter, at least by telephone, from their commercial health and dental plans, made possible by a first-in-the nation law that intends to eliminate language-related obstacles to effective care in medical settings. This new regulation of the California Department of Managed Health Care – Senate Bill 853 - went into effect in January, 2009. Doctors' orders now need to be translated at least orally into Spanish, Mandarin, Hmong, Russian and other spoken languages. Nevertheless, through the years individuals with limited English proficiency have not fully benefited from these laws and regulations as their enforcement and implementation have been inconsistent across medical facilities.

Health care organizations face challenges in providing language services for LEP clients. The building of language capacity has been a major challenge for the health care system in states with large numbers of limited English proficient individuals. In many facilities there are insufficient numbers of interpreters for the total number of LEP patients or parents of pediatric Hispanic/Latino patients being treated. A study of sixty-seven hospitals in New Jersey (Flores, Torres, Holmes, Salas- Lopez,

Youdelman, & Tomany-Korman, 2008) reported that only 3% of hospitals had full-time interpreters, and 80% did not provide training to staff on working with interpreters.

Currently, the language needs of LEP patients and their families for whom bilingual providers are not available are addressed with a variety of solutions, including certified professional interpreters, language lines, and incidental interpretation from bilingual staff or family members. However, it was difficult to argue that hiring and training more interpreters makes “business sense,” and that while the demand for interpreter services could be expected to grow, it would be difficult to attract more people to the field because the job was generally low-paying (Wu, et al., 2007). This tremendous need for interpreter services cannot be fully met with human interpreters alone, or be of acceptable cost. Costs for such services, particularly telephone translation, are often prohibitive for routine medical care. Additionally, while mandated by law for health care providers, most insurance companies will not cover human interpretation services.

Existing approaches include onsite ad hoc interpreting, onsite certified interpreting, language lines, videoconferencing, and remote simultaneous medical interpretation (RMSI). These approaches vary with respect to several factors: whether or not the interpreter is trained or remote or proximate; whether interpretation is simultaneous or asynchronous; whether or not the patient’s privacy is preserved; whether the interpreter has access to the patient’s (and provider’s) nonverbal cues and/or family dynamics (cues to context); scalability (i.e., whether the method can be easily and inexpensively scaled up for multiple simultaneous patient encounters); and 24-hour availability assuming no onsite competition for services. Each approach has advantages and disadvantages.

Much of the research conducted on the effects of interpretation methods has focused on the undesirable consequences of incidental (ad hoc) interpretation. One of the most egregious examples is the reliance on children to translate diagnosis and treatment plan to their LEP parents. Family members who translate for patients, even well intentioned ones, may not have appropriate medical knowledge. They may also be reluctant to provide information on a life-threatening diagnosis or a particularly difficult but necessary regimen of care; further, they may fail to explain the side effects and risks of particular medications or treatments due to embarrassment or fear of upsetting the patient or parents. Incidental translation of this sort may also compromise the confidentiality of information provided during a consultation. Furthermore, the use of incidental interpreters resulted in lower patient satisfaction than trained interpreters or bilingual providers, and that errors and distortions were commonplace when incidental translation was used (Flores, 2005; Gany et al., 2007; Laws et al., 2004) Medical errors obviously compromise patient safety and expose health care organizations to legal risk.

Hsieh (2006) summarizes available research on patient satisfaction, understanding, and physician supportiveness and facilitation and finds that there are conflicting results which may be attributable to the type of interpretation that prevailed in a particular study. There is probably general consensus that trained and certified translators make fewer errors and have more satisfied patients than incidental or ad hoc interpreters. There is some lack of consensus on whether interpreted provider-patient

encounters take longer (although probably general agreement that there is wasted time spent waiting for interpreters to arrive), or whether they create new problems. Davidson (1998) noted that interpreters function as “co-diagnosticians,” often ignoring patients’ questions or answering them without translating them first for the provider and obtaining an answer, engaging in side conversations, or acting as co-conversationalists.

Telephone interpretation has been available for a number of years as an alternative to onsite interpretation when patient and providers are not language-concordant. Although telephone interpretation been criticized by some as failing to provide non-verbal and contextual cues, such as seeing the patient interact with the provider and other family members (Hsieh, 2006), not being well-accepted by providers (Wu, Ridgely, Escarce, & Morales, 2007), and not very useful with children or the hard of hearing, Lee, Batal, Maselli, and Kutner (2002) reported that patients in a walk-in clinic who were provided with AT&T telephone interpretation had identical (and high) levels of satisfaction with the visit to language-concordant patients. Newer methods of remote interpretation including videoconferencing and RMSI have received less study, although they appear to offer advantages over telephone interpretation with respect to the lack of nonverbal and contextual cues in the case of the former and near-simultaneous (as opposed to consecutive) interpretation in the case of the latter.

A serious shortcoming of the comparative research on interpretation methods, which Flores (2005) noted in his review article, has been the paucity of randomized controlled trials (only 1 of 36 papers met the review criteria). Since that time a few papers have appeared which have attempted to address the issue more systematically. Ganey, Kapelusznik, et al. (2007) conducted a randomized controlled trial of RSMI, proximate trained interpreters, proximate untrained bilingual staff, and telephone interpretation with respect to interpretation speed and medical errors, using standardized scripts and doctor-patient volunteer pairs reading the scripts in English and Spanish, respectively. RSMI encounters were nearly fifty percent faster than the next fastest method (proximate untrained) and contained a fraction of the number of errors of the non-RSMI encounters. Similar results were obtained by Ganey, Leng, et al. (2007) in their comparison of RSMI to “usual and customary” interpretation methods. Patients who were randomized to RSMI reported greater feelings of being respected by the provider, were more satisfied with provider communication, and felt as if their privacy was more carefully guarded, although the effects were small and the levels of satisfaction did not rise to those of patients in language-concordant encounters.

Technology-based interpretation solutions offer tremendous promise for addressing the problem of cross-language communication, especially in structured, non life-threatening medical interactions. In particular they allow for scaling-up interpretation services at an incremental cost and thereby are useful to a much larger population. Supported by a grant from the National Science Foundation, we have been working to develop a technology for proximate simultaneous medical interpretation (PSMI) which will provide real-time, computer-mediated Spanish-English medical interpretation for providers and patients who are language-discordant. (Narayanan et al, 2004). As part of our efforts to learn, store and recognize from vocal input a wide array of terms from medical domains of interest including words for treatments, medications (including herbal remedies), and symptoms, as well as the euphemisms or acronyms by which they are commonly denoted in the target languages, and how

these may vary by country of origin of the LEP patient and family (e.g. Mexico, El Salvador, Guatemala), and in an effort to understand the relative importance of physical proximity, audio cues and visual cues to effective interpretation, we have been able to conduct controlled trials of the comparative impact on patient and provider satisfaction of four conditions which represent the interpretation circumstances typically found in hospitals and clinics today: a certified interpreter present in the consultation room with the provider and patient (“In Person”); a certified interpreter at a remote location mediated by audio only (“Telephone”); a certified interpreter at a remote location mediated by audio and video (“Videoconference”), and no interpreter present (“No Interpreter”).

Our review of the relevant literature on the comparative advantages of currently available methods of interpretation leads us to propose the following hypotheses:

H1: Type of interpretation (In Person, Telephone, Videoconference, and No Interpreter) is associated with the patient's rating of the provider

H2: Type of interpretation (In Person, Telephone, Videoconference) is associated with the patient's rating of the interpreter.

H3: Type of interpretation (In Person, Telephone, Videoconference) is associated with the providers's rating of the interpreter.

2 Method

2.1 Participants and Procedure

The project on which we report here used standardized patients (SPs) in simulated medical encounters. SPs can accurately and consistently portray a ‘case,’ for example a patient presenting with chest pain, in a “standardized” way, and they can evaluate the behavior of the provider in a “standardized” manner, accurately recalling and recording provider behaviors. For the present study, SPs were trained to enact standard scripts used at a teaching hospital with which the researchers were affiliated for evaluation of medical students’ communicative and diagnostic competence. Six scripts were used in the study, which addressed a range of health conditions encountered during medical consultations including diabetes, depression, lymphoma, and lower back pain. The scripts were revised to include appropriate cultural content reflecting health-related beliefs and attitudes likely to be encountered during consultations with Hispanic/Latino patients.

Standardized patients and a core group of trained interpreters were recruited between January and March 2010 for two experiments. Participants were drawn from the pool of standardized patients as well as from a snowball sampling. Provider participants were third and fourth year medical students from the university with which the researchers were affiliated. Providers spoke English as their primary language. All participants, including standardized patients, interpreters and providers were compensated \$20 per hour plus lunch for their participation.

In Study 1, five providers, five standardized patients and three professional medical interpreters participated. The medical interpreters were sufficiently trained and

experienced in consecutive interpretation in a medical setting. Dyads of a provider and a patient were randomly assigned to one of two interpretation communication methods on a rotating basis, producing 15 interpreted and 10 uninterpreted sessions.

In Study 2, five providers, five standardized patients, and four professional medical interpreters participated in a total of 25 encounters. Responses from one standardized patient who had inadvertently participated in both experiments were later excluded from the analysis. Participants were randomly assigned to one of four interpretation communication modes. Data were collected from a total of 5 In Person, 4 Telephone, 10 Videoconference, and 6 uninterpreted encounters.

The sample consisted of 19 participants, including 9 males and 7 females. Median age for patients and interpreters was 41 to 54 years old. Providers' ages were between 26 and 40 years old. Among the 19 participants, 4 were multilingual, 7 reported English as their primary language, 3 were predominantly Spanish speakers, and 1 reported 'other' as a primary language. All providers identified themselves as White. Among 11 patients and interpreters, 5 were Latino/Hispanic.

2.2 Measures

A 10-item demographic survey was administered to all participants prior to the experiments. Patients completed a 9-item survey to evaluate their provider and a 7-item survey to rate the quality of interpretation. Providers responded to a 9-item questionnaire about interpretation quality after each encounter. The survey items about quality of and satisfaction with the clinical encounter and method of interpretation were informed by previous studies on medical interpretation satisfaction (Gany et al., 2007). Surveys for providers and patients had core items nearly identical to each other but used different phrases from their perspectives. In addition to the scales, we held a semi-structured group discussion separately for providers, interpreters, and patients, providing an opportunity to reflect on the experience and voice their opinions on the interpretation methods.

2.3 Statistical Analysis

The primary test of within-subject differences in ratings was a repeated measure one-way analysis of variance (ANOVA). The statistical package R (ver. 12.2.1) was used. We also conducted multiple pairwise comparisons using the statistical software SPSS (ver. 17).

Composite measures were created using factor analyses on satisfaction items. Three factors were identified, including patient's satisfaction with providers, patient's satisfaction with interpretation, and provider's satisfaction with interpretation. The Chronbach's alpha for the three factors were .89, .76, and .82 respectively. A confirmatory factor analysis showed that a three-factor solution (Non-Normed Fit Index [NNFI] = .87, Comparative Fit Index [CFI] = .89, Incremental Fit Index [IFI] = .76) was superior to a one-factor solution (NNFI = .63, CFI = .76, IFI = .64), $\Delta\chi = 812.6$, $p < .05$, which did not differentiate patients' satisfaction versus providers and satisfaction of providers and interpreters.

2.4 Results

In order to understand the overall satisfaction level across interpretation conditions in two studies, as noted above we created three indices for patients' and providers' evaluation of the satisfaction provided by the encounters. The means and standard deviations of patient and provider ratings of encounter quality are shown in Table 1. Patient and provider's ratings for interaction quality were generally high across the interpretation conditions in the two studies.

Table 1. Satisfaction Rating Means and Standard Deviations for Interpretation Conditions

		Patient's Rating of Provider			Patient's Rating of Interpretation			Provider's Rating of Interpretation		
		Mean	SD	N	Mean	SD	N	Mean	SD	N
<i>Study 1</i>										
	In Person	23.7	3.46	15	16.6	.68	15	19.1	1.31	15
	No Interpreter	21.69	3.06	10	--	--	10	--	--	10
	Average	22.9	3.39	25	16.6	.68	15	19.1	1.31	15
<i>Study 2</i>										
	In Person	24.95	1.12	10	16.45	.89	10	20.58	.90	12
	Telephone	25	1.73	3	17	0	3	18.75	.5	4
	Videoconference	22.67	2.52	3	14	2.65	3	14.5	3.79	4
	No Interpreter	25.2	1.5	4	--	--	4	--	--	5
	Average	24.68	1.64	20	16.09	1.59	20	19	2.94	25
<i>Overall</i>										
	In Person	24.2	2.8	25	16.51	.76	25	19.76	1.36	27
	Telephone	25	1.73	3	17	0	3	18.75	.5	4
	Videoconference	22.67	2.52	3	14	2.65	3	14.5	3.79	4
	No Interpreter	22.71	3.12	14	--	--	14	--	--	5
	Average	23.69	2.87	45	16.32	1.24	45	19.04	2.36	40

In Study 1, patients' rating for the providers was uniformly high in the two treatment conditions, $F(1, 21) = .21$, $p = .65$, although it was slightly higher in the In Person than in the No Interpreter condition. In Study 2, patients provided the highest evaluation for providers in the No Interpreter condition followed by the Telephone, In Person, and Videoconference conditions. However, the ANOVA results indicated that the association between patients' ratings for providers and the interpretation treatment was not significant, $F(1, 15) = 2.28$, $p = .15$. Hypothesis 1 was not supported.

Patients' overall ratings for interpretation were significantly different by interpretation condition in that the Telephone condition yielded the highest satisfaction ratings, followed by No Interpretation, In Person, and Videoconference, $F(1, 15) = 8.49$, $p < .05$. Results provided support for Hypothesis 2.

Overall, patients' rating for providers and interpretation quality was relatively high across four interpretation conditions. The most satisfactory ratings were from the Telephone condition in both encounters although the difference was not statistically significant. Overall encounter ratings from patients were second highest in the In Person condition, followed by the No Interpreter and Videoconference conditions. A subsequent ANOVA test showed significant differences in patients' sense of privacy of the details discussed in encounters ($F = 9.01$, $p < .01$). Patients' ratings for privacy

was also highest in the Telephone mode ($M=4$, $SD=0$, $n=3$) followed by the In Person ($M=3.95$, $SD=.09$, $n=10$) and the Video mode ($M=3$, $SD=1$, $n=3$).

With respect to Hypothesis 3, providers' overall assessment for interpretation was highest in the In Person treatment condition followed by the Telephone, and Video-conference conditions. However, the difference in ratings was not statistically significant, $F(1, 20) = .01$, $p=.93$. Hypothesis 3 was not supported.

3 Discussion

This study confirms earlier research indicating potentials for technology-based interpretation such as telephone interpretation as alternative to onsite human interpretation options (Ganey, Leng, et al, 2007; Ganey, Kapeluesznik, et al, 2007; Lee, Batal, Maselli, & Kutner, 2002). Results show a noticeable preference for mediated interpretation via telephone over the in-person or no interpretation conditions among patients. Remote interpretation encounters using telephone communication was time effective and produced less errors commonly found in customary interpretation modes such as ad hoc or chance interpreter services. Findings from this project also confirmed that patients felt as if their privacy was most carefully guarded in the Telephone communication. The finding adds an empirical evidence of the merits of technology-based interpretation services as new solutions to the problem of providing adequate interpretation services to LEP patients in medical settings.

One of the shortcomings of technology-based interpretation is negative response from medical staff and providers and their reluctance to integrate the new solution into existing administrative system (Wu, Ridgely, Escarce, & Morales, 2007). The two studies in this project demonstrated potentials of diverse interpretation services in the medical field and showed that the difference in ratings among providers was not significantly varied across four interpretation conditions. Different interpretation methods were all well accepted by providers and produced overall positive ratings. Physicians' evaluation was also independent of the presence of a human interpreter during interactions or technology used as communication method.

It is noteworthy that technology-based remote and near simultaneous interpretation was perceived by physicians as desirable in achieving positive encounter quality as other modes of interpretation. Although the differences obtained were not statistically significant and the effects were small, the level of satisfaction among doctors slightly fluctuated by the treatment conditions. When we compared the average ratings of providers for each interpretation quality, doctors viewed the traditional human method as slightly more satisfactory than remote methods of interpretation. In regard to their ratings of remote interpretation methods, the telephone treatment received slightly higher scores over the video mode in both patient and physician groups. Videoconference was the least satisfactory to both patient and provider groups.

Findings shed lights on limitations on the two studies. We found that patients were not sensitive to different interpretation methods when it comes to rating their physicians in both studies. It may be that provider participants had varying levels of medical Spanish skills. Earlier research indicated that a bilingual provider often results in

higher patient satisfaction and accurate understanding of medical details among LED participants (Tchen et al, 2003; Floors, 2005). Bilingual physician participants in the two studies may have affected patients' assessment.

Uniformly high and indiscernible ratings for physicians by patients may also be due to technical problems during the second experiment. During the focus group discussion with the standardized patients, there were complaints in remote interpretation communications including the discomfort of wearing a head-set device. There were also cases when video and audio quality was not optimal or the placement of a computer monitor made it difficult for participants to make eye contacts during encounters.

4 Conclusion

This study shows that comparative advantage of interpretation methods vary by medical context, participants' characteristics or technical settings. Rising cost of hiring onsite human interpreters, administrative burdens and lack of adequate resources to patients with language barriers can be effectively addressed by efforts to develop cost effective, easily scalable and widely deployable options. This project demonstrated that technology-based interpretation methods provide similar level of emotional satisfaction and sense of being respected compared to onsite human services. This reinforces the need for widely available technologies that address participants' sense of privacy and satisfaction in medical interpretation. A serious future research endeavor is required to understand the capacity of such technology-based interpretation in responding to rich contextual information, relational dynamics, and various demographic and socioeconomic backgrounds of participants in medical encounters.

References

1. Gany, F., Leng, J., Shapiro, E., Abramson, D., Motola, I., Shield, D., Changrani, J.: Patient satisfaction with different interpreting methods: a randomized controlled trial. *Journal of General Internal Medicine* 22(suppl. 2), 312–318 (2007)
2. Belvin, R., May, W., Narayanan, S., Georgiou, P., Ganjavi, S.: Creation of a doctor-patient dialogue corpus using standardized patients. In: Proc. LREC, Lisbon, Portugal (2004)
3. Davidson, B.: Interpreting medical discourse: A study of cross-linguistic communication in the hospital clinic. Ph.D. dissertation, Stanford University (1998)
4. Flores, G.: The impact of medical interpreter services on the quality of health care: a systematic review. *Medical Care Research and Review* 62(3), 255 (2005)
5. Flores, G., Abreu, M., Tomany-Korman, S.: Limited English proficiency, primary language at home, and disparities in children's health care: how language barriers are measured matters. *Public Health Reports* 120(4), 418–430 (2005)
6. Flores, G., Laws, B., Mayo, S., Zuckerman, B., Abreu, M., Medina, L., Hardt, E.: Errors in medical interpretation and their potential clinical consequences in pediatric encounters. *Pediatrics* 111(1), 6–14 (2003)

7. Flores, G., Torres, S., Holmes, L.J., Salas-Lopez, D., Youdelman, M.K., Tomany-Korman, S.C.: Access to hospital interpreter services for limited English proficient patients in New Jersey: A statewide evaluation. *Journal of Health Care for the Poor and Underserved* 19(2), 391–415 (2008)
8. Gany, F., Leng, J., et al.: Patient satisfaction with different interpreting methods: A randomized controlled trial. *Journal of General Internal Medicine* 22, 312–318 (2007)
9. Gany, F., Kapelusznik, L., Prakash, K., Gonzalez, J., Orta, L., Tseng, C.-H., Changrani, J.: The impact of medical interpretation method on time and errors. *Journal of General Internal Medicine* 22(suppl. 2), 319, #J0132731 (2007)
10. Hsieh, E.: Understanding medical interpreters: Reconceptualizing bilingual health communication. *Health Communication* 20(2), 177 (2006)
11. Laws, M.B., Heckscher, R., Mayo, S.J., Li, W., Wilson, I.B.: A new method for evaluating the quality of medical interpretation. *Medical Care* 42(1), 71–80 (2004)
12. Lee, L.J., Batal, H.A., Maselli, J.H., Kutner, J.S.: Effect of Spanish interpretation method on patient satisfaction in an urban walk-in clinic. *Journal of General Internal Medicine* 17, 641–645 (2002)
13. Lie, D., Boker, J., et al.: Validating measures of third year medical students' use of interpreters by standardized patients and faculty observers. *Journal of General Internal Medicine* 22, 336–340 (2007)
14. May, W.: Training standardized patients for a high-stakes clinical performance examination in the California Consortium for the Assessment of Clinical Competence. *Kaohsiung J. Med. Sci.* (2008)
15. McLaughlin, M.L., Zhu, W., Peng, W., Jung, Y., Jin, S.: Touch in computer-mediated communication. In: Konijn, E.A., Utz, S., Tanis, M., Barnes, S.B. (eds.) *Mediated Interpersonal Communication. How Technology Affects Human Interaction*. Taylor & Francis Group/ Routledge, New York (2008)
16. Munet-Vilaró, F.: Delivery of culturally competent care to children with cancer and their families: The Latino experience. *Journal of Pediatric Oncology Nursing* 21(3), 155–159 (2004), doi:10.1177/104345420426440
17. Narayanan, S., Ananthkrishnan, S., Belvin, R., Ettaile, E., Gandhe, S., Ganjavi, S., Georgiou, P.G., Hein, C.M., Kadambe, S., Knight, K., Marcu, D., Neely, H.E., Srinivasamurthy, N., Traum, D., Wang, D.: The transonics spoken dialogue translator: An aid for English-Persian doctor-patient interviews. In: *AAAI Fall Symposium* (2004)
18. Tchen, N., Bedard, P., Yi, Q., Klein, M., Cella, D., Eremenco, S., et al.: Quality of life and understanding of disease status among cancer patients of different ethnic origin. *British Journal of Cancer* 89 (2003)
19. Wu, S., Ridgely, M.S., Escarce, J.J., Morales, L.S.: Language access services for Latinos with Limited English Proficiency: Lessons learned from. *Hablamos Juntos*. *Journal of General Internal Medicine* 22(suppl. 2), 350–355 (2007)

Toward a Virtual Companion for the Elderly: Exploring the Behaviors that Potentially Achieve Rapport in Human Communication

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Abstract. The elderly who live alone are increasing rapidly in these years. For their mental health, it is reported useful to maintain their social life with others. This work is aiming to develop a companion agent who can engage long-term relationship with the elderly users. This paper presents our first step to explore the rapport occurred in a human-human communication which is considered to be essential in keeping social relationship with others. We analyzed the corpus collected in a human-human dyadic conversation experiment from three view points, the speaker (potential user), the listener, and the third person who did not participate the conversation. Encouraging results that may provide the hints of agent development were found in the analysis: the attitude of the conversation can have an influence on the speaker's mood, the mood of the speaker can be potentially observed by another person, and the third person can detect speaker's attitude.

Keywords: elderly support, active listening, conversational agent, rapport.

1 Introduction

In these past years, the population of elderly people has grown rapidly. If they do not maintain social life with others, they may feel loneliness and anxiety. For their mental health, it is reported effective to keep social relationship with others, for example, the conversation with their caregivers. There are already some non-profit organizations recruiting volunteers to engage “active listening” with the elderly. Active listening is a communication technique that the listener listens to the speaker carefully and attentively by confirming or asking for more details about what they heard. This kind of support helps to make the elderly feel cared and to relieve their anxiety and loneliness. However, due to the lack of the number of volunteers comparing to that of the elderly who are living alone, the volunteers may not be always available when they are needed. In order to

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improve the effect, always-available and trustable conversational partners in enough number are demanded.

The ultimate goal of this study is the development of a virtual companion agent who can engage active listening and maintain a long-term relationship with elderly users. In order to conduct successful active listening, it is considered essential for the listener to establish the rapport from the speaker (elderly user). Rapport is a mood which a person feels the connection and harmony with another person when (s) he is engaged in a pleasant relationship with him / her, and it helps to keep long-term relationships [1, 2].

We assume that the state of rapport can be approximated by keeping positive mood in active listening dialogue. Therefore, the task of the active listener (a human volunteer or the agent) is to maintain the speaker's mood as good as possible and as long as possible. In order to do this, like a human listener, the listener agent has to observe the listener's attitude, to estimate the listener's mood from the observation, and to predict the change of listener's mood caused by his / her own behaviors both verbally and non-verbally [3]. However, estimating someone's mood and engaging this kind of mental interaction can be considered difficult or impossible even for a human, it would be more difficult for a machine, like the rapport agent. This paper presents our first step of this study, a human-human conversation experiment to validate whether it is possible to implement such an agent. The collected dialogue corpus was evaluated in the aspects of positive / negative state of attitude and mood of the subjects by themselves. The results were compared with that done by a third person who did not have premise about the subjects and prior knowledge about the dialogue contents. The third person view was used instead of an autonomous agent because they shared similar ability in evaluating the subjects. In this paper, the experiment settings and the relationship of the evaluation from the speaker, listener, and third person were reported. Base on the analysis of the corpus, we would like to implement a companion agent who automatically measures the speaker's attitude (approximated mood) and reacts to it, for the Japanese elderly users.

2 Related Works

The research works on making robots and agents to be the partners of the elderly and dementia patients have been getting popularity. One of the way to mitigate the progression of dementia is "coimagination" method proposed by Otake et al. [4]. It is a method by using pictures as the references for the topics in a group talking. All participants have equal chance to listen, to talk, to ask questions, and to answer questions. It is reported that the elderly who participated this activity talked and smiled more fluently than before. However, this method has the limitation that all of the participants have to meet at one single place which may be difficult in practical.

Bickmore et al. [5] proposed a companion agent to ease the anxiousness of elderly inpatients. Huang et al. [2] developed a rapport agent which analyzes facial expressions, backchannel feedbacks, and eye gazes of the user. The agent is designed to show behaviors which are supposed to elicit rapport. However, it does not try to

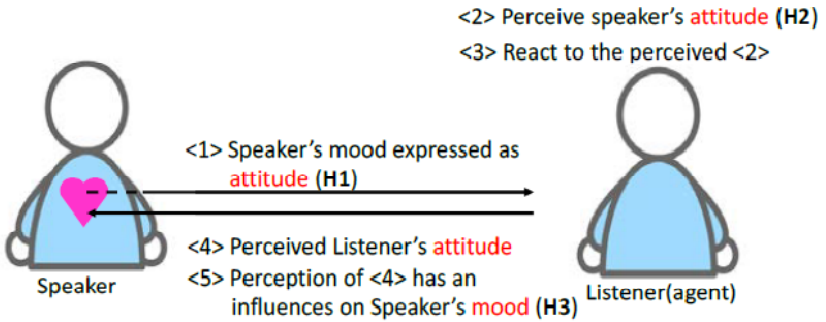


Fig. 1. Conceptual diagram of the proposed modeling of the interaction between the speaker and the listener (agent) during active listening

estimate and react to the user’s mood. For example, when the user looks in bad mood, showing the agent’s concern on the user by saying “Are you OK?” like human do. The SEMAINE project [6, 7] was launched to build a Sensitive Artificial Listener (SAL). SAL is a multimodal dialogue system with the social interaction skills needed for a sustained conversation with the user. They focused on realizing “really natural language processing [8] ” which aims to allow users to talk with machines as they would talk with another person.

These projects were developed base on the subject studies in the U.S. or in other western countries where the subjects’ communication style may diverge from that of Japanese ones [9]. In this study, we collected an active listening corpus of Japanese subjects and analyzed Japanese style verbal / non-verbal behaviors which potentially achieve the speaker’s rapport toward the listener. On the other hand, previous studies in developing companion agents were usually started already with the premise that agent’s behaviors have influence on the building of rapport. The analysis of this study bases on the self-evaluation on the subjects’ mood and attitude in numerical way at fine granularity. The detailed comparison is then conducted to explore whether it is actually possible for the agent to do that.

3 Modeling of Active Listening

Since the goal of this study is to build a virtual listener agent which can establish rapport with elderly users, two functions of the agent can be considered essential: the agent’s attitude perceived by the user has an influence on speaker’s mood, and the agent can estimate speaker’s mood from the speaker’s attitude perceived by the agent. As the discussion in section 1, we formalize rapport as the interaction between the interlocutors’ “mood” and “attitude” in this work. Here, we redefine these two general terms in the following way:

Mood: someone's internal mental status. It lasts for relatively longer time (say 10 or 20 minutes) than emotion and is difficult to be observed by another person.

Attitude: someone's mood expressed in the way how he or she behaves toward another person. These behaviors include verbal utterances and non-verbal ones like gestures, postures, change of voice tone, and facial expressions. It is supposed to be able to be detected by another person.

Figure 1 shows the conceptual diagram of the proposed modeling of the interaction between the speaker and the listener (agent) during active listening. <1> The speaker's internal mental state or his / her mood is expressed as his / her attitude <2> The speaker's attitude is perceived by the listener (or the companion agent) <3> The listener interprets the speaker's attitude and estimate the speaker's current mood. The listener then decides how he / she should react to the speaker's mood. For example, says "Are you feeling bad? Do you need some rest?" if the speaker looks tired; or says "It's ok. Everybody experiences that." if the speaker is talking about some sad memory and his / her mood is going downward <4> The listener's reaction is then perceived by the speaker as the listener's attitude for the speaker <5> The interpretation on the perception of the listener's attitude then has influence on the speaker's mood. The speaker's mood is then expressed as his / her attitude. This interaction continues as a loop until the conversation ends.

To build rapport with the elderly user, the companion agent should have two fundamental functions: its behaviors (or its attitude) perceived by the speaker has an influence on the speaker's mood, and it can estimate the speaker's mood from his / her observed attitude. However, whether these functions are possible cannot be verified directly because of the agent has not been implemented yet. Before actually developing the agent, we would like to verify whether these two functions are possible to be realized. As described in section 1, a third person without premised impression about the subjects and prior knowledge about the dialogue corpus is assumed to have similar ability in the evaluation of subjects' mood and attitude as the agent, i.e. can only judge objectively. Therefore, the verification can be formulized as validating the following hypotheses:

H1: the speaker expresses his / her mood as his / her attitude.

H2: the speaker's attitude can be perceived by a person who does not know the speaker well in advance.

H3: the speaker's mood is influenced by how he / she perceived the listener's attitude.

4 Hypothesis Validation

The three hypotheses raised in last section were validated by the following procedure. At first, a human-human active listening experiment was conducted. Second, the collected corpus was evaluated by the experiment participants (speaker and listener) and another participant with third person view. Third, the correlations between the results from each two evaluator were computed.

4.1 Active Listening Experiment

Experiment setup: five pairs of participants (four male pairs and one female pair) with the same gender were recruited in Ritsumeikan University, all of them were college students and native Japanese speakers (average age: 22.1 years old). The two participants of each pair were recruited with the condition that they are close friends. This is because close friends were considered easier to talk with each other in limited experiment time. In order to simulate the situation of talking with a 2D graphical agent, the participants of each pair were separated into two rooms and talked with each other via Skype. In each session, one participant played the role as the speaker, and the other one played the role as the listener. Large lower body movements may affect the movements of upper body which is more important in communication. They were instructed to sit on a chair so that the move of their lower bodies can be controlled within a limited range. Each room was equipped with two video cameras. One was used for recording the participant from the front. The other one was used for logging the Skype window which was duplicated on another monitor. In addition to video recordings, Microsoft's Kinect depth sensors were also used to record the participants' movement for further analysis. The speaker talked with the listener who was projected on a large screen at around life-size. The height of the projected image was adjusted so that the speaker can see the listener's eyes roughly at the level for eye contact. Natural head movements and eye gazes shifts can be further analyzed. The setup of the two experiment rooms are shown in Figure 2 and 3.

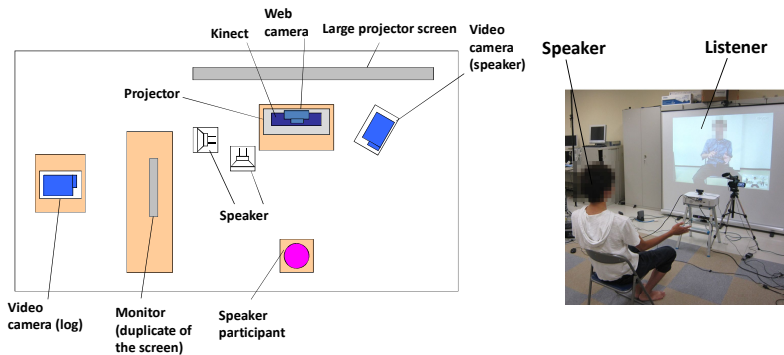


Fig. 2. Setup of the room where the speaker participant was in. The listener was projected roughly as life-size and the second monitor was used for video logging.

Experiment procedure: Each participant pair talked in four sessions. The topics of the conversation were “pleasant experience with family” or “unpleasant experience with family.” These topics were chosen because they are common for almost everyone including the young experiment participants and the elderly. Each participant played the role either as the speaker or as the listener. Speaker participant initiates the session and talks to the listener about his / her family. Listener participant was instructed to try to be a good active listener. That is, listen to the speaker carefully and

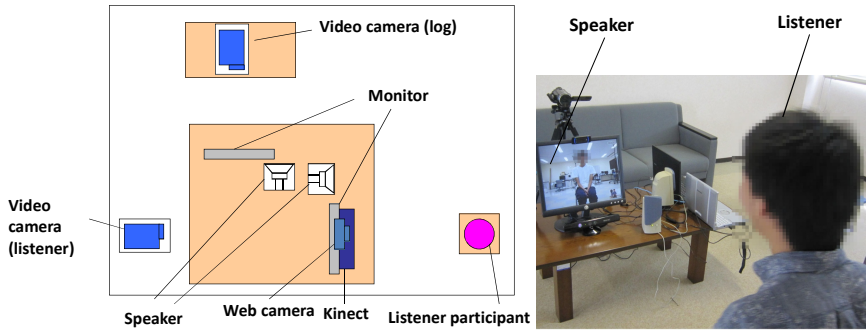


Fig. 3. Setup of the room where the listener participant was in. The second monitor was used for video logging.

attentively, follow the speaker's talk with questions or other feedbacks like nods or laugh. Table 1 shows the assignment of the order and talk topics of the two participants. They interchanged their roles in the sessions and started to talk from the pleasant experience at first because it should be easier to do. The duration of one session was set to be seven minutes because it is considered long enough for the participants to start to talk something meaningful and keep the whole experiment with a reasonable time.

Table 1. Arrangement of talk topics and the roles of the two participants (denoted as A and B)

Session	Topic	Speaker	Listener
1	Pleasant experience with family	A	B
2		B	A
3	Unpleasant experience with family	A	B
4		B	A

4.2 Evaluation of Mood and Attitude

After the end of four sessions, the participants were instructed to evaluate the mood and attitude of themselves and their partners by labeling on the recorded video corpus. The video annotation tool, ELAN [10] was used for this purpose. In order to align the granularity and label positions among different coders, the participants were instructed to label their evaluation by following the four rules:

1. The whole time line has to be labeled without blank segments
2. Starting and ending positions of the label should be aligned to utterance boundaries
3. One label can include multiple utterances
4. The maximum length of one individual label is 10 seconds

Phonetics tool, Praat [11] was used to label the boundaries of participants' utterances. Figure 4 shows a screen capture of ELAN software, the beginning and ending positions of all utterances 10-second scales are automatically labeled for the participants' easy

reference. Table 2 lists the assignment of the annotation. The experimenter who did not participate the conversation directly annotated the corpus as the third person. The mood of the speaker and the attitude of the speaker and the listener were evaluated by the speaker, the listener, the third person (the experimenter) by following criteria:

(Video corpus, Upper: Speaker, Lower: Listener)

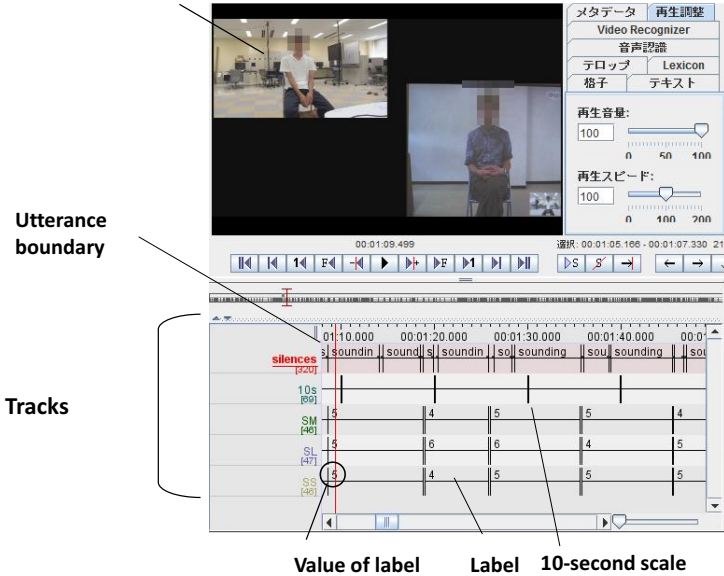


Fig. 4. Screen capture of ELAN annotation tool. 10-second scale and utterance boundaries are labeled with software tools for the convenience of the participants.

Mood: evaluated with 7-scale measure from 1 (negative) to 7 (positive). Comfort, intimacy, and sympathy are provided as positive examples in the instruction.

Attitude: evaluated with 7-scale measure from 1 (negative) to 7 (positive). Appropriate back-channel feedbacks like nods, questions, silence, agreeing opinions, smiles, or laughs were provided as positive examples in the instruction.

Table 2. Assignment of the annotation on mood and attitude. S, L, 3 at first character of the label is the abbreviation of the coder, speaker, listener, and the third person, respectively. M, L, S at the second character of the label is the abbreviation of speaker’s mood, listener’s attitude, speaker’s attitude, respectively.

Coder	Label	Meaning
Speaker	SM	Speaker’s mood
	SL	Listener’s attitude
	SS	Speaker’s attitude
Listener	LS	Speaker’s attitude
	LL	Listener’s attitude
Third person	3S	Speaker’s attitude
	3L	Listener’s attitude

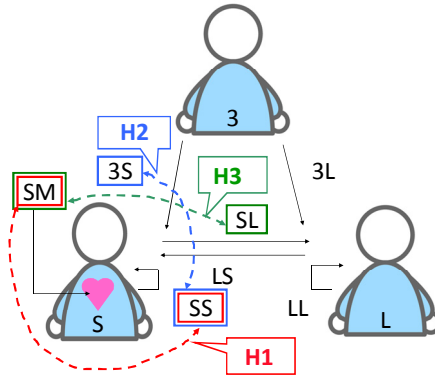


Fig. 5. Conceptual diagram of the relationship between the evaluation and the hypotheses

4.3 Computation of Correlations

The labeled mood or attitude tracks are wave-form like data sequence. In order to compare the data with different granularity and different boundaries, we cut the tracks to small slices (or resampled them). Since the shortest interval of the labels was 0.244 second, the sampling rate was set to 0.1 without losing data. Because the labeling evaluation are subject evaluation and the results among different coders cannot be compared directly. The data are then normalized with Z-score. Pearson product-moment correlation coefficient is computed between the labels which correspond to hypotheses, H1, H2, and H3 (Figure 5). The labeling results and the data number used for validating the hypotheses are shown in Table 3.

Table 4 shows the result of computing the correlation to validate the hypotheses. H3 has a strong correlation, and it means listener’s attitude has an influence on the speaker’s mood. H1 also has a strong correlation. H2 has lower, but shows positive tendency of correlation. It means that the third person (or the agent) can perceive the speaker’s attitude and estimate his / her mood. Three hypotheses have positive correlation. Therefore, it indicates that there are some behaviors which change speaker’s mood to positive or to negative state. If those behaviors are implemented to the agent, a companion agent who can build rapport with the human user should be possible.

Table 3. Summary of labeling results and the number of data used for correlation computation

Pair	Label #	SL and SM	SS and SM	SS and 3S
1	1,745	17,236	17,235	16,758
2	1,536	17,163	17,163	17,035
3	1,350	17,015	17,016	16,951
4	1,472	17,472	17,395	16,793
5	1,234	16,280	16,280	16,259

Table 4. Results of correlation hypothesis validation

Hypothesis	Label	Correlation
H1	SS and SM	0.50
H2	3S and SS	0.21
H3	SL and SM	0.48

5 Conclusion

In order to develop a companion agent which can engage active listening, two functions are essential: the listener's attitude have an influence on the speaker's mood, third person (agent) can estimate the speaker's mood from perception of the speaker's attitude. However the possibilities of these functions are not validated yet. To examine them, we proposed three hypotheses: the attitude of the conversation can have influence on the speaker's mood, the mood of the speaker can be potentially observed by another person, and third person can perceive the speaker's attitude correctly. These hypotheses were validated from a human-human conversation experiment with self-evaluations and third person view evaluation.

In the future, at first we would like to increase the corpus size with additional experiments. And then, we would like to analyze the low-level signals of listener and how they can be interpreted as the listener's attitude. Also, we would like to analyze the listener's strategy in how to react to the speaker's perceived attitude. When the technology becomes matured, we will implement this function to agent and test with the elderly.

References

1. Huang, H.H., Matsushita, H., Kawagoe, K., Sakai, Y., Nonaka, Y., Nakano, Y., Yasuda, K.: Toward a memory assistant companion for the individuals with mild memory impairment. In: 11th IEEE International Conference on Cognitive Informatics & Cognitive Computing, pp. 295–299 (2012)
2. Huang, L., Morency, L.P., Gratch, J.: Virtual rapport 2.0. In: 10th International Conference on Intelligent Virtual Agents, pp. 68–79 (2011)
3. Tickle-Degnen, L., Rosenthal, R.: The nature of rapport and its nonverbal correlates. *Psychological Inquiry* 1(4), 285–293 (1990)
4. Otake, M., Kato, M., Takagi, T., Asama, H.: Coimagination method: supporting interactive conversation for activation of episodic memory, division of attention, planning function and its evaluation via conversation interactivity measuring method. In: International Symposium on Early Detection and Rehabilitation Technology of Dementia, pp. 167–170 (2009)
5. Bickmore, T., Laila Bukhari, L., Vardoulakis, L., Paasche-Orlow, M., Shanahan, C.: Hospital buddy: A persistent emotional support companion agent for hospital patients. In: 12th International Conference on Intelligent Virtual Agents, pp. 492–495 (2012)

6. McKeown, G., Valstar, M.F., Cowie, R., Pantic, M.: The SEMAINE corpus of emotionally coloured character interactions. In: *IEEE Intl Conf. Multimedia & Expo*, pp. 1079–1084 (2011)
7. Pammi, S., Schroder, M.: Annotating meaning of listener vocalizations for speech synthesis. In: *Affective Computing & Intelligent (2009)*
8. Cowie, R., Schroder, M.: Piecing together the emotion jigsaw. In: *Machine Learning for Multimodal Interaction*, pp. 305–317 (2005)
9. Hofstede, G., Hofstede, G.J., Minkov, M.: *Cultures and Organizations: Software of the Mind*, 3rd edn. McGraw-Hill, New York (2010)
10. Max Planck Institute for Psycholinguistics, ELAN annotation tool, <http://tla.mpi.nl/tools/tla-tools/elan/>
11. Boersma, P., Weenink, D.: Praat: doing phonetics by computer, <http://www.fon.hum.uva.nl/praat>

Improvement Research of Shoe-Type Measurement Device for a Walking Rehabilitation Support System

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Abstract. We have developed a shoe-type measurement device which is able to measure gait information such as step length, width and pressure distribution while daily living. We hypothesized that a walking rehabilitation system could be realized by combining shoe-type device and comprehensively display which showed analytical results for gait with real time operation. In this paper, based on the previous researches, real time operation for foot position measurement was realized by improving hardware and software. However, measurement error became larger than that in offline operation. The reason was thought to be time difference in synchronization which was necessary to realize wireless measurement system. By considering time difference, most measurement errors became smaller. In the next research, it would be necessary to decide time difference in any communication condition.

Keywords: gait analysis, wearable device, distance measurement.

1 Introduction

The physician and physical therapist combine a 3D motion analyzer and a force plate (a ground reaction force measurement system) to reach an objective judgment of the patient's gait at the hospital. However, the use of these devices is complicated, and these methods have limitations as to the space required, the number of steps required and real-time data collection. Therefore, the use of these devices is limited to the hospital and the rehabilitation site. In addition, these devices cannot give walking guidance for rehabilitation. Therefore, we have been developing a system which assists walking rehabilitation [1, 2]. Several kinds of sensors were mounted on rehabilitation shoes and certain types of information, such as the step length, walking speed and pressure distribution, could be obtained by means of that shoe-type device. A similar system, called "GaitShoe," has already been developed [3]. The difference between that system and ours lies in the purpose. That is to say, the purpose of that system is to

evaluate the walk, whereas the purpose of our system is to give the user information about the feet during walking, in addition to evaluating the walk. In our system, the information on the feet is transmitted by a wireless system to a signal processing unit, and the foot position and pressure distribution are displayed in real time. By looking at this display, the physician, physical therapist and patient can understand the present condition of the gait.

2 Outline of Our Measurement Device

Figure 1 shows the outline of our system. Our device consists of a shoe-type device onto which sensor units (gyro sensor, acceleration sensor, ultrasonic sensor and pressure sensor), a wireless module, an electronic tag to collect the data from the shoe-type device, and a display for the gait information are installed. The shoe-type device collects the gait information (step length, step width, pressure, etc.). The collected data are sent to a personal computer by a wireless module. The gait information necessary for rehabilitation is displayed on the screen based on the collected data. The doctor, physical therapist and patient can understand the state of the gait based on the information shown on the screen.

With our device, we first measured the foot position during the swing phase (Fig. 2). By using foot rotational angle based on integrated data of three-axis gyro sensor, data of three-axis acceleration sensor were converted into three dimensional acceleration data (x-axis, y-axis and z-axis). And, after integral calculus was executed for x, y, and x-axis acceleration data, summation of integrated acceleration data in the direction of x, y and z-axis were defined as foot position in the x, y and z-axis. However, the integral calculus of the data sent by the gyro sensors/acceleration sensors generated an integral error. Then, we used our device to measure the distance between both feet by means of an ultrasonic sensor and a gyro sensor during the double-support phase in order to correct the integral error. After obtaining foot rotational angle by using gyro sensor, x and y-axis distances between both feet were calculated by triangulation method which was applied to a pair distance data between one ultrasonic transmitter and two ultrasonic receivers.

The gyro sensor was installed at the toe, and was set to measure 300 [deg/s] of foot rotation during walking. The acceleration sensor was also installed at the toe, and was set to measure 10 [g] of foot acceleration during walking. The maximum values (300 [deg/s] and 10 [g]) were determined in a preliminary examination. Four ultrasonic receivers were arranged on the inside of the shoe, and two ultrasonic transmitters were arranged around the heel on each foot, in order to measure a step length of about 0.6 m during walking. We used eight pressure sensors which were installed on the insole, and those sensors were arranged to measure the track of the COP (center of pressure) inside the sole. Also, the timing of ground contact of the foot was determined from the pressure change. IC tags, which were placed at certain spots, were used to measure the absolute location and correct the position of the feet.

First trial manufacture of shoes-type measurement device was developed [4]. From evaluation in terms of clinical usability, it was found that a physical therapist or

physician would be able to evaluate the walk using our first device and walking rehabilitation such as increasing step length would be performed by patients themselves. Moreover, it was found that our first device measured distance between both feet with about 0.05 [m] in the range of 0.1~0.6 [m] during the double-support phase. However, there were some cases that distance measurement could not be well done because step length was larger than 0.6 [m]. The reason was that number of ultrasonic sensor was insufficient to cover necessary area.

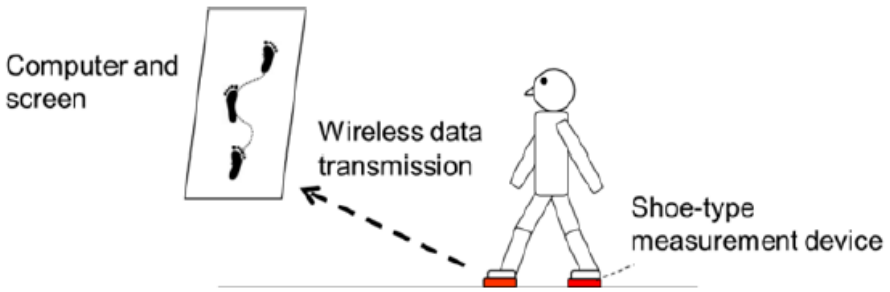


Fig. 1. Outline of our measurement system

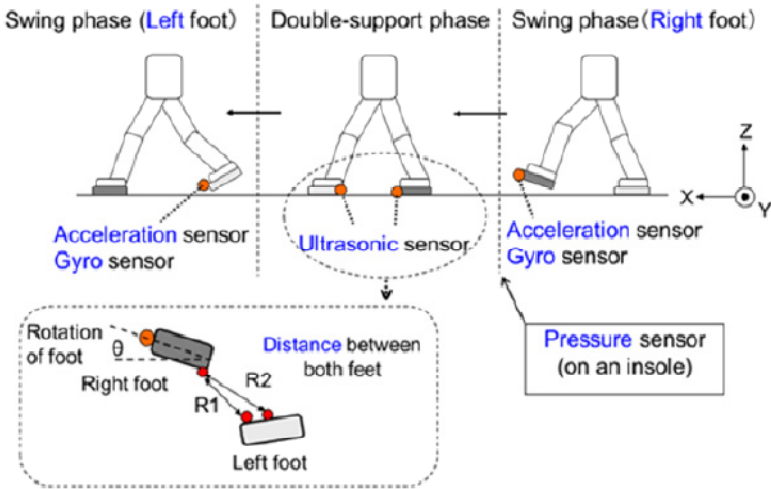


Fig. 2. Measurement method

Then, we redesigned and made the second trial manufacture of shoe-type measurement device [5]. Twelve ultrasonic receivers and five ultrasonic transmitters were set on both shoes in order to increase measurement area (1 [m] x 1 [m]) according to the results of simulation. However, sampling rate for ultrasonic sensors and pressure sensors was degraded to 15 [Hz] from 30 [Hz] because that increase number of ultrasonic sensors caused increase transmission data. On the other hand, sampling rate for acceleration sensor and gyro sensor was increased to 100 [Hz] by separating these two sensors from other sensors such as ultrasonic sensors, because 30 [Hz] in first

manufacture was not enough to measure acceleration and angle change accurately. Moreover, maximum measuring gravity of acceleration sensor increased to 16 [g] and maximum measuring rotation increased to 1,500 [dps]. In spite of improvement of acceleration and gyro sensor, it became impossible to measure foot position in real time operation because of not enough time to make control software [5].

Then, in this paper, we made the measurement system which could be performed in real time operation and investigated the measurement accuracy of our system.

3 Experiment

3.1 Redesigned Device

Photograph of device was shown in figure 3. Seven ultrasonic receivers were set on the toe, two were set on the side and three were set on the heel of the shoe. Five ultrasonic transmitters were set on the heel of the shoe. Eight pressure sensors were set on the insole for each shoe. Wireless data transmitter, signal processing unit with A/D and battery were set in the black box on the toe. Gyro sensor and acceleration sensor which were separated from the black box were set under the black box of the toe. The acceleration sensor and gyro sensor was sampled at 100 [Hz], while other sensors were 30 [Hz]. Data were inputted into a computer wirelessly and all data were synchronized.

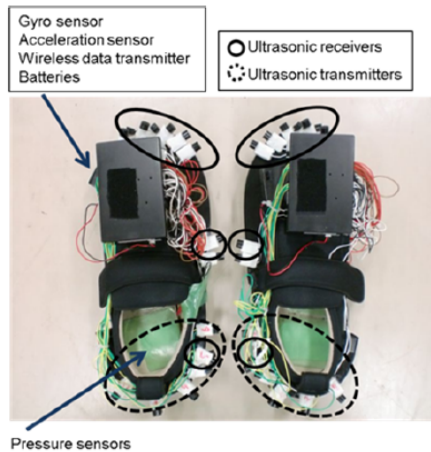


Fig. 3. Photograph of the second trial manufacture

To decrease measurement error when measuring distance by using ultrasonic sensors, the particle filter (PF) was used. In the particle filter, after comparison between all measurement data, most probable data was estimated from the view point of likelihood function, and making weight to all data and distance was measured. This PF method was expected to have smaller measurement error than the LSM (Least squares method, which was used in the previous research [5]) because that the PF method

calculated the distance stochastically from all data and therefore this method could absorb discrepancies in ultrasonic data. Moreover the PF method was expected not to be influenced by initial value because that distance was decided from using many measurement data while the LSM used only two measurement data.

3.2 Experimental Method

In order to investigate effectiveness of our proposition, measurement error of distance was calculated.

Measurement error of distance between both feet was evaluated for our device during walk. Experimental setup was shown in figure 4. Subjects were three young students who had no physical disorder. Subject was asked to walk straightly for about four steps within measurement area. Subject wore our shoe-type measurement device to measure distance between both feet. Also, motion of our device was measured by a motion capture system. This motion capture system was composed of eight infrared cameras and infrared reflection markers were set on toe and heel of shoe. Sampling rate of motion capture system was 60 [Hz]. Trial was repeated three times for each subject. Then, both feet distance was measured for over ten steps for each subject. In addition, measurement was performed in real time operation.

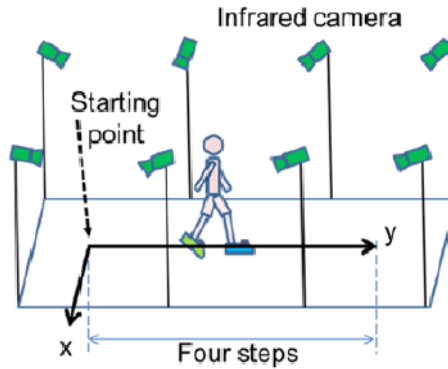


Fig. 4. Experimental setup for measuring distance error during walk

3.3 Experimental Results

Results were shown in figure 5. Vertical axis shows average measurement error in [m]. The legend shows that blue bars indicate the results of offline method in previous research [5] and red bars indicate the results of real time operation method in this experiment. Left two bars, middle two bars and right two bars show the results of distance between both feet, distance in x-direction and distance in y-direction, respectively. Definition of distance between both feet, distance in x-direction and distance in y-direction are shown in figure 6.

From this graph, measurement error in distance between both feet was 0.038 ± 0.015 [m] and there was not so big difference between offline method and real time operation

method. However, measurement error in x-direction was 0.055 ± 0.019 [m] and that in y-direction was 0.072 ± 0.042 [m]. These measurement errors in real-time operation method became worse than those in offline method.

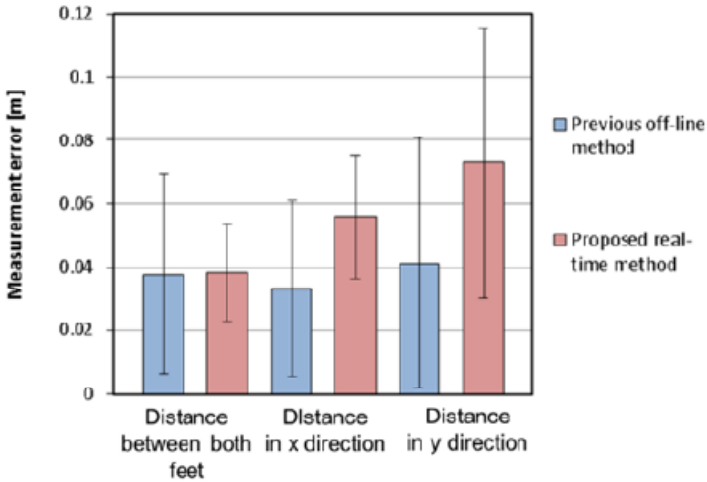


Fig. 5. Difference of measurement error between offline method and real time operation method

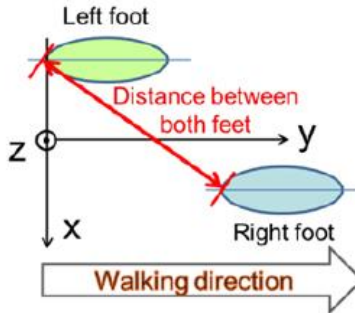


Fig. 6. Definition of distances in experimental environment

One reason why measurement errors in real time operation method became larger than those in offline method was hypothesized to be the time difference in synchronization between ultrasonic sensors of left foot and right foot. From the data analysis, there was 0.12 [ms] of time difference on average between both feet during walking experiment, although time difference was designed to be almost zero theoretically. This time difference meant about 0.04 [m] in distance calculated from sound velocity. This time difference was thought to cause bigger errors in real time operation.

Then, distance was tried to be corrected by considering distance difference of 0.04 [m] for all data obtained by ultrasonic sensors. Figure 7 shows the results. The blue bars indicate the results without any consideration and these bars were the same as the red bars in figure 6. While, red bars in figure 7 indicate the results after considering of

0.04 [m] for the blue bars in figure 7 (that is red bars in figure 6, without any consideration). From figure 7, measurement errors for both feet and y-direction became smaller but measurement error in x-direction did not decrease. The reason was thought to be that distance in x-direction was small and time difference was not so big. However, because distance in y-direction was relatively big and time difference was relatively big, consideration of time difference became effective. In this experiment, walking area was small and communication environment for data transmission did not change. Therefore, more detailed investigation for this time difference consideration was thought to be necessary.

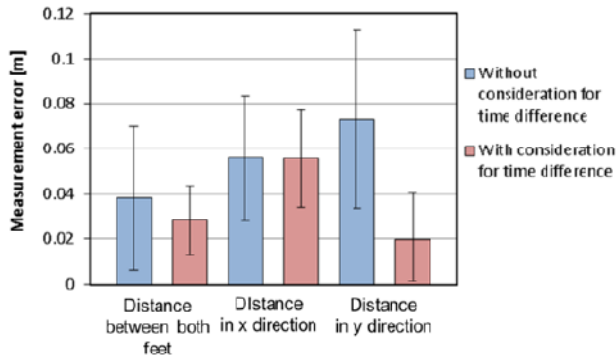


Fig. 7. Influence of time difference correction on measurement error

4 Conclusion

In this paper, we introduced our shoe-type gait measurement device. Based on the previous research, we made a system which could measure gait information in real time operation. However, measurement error in real time operation method became bigger than that in offline method. We hypothesized the reason of deterioration was time difference between both feet in order to realize real time operation. Then, in order to confirm hypothesis, most of measurement errors became smaller if time difference was considered.

In the next research, we would like to find a method in which time difference was decided in any kind of communication environment.

References

1. Sugimura, Y., Wada, F., Makino, K., Oda, T., Hachisuka, K., Ienaga, T., Yang, Z., Kimuro, Y., Otawa, T., Yukitaka, N., Koriyama, F., Tsuji, T., Wada, C.: Development of a shoe-type device for collecting gait information. In: 11th International Congress of the IUPESM, Medical Physics and Biomedical Engineering, pp. 514–515 (2009)
2. Wada, F., Sugimura, Y., Wada, C., Kimuro, Y., Ienaga, T., Tsuji, T., Otawa, T., Koriyama, F., Yukitake, N., Makino, K., Hachisuka, K.: A Wearable Device for Collecting Gait Information. In: Asian Prosthetic and Orthotic Scientific Meeting 2009 (APOSM 2009), p. 72 (2009)

3. Bamberg, S.J.M., et al.: Gait Analysis Using a shoe-Integrated Wireless Sensor System. *IEEE Transactions on Information Technology in Biomedicine* 12(4), 413–423 (2008)
4. Wada, C., Sugimura, Y., Wada, F., Hachisuka, K., Ienaga, T., Kimuro, Y., Tsuji, T.: Development of a rehabilitation support system with shoe-type measurement device for walking. In: *SICE Annual Conference 2010*, pp. 2534–2537 (2010)
5. Wada, C., Ikeda, S., Wada, F., Hachisuka, K., Ienaga, T., Kimuro, Y., Tsuji, T.: Improvement Study for measurement accuracy on Wireless Shoe-type Measurement Device to support Walking Rehabilitation. In: *Proceedings of the 2012 International Conference on Complex Medical Engineering*, pp. 471–474 (2012)

Influence of Organizational Culture and Communication on the Successful Implementation of Information Technology in Hospitals

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Abstract. In this paper, we report on a case study examining types of organizational culture influencing communication as an important factor in the study of successful IT adoption and implementation in health care. We observed a hospital organization and focused on technological innovations and the accompanying communication factors in the successful implementation of IT. The results demonstrate the importance of the organizational culture as an important factor in establishing well-balanced communication as a primary influence factor in the implementation of new technologies. Based on theoretical and empirical insights, we propose a model describing the relationship of organizational culture, communication, and the level of success in the implementation and adaptation of new IT systems in hospitals.

Keywords: Communication, Empathy, Hospital Culture, Information Technology, Model.

1 Introduction

Hospital administrators worldwide have recognized the importance of information technology (IT) as a strategic factor (see e.g. [1]). Success with technological innovation demands considerable strategic preparation. However, at many hospitals investments in information technology are viewed more as a necessary burden, than as a strategic requirement [2]. Hence, there is a need for a deeper investigation into the impact of culture and communication in relation to success when new IT is implemented within the organization of hospitals (e.g. [3]).

Apart from technological issues, organizational culture has to be considered when adapting and implementing new technologies. Successful communication for IT transformation needs to consider different mentalities, thought patterns and adaptation strategies that are anchored in culture. Thereby, communication requires mutual understanding in which empathy is a prerequisite [4]. Despite the noticeable importance of the empathy factor in communication and IT transformation, literature lacks studies regarding the relationship of organization culture in relation to empathy, communication, and IT system introduction success.

We investigated these relationships using the example of hospitals and demonstrate which organizational culture and characteristics enhance communication and therefore IT implementation success.

2 Background and Related Work

2.1 Organizational Culture

Organizational culture depends on the values and norms regarding technology and change. The knowledge transfer process requires empathy as the capacity to recognize emotions being experienced by another being [5]. Current research rather poorly focuses on this fact. When a new technology system is introduced, different reaction arises from individual staff members. The more empathy is engendered the more likely a smooth and efficient arrangement can be reached. Meanwhile, culture, through its myths, sagas, and organizational stories, provides “cognitive maps” that help organizational members orient themselves to organizational interactions and technological development [6].

Quinn’s competing values typology of organization culture is based upon two dimensions of implicit beliefs, and relies on human information processing within an organization in terms of spontaneity vs. predictability as well as external vs. internal factors. This results in four culture types and characteristics: developmental (flexible/external as e.g. adaptability, growth, risk taking); rational (predictable/external as e.g. planning, efficiency,); hierarchical (predictable/internal as e.g. stability, information management); and the group (flexible/internal as e.g. cohesion, morale) [7].

It has been found in competing research works [8-10], that value frameworks that the validity of measuring the cultural dimensions that are common across organizations, as well as evaluating culture types are relative to other variables [11]. This approach allows understanding the values underlying the organization cultures and to take action to communicate the organization the desired results.

Thus, the four culture types of developmental, rational, group and hierarchical will be adapted and discussed in this study in relation to communication.

2.2 Communication

Competitive technology innovation depends largely on the organizational ability to communicate IT knowledge to individuals [12, 13]. Thereby, communication focuses on the means to implement innovations. Organizational communication includes the

verbal and nonverbal communication that is used to influence the working environment in an organization. To implement new technology in an organization, communication in line with their organization culture plays a significant role. In the context of this paper, we focus on the review on using empathy for facilitating successful IT implementation based on the organization culture types before we propose implementation actions [4, 5].

Organization culture with its values influences the desire for a reaction to information that is gathered and transformed through the external and internal communication channels and turned into organizational knowledge. A culture that values both - an external focus (i.e. the improvement of its competitive position) and an internal focus (i.e. the maintenance of its socio-technical system) may maximize its efficient use of innovation [14]. Thus, communication is affected by the value an organization places on meeting the innovation completion or internal efficiency.

In addition, organizations react quicker to general environmental events, when the organizational values, perspective and policies reflect these [15]. Hence, if new technology introduction is too distant from the organization's expectations, the organization may resist accepting it, resulting in its rejection.

Therefore, communication channels enabling the consistent communication of innovation and organizational change are the key element in adapting new technologies.

2.3 Communication Channels

A communication channel is defined as a means by which information is moved from one point to another within the social system [16], and so communication channels are important for IT adoption. After reviewing research from a variety of research streams, [17] concluded that when communication is frequent, project teams are more likely to adapt and that they become more efficient at using the information gathered (similarly at applying agile methods, cf. [18]). In addition, boundary spanning, both inside and outside the organization, is important to skill and knowledge development and transmitting. External information must be mixed with those information already in use in the organization [19]. External communication channels can include the use of external sources of knowledge (e.g. periodicals), the existence of internal technical expertise, or boundary spanners that can recognize innovations of value, and internal structure that provide the bridge between external knowledge and the organization. This suggests that communication for new technologies is enhanced when internal and external information is addressed.

Internal communication channels linking organizational members should enhance knowledge flow once the idea for a new IT has entered the organization. Based on observing several organizations involved in knowledge management projects, Davenport et al. [20] suggest that a culture for multiple channels for knowledge transfer is important. Such communication channels include regular scheduled meetings and standard reports.

To allow external technical knowledge to reach organizational members, organizations often hire new staff, access documents describing new developments, trained within the organization, encourage personal contacts with knowledgeable individuals

outside the organization, and use other external communication channels (e.g. meetings, workshops etc.) [21].

In sum, external and internal communication channels supported by empathy constitute an organization's communication which is the basis for successful adaption of information technologies. Organizational culture would likely influence communication leading to IT implementation success.

Therefore, we will analyze organizational culture, empathy based communication and communication channels as well as the potential relationship between organizational culture, communication and IT implementation success.

3 Case Study

3.1 Method

Design research involves the analysis of the use and performance of designed artifacts to understand, explain and improve the behavior of information systems. The design science paradigm seeks to extend the boundaries of user and organizational capabilities by creating new and innovative artifacts, including constructs, models, methods, and instantiations [22, 23]. The act of designing new innovative solutions does not occur in isolation, but is a process of constant engagement with practitioners and artifacts are constructed as a living process engaging practitioners [24].

Thereby, the Design Science Research Methodology (DSRM) was applied for a large public hospital located in Dublin County that adapted several information system transformations. Following the general principles of conducting case studies [25], as including written materials, organizational structure reviews, open-ended and structured interviews, use of informants and focus groups as well as absorbing and noting details and actions in the field environment, Figure 1 shows the suggested research method.

The research was conducted in three phases, always considering engaging the study's participants. The first phase was to carry out an onsite survey to determine the general information about organization structure, organizational values and norms, daily communication patterns, technology embracement, etc. The second phase was to conduct the in-person interviews to determine the hospital culture types, system or new system implementation strategy and capability and their IT or system success satisfaction levels. The third phase was to analyze the results seeking for clear connections among the culture types, communication and success of IT implementation.

As the interview subjects for semi-structured interviews for this study, we found six top managers exhibiting a broad view of the organization regarding the organization's environment, available resources, workflow pattern and values [26]. We asked them to address issues regarding system implementation, influential factors, culture types, hospital communication channels and communication means as well as their IT adoption and implementation satisfaction level. The organizational culture questionnaire is adopted from [27], where questions for interviewees use the Likert-like five-point scale for scoring. The definitions are displayed to the interviewees before answering any of the structured questions. The communication questionnaire

consisted of questions that are related to communication channel and empathy. As communication channels can be viewed as external (boundary spanning) or internal (transfer of knowledge within the organization), the interview questions to analyze the communication channels contained condensed items from [28] and [16]. To address the aspect of empathy, the respondents were asked on their social awareness and emotional competencies on the staff when the new system was to be implemented.

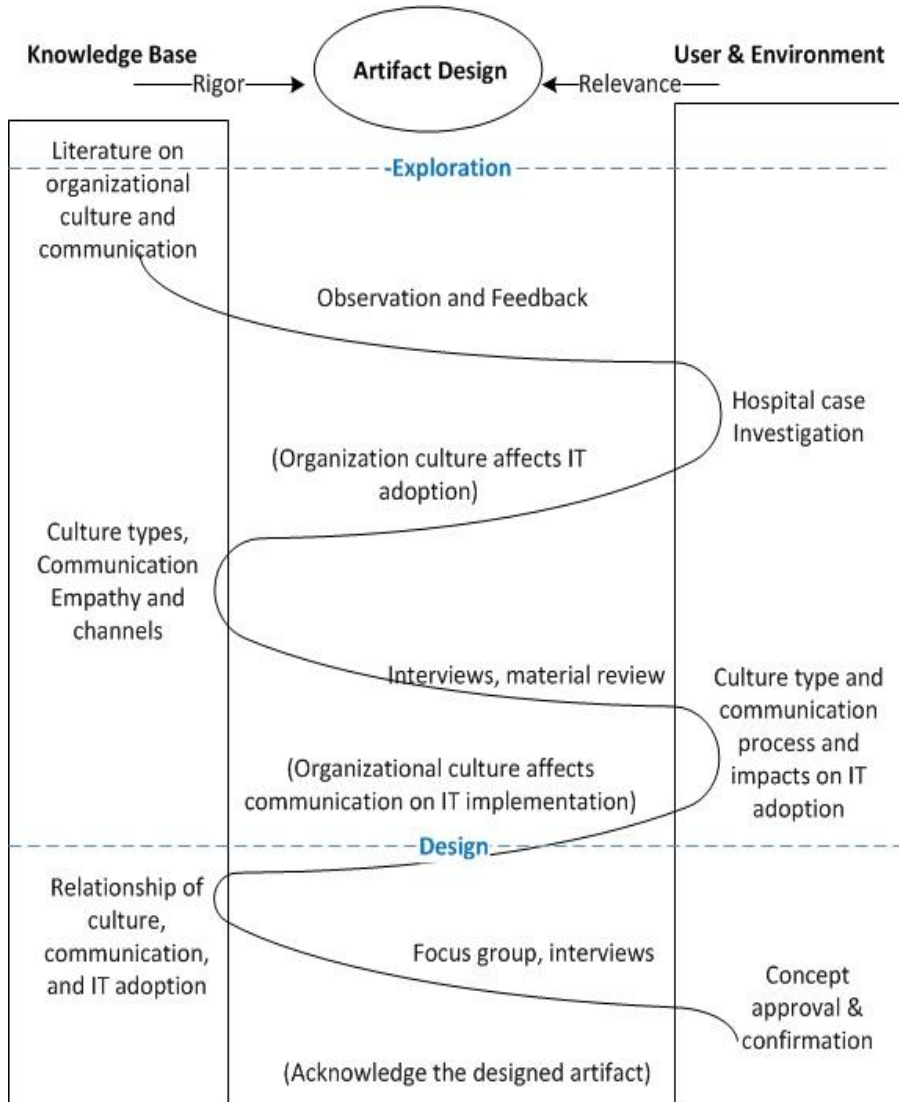


Fig. 1. Proposed Research Method Integrating Theoretical and Empirical Aspects

3.2 Results

The results indicated that the investigated hospital consists of *hierarchical* and *rational* culture types. The organizational structure of the hospital embraces a group of the powerful at the top with subsequent levels of power beneath them representing the dominant mode with different levels of management, power and authority. The managers state that such a structure emphasizes stability and control which cause resistance to change when any new technology or system is introduced. In their experience, such highly mechanistic structures with hierarchical values led to the failure in the implementation of advanced technologies because of the hospital's inability to adjust to the new technology. For instance, the introduction of the electronic medical records (EMR) system started in 2005, and it is still on hold after eight years. Such a structure led to limited communication channels due to the bureaucracy associate authorities and layers. At the implementation level, the means of communication is addressed with limitation as well. The CEO remarked on the challenge and frustration of initiating the system change that all levels of managers in the hospital have to be convinced that for system adoption. However, quite often mutual agreement cannot be reached due to various reasons localized resisting within a department or group of employees that means, efforts and time investment may just end up project with pending. This hierarchical culture is very common in the public sector and is very difficult for a complete change. In addition, the hospital also consists of rational culture type. It places emphasis on matters of external environment. This leads to the organization's main operation mechanism being based on economic considerations and likewise on competitiveness and productivity [29]. The bond between the hospital members is built on profit motives. Managers are encouraged to emphasize results and achievement of goals, but are discouraged to consider the works environments. When a new system is to be adopted for usage, communication focus is external (being competitive) and the communication within the hospital does not encourage empathy factors. One top manager stated that it is good to promote productivity by adopting any new systems, but it is also very important to have the staff passionately learn and use the system so that they positively embrace the change and operate with it well in the long run. In the hospital environment patient care delivery is the focus; however the outcome for patient treatment may not yield immediate profits. At the same time because rational culture is task-oriented and inclined towards independent action, it lacks teamwork and knowledge sharing, which withdraws back the long term benefits from new technology implementation. In that sense, the means of communication for system or technology change can be gentler and more humane, this means, that because communication involves empathy it will lead to a better and smoother transition.

To put it in a nutshell, the case study results support the claim found in literature that for successful IT implementation, hierarchical culture should be minimized and rational culture should be mixed with the empathy factor through communication.

4 Discussion

The review of the related work and the output of the conducted case study confirmed that communication channels and the empathy factor are key elements of communication related to successful IT implementation. These communication skills also have to be in line with the organization culture types. Communication focuses on the process and means to adopt IT, whereas, organization culture focuses on the value and norms regarding technology. Therefore, organization culture influences communication approaches for successfully implementing IT in hospitals. We think that strong organization cultures support greater sharing of information (group culture) and development of new approaches (developmental culture) which tend to facilitate communication by addressing empathy and communication channels and therefore facilitate IT adoption and implementation. Figure 2 shows the conceptual model derived from the integration of the findings from the case and literature study.



Fig. 2. Proposed Model for Improving IT Implementation Success

As discussed above, types of cultures that promote an external focus (i.e. developmental and rational) would promote change include risk taking, openness, and high expectations for action [30]. In that sense, the external focus culture types of developmental and rational would be conducive to developing communication channels. A cultural reward system that supports participation and knowledge sharing would also be important in developing communication. Therefore, a strong group culture would lead to greater internal communication channels.

Culture types also affect the intention of addressing empathy in communication. An organization with strong developmental culture will be likely to assimilate the cognitive model of its counterpart for desired outcomes. The same applies to the group culture, where affiliation emphasizes mutual understandings and members are more likely to use empathy as a means to reach a certain purpose (e.g. adopting and using newly introduced technologies). Alternatively, hierarchical culture with its emphasis on stability and control are most likely to result in resistance to change and less sensitivity for the environment [31]. When bureaucracy associated with hierarchical cultures and bureaucratic delays are reduced, such as in a flatter organization in which manager’s work directly with lower levels, communication and rapid turnaround time for innovation are facilitated.

Furthermore, the case study implied insights into the types of actions that management should undertake in order to enhance communication. These include extensive use of external and internal communication channels, such as exposing internal

groups to external environments and information, encouraging cross-functional teams and groups meetings to exchange information. Communication means should be pleasant and emphasize human feelings with empathy. It may be a productive exercise for managers to look closely at their underlying assumptions, attitudes and values towards organizational applications. In addition, the managers can learn that they are the ones who most influence the shared values reflected in the culture mix that, in turn, affects the hospital attitudes toward leaning and changing necessary to successfully adoption of new technology.

According to the proposed model in Figure 2, it is advisable to address both internal and external communication channels as well as emphasize the empathy factor in communication for successful IT implementation. The implications for the hospital investigated in the case study, this means, that it needs to investigate in how to change or minimize its hierarchical culture to group culture simultaneously strengthening their rational culture by adding empathy factors. The top managers agreed with the approach and signalized positive feedback to a certain degree. Although outlining the detailed plans to change the organization culture is difficult, it pinpoints the importance of relating culture types to communication path to boost IT implementation.

However, the proposed model and its implications must be supported by large scale statistically driven examinations to increase validity and reliability. Therefore, it is planned to carry out a large study using a high number of questionnaires distributed to top managers in healthcare organizations. Descriptive statistics should be performed to uncover the basic characteristics among the samples. The construction validity and reliability of the test methods must be ensured. The expected approach is to use LISREL to perform a conformational factor analysis on the sample data to determine the loadings for the organizational culture types. Thereby, for example, it should be possible to access the fitness of the final model from its absolute fit value, its incremental fit value and its parsimonious fit value [32].

5 Conclusions

The main objectives of this study were to define the relationship of organization culture and IT implementation success through communication and empathy. For the technology transformation and implementation, communication is the factor addressed in this study from the perspectives of communication channels and empathy factors. It is found that organization culture affects both communication perspectives, which can exert positive influence on IT implementation.

Communication channels between the external environment and the organization, as well as among the subunits of the organization are important. Our ongoing research on empathy is consistent with communication studies, i.e. emotional and intelligence competencies related to the processes of assimilation, transformation and exploration of knowledge.

Based on the literature and case investigation, we proposed a model to illustrate this relationship and empirically investigated it in a hospital organization. Organization culture types have either positive or negative impacts on technology or system adoption depending on the organizational culture types.

A major contribution of this study is an understanding of the adjustment of the culture types and communication as importance factors for hospitals' success in system implementation. As proposed, communication is related to hospital organization culture. A hospital culture that is focused externally and internally while limiting bureaucracy is most likely to lead to better communication. An external focus (developmental and rational culture) means that hospitals that value flexibility and the improvement of their competitive position are limited to communication and group culture should be mixed in. Hierarchical culture should be minimized in the hospitals.

In the future, large scale statistically driven examinations will be carried out to validate the proposed model.

References

1. Anonymous: Adoption of health information technology standards would save billions: study. *Health Care Strategic Management* 23, 4–5 (2005)
2. Glen, G.K.: Harnessing technology to redesign labor cost management reports. *Healthc. Financ. Manage.* 59, 94–100 (2005)
3. Holzinger, A., Kosec, P., Schwantzer, G., Debevc, M., Hofmann-Wellenhof, R., Frühauf, J.: Design and development of a mobile computer application to reengineer workflows in the hospital and the methodology to evaluate its effectiveness. *J. of Biomedical Informatics* 44, 968–977 (2011)
4. Heimgärtner, R., Tiede, L.-W., Windl, H.: Empathy as Key Factor for Successful Intercultural HCI Design. In: Marcus, A. (ed.) *HCII 2011 and DUXU 2011, Part II. LNCS*, vol. 6770, pp. 557–566. Springer, Heidelberg (2011)
5. Liu, C.-H., Wang, Y.-M., Yu, G.-L., Wang, Y.-J.: Related Theories and Exploration on Dynamic Model of Empathy. *Advances in Psychological Science* 5, 014 (2009)
6. Daft, R.L., Weick, K.E.: Toward a Model of Organizations as Interpretation Systems. *The Academy of Management Review* 9, 284–295 (1984)
7. Quinn, R.E., Rohrbaugh, J.: A Spatial Model of Effectiveness Criteria: Towards a Competing Values Approach to Organizational Analysis. *Management Science* 29, 363–377 (1983)
8. Ngwenyama, O., Nielsen, P.A.: Competing values in software process improvement: an assumption analysis of CMM from an organizational culture perspective. *IEEE Transactions on Engineering Management* 50, 100–112 (2003)
9. Yeung, A.K., Brockbank, J.W., Ulrich, D.: Organizational culture and human resource practices: an empirical assessment. In: Woodman, R.W., Pasmore, W.A. (eds.) *Research in Organizational Change and Development*, vol. 5, pp. 59–81. JAI Press, Greenwich (1991)
10. Zammuto: Quantitative and qualitative studies of organizational culture. *Research in Organizational Change and Development* 5, 83–114 (1991)
11. Howard, L.W.: Validating the competing values model as a representation of organizational cultures. *International Journal of Organizational Analysis* 6, 231–250 (1998)
12. Bassellier, G., Benbasat, I.: Business competence of information technology professionals: conceptual development and influence on it-business partnerships. *MIS Q.* 28, 673–694 (2004)
13. Boynton, A.C., Zmud, R.W., Jacobs, G.C.: The Influence of IT Management Practice on IT Use in Large Organizations. *MIS Quarterly* 18, 299–318 (1994)

14. Harvey, M., Palmer, J., Speier, C.: Implementing intra-organizational learning: A phased-model approach supported by intranet technology. *European Management Journal* 16, 341–354 (1998)
15. Antal, A.B., Dierkes, M., Hahner, K.: Business Perception of Contextual Changes: Sources and Impediments to Organizational Learning. *Business & Society* 36, 387–407 (1997)
16. Chakrabarti, A.K., Feineman, S., Fuentesvilla, W.: Characteristics of sources, channels, and contents for scientific and technical information systems in industrial R and D. *IEEE Trans. Engineering Management* 30, 8–82 (1983)
17. Brown, S.L., Eisenhardt, K.M.: Product development: Past research, present findings, and future directions. *Academy of Management Review*, 343–378 (1995)
18. Cockburn, A., Highsmith, J.: Agile Software Development: The People Factor. *Computer* 34, 131–133 (2001)
19. Macdonald, S.: Learning to Change: An Information Perspective on Learning in the Organization. *Organization Science* 6, 557–568 (1995)
20. David, W.: Successful Knowledge Management Projects. *Sloan Management Review* (1998)
21. Zmud, R.W.: The Effectiveness of External Information Channels in Facilitating Innovation within Software Development Groups. *MIS Quarterly* 7, 43–58 (1983)
22. March, S.T., Smith, G.F.: Design and natural science research on information technology. *Decis. Support Syst.* 15, 251–266 (1995)
23. Hevner, A.R., March, S.T., Jinsoo, P., Ram, S.: Design Science in Informaitona System Research. *MIS Quarterly* 28, 75–105 (2004)
24. Ostrowski, L., Helfert, M.: Reference Model in Design Science Research to Gather and Model Information. In: *AMCIS 2012 Proceedings. AISel* (2012)
25. Yin, R.K.: The Case Study Crisis: Some Answers. *Administrative Science Quarterly* 26, 58–65 (1981)
26. Buenger, V., Daft, R.L., Conlon, E.J., Austin, J.: Competing values in organizations: Contextual influences and structural consequences. *Organization Science* 7, 557–576 (1996)
27. Quinn, R.E., Spreitzer, G.: The psychometrics of the competing values culture instrument and an analysis of the impact of organizational culture on quality of life. *Research in Organizational Change and Development* 5, 42–115 (1991)
28. Nilakanta, S., Scamell, R.W.: The Effects of Information Sources and Communication Channels on the Diffusion of an Innovation. *Management Science* 37, 1503–1506 (1991)
29. Quinn, R.E.: *Diagnosing and Changing Organizational Culture: Based on The Competing Values Framework-3/E* (2011)
30. Kettinger, W.J., Grover, V.: Special section: toward a theory of business process change management. *Journal of Management Information Systems* 12, 9–30 (1995)
31. Fiol, C.M., Lyles, M.A.: Organizational Learning. *The Academy of Management Review* 10, 803–813 (1985)
32. Ullman, J.B., Bentler, P.M.: Structural equation modeling. *Handbook of Psychology* (2003)

The Interaction between Human and the Home Service Robot on a Daily Life Cycle

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Abstract. The objective of this paper is to explore the perceived roles of home service robots between different cultures. Human preferences on interaction modes and features of a home service robot were investigated in this ongoing study. Results of the study indicated a complicated issue related to the acceptance and reliability of a social robot. And participants from Taiwan and Japan reflected their preferences on communication matters in function, service, interaction, appearance, likability, and trust issues. Participants from both cultures preferred home service robot to provide information over social services, while Taiwanese participants possessed significant preference on scheduling/planning function. For the future needs of home service robots, Taiwanese participants preferred entertainment service robots, and Japanese participants preferred caretaker robots.

Keywords: culture, human robot interaction, communication, home service robots.

1 Introduction

A home service robot is a social-service robot used in people's home to provide convenience by having features such as cooking, providing care, being a companion, to areas which may relate to providing news, providing house security, sharing stock market information, checking the weather forecast, and others people can get hold of easily through the use of a robot. To understand a better linkage between human and robot relations, we wanted to observe what type of interaction and communication method affects human's likability and acceptance towards robots through a cultural view as we believe robots should be different for each culture.

Through this survey, we believe a better understanding of social robots will be given by interpreting human value to enhance robotic likability as social robots are not looked upon positively as we hoped. With the growing studies and the idea of having robots in every home, such as South Korea between 2015 and 2020 (CBC, 2007), we

hope to grow and push the home service robot project forward for future developments around the world.

2 Literature Review

2.1 Robotic Interaction and Communication

People communicate with other people through its personality, characteristics, speech pattern, voice style/tones, gestures, or body movements (O'Neill-Brown, 1997), while robots on the other hand needs to be programmed in order to facilitate these actions like a human, which many studies and research have been taken to enhance these areas of interaction in various developments. Non-verbal communications such as expressions in gestures, eye contact, and other social behaviors are user frequently while conversing or doing specific tasks, which makes human-human interaction a specialty compared with a robot. This human-human interaction (Nass & Moon, 2002) is a key to contribute a good human-robot relation, where computer's manner or character should follow the same style of characteristics a human being would to another human being.

When discussing about "appearance" in robotic term, people tend to refer this as a physical entity, thinking about its aesthetical form, forgetting to interpret the socially psychological side of robotics; where the idea of 'judging a book by its cover' can be used in relation with the concept of "appearance" of robots. Just because a robot may look dumb does not mean it does not have skill or is stupid. A robot that may look smart may not be intelligent as well. These questions raise studies in what "appearance" in both physical and psychological interpretation can lead to. Mori's research about robots physically appearing like a human is frowned upon, having people back away from having a robot. This uncanny valley (Mori, 1970) would be an area we will try to avoid as many people may perceive a home service robot may look scary or uncanny.

Ethical robots (roboethics) (Veruggio, & Operto, 2006) come in play to understand relational-respect to humanity issues of likability, trust, and privacy. We believe by understanding communicational response, perception of social likability, and also considering physical appearance, a robot will be better understood for a closer approach in people living with a robot on a daily level. This ethnographical approach into the study will also link back to cultural aspects of the research as well.

2.2 Home Service Robots in the Market

Currently, there are several home service robots out in the market. Robosapien by WowWee Robotics for personal entertainment use inside a home, Nabaztag who connects to the Internet by Wi-Fi to check and notify and remind people of certain information's or event's, an instant message notifier by iKnock for social and personal messaging use, a polar bear-like robot named RIBA (Robot for Interactive Body Assistance) who performs as a nurse or a caretaker by RIKEN-TRI Collaboration Center

for Human-Interactive Robot Research (RTC), GUARDROBO by Sohgo Security Services Company who provides security measures and also acts as a greeter, and Roomba for vacuum cleaning by iRobot Corporation. We believe these robots provide different service for different culture as the degree of robotic acceptance plays its role in appearance, likability, and trust towards a robot.

2.3 Culture and Robots

To understand a better linkage between human and robot relations, we wanted to observe what type of interaction and communication methods affect human's likability and acceptance towards robots. We feel a future for cultural robot can be studied through differences of opinion, where a connection between each culture may exist to have a culturally accepted robot in place.

As Western people are more independent, and Eastern people are more interdependent (Markus & Kitayama, 1991; Rau, Li, & Li, 2009), our research were explored amongst different nationality and culture to gain a better understanding of what a universally accepted robot may or may not be, and how the idea of robots are thought and are different compared between the Western and the Eastern world. With different ethnography between each culture, we predict a robot made in a Western geography may not be well accepted in the Eastern geography, vis versa, a robot developed in an Eastern geography may not be well accepted in the Western geography.

2.4 The Nature of a "Home" Environment

For a home service robot, one of the few challenges is to realize or become conscious of a home as a private area or sector rather than a public area. Private area also means privacy and confidentiality is considered, where a public robot are programmed for doing one thing well, such as a robot inside a museum, security robots, and tour guide robots although the task might be similar. These private robots are personalized for each user, whereas interaction and communication between family members, roommates, maid or domestic helper, owners, and pets should be quite different from relationships between classmates or co-workers. In cultural perspective, the communication level, freedom of control of a robot, and personal space will be few issues a user may experience different compared with the Eastern and Western geography as lifestyle and personal values differ greatly for both geography.

3 Methodology

A survey was conducted to understand what robots should have as its feature or service, physical appearance, likability, sincerity, trust and privacy issues, and to see a general view of what robots are being thought as today. The survey has a total of 19 questions, available both in English and Chinese. We currently started by doing an Asian overview first, where the research will still continue by collecting data from overseas aspect for the study. The survey was divided into 6 main sections.

Section 1 includes personal information about the surveyor by identifying its nationality, age group, gender, occupation, and to analyze their position and understanding of robots and their buying behaviors. We believe some answers to the question may refer to their style of buying behaviors as a survey safety issue.

Section 2 includes service and function questions, ranging from features and values a robot may provide humans with. This section was also used to provide information of what home service robots may be as people who may not know about robots may take the survey and understand what robots are little by little. This part of the survey was completed by asking the surveyor how strongly they need or don't need a certain feature that may exist in a robot.

Section 3 asked questions regarding the robots style traits, body structures, and size. The style traits questions were arranged with questions such as which style they like more: a modern or a futuristic robot, machine like or human like, have low character or high character... to see their preference of robots (Fig. 1). The response section was for them to mark the range of how they felt more comfortable in associating a robot with. Seven ranges were provided for this question. The body structures section asked questions related to if it should have a feet or use a wheel, have a palm to grab things or a finger to grab things, have or don't have facial features, virtual face vs. visual face, and more to see what type of robot will fit well for a home service robot.

Section 4 raised issues related to likability, sincerity and trust and privacy through human robot interaction (HRI) questions, where some were direct and indirect questions for the surveyor. The idea here was to see how home service robots can be improved or have in consideration when developing it. General questions here were related to personality, behavior, to attitude and ethical questions to see and relate it towards human-human interaction. We measured this by having the surveyor mark answers regarding how strongly they disagree or agree to each questions. For question on "trust" issue in question 14, we copied a study from Rau's study.

Section 5 and 6 were more of future ideation of what robots are being thought as today with current technology and science people may or may not know of. These 2 sections were more to open their mind and see what they know about robots and what they may or may not want to see in the future. By seeing this degree of acceptance of a robot, we wanted to seek information regarding the future of robots through their eyes. Lastly, section 6 was an optional comment area to gain feedbacks or suggestions they may want to share with us.

4 Preliminary Results

In total, 19 responses were received from Taiwan and 27 responses were received from Japan. We tested if there were some culture differences in robots' services, appearances and HRI factors.

Section 1: The 46 surveyors were all males and their ages were above 18 years old. They all bought new products after products were sold in several months. When we asked the willingness to own any home ISRs, 53% said they will and 42% were not

sure in Taiwan's surveyors; 22% said they will, 37% said they will not and 41% were not sure in Japan's surveyors.

Section 2: No matter in Taiwan or in Japan, the requirement of services were house chore related function, caretaker/nurse function, schedule/planner function, security function, detecting emergency phenomenon such as earthquake and typhoon, remotely turn appliances, providing information and find stuff function. These functions were all evaluated above 4 score (somewhat need) in both cultures. Only in schedule/planner function, we found significant higher evaluation in Taiwan than Japan ($t(44) = 2.14, p < .05$). The social factor service, charting service, networking service and greeting all evaluated near or below 3 score (somewhat don't need).

Section 3: The higher scores represented the surveyors were more comfortable in associating home ISRs with futuristic, machine-like, looks complicated, female figure, brighter color, looks thin, organic and high character. The opposite were modern, human-like, looks simple, male figure, darker color, looks strong, geometric and low character. The score 4 meant neutral or both not in the two opposite dimensions. Taiwanese and Japanese all liked robots be futuristic, looks simple, female figure and brighter color. The Taiwanese emphasized more on high character and significantly more on organic ($t(44) = 2.60, p < .05$). There were no preference of machine-like/human-like and looks strong/looks thin traits. The evaluated scores of them were closing to the middle score 4.

Considering the body structures, we conducted chi square to examine the proportion differences in each body structure question. We only found significant culture difference in wheel vs. feet character ($\chi^2 = 7.26, p < .01$). For Taiwanese, they preferred wheel than feet and we got reversed preference for Japanese. In other structures, Taiwanese and Japanese preferred finger, no facial feature, arm and body screen. Taiwanese more liked virtual face than visual face and there was only minor reversed preference for Japanese. But we did not find significance in this structure ($\chi^2 = 3.0, p = .08$). Lastly, the medium size of home robots (66.7%) was most popular in Taiwanese and Japanese.

Section 4: In Taiwan surveyors, the Cronbach's α for likability, sincerity and trust and privacy were 0.87, 0.90 and 0.86. And in Japan surveyors, the the Cronbach's α for the three scales were 0.86, 0.88 and 0.84. The evaluation of robots in these HRI factors, Taiwanese significantly evaluated higher than Japanese (Likability: $t(44) = 2.90, p < .01$; Sincerity: $t(44) = 2.82, p < .01$; Trust and Privacy: $t(44) = 2.26, p < .05$).

Section 5 and 6: Table 1 and 2 show the surveyors' percentage in each rank. Most surveyors in Taiwan thought the most popular robot was entertainment service robot in the future. The second were the labor robot, safety/security robot or information providing robot. The following sequence was assistant/servant robot, remotely accessed robot, and caretakers/nurse robot. The last one was social companion robot. In Japan, the first one was caretakers/nurse robot. The following sequence was safety/security robot, assistant/servant robot, remotely accessed robot, information providing robot. Counting back second place was entertainment robot and labor robot. The last one was also companion robot.

5 Discussion

The services of robots: In both cultures, the following services should be first implanted: house chore related function, caretaker/nurse function, schedule/planner function, security function, detecting emergency phenomenon such as earthquake and typhoon, remotely turn appliances, providing information and find stuff function. However, in the section 5's popularity sequence arrangement, the second to seventh rank of robots' functions corresponded to the section 2's requirements investigation. Our surveyors wish the home ISRs which relate to services in labor, secure, servant or information providing dimensions are popular soon. The interesting thing is caretaker/nurse robots are required but doesn't think should be popular first in Taiwanese. And the entertainment robot is in the seventh popular rank in Taiwanese. But in Japan, the caretaker/nurse robots are ranked in first place. The social companion robots are the lowest required and most unpopular.

The appearance of robots: In Taiwan and Japan, the physical structures of the robots are finger, no facial feature, arm and body screen. Taiwanese more like virtual face and wheel robot. Japanese liked feet robots but no difference in preference of virtual or visual face. On the other hand, we can follow the questionnaire's results to design our robots for different countries. The only consideration is designed a more organic and high character robots for Taiwanese. Lastly, medium size robot is well accepted for all surveyors no matter their cultures.

The HRI dimensions: HRI factors of likability, sincerity and trust and privacy are thought more important in Taiwan. This might relate to degree of acceptance of robots' information. In Japan, the development of robots is more emphasized and robots are more accepted. Japanese might more confident and reliable to interact with robots than Taiwanese. As a result, the psychological factors for Japanese to evaluate in agreement degree are lower than Taiwanese.

Our current goal is to provide future studies into cultural aspect of robotic development in the field of home service robots. The questions about what robots can do, how they look like and how the interaction between human and robots can all be found out in our study. Further testing, experiment, and exploration will be continued to bring in the Western geography into our test results. Further studies may include a topic related to culturally accepted robots and how they can be developed.

References

1. CBC, Ethical code for robots in works, South Korea says (2007), <http://www.cbc.ca/technology/story/2007/03/07/tech-robot-ethics.html>
2. Markus, H.R., Kitayama, S.: Culture and the self: Implications for cognition, emotion, and motivation. *Psychological Review* 98(2), 224 (1991)
3. Mori, M.: The uncanny valley. *Energy* 7(4), 33–35 (1970)
4. Nass, C., Moon, Y.: Machines and mindlessness: Social responses to computers. *Journal of Social Issues* 56(1), 81–103 (2002)

5. O'Neill-Brown, P.: Setting the stage for the culturally adaptive agent. In: Proceedings of the 1997 AAAI Fall Symposium on Socially Intelligent Agents, pp. 93–97 (1997)
6. Rau, P.L., Li, Y., Li, D.: Effects of communication style and culture on ability to accept recommendations from robots. *Computers in Human Behavior* 25(2), 587–595 (2009)
7. Veruggio, G., Operto, F.: Roboethics: a bottom-up interdisciplinary discourse in the field of applied ethics in robotics. *International Review of Information Ethics* 6, 2–8 (2006)

Part III
**Cross-Cultural and Intercultural
Collaboration**

Extending Role of “I” Virtually – Identity Performance and Their Influence on Individual Behaviour and Team Performance in Globally Distributed Work Virtual Teams

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Abstract. The customer driven innovation systems, market pressures, accelerating technologies, limited resources, technical complexities and need for expertise have driven organization beyond boundaries. Globally distributed work force is one of the competitive strategies of any leading organization and synergy among team members is vital to achieve excellence. This paper extends the line of research to identify performance and its role of self-presentation among virtual teams to strengthen trust, task interdependence, task oriented communication and interpersonal relationships. Identifying the role of “Digital Identity in self presentation” and understanding team process from “Psycho-Social dimension” by emphasizing importance on the form of social interaction that takes place, rather than the content or structure itself presents a new perspective. The proposed model emphasizes trade-off between identity consolidation and mobilization of virtual teams. We believe that the proposed framework will increase our understanding the role of individual behavior and team performance in globally distributed virtual teams.

Keywords: globally distributed virtual teams, computer mediated communication, identity performance.

1 Introduction

The impact of Information Communication Technology (ICT) and Computer Mediated Communication (CMC) has redefined the global connectivity. Globally Distributed Virtual Teams (GDVT) is one of the competitive strategies of any leading organization. GDVT facilitate organizations to be cost-effective across the border operations, improves flexibility and agility to increase its competitive advantages over the international markets [1]. GDVT are described as temporary teams of people who are connected via communicational technologies across functional, organizational and geographic boundaries in order to combine skills and resources to accomplish a goal [14]. The GDVT are affected by geographical dispersion, time zone difference, and

cultural difference along with the differences in language, national tradition, values and norms of behaviour [4]. According to the RW3 culture wizard's survey on virtual teams, 70% of respondents reported that virtual teams face more challenges than face-to-face (FTF) teams in managing conflict. Furthermore, 88% replied that the greatest personal challenges faced by the respondents were related to their inability to read non-verbal cues. Additionally, 75% faced difficulty establishing rapport and trust, 70% noted an absence of collegiality, and 47% reported a sense of isolation [29].

The presentation of identity has changed from an individual to virtual space. In the 1990's, it was common for psychologists to refer to the internet as a medium with unlimited potential for identity management. The literature was abounded with the terms like identity laboratory [40], the implication being that computer users could play any social role they liked and transform themselves into fantasized, free from all physical and natural constraints [39]. Most CMC are text based [36] which allows individual to construct messages carefully [15] therefore enabling them to express their "true" self [2]. In mediated environment, individuals are not immediately visible and the required skills to interpret situations to manage impressions are different [33].

Identity is an important part of the self-concept. Self-concept is the totality of a person's thoughts and feelings in reference to oneself as an object [28], and identity is that part of the self "by which we are known to others". The construction of identity a public process which involves both the 'identity announcement' made by the individual claiming an identity and the 'identity placement' made by others who endorse the claimed identity, and an identity is established when there is a 'coincidence of placements and announcements' [32]. Papadopoul, D accentuates that identity usually has a double connotation: individual identity and identity politics. This distinction is observed in social sciences. Psychology and Behavioral sciences deal with individual processes of identity formation, while sociology and cultural studies explore social and cultural configurations of identity and their relevance for different communities and social institutions relying on these identities [24].

Understanding of identity in psychology literature can be traced back to Erickson's theory of psycho-social development describing identity as a subjective feeling of self-sameness and continuity over time. He further described identity as "a configuration gradually integrating constitutional givens, idiosyncratic libidinal needs, favored capacities, significant identifications, effective defenses, successful sublimations and consistent roles" [6]. In the seven functional blocks of social media proposed by Kietzmann J.H et al., the first functional block of the honeycomb framework represents the role of individual identity and indicates the level to which users reveal their identities in a social media setting. Each functional block represents the social media user's experience and its implication on firms [16]. As the emergence of social technology in managing and steering the passage of people from one social institution to another like GDVT, acknowledging individual identities in a mediated environment is critical. This necessitates development of novel strategies for monitoring, understanding, and responding to virtual team performance.

2 Background – GDVT and CMC

New definition of distance, based on connective gaps between places and actors, have shown why distance can never die [18]. According to the Social Presence Model by Short, social presence is more difficult to build relationships through CMC than FTF communication [30], but Walther’s Social Information Processing Theory (SIP) argues that individuals adapt the communication cues, such as language and typographical displays [42]. The use of paralanguage is an important factor in the development of impressions. Walther found the effects of CMC over time on a groups’ impression development, message personalization, and relational communications showed that CMC participants’ task orientation, self absorption, arousal and impersonality have increased, while dominance decreased over a period of time. Further, CMC groups were more positive and task oriented in the interpersonal behavior than FTF groups [41]. He emphasized that time plays an important role in order to build up trust and friendships via CMC.

One of the first descriptive models focusing on interaction process was developed by McGrath who posited that inputs affect group outputs via the interaction (or process) that takes place within the group and other influential models of group effectiveness have been proposed by [10], [11], [12], [13]. The normative model of group effectiveness by Hackman, aims to increase the understanding of group behavior in order to improve the group’s performance [13]. The intent of the normative model is to identify the factors that enhance or depress the task effectiveness of a group in a way that increases the possibility of constructive changes occurring. The overall performance of work teams in organizations is a function of the group members effort collectively expend on carrying out task work, the amount of knowledge and skill members bring to bear on group task and the appropriateness to the task of the performance strategies used by the group in its work [13].

According to Global Virtual Team performance conceptual model proposed by [27] the team structure is impacted by strategic objectives, work characteristics and contextual constraints. According to the author, the global virtual teams’ structure is governed by the degree of virtual-ness, team process, alternate mechanisms and attitudinal aspects [27]. As Newell et al., suggests that team members cannot build trust through competence and personal relationships when the social dynamics of the firm creates fragmentation like “Us versus Them” feeling and an environment of distrust [23]. Garrison et al., empirically tested the effect of perception of diversity on trust, cohesion and individual performance. The results indicated that individual productivity is negatively influenced by the extent of diversity within a team and that trust is a critical requirement for its success [8].

Daim et al. uses mathematical decision models to identify the factors that contribute to communication breakdown in GVT. The study discusses five distinct areas constituting trust, interpersonal relations, cultural differences, leadership and technology [7]. Further Cramton explored thirteen virtual teams’ difficulties in maintaining “mutual knowledge” and she identified five types of problems constituting failures of mutual knowledge, failure to communicate and retain contextual information, unevenly distributed information, difficulty communicating and understanding the salience

of information, differences in speed of access to information and difficulty interpreting the meaning of silence. These difficulties were associated with episodes of conflict, frustration or confusion in the teams [5]. A study on cross cultural virtual environment found that behavioral cultural intelligence strongly influence the virtual team member's trust, which is governed by the language proficiency, team members satisfaction and technical skills [43]. It is evident that prior researches on virtual team have empirically revealed that trust, cultural differences, task-interdependence and communication are major challenges of the GDVT performance.

The synergy among the members in the GDVT is vital to achieve excellence. The GDVT are dynamic in nature, depending upon the organizational short term or long term goals, members of the team may undersized or oversized, duration of the team may be long or shorter period, diverse in the group may amplify depending upon the need for technical expertise. More importantly onetime market pressures has direct implication on the speed, processing and performance of the team members, they have to be more reactive than resource myopic. Hence, members of GDVT requires a rare combination of identity performance abilities which enhance the intra and interpersonal relationship skills, trust, task oriented communication, task-interdependency towards the ability to manage effective interaction process.

To explain the determinants of virtual team effectiveness, Naik, et al., proposed Extended Adaptive Structuration Theory (EAST) Framework. The EAST framework proposes (a) Structural characteristics comprising of organizational dimension, task dimension, technology dimension, group dimension and individual dimension, social interaction (b) Social interaction constituting socio-emotional processes and decision processes (c) Control structure or Mission and (d) Outcomes as performance and satisfaction as determinants of success [22]. In the proposed EAST framework, it emphasises only on socio-emotional process contributing to trust, shared understanding, relationship building and cohesion towards GDVT performance. As George Simmel (1858 –1918) pointed out that the real world composed of innumerable events, actions, interaction and so forth, to cope up with real world one needs to be concerned with the form rather than the content of social interaction [9]. Our research is based on the frame work grounded on input-process-output relations work teams developed by Hackman [13] and the Social Identity model of Deindividuation Effects is research(SIDE) by Klein et al., [17]. The goal is to understand the nature and dynamics of identity performance in GDVT. This paper extends the line of research in GDW and its role of self-presentation in virtual teams.

3 The Theoretical Framework and Propositions

The first effort to explain identity through sociological approach was Social Identity theory (SIT) proposed by Tajfel. The theory assumes that one part of the self-concept is defined by our belonging to social groups [34]. According to Tajfel and Turner (1979), people categorize themselves and others belonging to different social groups

and evaluate these categorizations [34]. Later, Turner distinguishes between social identity as self-definitions in terms of social category memberships and personal identity as self-definitions in terms of personal or idiosyncratic attributes [35]. By proposing Self-Categorization Theory (SCT) Turner highlights social identity processes where identification leads individuals to perceive themselves in terms of the characteristics they share with other members of their in-groups rather than in terms of the idiosyncratic characteristics that differentiate them from other individuals [38].

Later Deindividuation theory was proposed to explain the phenomenon of people in crowds can become capable of acts that rational individuals would not normally endorse, but the historical evidence and case studies strongly suggested that the psychological process proposed by deindividuation theory (a loss of self) did not occur in the crowd [21]. SIDE model developed as a critique of deindividuation theory. The model took Reicher's ideas about the crowd, applied and extended them to CMC. The model articulated that during anonymous CMC, a user's personal identity or social identity can be more or less salient, when a social identity becomes salient, and the person identifies with the group, the conformity to an internalized group norm will be strong [31]. The normative and even stereotyping effect is thought to be more accentuated than in FTF interaction because individual characteristics of other users cannot be identified [37]. SIDE argues that anonymity and social context in interaction have cognitive and strategic consequences. The strategic consequences were extended to strategic dimensions referring to the “Identity Performance” [17].

The SIDE extends the social identity and SCT to CMC by demonstrating that certain features of Internet communication, such as anonymity, create greater closeness and intimacy between group members [19], [20], [25], [26]. The Identity performance is defined as “purposeful expression of behaviors relevant to those norms conventionally associated with a salient social identity” The word purposeful means that identity performance behaviors that are deliberately performed with the intention of manifesting one's relation to a group identity. The phrase relevant means behavior that is anti-normative with respect to salient social identity. The association between the behavior and the social identity are thought to be “conventional” indicating that performing a norm relevant behavior, the communicator expects the audience to recognize the association between behavior and relevant social identity [17]. Further author identifies two functions of identity performance for in-group audiences and out-group audiences; they are *Identity consolidation* and *Identity Mobilization* [17].

Identity Consolidation operates on social identity at two different levels. One hand, individuals may act to secure their social identity as members of a particular group, on the other hand members of a group may act together to secure the recognition of their shared social identity under two different contexts one is single identity and other is dual identity [17]. Identity Mobility operates on collective mobility of the group. Author emphasises that this function is used to mobilize in-group members into supporting specific political projects. The mobilization function is implied by a process of social influence. It is the act of expressing group norms to enjoin group members to

act together in a way that is socially potent and capable of bringing proposals to fruition [17]. Author identifies the role oppression and objectification facilitating the mobilization function. We centre the functions of Identity performance for in-group audiences only as the purpose of the study is limited to GDVT and suggest the following propositions of our proposed frame work.

- Proposition 1: Globally distributed virtual teams construct, manage and promote identity to facilitate team performance
- Proposition 2: Globally distributed virtual teams will demonstrate high levels of Identity Consolidation and Identity Mobilization.
 - Proposition 2 (a): High levels of Identity Consolidation and Mobilization will positively influence the team performance outcomes.
 - Proposition 2 (b): Low levels of Identity Consolidation and Mobilization will negatively influence the team performance outcomes.
- Proposition 3: Digital Identity constituting the properties of mediating technologies such as traceability, searchability and promotability will affect the team process and team performance.
- Proposition 4: The shared “Digital Identity” among the team members has a reciprocal relationship with team performance outcomes.

4 Proposed Model and Discussion

The proposed model is grounded on input-process-output relations by Hackman [13] and the SIDE model by Klein et al., [17]. According to Hackman, there are three ways of construing input-process-output relations in work teams; (a) Input conditions affect performance outcomes only through group interaction process, (b) Input conditions affect both process and performance and (c) Input conditions affect both process and performance and there is also a reciprocal influence between process and performance [17]. This study explains how the input conditions affect both process and performance and their reciprocal influence between process and performance of GDVT.

The figure 1 below represents our proposed framework. There are internal input condition and external input conditions. The internal input conditions are organization structure, team Structure, mission, time and complexity and the external input conditions are market pressures, limited resources, technology changes and customer demands. As Danah Boyd accentuates, the potential audience is affected by the properties of the mediating technologies namely persistence, replicability, invisible audiences and searchability [3]. Similarly, in group interaction process that we have proposed in hierarchical model, “Digital Identity” is affected by the properties of mediating technologies such as traceability, searchability and promotability. Digital Identity plays a critical role in self presentation and building self-concept. The hierarchical model proposes three different forms of Identity take place in a GDVT team process: (a) Tangible Identity, (b) Social Identity and (c) Self-Concept.

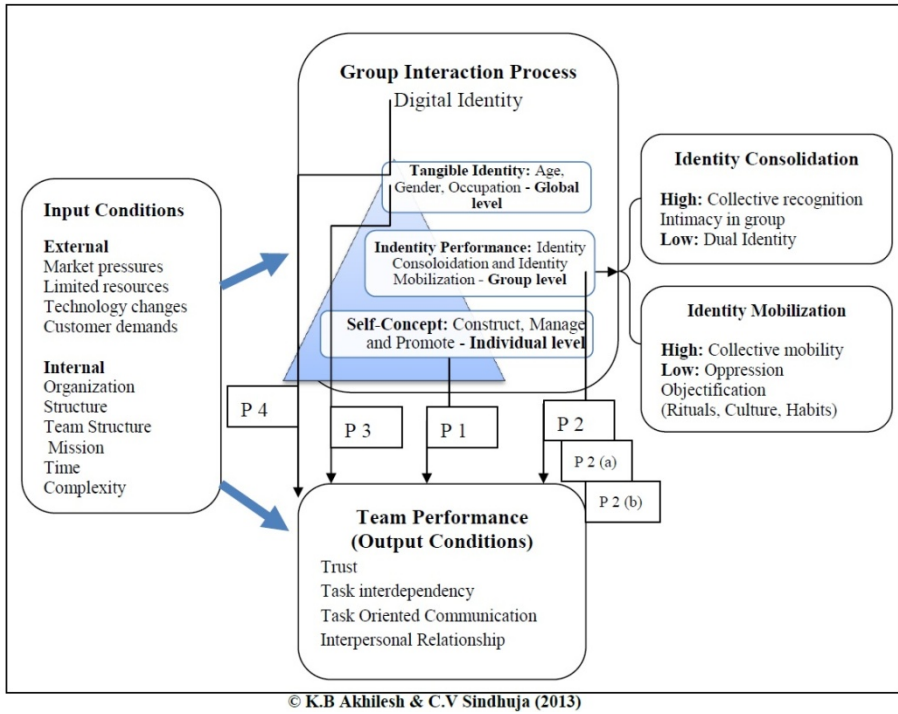


Fig. 1. Showing the Proposed framework

In the hierarchical model, we proposed tangible identity as the tip of an Iceberg, it is the readily available information of the individual identity like who am I? What I am Doing? And Where I am coming from? Hence we coin the term tangible identity with respect to availability of any individuals’ identity information via intranet or internet; it may be a blog, picture, video, post or social media. The next level is identity performance of individual governed by in-group audience. The expression of social identity is affected by power balance within or out group characterized by the Identity consolidation and Identity mobilization.

During the high levels of identity consolidation individuals act to secure their social identity as members of a particular group by of collective recognition. On the other hand, members of a group may act together to secure the recognition of their shared social identity by showing intimacy and low level of identity consolidation is constituted by dual identity [17] this may lead in formation of subgroups, lack of trust, sharing less information. In Identity mobility function high level indicates the collective mobility of the group. The mobilization is an act of expressing group norms to enjoin group members to act together, low level of identity mobility is governed by oppression and objectification which contributes forming conflict, communication error and silence.

The bottom of the Hierarchical model represents the Self-Concept of Digital Identity, which provides opportunity to individual to construct, manage and promote identity which is an important and integral part of the self-concept. Self-Concept is the totality of a person's thoughts and feelings in reference to oneself as an object. The higher levels of self-concept is shared among the group will result in building trust, effective communication followed by greater understanding about self and others, but time and internal crucial role in opening up the true-self, as Walther highlights that time plays an important role and it takes longer to get used to the medium, to get to know each other and to build up trust and friendships via CMC.

5 Conclusion

The proposed model with set of inter-relationships could be regarded as a primary step towards theory building in GDVT which is still in its early stages. The current model attempts to blend ideas, theories and results from varied areas of research, particularly groups and teams, organization design, CMC, technology management and strategic management. With respect to the specific contribution in this area, from our point of view are the suggested dimension of the two key functions of identity performance an individual impacts on the level of trust, task interdependence, task orientated communication and interpersonal relationship towards performance in virtual team. Emphasizing the role of "Digital Identity in self-presentation" and understanding the team process from "Psycho-Social dimension" by underlining the form of social interaction takes place rather than the content or structure itself are unique to virtual teams and presents a new perspective that has not been advanced before.

In this paper, we developed the theoretical framework. However, the scope of this research did not include quantifying the instruments to test this theory empirically. Next stage of this research should be to come up with measures and develop reliable instrument for each dimensions within the model. First, we will focus on certain industry domains and then move on to application of our theory in a global distributed virtual environment. We are also interested in developing an instrument to accurately measure team performance that reflects upon the psycho-social aspect of team process. These further studies and outcomes of these measurements may be implemented for tailoring suitable intervention programs for GDVT.

References

1. Araujo, A.L.: Implementing global virtual teams to enhance cross-border transfer of knowledge in multinational enterprises: A resource-based view. *International Journal of Networking and Virtual Organizations* 6(I2), 161–176 (2009)
2. Bargh, J., McKenna, K.: The Internet and social life. *Annual Review of Psychology* 55(1), 573–590 (2004)
3. Boyd, D.: Why Youth (Heart) Social Network Sites: The Role of Networked Publics in Teenage Social Life. In: Buckingham, D. (ed.) *MacArthur Foundation Series on Digital Learning – Youth, Identity, and Digital Media* Volume. MIT Press, Cambridge (2007)

4. Carmel, E.: *Global Software Teams: Collaborating Across Borders and Time Zones*. Prentice Hall (1999)
5. Cramton, C.D.: The mutual knowledge problem and its consequences for dispersed collaboration. *Organization Science* 12(3), 346–371 (2001)
6. Erikson, E.H.: *Identity. Youth and crisis*. W. W. Norton & Company, New York (1968)
7. Daim, T.U., Ha, A., Reutiman, S., Hughes, B., Pathak, U., Bynum, W., Bhatla, A.: Exploring the communication breakdown in global virtual teams. *International Journal of Project Management* 30(2), 199–212 (2012), doi:10.1016/j.ijproman.2011.06.004
8. Garrison, G., Wakefield, R.L., Xu, X., Kim, S.H.: Globally distributed teams: The effect of diversity on trust, cohesion and individual performance. *DATA BASE Advances Inform. Systems* 41(3), 27–48 (2010)
9. George, R.: *Sociological Theory: Maryland, Newyork*, pp. 159–160. McGraw Hill (2011)
10. Gladstein, D.L.: Groups in Context: A Model of Task Group Strategic Formation Effectiveness. *Administrative Science Quarterly* 29(4), 499–517 (1984)
11. Goodman, P.S.: *Designing Effective Work Groups*. Jossey-Bass Publishers, San Francisco (1986)
12. Guzzo, R.A.: Group decision making and group effectiveness in organizations. In: Goodman, P.S. (ed.) *Designing Effective Work Groups*. Jossey-Bass, San Francisco (1986)
13. Hackman, J.R.: The design of work teams. In: Lorsch, J. (ed.) *Handbook of Organizational Behavior*, pp. 315–342. Prentice-Hall, Englewood Cliffs (1987)
14. Hinds, P.J., Bailey, D.E.: Out of Sight, Out of Sync: Understanding Conflict in Distributed Teams. *Organization Science* 14(6), 615–632 (2003)
15. Jacobson, S.K.: *Communication skills for conservation professionals*, Island, Washington, D.C., USA (1999)
16. Kietzmann, J.H., Hermkens, K., McCarthy, I.P., Silvestre, B.S.: Social media? Get serious! Understanding the functional building blocks of social media. *Business Horizons* 54(3), 241–251 (2011), doi:10.1016/j.bushor.2011.01.005
17. Klein, O., Spears, R., Reicher, S.: Social identity performance: extending the strategic side of SIDE. *Personality and Social Psychology Review* 11(1), 28–45 (2007), doi:10.1177/1088868306294588
18. Kolb, D.G.: Introduction to globally distributed work: redefining Distance (Why the World is Not Flat and Distance Can Never Be ‘Dead’). Report of the University librarian for the year 2007, University of Auckland, New-Zealand (2007), doi:26082012
19. Lea, M., Spears, R.: Computer-mediated communication, de-individuation and group decision-making. *International Journal of Man Machine Studies* 34, 283–301 (1991)
20. Lea, M., Spears, R.: Paralanguage and social perception in computer-mediated communication. *Journal of Organizational Computing* 2, 321–341 (1992)
21. McPhail, C.: Civil disorder participation. *American Sociological Review* 38, 1058–1073 (1971)
22. Naik, N., Kim, D.: An Extended Adaptive Structuration Theory Framework for Determinants of Virtual Team Success. *Sprouts: Working Papers on Information Systems* 10(2) (2010), <http://sprouts.aisnet.org/10-2>
23. Newell, S., David, G.: Exploring trust among globally distributed work teams in globally distributed. In: 40th International Conference on System Sciences, pp. 1–10 (2007)
24. Papadopoulos, D.: In the ruins of representation: Identity, individuality, subjectification. *British Journal of Social Psychology* 47(1), 139–165 (2008)
25. Postmes, T., Spears, R.: Deindividuation and anti-normative behavior: A meta-analysis. *Psychological Bulletin* 123, 238–259 (1998)

26. Postmes, T., Spears, R., Lea, M.: Breaching or building social boundaries? SIDE effects of computer-mediated communication. *Communication Research* 25, 689–715 (1998)
27. Prasad, K., Akhilesh, K.B.: Global virtual teams: what impacts their design and performance? *Team Performance Management* 8(5/6), 102–112 (2002)
28. Rosenberg, M.: Self-concept from middle childhood through adolescence. In: Suls, J., Greenwald, A.G. (eds.) *Psychological Perspectives on the Self*, vol. 3, pp. 107–136. Erlbaum, Hillsdale (1986)
29. RW3 Culture Wizard.: The challenges of working in virtual teams: The Virtual team survey report (2012) doi: rw-3.com/2012VirtualTeamsSurveyReport.pdf (2012)
30. Short, J., Williams, E., Christie, B.: *The social psychology of telecommunications*. Wiley, London (1976)
31. Spears, R., Lea, M.: Social influence and the influence of the “social” in computer-mediated communication. In: Lea, M. (ed.) *Contexts of Computer Mediated Communication*, pp. 30–65. Harvester-Wheatsheaf, London (1992)
32. Stone, G.: Appearance and the self: A slightly revised version. In: Stone, G., Farberman, H.A. (eds.) *Social Psychology through Symbolic Interaction*, 2nd edn. Wiley, New York (1981)
33. Sundén, J.: *Material Virtualities*. Peter Lang Publishing, New York (2003)
34. Tajfel, H., Turner, J.C.: Towards a cognitive redefinition of the social group. *Social identity and intergroup relations*, pp. 15–40. Cambridge University Press, Cambridge (1982)
35. Tajfel, H.: *Social Identity and Intergroup Relations*. Cambridge University Press (2010)
36. Tidwell, L.C., Walther, J.B.: Computer-mediated communication effects on disclosure, impressions, and interpersonal evaluations: Getting to know one another a bit at a time. *Human Communication Research* 28(3), 317–348 (2002)
37. Trepte, S.: Social Identity Theory. In: Bryant, J., Vorderer, P. (eds.) *Psychology of Entertainment*. Lawrence Erlbaum, Mahwah (2006)
38. Turner, J.C., Hogg, M.A., Oakes, P.J., Reicher, S.D., Wetherell, M.S.: *Rediscovering the social group: A self-categorization theory*. Blackwell, Oxford (1987)
39. Turkle, S.: *Life on the Screen: Identity in the Age of the Internet*. Touchstone, New York (1995)
40. Wallace, C.: How old is young and young is old? The restructuring of age and the life-course in Europe. Paper presented at Youth 2000: An International Conference Middlesborough, UK (1995)
41. Walther, J.B.: Interpersonal effects in computer-mediated interaction: A relational perspective. *Communication Research* 19(1), 52–90 (1992)
42. Walther, J.B., D’Addario, K.P.: The impacts of emoticons on message interpretation in computer-mediated communication. *Social Science Computer Review* 19, 323–345 (2001)
43. Li, Y., Li, H., Maedche, A., Rau, P.-L.P.P.: Are You a Trustworthy Partner in a Cross-cultural Virtual Environment? – Behavioral Cultural Intelligence and Receptivity-based Trust in Virtual Collaboration. In: 4th International Conference on Intercultural Collaboration, pp. 87–96 (2012)

Diversity in Unity - How Industry Policy Shaping UI/UX Research

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Abstract. Industry policy is usually a tool to promote the growth and efficiency of countries overall economy, in particular, to promote "specific growth of industry". Generally speaking, it allocates the funds, talented people, regulations, and consider how to stimulate the usage from the demand side, and how to accelerate the development of the industry from the supply side. In this paper, the change of the industry policy is described based on the ICT(information and Communications Technology) industrial competitive advantage migration. The goal of the paper is delivering a few points on how industry policy shaping global competitiveness from a technology-driven era to a user-driven era. The differences of the policy focus will be the key discussion.

Keywords: Industry Policy, UI/UX Research, User Experience, Global Competitiveness.

1 Introduction

Industrial Technology Research Institute (ITRI) is a nonprofit R&D organization in Taiwan. Founded in 1973, ITRI has played the role of transforming Taiwan's economy from labor-intensive to tech-intensive, by engaging in applied research and technical services. Numerous well-known tech companies such as TSMC, which the leader in semiconductor industry, was spin-off from ITRI.

IEK, which stands for Industrial Economics and Knowledge Center, is taking responsibility to provide industry policy and help business in Taiwan meet revolutionary changes in a fast-moving knowledge economy. As part of ITRI, it coordinate the vast R&D capabilities of its parent organization (ITRI), and by taking advantage of ITRI's footing in the international arena. With its knowledge management and active interactions with government and industries, IEK helps the nation gain competitive advantages as well as helps the business community create value.

IEK has more than 150 technology and management analysts and professional consultants with extensive research skills and practical experience. Its studies cover electronics, information, communications, nanotechnology, petrochemical materials, chemical materials, biotechnology, healthcare, advanced manufacturing, and regional industrial development. In response to emerging issues, IEK's recent research

interests span green energy, technology-enabled services, and urban development. It also actively assists the government in formulating competitive policies while promoting dissemination of research results and industrial innovation and development.

IEK’s unique role as a government think tank has placed it in close contacts with several government entities that set policies for industry development and for the nation’s economy. How policy enables industry to develop a core competitiveness based on the understanding of people. The issues will be discussed in the paper in detail.

2 Background

2.1 ITRI

The operational model of ITRI is providing technology services to industries. It’s just like the headquarters of a company taking responsibility for basic technology R&D, and transferring research results to business units to develop products or services. The model works well in a technology-driven era and also benefits many start-up companies in Taiwan and helps them be competitive.

2.2 How Industry Policy Shaping Global Competitiveness in a Technology-Driven Era

Industry policy is shaping the technology R&D topics of ITRI.

In over thirty years, ITRI has been providing assistance to the government in executing industrial technology policies and in promoting industrial development by nourishing industrial technology capabilities.

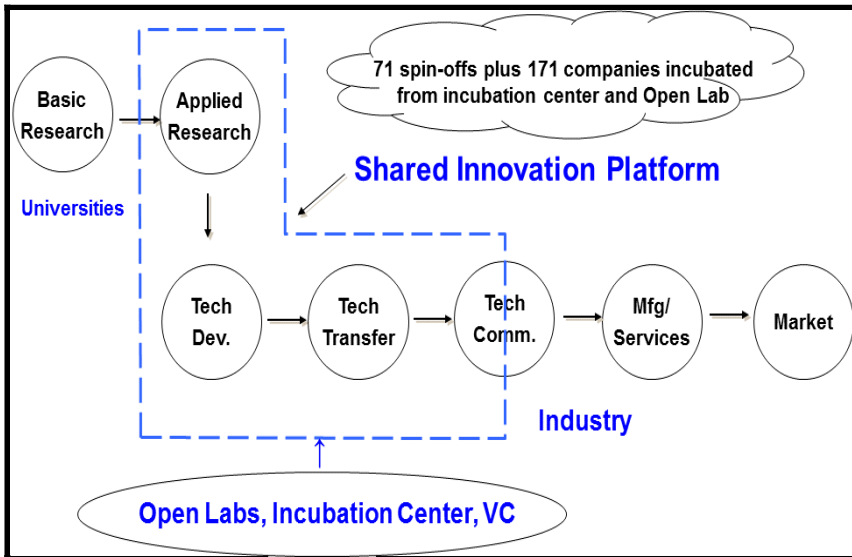


Fig. 1. R&D of Industrial Technology at ITRI (Source: ITRI, 2012)

Six technologies are included, and they are:

- Information and Communications Technologies;
- Electronics and Optoelectronics Technologies;
- Material, Chemical and Nanotechnology;
- Mechanical and Systems Technologies;
- Medical Device and Biomedical Technologies; and
- Green Energy and Environment Technologies.

To date, ITRI holds more than 17,659 patents and has assisted in the creation of start-ups and spin-offs. In recent years, the institute received the Overall Gold Wall Street Journal Technology Innovation Award and R&D 100 Awards.

3 Analysis

3.1 Current Status

These changes have taken place in the core competencies of industrial competitiveness and involve mastery of technology and products from the past for the provision of services and user experiences. For example, a new generation of global electronics industry leaders came to enhance the degree of product differentiation and move the core of the industrial development competition to focus on the understanding of people.

3.2 Industry Competitive Advantage Migration

Taiwan has always been the leading country for ICT(Information and Communications Technology) hardware equipment manufacturing. In recent years as the global industry gradually escape the logic-based thinking to produce, plus the gradual decline in gross profit margin of all types of end products, but also make the device industry to start thinking how through application with added services, to create sources of revenue other than equipment sales.

Application services value added to lead the wave of terminal equipment for the global industrial development crisis also proved to be a turning point, information and communication electronics industry into the PC generations and generations of smart terminal transfer application software will be play a key role of bring users new experience.

The combination of software services and applications platform for mastering the rise of the global application software economy, strengthening the competitiveness of the industrial structure of Taiwan's information and communications electronics, will be hardware upgrade the industrial added value and revenue. To grasp the new dynamics of the industry growth, shaping Taiwan become the town of intelligent life, the development of application services.

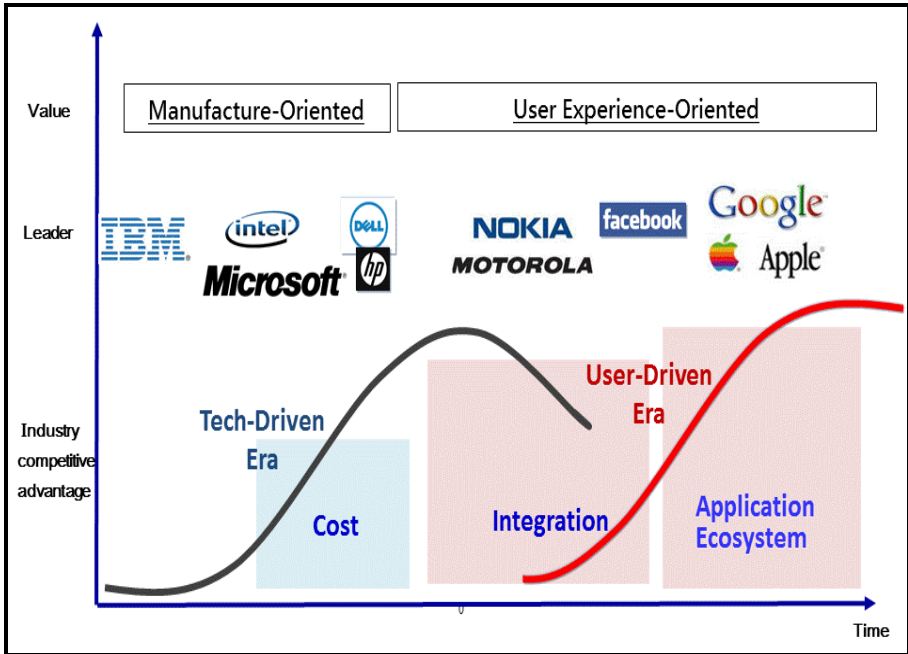


Fig. 2. ICT industrial competitive advantage Migration (Source: IEK/ITRI, 2012)

3.3 Future Development

Reference Sites will be the key that industry policy should focus on.

For example, three years ago, a policy program promoted resources integration on e-book cloud applications, and make industry bodies involve more on user understanding. Through book lending service trial programs connecting public libraries in total of 22 cities in Taiwan, cross major & small cities integrate various student groups from learning bookshelf service. Why the public library applications were chosen? It's all about the market size. First of all, around 70% of book market share is in the education field. Also, They are universal solutions. Once the implementation is completed in Taiwan, there are opportunities to sell the same solution to other countries. And that attracts private companies to invest in the industry. And why the cloud-based? Individual library can digitalize books by itself. But if every library in Taiwan does the same thing, why not connecting all libraries database together and make them a virtual cloud library. The benefit to users is one account to access all libraries. People live in remote areas can also enjoy library resources just like people live in cities. The same concept is for the education. Teachers from different schools are sharing teaching materials with the cloud-based database. That makes the market make sense, and drive industry bodies to put into resources on user friendly usage.

Industrial policy tend to encourage companies on culture the ability of knowing user needs, besides the functions of the product. The resources are concentrated in building the industry environment to close users, such as providing field trials and building further reference sites in real life for product and service. Industry has to think of the changed life and needs in the future, in order to filter out the future in the global industrial competition. In addition, for industry policy has to deliver regulation on business model such as contents through different networks and devices, to encourage industry investment in the future focus on user understanding. Also approaches to attract talented people involved.

4 Conclusion

4.1 Industry Policy

Industry policy is that when countries want to promote the growth and efficiency of the overall economy, in particular, to promote "specific growth of industry". Generally speaking, it includes the issues of funds, talented people, regulations, and consider how to stimulate the usage from the demand side, and how to accelerate the development of the industry from the supply side. This should be a positive cycle. When talking about allocation, it also occurs things not to do. For example, not picking the winners and rescuing the losers. The main focus should be on the fair competition environment, and make the market mechanism decides.

4.2 How Industry Policy Shaping Global Competitiveness in a User-Driven Era

In the era of technology as a competitive advantage, industrial policy tend to focus on technical screening and selection, the resources are concentrated in a few specific technical research and development. Industry analysis has to answer the forecasts of the leading technology in the future, in order to filter out the future in the global industrial competition. Inferred that usually requires investment of capital and talent. For industry policy has to deliver such as investment tax credits, tax relief, to encourage industry investment in the future focus on technology development.

In the era of understanding users as a competitive advantage, industrial policy tend to focus on culture the ability of knowing user needs, the resources are concentrated in building the industry environment to close users, such as providing field trials in real life for product and service testing. Industry analysis has to answer the forecasts of the changed life and needs in the future, in order to filter out the future in the global industrial competition. In addition, for industry policy has to deliver regulation on business model such as contents through different networks and devices, to encourage industry investment in the future focus on user understanding.

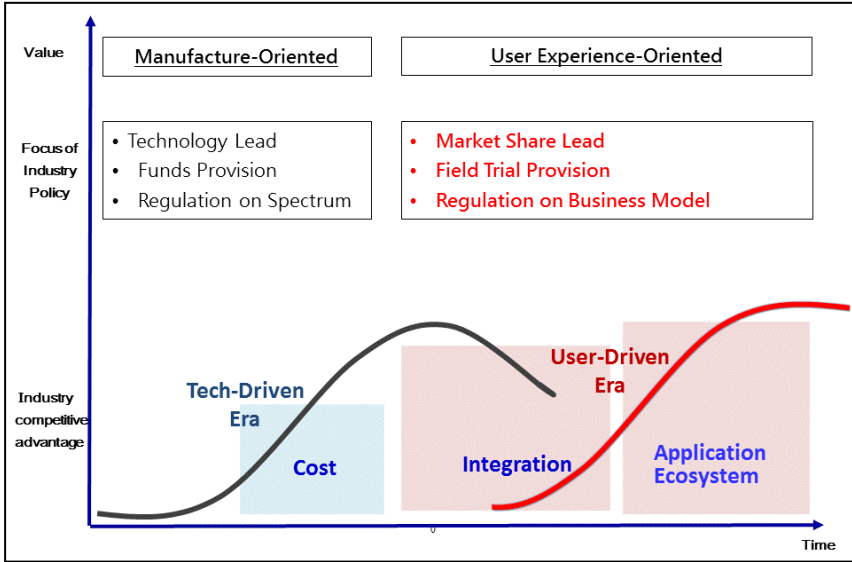


Fig. 3. Focus of ICT Industry Policy Migration (Source: IEK/ITRI, 2012)

The Research on Knowledge Diffusion Based on Small World Network

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Abstract. Small world is a sort of network between regular and random network that has the feature of both shorter characteristic path length and higher clustering coefficient, which is an appropriate model for the research of knowledge diffusion. There is simulation in this paper to certificate the validity of small world network in knowledge diffusion. In order to reflect the real world the model is completed by including expert as one influence factor and currency as the other to reflect knowledge transaction. Simulation results show that small world network do exist in knowledge diffusion.

Keywords: Small world, knowledge diffusion, expert.

1 Introduction

The varieties of elements in the nature construct numerous huge and complex systems. The diversity and uncertainty of these systems leads to the complexity of the research works on them. As the development of science and technology, people find that network is a very good expression to the complex systems. The theory of the complex networks was raised in the late twentieth century; it is the powerful tool for the research of complex system. The small world network is the latest hotspot in the research of complex networks. Lots of interesting experiments has been executed to uncover the phenomenon of “the world is small”. As Interdisciplinary, the small world theory has rapid growth and applied into many different fields.

At the same time, knowledge management is also the hottest topic in the twentieth century. The most important forms of knowledge management are diffusion. To take the small world theory into the study of knowledge management is a more and more extensively researched topic both in theory research and actual research.

In real world, the diffusion of knowledge has different forms inside different organized system. Such as the “team-work” or the “small organize” in some enterprise, or the “group teaching” in the school, are all the good research material for the study of small-world network.

2 Small World Theory

2.1 The Development of Small World Theory

Small world theory was originated in 1960's by the social psychologist Stanley Milgram in his research named "Tracking the shortest path to the rule of the social network in the United States". In this experiment, he asked the subjects to mail to a people who lived nearby Boston, and constrained that they can only mail to someone they know. In the end, he realized that to reach the target, there is average 6 times to forwarding the mail. This is the famous six degrees of separation, or the small world phenomenon[1]. This phenomenon reviews that anyone who doesn't know each other; they only need Six degrees of separation to get the link between them. Before this theory, most research of networks are based on its topological structure like regular or random. While in real world, it is neither regular nor random, but as a topological structure between them. In 1998, Watts and Strogatz put forwards the small world network theory on the journal of science. They studied three real networks, Elegans worm network, US western power network and movie star corporation network, and realized that they all have the character of the small world networks[1].

2.2 The Structure and the Characteristic Parameters of the Small World Theory

Watts and Strogatz provided the construct algorithm of the small world theory: first begin with a regular annular network which has n vertexes and each vertex has k edges. The probability p represents the random degree of the network. Then breaks the edges and reconnects between the vertexes with limits of probability p with the restriction of no self-connection or duplicate connection, this will generate $pkn/2$ edges (it is called shortcuts)[2]. By adjust the value of p , the network can be changed to regular ($p=0$) and random ($p=1$), the so called small world is the between area of $0 < p < 1$, as shown in figure 1.

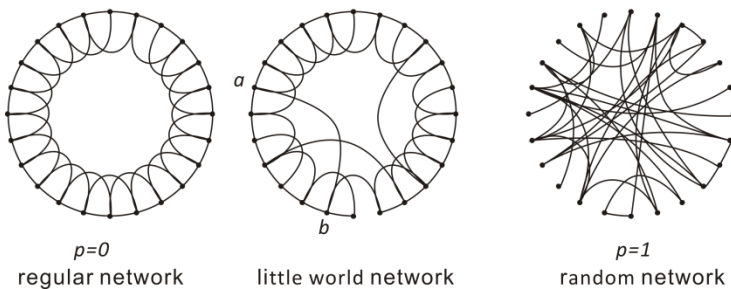


Fig. 1. The relationship of the regular, small world and random network

W-S' small world network model has two parameters to describe the features of the structure, one is the characteristic path length $L(p)$, the other is the clustering coefficient $C(p)$. $L(p)$ means from one vertex to the target vertex the minimum edges that must be passed, it reflect the difficulty of linking one vertex to the other. $C(p)$ shows

the local characteristics of the network. That decides whether there are relatively stable sub systems in the whole network, in another word the degree of association of the neighbor vertexes. In the research of Watts and Strogatz, when $p \rightarrow 1$, $L \sim n/2k \gg 1$, $C \sim 3/4$; when $p \rightarrow 0$, $L \approx L_{random} \sim \ln(n)/\ln(k)$, $C \approx C_{random} \sim k/n \ll 1$ [3]. Conclusion: When network tends to regular, it has higher clustering coefficient, but longer characteristic path length; on the contrary, when network tends to random, it has lower clustering coefficient, but shorter characteristic path length, so any two vertexes in the network are easily to be linked in random network. When increase the numerical of p , network moves from the regular to the random, there is an area has the feature of both shorter characteristic path length and higher clustering coefficient, this area is called small world network.

3 Theory of Knowledge Diffusion

The knowledge flowerage can be divided into two style, transaction type and broadcast type. The difference between these two types is when during flowerage, there is condition or not. The former has no condition, and the rare has [4]. To compare the effect of the small world network and the scale-free network, the broadcast type is taken in this paper, because when there are conditions, the separation degree of the result will be poor.

Cowan and Jonard use network model to simulate knowledge diffusion in human society. They discover that the most efficient knowledge diffusion is happening in small world network, but also has the most unfair knowledge spread (which means that the knowledge spread is unfair for everyone)[3]. They put a limitation to the model, that the diffusion only occurs when the both side of the diffusion have the same degree of knowledge. This makes the diffusion process actually a swap process. But swap is not the only way of knowledge exchange. First, knowledge exchange is not barter. Second, sometimes knowledge exchange is one-way transfer when communicate with a friend. Pier Giuseppe and Richard (2001) have improved the model of Cowan and Jonard. But both of them didn't solve the problem mentioned above. And there is another situation that they didn't notice, knowledge retention. It's a very similar situation in company, because some knowledge is the core competitiveness of an enterprise, they will not share it. Even in personal contact, sometimes there will be retention too.

To isolate the effect away from the structure of network, which can make lots difference to knowledge diffusion; most researchers use the way of changing the edges connected to the vertex in the network. This method is concentrated on the density of the network but not structure. While in this research, structure is the most important factor but not density. So in the model of this paper, the number of edges is fixed, only the link of vertexes in space distribution is changed.

4 Model of Small World Network

Small world model is a sort of one-dimensional regular lattice with some randomness by breakpoint reconnects. The construction algorithm is: first begin with a regular

network ring, which has N vertexes, every vertex has n edges that connect with n neighbor, and meet the constraint $N \gg n \gg \ln(N) \gg 1$; then, for every edges, relink it to another vertex with probability p with no repeated edges. By this way, there will be $(p \cdot n \cdot N)/2$ longer edges to connect one vertex to another faraway vertex.

For example, to vertex A_0 , the vertexes connect with it are A_1, A_2, \dots, A_n , then the maximum connect number of vertexes will be $b = n \cdot (n + 1)/2$, the actual number of edges connected is m , then the gathering coefficient will be m/b . The gathering coefficient of the whole network is the average of all the gathering coefficient of every vertex calculated with this formula[5]:

$$C(p) = \frac{1}{N} \sum_{i \in I} \sum_{j, l \in \Gamma(i)} \frac{X(j, l)}{|\Gamma(i)|(|\Gamma(i)| - 1)/2}$$

In this formula, if $j \in \Gamma(i)$, then $X(j, l) = 1$; or else $X(j, l) = 0$. L as the average distance is to reflect the overall features of the network structure. If two vertexes in the network can be connect with several edges that connect with each other sequential, then we called these two vertexes is reachable. The minimum number of edges to connect two vertexes is called the distance. If the two vertexes is not reachable, then we define their distance is infinity. The network's average distance is calculated by average all the distances of very pair of vertexes in the network. If we take $d(i, j)$ as the distance of vertex i to vertex j , then the average distance of the network will be[5]:

$$L(p) = \frac{1}{N} \sum_{i \in I} \sum_{j \neq i} \frac{d(i, j)}{N - 1}$$

When $p=0$ and N is big enough, $C(0) = 3/4 \cdot (n - 2)/(n - 1)$, $L(0) \sim N/(2n)$; when $p=1$ and N is big enough, $C(1) \sim n/N$, $L(1) \sim \ln N / \ln n$. The result is higher degree of aggregation always leads to longer distance, and lower degree of aggregation leads to shorter distance. While in small world networks model, $L(p)$ is very close to $L(1)$, and $C(p)$ is much bigger than $C(1)$. To fulfill this, shortcut is added into the network to make the average distance shorter, this method is called reconnect. By this way, L is approaching the level of random network, while C is approaching the level of regular network.

Corresponding to real world, people or enterprise (called agent in this paper) is the vertex of the network, and the link of them is the edges. The clustering coefficient C expresses the gathering level of the agent in the real world. When C is high, there are a lot of clusters in this network, like enterprise alliance for the corporation or the coterie for personal. Distance L is representing the tightness of the agent. If L is short, means that two agents has very close relationships, like the parent and subsidiary companies, the link between them is called strong ties. On the contrary, that is the weak tie [6]. Convenient for research, take the weights of the agent to 1, and suppose the edges are undirected. With these assumptions the model mentioned above then can be put into research. For every agent in the network, a vector is defined to

indicate their knowledge level, the dimension of the vector indicate the types of the knowledge they have. The knowledge level of the agent will change by knowledge diffusion as time goes by.

Expert is another issue that should be mentioned. In real world, there are always some people they grasp much more knowledge than others, but they usually will have some reservations in diffusion. For example when an expert wants to maintain his core competencies, he will stop to diffuse his knowledge to those non-experts when they reached some height [7]. So in this model, we assume that only part of knowledge will absorb by the audience during knowledge diffusion. A coefficient α is introduced in, and $0 < \alpha < 1$, it means the ratio of diffusion result with the initial difference of the knowledge level from the both side of the diffusion. By define $V_{i,k}(t+1) = V_{i,k}(t) + \alpha \cdot (V_{j,k}(t) - V_{i,k}(t))$, the reservation of knowledge diffusion is reflected by this formula. The more difference of the knowledge level, the more the receiver can acquire knowledge, and the incremental of each knowledge diffusion will decrease. It is according to the real situation.

5 Simulation and Analysis

5.1 Simulation

In this paper, Matlab was used as the analysis tool. The network is designed as: 500 vertexes and every vertex have 20 edges. So in the model we define $N=500$, $n=20$. In this analysis, the only variable is the probability p . The average distance L and average clustering coefficient C are all calculated with this parameter p .

To characterize small world networks, a notion of far-edge is introduced in to identify the “faraway” connection in the network .In figure1, the edge from vertex a to vertex b, are the so-called far edge.

The algorithm design is as follow: From the beginning, the network is a regular network, as the reconnection with probability p from 0 to 1, the average distance L and average clustering coefficient C changed [8]. To reflect the changing trend, $L(p)/L(0)$ and $C(p)/C(0)$ should be taken to standardize the L and C . The quantity $L(p)$ denotes the average length of the shortest path between any two vertexes, and the $C(p)$ denotes the average of C_v over all the vertexes, while C_v is the number of edges connecting the neighbors of vertices v , normalized with respect to the maximum number of possible edges between these neighbors[2]. With this definition, we introduced the variable f as the ratio of far edges with the total number of edges. When p is very small as $p \leq 0.1$, f is approximately equal with p . When p get bigger, f grow slowly. When $p=1$, f saturates to a value of about 0.2. So in this paper, the simulation is based on the variable of f , but not p . Thus we plot $C(f)/C(0)$ and $L(f)/L(0)$ as functions of f . Actually this figure has the same expression of $C(p)/C(0)$ and $L(p)/L(0)$ [2], as shown in figure 2.

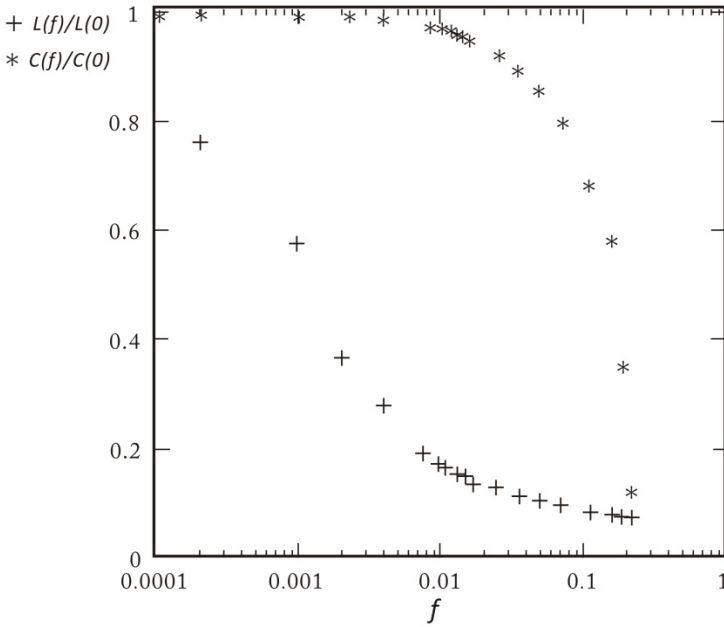


Fig. 2. $C(f)/C(0)$ and $L(f)/L(0)$ as functions of f

5.2 Analysis

From figure 2, we could clearly find that with the change of p , the network experience 3 stage: regular, small world and random. In first stage, f is close to 0 correspond to the area 0.001 to 0.01, reconnection is seldom happened, the network reflect the characteristic of the regular style. In this region L and C both have bigger numeric. As f getting bigger in region 0.01 to 0.1, L declined rapidly, this reviewed that the reconnection of several edges could make much reflection on the construct of the network, especially on distance. But to the average clustering coefficient C there's not much influences, which means the changing of f didn't affect the local relationship of the network, this phenomenon is called small world. When f increases more than 0.1, L is stabilized, while C declined sharply, the network shows the characteristic of random network.

The small world network can be identified within the region of $C(p)/C(0) \approx 1$ and $L(p)/L(0) \approx L(1)/L(0)$, this region is correspond to $f \approx 0.01$. So f can be used to characteristic network between regular, small-world and random. It is more Intuition than p in identifies the style of the network.

In the simulation, the knowledge of each agent is expressed with a five dimension vector. The initial knowledge level of every vertex is given randomly from 0 to 9. The ratio of expert in this model is set to 1%[9]. That is, pick 1 agent as expert and assigns its level of knowledge to 9 from every 100 agent. To simulate the situation of

retention, when one agent's knowledge is grown up to 7 by diffusion, 90% of the experts will stop diffusion to him to maintain their own superiority. That mentioned before to identify the effect of diffusion is set to 50%, which means that only half of the knowledge gap can be transferred in every diffusion [7], [9]. Another premise is that diffusion is happened in all the edges that connect to the vertex. To separate the small world region, the reconnection ratio is grow with the step of 0.001, with every value of p , there are 8 times of diffusion [7]. One time of diffusion means diffuse from one vertex by all the edges connected with it.

In the network of the real social environment with strong ties, people or enterprise is very familiar with each other. Since people have the same knowledge background, there's actually not too much knowledge to diffuse. While in social environment with weak ties, the different clusters can be connected, that will generate new channel for knowledge and conception diffusion [4]. As in real world, good friends usually exchange their knowledge and conceptions, but this knowledge is much the same. While people with ordinary relationships, they won't exchange their knowledge unreserved, retention will happen more or less. But when these clusters are connected, new knowledge and conception with much effect can be diffused. This phenomenon will also happen between the enterprises. This is the advantages of the weak ties. The reconnection of the small-world is the same effect as the weak ties. Also reconnection has little effect on the local environment of the network, but has big effect on the whole structure. That reflect the meaning of $L(p)$ and $C(p)$ in the small-world. When $L(p)$ is smaller, the net connection is shorter, which means the knowledge diffusion is faster. When $C(p)$ is higher, the degree of aggregation is higher, it is good for the knowledge diffusion in local circumstances but not good for other clusters and the whole network.

In this research we discovered that the average knowledge level is not the monotonic function with p , it reach maximum at the region of small-world area ($0.005 < p < 1$), then as p grow up, the average knowledge descend slowly and finally remained at a certain area. This come to the conclusion that the higher gathering degree and the shorter average distance make the most efficient knowledge diffusion. $L(p)$ and $C(p)$ are not irrelevant.

The gap between the different agents is another focus in research to show the fair degree of knowledge diffusion. After several diffusions, the difference of knowledge level is quite similar; this phenomenon is different with the research of Cowan and Jornard's. In their model, the difference of the knowledge level is the maximum in the small world network, because if the reconnection ratio p is equal to 0 or very small, the gathering of groups is high. It leads to the diffusion of knowledge in the group is very fast, while the diffusion between the groups are very slow. This will lead to such result: group without profession will remain a low level of knowledge after diffusion; while the group with profession will get a higher knowledge level after diffusion. This will lead to knowledge gap. When the parameter p getting higher, the degree of aggregation will get lower, this means the small group gradual disintegration. In the other word, the difference of the network becomes smaller. But in our model, two important influencing factors are introduced, one is the currency which indicates the knowledge transaction between the corporations in real world, the other is the

unilateral knowledge diffusion which indicates the situation between personal. These two situations of knowledge diffusion reduce transaction costs and improve the efficiency of the transaction. Offset the adversely affected of the high degree of aggregation to some extent, which leads to reduce the difference of knowledge level between the agents in the network and makes the diffusion more equitable in the network.

6 Conclusion

By including expert as one influence factor and the currency in knowledge transaction, the small world network model is more completed to reflect the real world. Simulation results show that small world network do exist in knowledge diffusion. In small world network, the whole knowledge level is the highest among the regular ($p=0$) and random ($p=1$) network after knowledge diffusion. And it has fairer diffusion opportunity.

But in this paper it is a relatively ideal state. In real world, people wish that the group has a faster knowledge diffusion speed and still remain the knowledge distribution inhomogeneity. This can both integrate the group's overall capacity, and remains the competitive pressures within the group which can lead to the long-term development of the group. The result in this paper not touches this area yet. The other factor that not discussed in this paper is the innovation of knowledge which still needs further research.

References

1. Cowan, R., Jonard, N.: Network Structure and the Diffusion of Knowledge. In: MERIT Working Papers, 99–128 (1999)
2. Pandit, S.A., Amritkar, R.E.: Characterization and control of small-world networks. arXiv: chaos-dyn/9901017v1 (January 16, 1999)
3. Cowan, R., Jonard, N.: Statistical mechanics of complex network. *Economic Dynamics & Control* 28, 1557–1575 (2004)
4. Plouraboue, F., Strayer, A., Zimmermann, J.-B.: Learning Induced Criticality in Consumers' Adoption Pattern: A Neural Network Approach. *Economics of Innovation and New Technology* 6, 73–90 (1998)
5. Latora, V., Marchiori, M.: Economic Small-world Behavior in Weighted Networks. *The European Physical Journal* 32(2), 249–263 (2003)
6. Kleinberg, J.: The Small World Phenomenon and Decentralized Search. *SIAM New.* 37(3), 1–2 (2004)
7. Feng, H., Li, Z.: Network Model of Knowledge Diffusion and Its Implications. *Journal of the China Society for Scientific and Technical Information* 25(1) (February 2006)
8. Watts, D.J., Strogatz, S.H.: Collective dynamics of "small-world" network. *Nature* 393(6), 440–442 (1998)
9. Computer Programs for Social Network Analysis [EB/OL], <http://www.insna.org/INSNA/softinf.html>, 2007-03-27

Implement User-Centered Design in Internationally Distributed Design Teams

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Abstract. With globalization, international business expansion and acquisition, business process outsourcing, distributed design teams become a common practice in many companies and organizations. Many challenges exist for distributed teams. Research conducted in the past looked into communication, project management, and organizational and people management to overcome those challenges. This paper provides a case study, which not only leveraged the findings provided in the previous research, but also looked into the advantages and disadvantages within each user-centered design role in distributed locations. The organizational, project, and role arrangement in distributed teams were discussed with emphasis on how to implement user-centered design in internationally distributed design teams.

Keywords: Distributed Team, Design Management, User-centered Design.

1 Introduction

Distributed design teams become a common practice in many companies and organizations with globalization. Companies and organizations add internationally distributed teams through international business expansion, acquisition, and outsourcing. Technology advances further reduced the communication cost and enabled such business arrangement.

2 Literature Review

2.1 Advantages of Distributed Teams

Benefits of internationally distributed teams are apparent. In many cases, distributed teams are not only to reduce time-to-market and development cost [7] but can also promote diverse knowledge, local expertise, and discovery of innovative solutions from the diversity in the different cultures, background and language [1, 13, 3, 7]. Members at different sites are likely to use different knowledge sources and networks to search for solutions [3]. This arrangement will allow for individuals to work with different people through various projects, create opportunities in knowledge sharing and “*cross-pollination of ideas among different groups*” [13]. The internationally

distributed teams bring opportunities and competitive advantage to companies and organizations.

Challenges in Distributed Design Team. While diversity can bring new perspectives, it can also cause conflicts in the differences in work ethics, cultural perspectives and use of processes and tools [7]. Thus, distributed teams are not without its challenges – challenges in diversity, distance, technology, and communication can threaten to fragment the team [3].

Communication Challenges. For distributed teams, communication is a key factor but the ability to achieve effective design communication is immensely difficult often due to the restraints in collaborative tools. Distributed teams face intensified mental workload, physical demand, and frustration as correspondence becomes restrained from face-to-face to video to audio [6]. Collaborative tools often make communication become less natural and fluid as well as cause disturbances in the creative and social processes for the design team [1]. These disturbances include the lost in body language, gestures, gazes, and eye contact [1]. As Bergstrom and Torlind concluded from their comparison between a co-located and distributed design session, “*if the communication flow is to be more natural, such as in the co-located setting, it could also give greater support to embodied representations and potentially support the flow of a bodystorm*” [1]. Another unfortunate lost is the informal side conversations or water cooler discussions, which can be crucial in building on the ideas of others [1] and the development in mutual understanding of projects at a faster pace [1, 14, 13]. Such restraints cause group interaction to decrease as it becomes less likely to discuss issues and alternatives as they arise and will often wait until they face a critical issue before they interact [6].

Time Zone Challenges. Depends on the location of the distributed team, the time zone challenge is different. In some cases, teams are located in a place with large time zone differences, for example, U.S. and China. While there are many tools available for brainstorming and facilitating design sessions, it is not a sustainable model to have design teams frequently collaborate in the office over video conference with 16 hours of time difference.

Outsourcing Model Challenges. In most cases, outsourcing within the organization would not work in the long term. In such cases, teams are located in different economics zones where one location is much more expensive than the other. It may seem like a good idea to leverage an outsourcing model by focusing the more expensive team on more highly creative and value-adding activities, and have the less expensive team work on routine and less value-adding services, such as picture cropping and banner creation. But in the long run, there is a big challenge to motivate the less expensive team.

Cultural Differences. Team members may come from different cultures and countries. As Hofstede [8] identified, cultures could be different in several dimensions. Value, way of communication, inspiration, and team dynamics are different from one culture group to the other. Hall [5] looked at the culture differences from communication

context point of view. For example, people with high context culture are more relational, collectivist, and indirect with emphasis on interpersonal relationships. Working with high context culture, developing trust is an important first step as the preference is in group harmony and consensus to individual achievement. People in high context cultures are less governed by reason than by intuition or ings. Words are not so important as context, which might include the speaker's tone of voice, facial expression, and gestures. In some cases, even the person's family history and status is an important context to the communication. The information flows efficiently among the group members, where discussion and decisions happen before meetings. Meeting is considered official ceremony rather than a formal decision making process. Communication between high context and low context culture might be problematic [2]. When people with low context culture provide too much information to people with high context culture, people with high context culture might feel impatient. When people with high context culture do not provide enough information to people with low context culture, people with low context culture might feel puzzled. The challenge of the communication is to find the right amount of information based on the context.

Lack of Influence. Distance in physicality for distributed teams can often cause uneven distribution of critical task-related information [3, 7], exclusion from important team decisions, and reduction in contribution opportunities causing feelings of isolation, disidentification, and uncertainty in their value within the team [3]. Separate locations, especially from different time zones, have distributed teams further strained from the inability to do on the spot verification, lack of visible progress, lack of trust from miscommunication, and failure to maintain mutual knowledge through differences in speed to access information and interpreting the meaning of silence [7].

Ways to Overcome Challenges in Distributed Design Team. Several articles looked into ways to overcome the challenges for distributed design teams. Those include communication tools, project management, leadership and people management.

Design Artifacts and Communication Tools. As companies venture into distributed teams, an important factor in its success is the use of materiality of artifacts - tools to support and/or to represent work [15]. There are two types, procedural artifacts (office memos, letters, Gantt charts, etc.) and design artifacts (sketches, models, prototypes, etc.) [1]. As Vyas, Heylen, Nijhot, and van der Veer found through their ethnographic fieldwork of design teams, the “*material signals – signals in which people communicate through material artifacts, locations and their embodied actions*” – are an integral part in helping different co-workers make sense of each other's collaborative activities [15]. The need for collaboration and communication tools such as project discussion forums, project file depository, real-time data exchange (file sharing and collaboration), instant messaging augmented with voice and email [14], video [6], and shared surfaces to build on ideas of others [1] are also key factors in achieving success in virtual teams. Because of geographical distribution, face-to-face time occurs only rarely. This, according to research, results in weaker social links between team-mates and leads the team to be more task-focused than socially focused. [14] If

face-to-face meetings are feasible, meetings should be held as much as possible at the beginning of the team formation in order to bring team-mates closer and form interpersonal bonds. These meetings should focus more on relationship building than on actual business. However, with socializing, different cultural preferences have to be remembered. If face-to-face meetings are not possible or feasible to the desired extent, other approaches can be applied. Social-bonding can be done partially via electronic communication tools. Jarvenpaa's and Leidner's [10] study found that if teams communicate more socially they achieve higher trust and better social and emotional relationships. Leaders can help foster relationship building and general team building in many ways, e.g. by providing continuous feedback, listening to team members' opinions and suggestions, clearly stating the team member roles and having consistency in their leadership style. With technology and network advance, many collaboration tools are available, for example, cloud-based collaboration services, like Basecamp, Dropbox, Google Drive, Amazon Cloud Drive, AliCloud, etc. Widely available high-speed broadband at homes and offices also made the international video and audio communication a commodity through tools such as Skype, Yahoo Messenger, Alibaba Trade Manager, and WeChat, etc.

Project Management. Project management in distributed teams is most influential during the planning and development phases. Team leaders must plan regular interim deliverables to keep the global teams on track with the overall schedule [7] as well as organize and encourage regular meetings to promote the free exchange of ideas [6]. As further noted by the studies of distributed collaborative design teams conducted by Hammond, Harvey, Koubek, Compton, and Darisipudi, "*the use of a facilitator or trained leader is needed to ensure participation by all members to promote effective communication and free exchange of ideas*" [6]. Some type of formal discussion techniques or training must be utilized to encourage participants to interact frequently and freely explore issues and alternatives for consideration [6]. These discussions will need to be followed by a well-defined and documented process, clearly communicated and understood by the team, to act as a "*shared depository of project wisdom*" in order to allow resurfaced issues to be resolved quickly without reworking them [7].

Leadership and People Management. Despite these challenges, there are solutions to dissolve them through team leadership and management. Wilczynski and Jennings emphasized that "*the success of virtual teams is heavily dependent on the preparation of the project leaders*" [14]. Web collaboration tools are just half of the set of tool, it must be augmented by effective leadership in guiding the entire design process and close management of the design infrastructure. Teams must be trained and well organized where individual activities are clearly articulated and all are aware of the assigned responsibilities and deliverables [14]. As further noted by a series of structured interviews conducted by Hashia, Whelan, and Shewaramani, it is crucial to pay attention to project management, training, and people management in distributed teams in order to combat challenges in communication, cultural differences, and sense of being a single team [7]. People management in the form of relationship-based leadership is the most vital aspect in the success of distributed teams. As the empirical study conducted by Gajendran and Joshi reveals, high quality Leader-Member Exchange

(LMX) in combination with frequent leader-member communication in distributed teams helps enable member influence on team decisions and foster critical team-level outcomes such as innovation [3]. LMX is a relationship-based leadership approach *characterized by leaders treating followers as unique individuals developing ongoing dyadic relationships that are sustained through exchanges of materials and socioemotional resources* [3]. With LMX amplified by frequent team leader communication, it creates opportunities to contribute ideas and strengthen knowledge through feedback from leaders. This positive and supportive communication atmosphere can help create an environment to build upon ideas similar to the benefits of side conversations that were being lost in distributed teams. By working and reasoning on a personal level, this allows people to interact more naturally [7] and also act as a supplement to the feelings of isolation by creating a sense of proximity, value and belonging within the team as they gain a voice in team decisions. For this to be a success, team leaders must create opportunities for all team members to be involved in team decisions [3] and must promote a sense of equality where their input is equal to everyone else's [7]. "*Us versus them*" mentality must be discouraged by treating both locations as a single team with single focus but separate deliverables while celebrating success jointly. To provide this sense of belonging as well as build trust and personal relationships, team leaders must create opportunities for face-to-face time by organizing visitations and exchanging of people to different locations of the distributed teams [7]. These remote team visitations accompanied by classes and seminars on culture awareness and differences among work ethics, honesty, social issues, etc. can accelerate the sense of understanding and trust [7]. Pemberton-Billing's, Cooper's, Wootton's, and North's empirical studies of two co-located and distributed design projects further emphasize the importance of face-to-face contact at certain points within the life cycle of design projects - some being a central component in the formation and maintenance of distributed community of practices [13].

2.2 User-Centered Design

The concept of user-centered design was widely utilized in the design field. It was included in ISO standards [9] as part of the product development process. The ISO standard outlines 6 key user-centered design principles: (i) The design is based upon an explicit understanding of users, tasks and environments; (ii) Users are involved throughout design and development; (iii) The design is driven and refined by user-centered evaluation; (iv) The process is iterative; (v) The design addresses the whole user experience; (vi) The design team includes multidisciplinary skills and perspectives.

A typical user-centered design process is illustrated in Figure 1. The process typically includes a few phases, such as understand, design, prototype, research, improve, document, and develop. The design process is iterative. For example, the design could start with concept design, followed by low-fidelity prototype, concept user interviews, design improvement based on the research findings, then redesign, high-fidelity prototype, formal lab testing, etc. The final design will be documented in design specification and go through full production development.

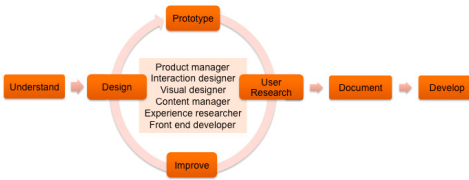


Fig. 1. A typical user-centered design process

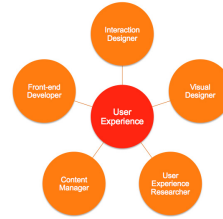


Fig. 2. Multi-disciplinary design team

The design process is a multi-disciplinary process requiring different roles to work closely. Different roles involved in this process are also illustrated in Figure 3. Product manager typically is responsible for the business side of a product, such as product planning, forecasting, and marketing in all stages of the product lifecycle. Interaction designer oversees the design process, and is responsible for understanding business requirement and user needs, design product information architecture and user interaction process. During the design process, the interaction designer, in most cases, will need to work with visual designers to come up with page details, as well as user experience researchers to understand user needs and test product usability.

Visual designer uses visual elements as the communication and expression methods. The elements include font, shape, color, graphics, and layout etc. The emotional and aesthetic aspects of the design play very important roles in the product success. User experience researcher utilizes different research methods to collect user needs, and exanimate product usability from user's point of view. While interaction and visual elements are an obvious part of design, content is also an integral part of the design process. Content manager is responsible for content strategy, communication plan, and final deliverable copies. Front-end developer is responsible for design prototype and front-end coding. Prototypes need to be developed with low cost and high speed, most of the time without backend support, in order for user experience researchers to conduct usability studies. Front-end developer is also responsible for final production of the front-end interface coding.

3 Case Study: Implementing UCD in Distributed Teams

With distributed teams in the U.S. and China, we faced many of the challenges illustrated in the literature review section including: communication, time zone, outsourcing model challenges, cultural differences and lack of influence. Communication tools, leadership, project and people management solutions presented in the literature review sections were helpful in combating challenges facing distributed design teams. However, in our case, with oversea distributed teams, some of the arrangements in the literature were unfit. For example, we have very advanced videoconference facilities with dual monitors and projectors, but due to the big time zone differences the usage of such office equipment is inconvenient and thus infrequent. As project collaborations increased, our teams began to adapt through trial and error and began naturally developing solutions fitting our own company culture. With that in mind, we realized

the inefficiency and ineffectiveness in building a parallel design team in each location and forcing them to collaborate together. Instead, the advantage and disadvantage of each distributed team were identified to pinpoint how each role in different locations could contribute uniquely. Strong leadership was developed in each location to build teams with different focuses to leverage the advantage of the location – turning some of the disadvantages to unique opportunities.

Organizational Consideration. One of the natural occurrences during our collaboration process was the establishment of one-to-one discussions and dyadic relationship between leader and members within distributed teams. It was not until later that we realized that such bonding was one of the most important aspects of high quality LMX. As a result, we understood the need for leadership in globally distributed design teams to enhance team innovation and enable member influence on team decisions. As revealed by Gajendran's and Joshi's research [3], high-quality leader member exchange relationships were effective in creating member inclusion and involvement in team decisions in highly distributed settings when they were accompanied by frequent leader-member communication. We took a few steps to assess and change the organizational structure. First, we looked into the status of the team, similar to the in-group and out-group status in LMX theory. For example, the U.S. office overall was playing a consulting role, due to being separated from the main product development process and the lack of unique contribution. Geographic location and time zone difference incorporated additional hindrance to the communication.

Then, we took the effort to improve the communication, especially the dyadic communication between the leader and member. Our communication channels included video and voice conference, phone, and instant messaging tools. International travel might be costly in some cases, but in a Chinese cultural point of view, face-to-face communication was a crucial and worthwhile investment in personifying the team member and building relationships. While regular group level communication was needed, frequent leader-member communication was even more important – leader and member worked together to identify ways to remove these barriers. Dyadic relationship between leader and member was fostered through the effective communication. The decisional power of the leader in organizational hierarchy and the existence of transparency in the workings of organization have direct positive influence. When our leaders were moved higher in the organizational hierarchy, we had higher influence to the upper hierarchy of the organization. The team members found it satisfying and motivating. More transparency was enforced by providing detailed organizational and project information, which in turn lead to more member confidence and motivation to exceed the expectation.

Finally, we established user-centered design thinking and process within the distributed user experience team as well as the whole organization. Research showed when both leader and member have the same approach to problem solving, or cognitive similarity, high leader-member exchange level is achieved. For our design teams, user-centered design was the base guiding principle to establish some level of cognitive similarity. Presentations, seminars, and training were carried out to promote

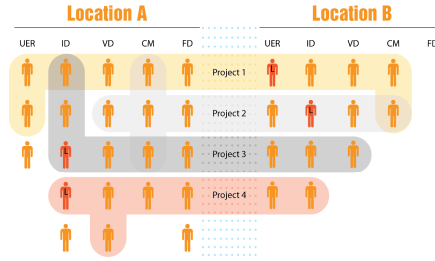


Fig. 3. Project Organization of Distributed Design Team

user-centered design within the user experience team and whole organization. The user-centered design process was integrated into the product development process: key projects would go through an iterative design, testing, and improvement cycle as the UCD process specified.

Project Organization. At project level, the distributed or virtual team concept was utilized to organize our team. Virtual team was groups of geographically, organizationally and time dispersed designers and researchers brought together by information and telecommunication technologies to accomplish one or more design and research project. For each project, a project leader was selected. Dependent on the nature of the project, people in different role can be the leader. As for a typical product design project, an interaction design lead would be more likely to work as a leader for the virtual team. The designer was responsible for carrying out the user-centered design process for the project. In the beginning of a project, face-to-face meetings were highly encouraged either through videoconferences or if feasible, international travel. The goal of those meetings were to focus more on relationship building, through bringing teammates closer together and forming interpersonal bonds, than on actual business. If face-to-face meetings were not possible or feasible to the desired extent, other approaches were applied. For example, social bonding were encouraged via electronic communication tools, such as videoconference, Skype, etc. A very important role of our project leaders was in communication and relationship building. Leaders were urged to clearly state team member roles and apply consistent leadership style as well as help foster relationship building and general team building by providing continuous feedback and listening to team members' opinions and suggestions. Culture differences had to be considered in project communication.¹ For example, in high context culture, decisions were very likely to be made before a formal meeting. With this in mind, team members in low context culture would communicate with high context culture members before the meeting to influence the decision effectively.

UCD Role Consideration in Distributed Teams

Interaction and Visual Design. Two main factors were considered in deciding where to place the designers: location of project target audience and related organizational functions. Designers closest to the target user culture had the sense of context and understanding to significantly contribute in making the right design decisions. Designers from different locations were also more likely to use different source and

network to come up with distinct and localized design ideas. The closeness to the related functions was the second factor in consideration. For example, designers located closer to the product managers could communicate more efficiently and effectively with product managers. These designers were put on the top of the consideration list for such projects. Designers were tasked with the establishment of design guidelines and appropriate design review process to ensure consistent execution across different locations. These basic design patterns were specified in a shared design pattern library to ensure all files and guidelines were easily and universally accessible. The resulting efficiency from the prevention of double or lost work allowed for more valuable time spent on studying users, understanding business goals, and project communication. Several papers mentioned about the importance of using design artifacts in distributed teams, including prototypes, demos, mockups, etc. A design review process based on those design artifacts was established to create opportunities for member contribution of ideas and knowledge sharing, creation of a positive environment to build upon ideas, and control design quality. In turn, these activities promoted the sense of member involvement and value within distributed team members.

User Experience Research. User experience research conducted internationally was a great way to leverage the distributed team. Many of the research methods, such as interviews, lab testing, and ethnographic research, etc. require face-to-face communication with users. Distributed team had easier access to local users as local offices could serve as locations to conduct such research. It was also found that researchers with similar background to the participants could identify more findings. In some cases, where participants were hard to access even with distributed offices, remote usability test tools were used. There were two types of remote testing tools: remote lab testing and quantitative automated testing. In remote lab testing, video conversation tools were used to help researchers observe and collect participants' behaviors on the screen, facial expressions, if additional cameras were available, and voice over the tool or phone. Remote quantitative testing tools allowed researchers to program test tasks with questionnaires as well as direct participants through a set of tasks using the live site, prototype, and/or mock-ups. With this tool, a large number of users could participate simultaneously from their home or office.

Content Management. With internationalization, more products needed to be supported or be marketed in more than one language. In most cases, especially with web sites, majority of interfaces were textual content making content creation an integral part in design. Similar to how the interaction and visual aspects of the interface needed design, content also needed design. Content managers were responsible for telling the story, crafting it in such a way that it resonated with the users and ideally producing an emotional response. Distributed teams closer to the target users had the advantage of understanding the context and local expertise in composing the right content or language for communication. Thus, content managers geographically and culturally closer to the target users were among the first to be considered for such projects.

Front-End Development. Front-end development's work typically was more separated from the rest of the design team with it being more technical and instruction based. Such attributes allowed communication to be done through detailed design specification and written communication, with less of a requirement for face-to-face interactions. Placement of the team was based on the need of face-to-face interaction for more advanced and innovative projects. Location cost was another factor to consider in deciding where to place the team. It was hard to set up experiments in reality to test the effectiveness of two different team setups. We looked into other comparisons, such as attrition rate and team satisfaction, to find evidence of the effectiveness of the effort above. With the considerations and arrangement described above, the user experience team achieved higher than company average satisfaction and lower than company average attrition rate. Although it was not a direct scientific comparison, those were definitely important factors in influencing team satisfaction and attrition rates.

References

1. Bergstrom, M., Torlind, P.: Examining Creative Collaboration in Distributed and Co-located Design Teams. In: ICED 2007: 16th Int. Conf. of Engineering Design (2007)
2. Dong, J., Fu, L., Rau, P.L., Stephanidis, C., Salvendy, G.: Human-computer Interaction: User-centered Design and Evaluation, 4th edn. Tsinghua Univ. Press (2013) (in Chinese)
3. Gajendran, R., Joshi, A.: Innovation in Globally Distributed Teams: The Role of LMX, Communication Frequency, and Member Influence on Team Decisions. *Journal of Applied Psychology* 97(6) (November 2012)
4. Hall, E.T.: *Beyond Culture*. Doubleday, New York (1976)
5. Hall, E.T.: Context and meaning. In: Samovar, L.A., Porter, R.E. (eds.) *Intercultural Communication: A Reader*, 9th edn., pp. 34–43. Wadsworth Pub. Co., Belmont (2000)
6. Hammond, J., Harvey, C., Koubek, R., Compton, W., Darisipudi, A.: Distributed Collaborative Design Teams: Media Effects on Design Processes. *International Journal of Human-Computer Interaction* 18(2) (2005)
7. Hashia, A., Whelan, J., Shewaramani, R.: *An Innovative Approach to Managing Distributed Teams*, Technical Report, Seattle University, Department of Computer Science & Software Engineering, SU-CSSE-2007-2 (2007)
8. Hofstede, G., Hofstede, J.: *Cultures and Organizations: Software of the Mind*. McGraw-Hill, New York (2005)
9. *Human-centred Design for Interactive System*, ISO 9241-210 (2010)
10. Jarvenpaa, S., Leidner, D.: Communication and Trust in Global Virtual Teams. *Journal of Computer-Mediated Communication* 3(4) (1998)
11. Norman, D.: *The Design of Everyday Things*. Basic Books, New York (2002)
12. Norman, D.: *Emotional Design: Why we love (or hate) everyday things*. Basic Books, New York (2004)
13. Pemberton-Billing, J., Cooper, R., Wootton, A., North, A.: Distributed Design Teams as Communities of Practice. In: *Proceedings of 5th European Academy of Design Conf.* (2003)
14. Wilczynski, V., Jennings, J.: Creating Virtual Teams for Engineering Design. *International Journal of Engineering Education* 19(2), 316–327 (2003)
15. Vyas, D., Heylen, D., Nijholt, A., van der Veer, G.: Designing Awareness Support for Distributed Cooperative Design Teams. In: *ECCE 2008 Proceedings of the 15th European Conference on Cognitive Ergonomics*, vol. (6) (2008)

Supporting Globally Distributed Work - Cultural Adaptivity Meets Groupware Tailorability

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Abstract. Computer Supported Cooperation has developed into a quite mature technology over time. Key factors such as awareness and synchronization between cooperating partners and work bench are widely solved. For application in real live, some tools are available, some in use, but the general breakthrough did not happen. Well known “Globalization” is a field where CSCW and similar tools can bring major contribution – but also new challenges have to be faced as user groups, or teams, will encounter more and more people from different nationalities and cultural background. Therefore, adaptation is needed beyond social behavior where culture becomes a key factor and resulting flexibility of CSCW-tools becomes a must. As a respond to this demand, Tailor-SMaDe (Tailorable Software Modeling and Design) has been developed as web-based synchronous groupware tool that supports globally distributed work. The tool provides high flexibility by allowing users to tailor their collaboration environment. It is implemented as a web-based application, which adds to the advantage that users need only to use their web-browsers to access the application. Tailor-SMaDe is built modularly so as to ease future extension of the groupware. Tailor-SMaDe is intended to be equipped with a culturally-aware expert system that suggests the most optimal configuration of a collaboration environment.

Keywords: tailorable collaboration environment, distributed collaboration, cultural awareness, synchronous groupware, adaptable groupware, adaptive expert system.

1 Introduction

This work presents a conceptual design to integrating two aspects of globally distributed work - human-computer interaction and human-human interaction into one collaboration environment.

On the human-computer interaction part, we introduce a web-based synchronous groupware prototype - Tailor-SMaDe as a tool that supports globally distributed work which specifically supports but is not limited to software design activities. On the human-human interaction part, we describe Intercultural Collaboration Environment Expert System (ICEES), a web-based expert system that suggests the most optimal collaboration environment settings depending on the cultural background of the participants.

The success of team work generally depends on factors like how well the team members can cooperate with one another in order to accomplish their common tasks. Assuming that the team members are able to communicate and cooperate well with one another, the fact that each member may have differing preferences in performing their tasks should not be neglected, as this may play an important role in the success of the collaboration. We share the same opinion as many researchers in this area like Wulf et al. [1], Slagter [2], that a flexible groupware should be able to fulfill the ever-changing demands of the collaborators, both in the group level as well as in the individual level. The usual groupware found in the market are those designed to satisfy the requirements of a wide range of users with varying functions and tasks [3]. Such generic groupware are not capable to fulfill the requirements of specific group with specific characteristics [1].

Also, tasks of a group work change over time. Varying tasks also means varying requirements on the collaboration tools. In our opinion, a flexible groupware should be able to provide an integrated collaboration environment for the collaborators and allow the collaborators to choose the tools they require at that moment to complete their common tasks. By integrated collaboration environment we mean that the users need not switch from one tool to another, hence losing the group awareness.

These are the reasons why a groupware need to be flexible. We intend to provide flexibility by providing tailorability. Tailoring belongs to the area of adaptable system [4], where the users trigger the changes in the system as a result to the changes that occurred in their requirements.

The impact of globalization on software development has introduced offshoring and outsourcing of software development [5], [3]. This phenomenon induces the need that global team members possess cultural understanding and competence. When providing a collaboration platform for globally distributed work, cultural differences often become the hindrance to the success of collaboration [6]. Cultural differences may lead users to operate using their tools differently and have different attitudes towards the applications they are using [7]. Although global players are well aware of the importance of cultural competence in distributed collaboration, many are overwhelmed in attempting to learn and adopt cultural knowledge into their work processes. The same is also valid when applying groupware as a means of distributed collaboration. Most of the groupware available in the market are not equipped to support users with differing cultural backgrounds [8]. In response to this, we introduce ICEES [9] as the ambassador in providing cultural awareness for groupware users.

2 Tailor-SMaDe - A Web-Based Tailorable Synchronous Groupware

Tailor-SMaDe (**T**ailorable **S**oftware **M**odeling **a**nd **D**esign) is a web-based tailorable synchronous groupware which was initially designed to support distributed software design activities. Its modular structure, however, allows it to be extended with other tools and other collaboration components, that makes it more flexible in its application area. The synchronous groupware provides an integrated platform for real-time distributed collaboration. It is implemented as a web-application that exploits the latest web-technologies such as HTML5 [10], [11] and WebSockets [12], [13]. Characteristic to this synchronous groupware is user empowerment to *tailor* their own collaboration environment. Tailoring can be performed *prior* to a session begin (during a session configuration phase) or during a running session.

The tailorable synchronous groupware can be accessed through HTML5-enabled browsers like Google Chrome and Firefox. The web-application is deployed in a web-server and co-exists with the WebSocket server and a MySQL database server. The WebSocket server is responsible in rendering the selected components to all the client browsers during a running session. As soon as clients have joined a session, the WebSocket server generates the necessary connections with the clients. The number of connections created per session depends on the number of components selected for the session and the number of clients. If one client updates the state of a shared artifact, the WebSocket server forwards the update to all clients connected to that particular session. This way, the synchronization of the distributed work is maintained at real-time. The only components that are administered by the WebSocket server are the audio and video components. The audio and video transmission is managed by WebRTC API [14], which is an open source API for enabling web-browsers with real-time communications. At the time this paper is written, a session set up with audio or video transmission is only accessible through Google Chrome web browser.

2.1 Tailor-SMaDe's Modules

Tailor-SMaDe consists of four main modules; user management module, session management module, conference management module and groupware components module. The user management module provides the interface for users to manage their profiles like personal information, areas of interests, location and so on. Through the session management module users are able to create or modify session, while the conference management module presents users with all the existing sessions and provides the entry point to the session to which the user has been invited to. The groupware components module is composed of sub-modules relevant to a groupware. In our case, these are collaboration components sub-module, communication components sub-module, coordination components sub-module, session control components sub-module, awareness sub-module, concurrency and consistency sub-module. The components of these sub-modules are summarized in Table 1.

Table 1. Groupware Components Module

Groupware Components Module	
Sub-Module	Components
Collaboration	shared workspace, shared UML Editor, shared HTML Editor, graphical Editor
Communication	Text chat (shared and private), audio and video chat
Coordination	Group calendar, project management
Session Control	Stop session, modify session, modify layout, modify user roles, modify tools
Awareness	Multiple tele-pointer, colour coding, running session history
Consistency & concurrency mechanism	Locking of shared artifact

Although a video component is normally deployed together with audio component, we implemented the two components as two separate entities. This is to provide the possibility for users who prefer to only hear their collaborators rather than hearing and seeing them to do so.

The session control components are destined mainly for a *tailor* - the user who creates the session and possesses the role *manager*. Roles in Tailor-SMaDe are explained in section 2.2.

To provide workspace awareness, each participant of a session can be equipped with a tele-pointer. Each participant is also assigned a colour either manually (chosen by the session author) or automatically by the system. Provided that the multiple-tele-pointer option is included in the session, the assigned colour is displayed together with the name of the participant below the user's pointer. The colour coding is also applied to the text chat component.

Generally, to maintain consistency of the shared artifacts in the shared workspace, the locking mechanism [15] is applied.

2.2 User Roles and Shared Artifacts in Shared Workspace

Any registered user can be a tailor; i.e. a group representative who defines the characteristics and behaviour of a collaboration environment. However, only one person can tailor a session at a time, be it during session configuration phase or during a running session. To enable the latter, we implement user roles as a mean to assign user with tailoring rights while at the same time confining some other users with limited access to the collaboration tools if this is desired. To enhance flexibility, users' roles are also made adjustable during a running session. The user roles implemented in Tailor-SMaDe are as follows:

1. *Manager*: this reflects the super user of the groupware. Users possessing this role have absolute access to all the components in the collaboration environment, and hence can perform any modification required. This role also grants the owner to adjust other users' access to the collaboration components or change other users' roles completely to another.
2. *Contributor*: represents users who actively contribute to the common task, are granted some access to the collaboration environment components.
3. *Viewer*: are users who are present in the session but have little or no contribution to the common work, and therefore have little access to the session's selected tools.

2.3 Tailoring Activities

As aforementioned, the provision of tailorability is aligned to Mørch's [4] customization level. Users are presented a palette of components they can select from, and are able to configure their collaboration environment according to their group's requirements. The act of tailoring can be performed *prior* to session begin or during a session configuration phase, and *during* a running session phase.

During a session configuration phase, a groupware user can either create a new session, modify or delete an existing session. Since any user can perform tailoring, it is imperative that the system maintain the integrity of the relationship between session owner and session. For this, session authorship is applied to each session. Fig. 1

depicts the session authorship mechanism. If a logged in user opts for modifying a session, his UserID is matched against the session and the session authors. If he is the author of a session, then he is allowed to modify, copy or delete the session. If he is not the author of a session, then he is only allowed to copy the session.

Tailoring during a running session can only be performed by a user possessing the *manager* role. We classify the tailoring activities during a running session into four types; namely: modify session, modify roles, modify tools and modify layout. Modify session means changing the parameters of the session like reducing the number of participants by kicking out some participants, extending the session duration. Here, the previously assigned user roles can be changed and individually modified. For example, a user who was previously assigned a viewer role requested for allowance to contribute using a chat text. The manager can either change his role to become contributor role or simply add the text chat access for this user. The following figures Fig. 3 and Fig. 4 show the difference in access grants to the text chat tool.

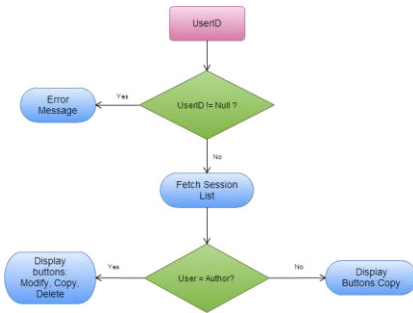


Fig. 1. Session Authorship Mechanism

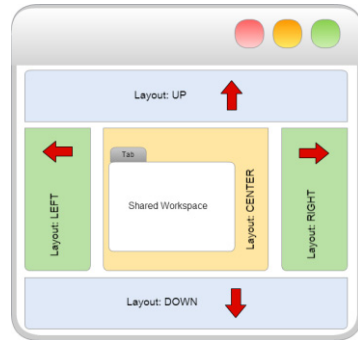


Fig. 2. Running Session Layout

Also during a running session, tools can be added and deleted according to the momentary requirement. Additionally, the layout of the session can be determined dynamically through dragging and dropping the components into the desired space as illustrated in Fig. 2. In order to guarantee an intact provision of workspace awareness [16], the workspace is guarded by a rule that prevents tailors from dropping into the center space.

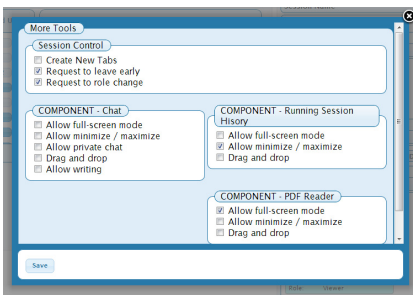


Fig. 3. Viewer Role

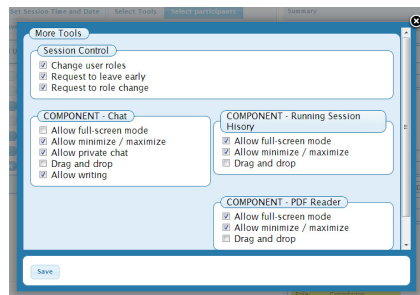


Fig. 4. Contributor Role

3 ICEES - A Culturally Aware Expert System

Intercultural Collaboration Environment Expert System (ICEES) is a knowledge-based system that recommends the most optimal groupware settings based on users' cultural background. The cultural knowledge and user preferences on the groupware components and features are obtained from a field research study that was performed for Germany, Malaysia and Indonesia. The three countries have been chosen due to the long-term educational cooperation between the Engineering Faculties of University of Duisburg-Essen, University Kebangsaan Malaysia and Universitas Indonesia. ICEES is also a web-based system, which is hosted in a web-server and is equipped with a MySQL database server.

3.1 ICEES Knowledge-Base and Rules

The cultural knowledge included in ICEES consists of the common cultural dimensions [17], [9], like High-Low context, Individualism-Collectivism, Specific-Diffuse, Monochromic-Polychromic and Power Distance. The following table shows a sample of the ICEES knowledge base.

Table 2. ICEES knowledge-base sample

Cultural dimension	Rule	
	If	Then
Specific	User <i>strongly agrees</i> to keep private and business agenda separate	Private chat is recommended
	User <i>strongly disagrees</i> to keep private and business agenda separate	Public chat is recommended
Polychromic	User prefers to do one thing after another and needs to be fully alert of all the changes done by other users	Recommended awareness mode is tight
	Users prefer to do several things at a time and do not need to be alert of all changes done by other users	Recommended awareness mode is loose

4 Integrating ICEES into Tailor-SMaDe - Cultural Adaptivity Meets Groupware Tailorability

In this section, we elucidate our concept in integrating ICEES into Tailor-SMaDe so as to provide a wholesome web-based tailorable, culturally aware synchronous groupware. Although the two systems occupy the two areas of adaptability; adaptable system and adaptive system, we do not intend to transform the system into an adaptive system, instead we mean to sustain the two qualities altogether. The resulting system should remain tailorable, while it additionally suggests the most optimal collaboration environment configuration for a specific cultural composition.

ICEES will be integrated into Tailor-SMaDe as an independent module which in turn is composed of sub-modules and components. We call this module the cultural awareness module, as depicted in Fig. 5.

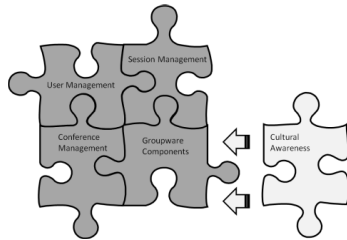


Fig. 5. Integration of ICEES in Tailor-SMaDe

ICEES makes use of the user information that is administered by the user management module. Personal information like language proficiency, country of origin, gender, age and so on are used as inputs. The resulting suggestion is displayed in the session configuration phase, prior to confirming the submission of the session configuration. The session author can accept the suggestion, which will lead to automatic alteration of the manually inputted session configuration, or reject the suggestion. If the suggestion has been rejected during the session configuration phase, the system will make the suggestion accessible during the running session, in case the manager should need it as a reference in the course of changing the collaboration environment.

5 Evaluation Concept

The tailorable synchronous groupware presented in this paper is yet to be evaluated for its usability. The usability aspect we intend to evaluate is: *Usability through the enhancement of collaboration efficiency*. Since tailorability is implemented in order to attain a flexible and adaptable system, it becomes important to determine whether the tailorability introduced in the synchronous groupware indeed enhances the efficiency of collaboration.

To evaluate our system, we adhere to the Keystroke-Level-Model (KLM) [18] - an instrument to measure the execution time of a group task, introduced in the Human-Performance Models (HPM) [19]. However, instead of using the KLM framework, we intend to implement a user activity monitoring application in the groupware. This application records users interactions with the graphical user interface components within a running session. The user activities are categorized into tailoring activities and collaboration activities.

Our evaluation method is described as follows:

1. Step 1: define a benchmark scenario. A standard scenario is selected, typically from within the domain of software design.
2. Step 2: set up a contradicting session. To test the tailorability of the system, a session is set up using a non-tailorable system. Alternatively, Tailor-SMaDe can be

also used to configure a session where the tailoring functions of the session are deactivated.

3. Step 3: compare group performance. The group performance is measured by subtracting the session end time with session start time. For the non-tailorable system, the collaboration time = session duration, while for a tailorable system collaboration time = session duration - tailoring time.

When evaluating the integrated culturally aware synchronous groupware Tailor-SMade, we intend to combine the previously described quantitative evaluation with a qualitative evaluation. For the qualitative evaluation, a generic user questionnaire will be generated.

6 Conclusions

The concept described in this paper combines two key aspects of flexibility, or better say options for adaptation of a CSCW session:

- a) Choice groupware components which are best suited for a work scenario with a given team
- b) Choice of groupware components based on the actual team consisting of members with different cultural background.

While decisions under option a) can be made by the team members, depending on working conditions or personal preferences, b) is more an advisory system, making suggestions to the team automatically.

In global acting industry, both options must be available to allow smooth cooperation and best results. But such a system becomes very complex, by combining technical components to be used based on decisions following advises made by acting persons or based on hints developed from findings in social science. Authors are in process do run further case studies under supervision in order to prove efficiency of this combined concept.

References

1. Wulf, V., Pipek, V., Won, M.: Component-based tailorability: Enabling highly flexible software applications. *International Journal Human-Computer Studies* 66(1), 1–22 (2008)
2. Slagter, R.-J.J.: Dynamic groupware services: modular design of tailorable groupware (2004), <http://doc.utwente.nl/41559/> (accessed December 8, 2009)
3. Wulf, V.: On Search for Tailoring Functions: Empirical Findings and Implications for Design. In: *Proc. of the OZCHI 1999, WAGGA WAGGA*, pp. 105–111 (1999)
4. Mørch, A.: Three levels of end-user tailoring: customization, integration, and extension. In: *Computers and design in Context*, pp. 51–76. MIT Press (1997)
5. Casey, V.: Imparting the importance of culture to global software development. *ACM Inroads* 1(3), 51–57 (2011)
6. Carmel, E.: *Global software teams: collaborating across borders and time zones*. Prentice Hall PTR, Upper Saddle River (1999)

7. Suadamara, R., Werner, S., Hunger, A.: Cross-Cultural Design of a Groupware Application for Global Virtual Team. In: Rau, P.L.P. (ed.) IDGD 2011. LNCS, vol. 6775, pp. 104–113. Springer, Heidelberg (2011)
8. Suadamara, R., Werner, S., Hunger, A.: Cultural influence on user preference on groupware application for intercultural collaboration. In: Proceedings of the 3rd International Conference on Intercultural Collaboration, Copenhagen, Denmark, pp. 215–218 (2010)
9. Suadamara, R.: Integrating Culture in Designing Groupware Applications as Contribution to Intercultural Collaboration Technology. Winter Industries (2012)
10. HTML5 A vocabulary and associated APIs for HTML and XHTML (December 17, 2012), <http://www.w3.org/TR/html5/>
11. HTML 5.1 Nightly A vocabulary and associated APIs for HTML and XHTML (February 23, 2013), <http://www.w3.org/html/wg/drafts/html/master/>
12. Hickson, I.: The WebSocket API, The WebSocket API (September 2, 2013), <http://dev.w3.org/html5/websockets/>
13. The WebSocket Protocol RFC 6455 (December 2011), http://datatracker.ietf.org/doc/rfc6455/?include_text=1
14. Bergkvist, A., Burnett, D.C., Jennings, C., Narayanan, A.: WebRTC 1.0 Real-time Communication Between Browsers (January 16, 2013), <http://dev.w3.org/2011/webrtc/editor/webrtc.html>
15. Yang, Y., Li, D.: Supporting Adaptable Consistency Control in Structured Collaborative Workspaces. *Comput. Supported Coop. Work* 14(5), 469–503 (2005)
16. Gutwin, C., Greenberg, S.: A Descriptive Framework of Workspace Awareness for Real-Time Groupware. *Journal Computer Supported Cooperative Work* 11(3) (2002)
17. Suadamara, R., Werner, S., Hunger, A.: Cultural aspects in groupware application as an intercultural collaboration technology. In: 2011 International Conference on Collaboration Technologies and Systems (CTS), pp. 587–592 (2011)
18. Card, S.K., Moran, T.P., Newell, A.: The keystroke-level model for user performance time with interactive systems. *Commun. ACM* 23(7), 396–410 (1980)
19. Antunes, P., Ferreira, A., Pino, J.A.: Analyzing shared workspaces design with human-performance models. In: Dimitriadis, Y.A., Zigurs, I., Gómez-Sánchez, E. (eds.) CRIWG 2006. LNCS, vol. 4154, pp. 62–77. Springer, Heidelberg (2006)

Mobile Application Development in FLOSS Platform: A Collaborative Network Approach

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Abstract. We are deluged by wide variety of mobile applications (thereafter terms as mobile apps) to run on our mobile devices such as smartphones and tablets. However, few studies have been conducted to investigate the issue of how mobile applications are developed in academia so far. In order to bridge such gap, we collected data on mobile application development projects from the largest FLOSS (Free and open-source software) platform, i.e., SourceForge, longitudinally. Four key indicators, graph density, reciprocity, modularity, and dyad census asymmetry, which had been drawn from previous social network literatures, were adopted to investigate the collaborative network. We found that the interactive collaboration was especially important for mobile application development process. Developers formed centralized/mutual structure for collaboration instead of several collaborative subdivisions.

Keywords: Open source software, Mobile applications development, social network analysis.

1 Introduction

There is no doubt that we are living in a mobile world. We are deluged by wide variety of mobile applications (thereafter terms as mobile apps) to run on our mobile devices such as smartphones and tablets. Gartner predicted that the mobile apps market would reach 9 Billion USDs in 2012 and the number of mobile app development projects will rise four times more than native PC projects in 2015 [1]. Despite such emergence, to-date in academia, few studies have been conducted to investigate the issue of how mobile applications are developed, particularly in an open innovation environment such as FLOSS. The most relevant study we found is a pilot work discussing the developers' opportunities in the mobile age [2], but this work falls short of empirical verification. In order to address this research scarcity and to gain a better understanding of mobile apps development, we collected data on mobile application development projects from the largest FLOSS (Free and open-source software) platform, i.e., SourceForge, longitudinally. We seek to identify factors influencing the success of these mobile application development projects.

We used the data from FLOSS mobile application development projects for two reasons. First, SourceForge stores complete data archive of each project, which allows us to analyze the projects in great details. Second, the learning curve effect, previously identified as an obstacle for FLOSS development participation in previous literature [3], could be weakened in FLOSS mobile application development projects due to the availability of development tools and instrumental instructions such as iOS¹ and Android² development toolkits. The backbones of functionalities of each mobile platform have been well packaged and documented, which could enable a newcomer to be familiarized with the development environment fast.

In accordance with the previous studies on FLOSS [4, 5], we adopted the information systems (IS) success as the key dependent variable in this study, which is also a prevalent research topic in IS and project management arenas. To contextualize the IS success of mobile application development project, we used two dimensions of IS success as measurements, namely, project awareness and project usage popularity. For project awareness, we counted the amounts of page views within each project; for project usage popularity, we counted the number of application downloads of each project. Both measurements have been validated as meaningful indicators of IS success in the previous studies [5, 6]. For the independent variables, we have four variables measuring the collaborative network characteristics and a time-lag dependent variable. The four network related variables are graph density (reflecting whether the network is tight or sparse), modularity (measuring the strength of division of a network into subgroups), dyad census asymmetry (operationalized by the number of non-mutual connected pairs of vertexes), and reciprocity (that is, whether the pairs of vertexes tend to form mutual connection), which were all based on prior literature on social network analysis [7, 8, 9, 10, 11]. Furthermore, we included three control variables, i.e., incremental ratio of number of files released, the incremental ratio of project developers, and the age of project in the analysis model.

We utilized the seemingly unrelated regression model to analyze the data and obtained consistent results involving the two dependent variables. The results indicate that the sparser network (lower graph density) and the network with greater strength to form subgroups (higher modularity) are negatively related the projects' success. Higher tendency of mutual connection between vertexes is of positive relationship with projects' success. Likewise, we also observed that the more non-mutual connected vertexes exist in network, the lower projects' success probability. In addition, the results reveal that the lag downloading or page viewing amounts also has positive relationship with projects' success.

2 Prior Investigations on FLOSS

Studies on FLOSS development have been prevalent in the last two decades in various academic areas, including computer sciences organization studies, and IS.

¹ <https://developer.apple.com/devcenter/ios/index.action>

² <http://developer.android.com/sdk/index.html>

For instances, a private-collective model of OSS innovation was presented in the seminal work by Von Hippel and Von Krogh [12]; Shah [13] extended such model and identified several additional key elements, such as need of satisfaction, reciprocity, and enjoyment, by studying two open source software (OSS) development communities. Besides the investigations from the institutional perspective [12, 14, 15], prior studies also utilized the econometric models to understand the dynamics of FLOSS. For instances, Subramaniam et al. [5] analyzed 8,627 projects hosted in SourceForge and measured three dimensions, namely number of developers, number of downloads, and number of files released, to understand the OSS projects' success; Sen et al. [16] analyzed 7,720 projects hosted at SourceForge to uncover how the intrinsic elements, such as whether to accept donation, programming language, or operation systems, influence projects' success. In addition, some studies utilize the notions from SNA (social network analysis) to investigate how social relationships or capital influencing on the project success. For instances, Grewal et al. [17] randomly selected and measured the network embeddedness of 10 OSS projects, and they found the embeddedness of different project roles (developers and leaders) had different influences (number of CVS commits and number of downloads); Hahn et al. [18] measured network ties to uncover whether the prior collaborative experiences affected the tendency of future collaboration; and Singh et al. [19] deployed the internal and external cohesion within the development network to estimate the OSS project success which was measured by the number of Concurrent Versions System (CVS) commits.

While these studies provide great insights, they, like any other studies, suffer from several precincts, such as the limitation of data sample [13, 17], simplex measurement [19], and lack of sense of social collaboration [5, 16]. Furthermore, the OSS development for mobile application did not draw serious attention in the previous literatures although both industries and academia had realized the importance of application on mobile platform. All of these antecedents motivate us to shift the attention from gaining general insights on overall OSS development to specific understandings on OSS mobile application development.

3 Collaboration from Network Approach

The notions from SNA are introduced to investigate the issues of collaboration for some time. For instances, Singh et al. [19] used internal cohesion, direct and indirect ties, and external cohesion to estimate the number of CVS commits by examining 2,378 OSS project hosted in SourceForge; Cocaldi et al. [20] used rate of network changes and degree centrality to depict the intrinsic structure of bug-fixing network of an OSS project; Singh [21] used cluster coefficient ratio and path length ratio within a network to predict the success of an OSS project. Due to the page limit, we did not review all the studies utilizing SNA to investigate the OSS collaboration here. After a comprehensive extent of literature review of SNA, we identified four most

representative SNA indicators, namely (1) graph density, (2) reciprocity, (3) modularity, and (4) dyad census asymmetry, to evaluate the collaboration networks of the mobile OSS projects hosted in Sourceforge.

Graph density denotes the number of edges within a network [10]. In other words, the graph density determines whether the network is tight or sparse, and the dense graph indicates the number of edges is close to the maximal number of edges. In the context of collaboration, the denser graph indicates the higher extent of mutual cooperation.

Reciprocity measures the tendency of vertex pairs to form mutual linkage between each other [11]. Such measurement can be used to estimate the likelihood of bidirectional connection between vertexes. Hence, the higher value of reciprocity indicates the stronger bidirectional connection within such network. In our context, the reciprocity can be used to measure flatness of the collaborative atmosphere. More specifically, the project leaders assigned the tasks of developers and the project leaders also took the tasks left by the developers. The job boundary between developers and leaders is equivocal.

Collectively, the graph density represents the mutuality from an overall perspective while the reciprocity represents the mutuality in the vertex level, and both of them can be used to depict a centralized collaborative network.

Modularity is designed to measure the strength of division of a network into subdivisions [9]. A higher value of modularity indicates that a network has more obvious structure where vertexes have dense connection within the same subdivision but sparse connection between vertexes across subdivision. More specifically, there are several leaders who had been surrounded by their own ‘troops’. Hence, in the view of collaborative work, such structure could be seen as a kind of decentralized co-working style.

Dyad census asymmetry is obtained in terms of counting the number of non-mutual connected pairs of vertexes. Such index can be seen as an opposite of reciprocity. If a network containing more subdivisions, the mutual connection of vertexes across subdivisions will be unlikely to being high. Hence, the value of dyad census asymmetry within decentralized network should be lower than that of the centralized network. In this regard, we used modularity and dyad census asymmetry to depict a decentralized collaborative network. In the similar vein, the modularity represents the decentralization from an overall level while the dyad census asymmetry represents the decentralization in the vertex level.

The benefits or defects of both centralized/mutual and decentralized collaborative structure can be found in the previous literatures [19, 22, 23, 24, 25]. Hence, we proposed the competing propositions:

Proposition 1 (competing): A centralized/mutual collaborative network can accelerate the project success in the context of FLOSS mobile applications.

Proposition 2 (competing): A decentralized collaborative network can accelerate the project success in the context of FLOSS mobile applications.

4 Methodology and Data Analysis

By collaborating with Sourceforge, we were permitted to access the information of entire OSS projects hosted in Sourceforge. We selected the all the mobile projects incepted from May 2008; the data was collected till July 2011. In total, there were 3,076 mobile projects hosted in Sourceforge during the period. After filtering out the inactive projects and the outliers, there were a total of 383 projects being entered our analysis model. The collaborative networks of these projects were examined and the focal social network indexes were computed. The detailed descriptive analysis is shown in Table 1. In order to control for the bias of longitudinal effect, we did not set a fixed time stamp of T1 to measure number of downloads or number of page views but obtain such values in the middle of project inception and July 2011. Furthermore, the correlation table is shown in Table 2. We can find that all the correlation coefficients between the predictors are less than 0.7. Hence, there is inexistence of multicollinearity in our analysis model.

Table 1. Descriptive Data Analysis

Variable	Definition	Mean	Std. Dev.	Min.	Max.
ND_t2*	Number of downloads at T2	0.5048	0.4003	0.0001	1
PV_t2**	Number of page views at T2	1.5876	0.9493	0.2218	5.4014
ND_t1*	Number of downloads at T1	0.3044	0.3803	0.00004	1
PV_t1**	Number of page views at T1	2.0350	0.9395	0.1663	4.9657
Gd_t2*	Graph Density at T2	0.5780	0.1808	0.0021	0.9949
R_t2***	Reciprocity at T2	0.0387	0.1232	0	1
M_t2**	Modularity at T2	0.0071	0.0246	-0.0085	0.1761
Dca_t2*	Dyad census asymmetry at T2	0.2489	0.1754	0.0004	0.5
Usr_r*	Incremental ratio of project developers	0.4904	0.0525	0.2	0.8
Page_t2	Project age at T2 (by days)	2060.595	1307.571	56	4252
Frs_r*	Incremental ratio of number of released files	0.5256	0.1256	0.0269	0.9790

Inversed normalization; **Log-transformed normalization; *square rooted normalization*

In order to control for the contemporaneous cross-equation error correlation between two dependent variables, namely number of downloads and number of page views, we applied the seemingly unrelated regression model to test our competing hypotheses. The results are shown in Table 3.

Table 2. Correlation Table

	ND_t1 (PV_t1)	Gd_t2	R_t2	M_t2	Dca_t2	Usr_r	Page_t2	Frs_r
ND_t1 (PV_t1)	1							
Gd_t2	-0.1360 (0.2179)	1						
R_t2	-0.0292 (0.1617)	-0.1048	1					
M_t2	-0.1227 (0.0921)	0.1803	0.0196	1				
Dca_t2	0.3362 (-0.5426)	0.1425	-0.2085	-0.1507	1			
Usr_r	0.0517 (-0.1355)	0.0260	0.0493	0.0781	0.0049	1		
Page_t2	-0.1666 (0.1229)	0.2670	0.0539	0.1560	-0.1899	0.1634	1	
Frs_r	-0.1742 (0.2888)	0.0387	0.0585	0.0479	0.2367	-0.0363	0.0290	1

Model 1 is the baseline model with all control variables. We can find either the number of downloads or the number of page views in the current time point to be positively influenced by such values in the previous lag. The project ages and the incremental ratio of users and released files only positively influenced the times of downloading but not the page views of project. The indicators depicting the centralized/mutual collaborative network were entered in Model 2. Both graph density and reciprocity have positive impact on the project success, namely number of downloads (such value was inversed for normalization) and page views. The effect of released files is not shown after including two focal variables. Model 3 is the full model. It is obvious that the graph density and reciprocity positively influence the project success but the modularity and dyad census asymmetry have negative impact on the project success. Hence, we can reach the conclusion that the proposition 1 is supported. Thus, in the context of mobile OSS projects, a centralized/mutual collaborative network is preferred.

Table 3. Results

	Model 1		Model 2		Model 3	
	Coef.		Coef.		Coef.	
	(Std. Err)		(Std. Err)		(Std. Err)	
	ND_t2	PV_t2	ND_t2	PV_t2	ND_t2	PV_t2
ND_t1	0.7433*** (0.0309)	-	0.7564*** (0.0351)	-	0.6877*** (0.0347)	-
PV_t1	-	0.69686*** (0.0305)	-	0.6772*** (0.0348)	-	0.5449*** (0.0398)
Gd_t2	-	-	-0.2315*** (0.0765)	0.9434*** (0.1796)	-0.3866*** (0.0748)	1.4245*** (0.1852)
R_t2	-	-	-0.2940*** (0.1082)	0.6828*** (0.2532)	-0.1713* (0.1029)	0.5007** (0.2413)
M_t2	-	-	-	-	0.5806*** (0.0814)	-1.9681* (1.2144)
Dca_t2	-	-	-	-	1.5122*** (0.5200)	-1.5632*** (0.2162)
Usr_r	0.9536*** (0.2541)	-0.3939 (0.5750)	0.9192*** (0.2553)	-0.2290 (0.5940)	0.8418*** (0.2396)	-0.3389 (0.5655)
Page_t2	0.00004*** (0.00001)	0.00002 (0.00002)	0.00004*** (0.00001)	-0.00001 (0.00002)	0.00005*** (0.00001)	-0.00005** (0.00002)
Frs_r	-0.2291** (0.1029)	-0.2610 (0.2370)	-0.1423 (0.1066)	-0.3953 (0.2518)	-0.0042 (0.1018)	-0.6142 (0.2403)**
R ²	0.5710	0.5741	0.5856	0.6059	0.6368	0.6468

* $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$

5 Discussion and Conclusion

Our results suggest that the interactive collaboration is especially important for mobile application development process. Developers formed centralized/mutual structure for collaboration instead of several collaborative subdivisions. Such findings provided both theoretical and managerial implications for either existing or future work. For the researchers, this article examines the mobile application development in the FLOSS platform, which has been inadequately examined. To the best of our knowledge of project management, such collaborative network is analogous to the notions from LMX (leader-member exchange) theory or path-goal theory. Future work may be explored and endeavored in-depth discussion of such topics. For the practitioners, we suggest that project managers should pay more endeavors on establishing interactive collaboration network among the developers instead of overemphasizing the

decentralized collaborative structure for developing an OSS mobile application. The intelligence or skills from each person should be centralized instead of locating in her/his own 'circle(s)'.

Like any other studies, this work also has a number of limitations that afford opportunities for future research. First, we examined the collaborative network of each project. However, we did not consider the case of projects of same project leader(s). Second, we only use two indexes, number of download and number of pages views, to depict the project success. A more holistic measurement of OSS project success is needed in the future research. Third, the developers might have used other IT artifacts, such as forums, mailing lists, or private messages, for communication, even for organizing or allocating the tasks. All such caveats provide researchers with the opportunity to refine this exploration in the future.

References

1. Gartner, Inc., <http://www.gartner.com/technology/research/predicts/> (2012)
2. Holzer, A., Ondrus, J.: Trends in mobile application development. In: Hesselman, C., Giannelli, C. (eds.) *Mobilware 2009 Workshops*. LNICST, vol. 12, pp. 55–64. Springer, Heidelberg (2009)
3. Von Krogh, G., Spaeth, S., Lakhani, K.R.: Community, joining, and specialization in open source software innovation: a case study. *Research Policy* 32(7), 1217–1241 (2003)
4. Crowston, K., Howison, J., Annabi, H.: Information systems success in free and open source software development: Theory and measures. *Software Process: Improvement and Practice* 11(2), 123–148 (2006)
5. Subramaniam, C., Sen, R., Nelson, M.L.: Determinants of open source software project success: A longitudinal study. *Decision Support Systems* 46(2), 576–585 (2009)
6. Stewart, K.J., Gosain, S.: The impact of ideology on effectiveness in open source software development teams. *MIS Quarterly* 30(2), 291–314 (2006)
7. Coleman, T.F., Moré, J.J.: Estimation of sparse Jacobian matrices and graph coloring blems. *SIAM Journal on Numerical Analysis* 20(1), 187–209 (1983)
8. Rosvall, M., Bergstrom, C.T.: Maps of random walks on complex networks reveal community structure. *Proceedings of the National Academy of Sciences* 105(4), 1118–1123 (2008)
9. Newman, M.E.J.: Modularity and community structure in networks. *Proceedings of the National Academy of Sciences* 103(23), 8577–8582 (2006)
10. Wasserman, S., Faust, K.: *Social network analysis: Methods and applications*. Cambridge University Press (1994)
11. Garlaschelli, D., Loffredo, M.I.: Patterns of link reciprocity in directed networks. *Physical Review Letters* 93(26), 268701 (2004)
12. Von Hippel, E., Von Krogh, G.: Open source software and the “private-collective” innovation model: Issues for organization science. *Organization Science* 14(2), 209–223 (2003)
13. Shah, S.K.: Motivation, governance, and the viability of hybrid forms in open source software development. *Management Science* 52(7), 1000–1014 (2006)
14. Hagedoorn, J., Duysters, G.: External sources of innovative capabilities: the preferences for strategic alliances or mergers and acquisitions. *Journal of Management Studies* 39(2), 167–188 (2002)

15. Lounsbury, M., Crumley, E.T.: New practice creation: An institutional perspective on innovation. *Organization Studies* 28(7), 993–1012 (2007)
16. Sen, R., Singh, S.S., Borle, S.: Open source software success: Measures and analysis. *Decision Support Systems* 52(2), 364–372 (2012)
17. Grewal, R., Lilien, G.L., Mallapragada, G.: Location, location, location: How network embeddedness affects project success in open source systems. *Management Science* 52(7), 1043–1056 (2006)
18. Hahn, J., Moon, J.Y., Zhang, C.: Emergence of new project teams from open source software developer networks: Impact of prior collaboration ties. *Information Systems Research* 19(3), 369–391 (2008)
19. Singh, P.V., Tan, Y., Mookerjee, V.: Network effects: the influence of structural capital on open source project success. *MIS Quarterly* 35(4) (2011)
20. Conaldi, G., Lomi, A., Tonellato, M.: Dynamic models of affiliation and the network structure of problem solving in an open source software project. *Organizational Research Methods* 15(3), 385–412 (2012)
21. Singh, P.V.: The small-world effect: The influence of macro-level properties of developer collaboration networks on open-source project success. *ACM Transactions on Software Engineering and Methodology (TOSEM)* 20(2), 6:1–6:27 (2010)
22. Kirsch, L.S.: Portfolios of control modes and IS project management. *Information Systems Research* 8(3), 215–239 (1997)
23. Boutellier, R., Gassmann, O., Macho, H., Roux, M.: Management of dispersed product development teams: The role of information technologies. *R & D Management* 28(1), 13–25 (1998)
24. Bresnen, M., Goussevskaia, A., Swan, J.: Embedding new management knowledge in project-based organizations. *Organization Studies* 25(9), 1535–1555 (2004)
25. Koskela, L., Howell, G.: The underlying theory of project management is obsolete. In: *Proceedings of the PMI Research Conference*, PMI, pp. 293–302 (2002)

Uncovering the Effects of Cultural Intelligence on Cross-Cultural Virtual Collaboration Processes

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Abstract. People from different countries are increasingly working together with the support of information and communication technologies. Such cross-cultural virtual collaboration is highly challenging due to the geographical separation and cultural diversity among collaborators. This study investigates the effects of an individual capability, cultural intelligence, on cross-cultural virtual collaboration processes in a controlled experiment. Thirty-five cross-cultural virtual dyads were formed and instructed to collaborate in a proposal writing task. Their interaction processes were analyzed with Bales' Interaction Process Analysis. The results suggest that individuals with higher CQ demonstrated more positive reactions and attempted answers in the cross-cultural virtual collaboration after controlling for foreign language proficiency. The increased amounts of the two categories of interaction acts led to improved peer satisfaction. The study links CQ with proximal behavioral outcomes and identifies CQ as a key individual capability that predicts behaviors and affective outcomes in cross-cultural virtual collaboration.

Keywords: Cultural intelligence, cross-cultural communication, cross-cultural collaboration, Bales' interaction process analysis, global virtual team.

1 Introduction

Staffing teams with people in two or more countries and supporting the teamwork with information and communication technology (ICT) has become a common practice in organizations [1]. Such teams, also termed as global virtual team (GVT), brings significant benefits to organizations (e.g., access to a global talent pool, improved responsiveness to global markets) [1]. However, achieving high performance in GVT is a challenge undertaken due to the geographical separation and cultural differences among team members [2]. As members in GVT are geographically separated, their communication and collaboration is primarily supported by ICT, which reduces interpersonal contacts and nonverbal communication compared with collocated teams [2]. If individuals' communication and collaboration behaviors are not adapted to the virtual environment, their work partners' perception as well as team outcomes might be negatively affected [3]. In addition, national cultural differences

among GVT members also create challenges, as the differences significantly increase miscommunication and coordination effort [4], reduce interpersonal trust and satisfaction, and negatively affect GVT outcomes [5].

Seeing the issues related to virtualness and cultural diversity in GVT, we focus on cross-cultural virtual collaboration processes in this study, which is a critical instance in GVT processes. Recent studies in GVT increasingly indicate that cross-cultural virtual collaboration processes are influenced by individual characteristics, suggesting that GVT could be supported through recruiting individuals with right characteristics or providing appropriate trainings to GVT members [6, 7]. Yet Martins and Schilpzand's [2] literature review highlights that a knowledge gap exists in understanding which individual characteristics significantly influence the processes.

To address this knowledge gap, we leverage an emerging research stream in cross-cultural psychology and management, investigating the effects of cultural intelligence (CQ) on cross-cultural virtual collaboration processes. CQ is defined as an individual capability to perform in culturally diverse settings [8]. Its positive effects on individual performance in multicultural teams have been well acknowledged [9]. However, as highlighted in Ng, Van Dyne and Ang's [9] review on CQ, relatively little research has been done on discovering the underlining mechanisms that link CQ to positive outcomes. How CQ influences cross-cultural interaction processes requires further investigation. Besides, only recently researchers started to discuss implications of CQ in a virtual environment [10, 11]. As behaviors and perceptions in a virtual environment differ from those in collocated settings in various ways [12], findings in collocated studies may have limited generalizability to the virtual environment.

In this study, we examine the effects of CQ on cross-cultural virtual collaboration processes in a controlled experiment. The findings contribute to CQ studies by uncovering the effects of CQ on proximal behavioral outcomes, which have the potential to explain the positive relationships between CQ and performance. For GVT research, the study examines the effects of a prominent individual capability, which can be leveraged to improve GVT processes and thus outcomes through staffing and training. The study also shed some lights on designing innovative technology to support GVT.

2 Theoretical Foundation

2.1 Effects of Cultural Intelligence on Cross-Cultural Collaboration Processes

Developed by Earley and Ang [8], CQ is an aggregate multi-dimensional construct, comprising metacognitive, cognitive, motivational and behavioral dimensions. Metacognitive CQ refers to mental processes that are used to acquire and understand culture-related knowledge. Cognitive CQ reflects knowledge about other cultures' social norms, practices and languages. Motivational CQ reflects the capability to direct and maintain attention to act in cross-cultural situations. Behavioral CQ reflects the capability to adjust and adapt verbal and nonverbal behaviors when interacting with people from other cultures [13]. The four dimensions of CQ characterize different types of capabilities to perform in culturally diverse settings, which form an overall CQ construct together [9]. As an individual capability, CQ is not defined in the

context of a specific culture and it can be improved through education and training, as well as personal experiences [9].

Prior studies have linked CQ to interpersonal interaction and outcomes in cross-cultural teams, both in collocated and in virtual settings [9]. In collocated settings, Rockstuhl and Ng's [14] study with cross-cultural dyads indicated that people with higher metacognitive CQ and cognitive CQ were more likely to trust their partners, and people with higher behavioral CQ were more likely to be trusted. Chua and Morris [7] found that managers higher in metacognitive CQ were rated as more effective in intercultural creative collaboration. Their experiment on cross-cultural student dyads indicated that as long as a personal conversation was conducted prior to the task, higher metacognitive CQ led to greater idea sharing and creative performance [7]. Beyene [15] conducted a field study on interactions between native-English-speakers and non-native-English speakers in a French company. The result suggested that non-native-English speakers with higher CQ interacted with native-English-speakers more often, and this effect existed over and beyond their ability to speak multiple languages. In a study of intercultural negotiations, Imai and Gelfand [16] found that CQ predicted negotiators' sequenced integrative information behaviors, which in turn predicted joint profit within a negotiation dyad. Only recently, researchers started to discuss the implications of CQ in virtual settings, with a strong focus on global software teams. Koh, Joseph and Ang [17] proposed that CQ should be taken as a critical individual capability for IT professionals working in global software teams. Beck, Gregory and Prifling [18] studied the effects of CQ in IT offshore outsourcing projects and found that CQ and project management skills jointly reduced risks introduced by cultural diversity in the projects and both contributed to offshore outsourcing project success. In another study of IT offshore outsourcing projects, Gregory, Prifling and Beck [19] found that project members' CQ could drive the development of a negotiated culture, characterized by trust-based interpersonal relationships, common understanding and effective conflict resolution. Li et al. [10] conducted an experiment on cross-cultural virtual collaboration with students and they found that individuals' behavioral CQ predicted their partners' receptivity-based trust, which in turn predicted the partners' satisfaction.

Overall, the positive relationships between CQ and team progresses, CQ and team outcomes were detected both in collocated and in virtual settings. Studies in collocated settings have begun to examine more proximal outcomes of CQ (e.g., emergent states, interaction behaviors), whereas studies in virtual settings focus more on distant outcomes (e.g., project success). In this study, we investigate the effects of CQ on proximal behavioral outcomes in a virtual setting.

2.2 Bales' Interaction Process Analysis in Team Research

Bales' Interaction process analysis (IPA) was chosen to analyze the cross-cultural virtual collaboration processes in this study. Bales' IPA is a robust and widely applied methodology to analyze interpersonal interaction processes [20]. It provides a coding scheme that categorizes interaction acts into socio-emotional area (incl. positive and negative reactions) and task area (incl. attempted answers and questions).

Among all the categories, positive reactions and attempted answers are most frequently linked to preferable affective outcomes in team research. Positive reactions include acts that show positive feelings toward another person (seems friendly), reduce the anxiety that other persons may be experiencing (tension release) and show acceptance to another person (agreement) [21]. Attempted answers consist of acts that give direction (gives suggestion), advance a belief or value that is relevant to the task (gives opinions), and report factual observation or experience relevant to the task (gives information) [21]. Shaw et al.'s study on collocated student group discussions showed that students giving more attempted answers were more likely to be perceived as facilitating the group processes by other members in the group [22]. In virtual settings, Scharts-Asher, Ahituv and Etzion found that in structured teams, members' social-oriented communication led to higher satisfaction than task-oriented communication [23]. Richter and Lechner [24] investigated team dynamics in a virtual computer game environment and they found that people demonstrating more positive reactions or attempted answers were more likely to be trusted by their virtual partners. The study also indicated that teams showing higher amounts of attempted answers were perceived to be better coordinated than those showing lower amounts of attempted answers [24]. In this study, we investigate the relationships between individuals' CQ and the two categories of acts in cross-cultural virtual collaboration.

3 Research Framework and Hypotheses

Based on the literature review, we develop a theoretical model (see Fig. 1) to predict the effects of CQ on interaction processes, which in turn predict affective outcomes in cross-cultural virtual collaboration. For interaction processes, we focus on positive reactions and attempted answers defined by Bales' IPA categories, as prior literature suggests strong relationships between the two categories of acts and positive team outcomes. For affective outcomes, we use the construct of peer satisfaction, which is a key affective outcome in team research as it strongly predicts individuals' intention to engage in future team work [1]. Four hypotheses are developed as follows.

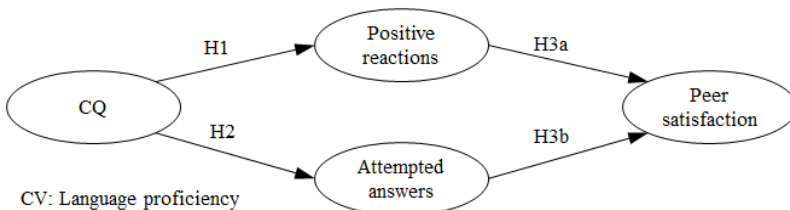


Fig. 1. A Theoretical Model of Effects of CQ in Cross-Cultural Virtual Collaboration

Ng et al. [9] suggest that the decision of whether to use multidimensional conceptualization of CQ or aggregated CQ depends on the breadth and nature of the dependent variables. In our model, the dependent variables for CQ are the amounts of positive reactions and attempted answers. To which extent participants demonstrate interaction acts in the two categories can be influenced by all the four dimensions of

CQ and the strength of the influences might vary when the content of the conversation changes. Thus, we decide to use aggregated CQ in the model and predict its effects on positive reactions and attempted answers respectively. As indicated in prior studies, individuals with higher CQ tend to have more frequent interactions with people from other cultures in the work place [15] and they are more likely to share new ideas across cultural boundaries [7]. We hypothesize that the positive effects of CQ can be observed in cross-cultural virtual collaboration in the sense that people with higher CQ demonstrate more positive reactions and also provide more attempted answers to their cross-cultural partners. As individuals' language proficiency is positively related to total acts in communication process [25], we take language proficiency as a control variable and hypothesize that the effects of CQ should exist over and beyond the effect of their foreign language proficiency.

H1: In cross-cultural virtual collaboration, an individual's CQ is positively related to the amount of positive reactions after controlling for language proficiency

H2: In cross-cultural virtual collaboration, an individual's CQ is positively related to the amount of attempted answers after controlling for language proficiency

Positive reactions and attempted answers have been linked to positive affective outcomes in prior studies. Specifically, Dekker et al. identified that socio-emotional communication predicted satisfaction in global virtual teamwork [26]. As negative reactions in the socio-emotional area were found to be negatively related to satisfaction [27], we predict that in a cross-cultural virtual collaboration, people are more satisfied with those who produce more positive reactions in the socio-emotional area.

H3a: In cross-cultural virtual collaboration, the amount of an individual's positive reactions is positively related to his/her partners' satisfaction with him/her

Similarly, attempted answers have been linked to perceived contribution in teamwork [22] and active participation affects satisfaction in virtual teamwork [26]. Thus, we hypothesize that people demonstrating more attempted answers are perceived to be more satisfactory by their partners in a cross-cultural virtual collaboration.

H3b: In cross-cultural virtual collaboration, the amount of an individual's attempted answers is positively related to his/her partners' satisfaction with him/her

4 Research Method

A laboratory experiment was conducted to test the hypotheses. The method is effective to examine the causal relationships between CQ and collaboration processes, as it enables us to control on the effects of other influential factors (e.g., task complexity, interaction duration, technology etc.).

Participants were recruited among undergraduate and graduate students in two public universities in China and Germany. All participants were either citizens in the respective country or had lived in that country for more than 10 years. Overall 36 participants from China and 36 from Germany took part in the experiment. They were randomly paired into 36 cross-cultural virtual dyads. Due to technical reasons, the collaboration process of one dyad was not voice recorded and thus excluded from

further data analysis. The final sample of participants consisted of 35 cross-cultural virtual dyads, 34 males and 36 females, with an average age of 21.44 ($SD=1.870$).

A collaborative writing task was designed for the study. Participants were described as employees in a medium-size international company. They were required to collaborate with a colleague sitting in another country to jointly produce a proposal for the managerial board about adopting social media in the company for business purposes. The writing task consisted of three subtasks: 1) brainstorming: generating eight ideas on how to use social media to benefit the company, 2) justification: selecting three best ideas among the generated ideas and providing reasons for the selection, and 3) analysis: analyzing risks and benefits of using social media for business. The three subtasks covered creative, reasoning and analytical processes, requiring different modes of information gathering and processing. A proposal template was provided for every dyad and they were given 30 minutes to complete the task.

A collaboration environment was established online, which was equipped with a text-based communication tool, a voice communication tool and a synchronous shared text editor. Participants were instructed to communicate with their partners with the communication tools and jointly produce the proposal with the synchronous shared text editor. All chat logs, verbal conversations, text revision histories were recorded.

The experiment was carried out in China and Germany simultaneously, consisting of a pre-task questionnaire, a laboratory session and a post-task questionnaire. The pre-task questionnaire asked about individual characteristics (e.g., demographic information, cultural intelligence, and language proficiency), which was filled out by participants before the laboratory session. In the laboratory session, participants from the two countries came to a computer lab located in their campuses at the same time. They were randomly paired up into cross-cultural virtual dyads. Participants were provided a short training on how to use the virtual collaboration environment and then were instructed to collaboratively complete the experimental task on the virtual collaboration platform. After the experiment, participants were asked to report their satisfaction towards their partners and other psychological responses in a post-task survey. All the questionnaires, instructions, trainings were given in English, and participants were required to communicate in English during the laboratory session. The total time for the experiment lasted about one hour.

We assessed participants' CQ with a 20 item Cultural Intelligence Scale (CQS) [28]. The subscales of metacognitive, cognitive, motivational and behavioral CQ achieved an internal consistency of 0.743, 0.781, 0.839 and 0.614 respectively. Thus, we used the average values of each subscale as indicators for CQ in the data analysis. As English was chosen as the communication language in the experiment, participants reported their English proficiency on a 6-point Likert scale developed according to the Common European Framework of Reference for Languages. After the experiment, the first author randomly sampled 50% of the dyads' voice records and conducted external assessment of the participants' English proficiency with the same assessment framework. The external assessment and the self-assessment achieved an inter-rater reliability of 0.887, which indicated high reliability of the self-assessed language proficiency. Thus, the self-assessed language proficiency was used as an indicator for language proficiency in the data analysis. We adapted a three-item scale

of group outcome perceptions from Hardin et al. [29] to measure participants’ general satisfaction with their partners. In addition, three questions were added asking about participants’ satisfaction with the partner’s contribution, communication and collaboration specifically. To analyze the interaction processes, all voice records during the experiment were transcribed into text and coded with MAXQDA into different Bales’ IPA categories. In the first coding phase, the two authors selected five voice records among the 35 voice records randomly and applied the coding scheme to analyze the records independently. Their coding results were then compared, which achieved a percent agreement of 84.1% and Cohen’s Kappa of 0.813. The inter-coder reliability was considered reliable for further coding. In the second coding phase, the second author coded all the remaining voice records. Total acts for positive reactions and attempted answers were taken as indicators for the two constructs in the data analysis.

5 Results and Discussions

Partial least square (PLS) was used to test the hypotheses, as it is applicable to handle relatively small sample size and appropriate for predictive analysis in the early stage of theory development [30]. SmartPLS was used to evaluate the measurement and structural model. For the measurement model, discriminant validity of all constructs was assessed by cross-loadings. The result showed that all indicators loaded significantly higher on the intended constructs than on other constructs, indicating adequate discriminant validity [30]. For constructs with reflective measurements (i.e., CQ and peer satisfaction), internal consistency, composite reliability and average variance extracted (AVE) were examined. Both constructs achieved adequate internal consistency (0.804, 0.941), composite reliability (0.871, 0.953) and AVE (0.630, 0.773), indicating sufficient internal reliability and convergent validity [30].

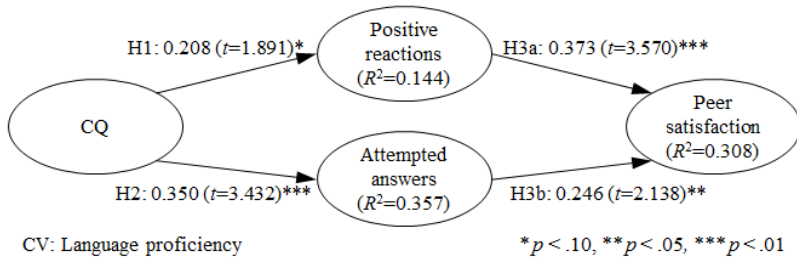


Fig. 2. Hypotheses Testing Results (N=70)

To test the hypotheses, we examined the path coefficients in the structural model and evaluated the explanatory power of the structural model with R^2 value. As shown in Fig. 2, the model explained 14.4% of the variance of positive reactions, 35.7% of the variance of attempted answers, and 30.8% of the variance of peer satisfaction. The explained variances exceeded 10%, indicating substantive explanatory power [31]. A bootstrapping with 1000 resamples was performed to evaluate the significance of path

coefficients. As presented in Fig. 2, hypothesis 1 received marginal support, and hypothesis 2, 3a and 3b were strongly supported by the data.

The results indicate that participants with higher CQ demonstrated marginally more positive reactions and significantly more attempted answers in a cross-cultural virtual collaboration over and beyond the influence of their foreign language proficiency. The findings are in line with Beyene's observation that non-native-English speakers with higher CQ have more interactions with native-English speakers in the workplace [15]. CQ seems to have greater predictive power on the amount of attempted answers than on the amount of positive reactions. When examining the correlations between CQ and subcategories in positive reactions, we found that CQ was significantly related to the subcategory "seems friendly" but not significantly related to the subcategory "tension release" and "shows agreement". It indicated that "seems friendly" could be reliably predicted by individuals' CQ in a cross-cultural virtual collaboration, whereas "tension release" and "shows agreement" might be influenced by other factors. For attempted answers, all subcategories (i.e., gives suggestion, opinion and information) can be reliably predicted by individuals' CQ, suggesting that people with higher CQ demonstrated more acts in all the subcategories.

The amount of positive reactions and attempted answers translated into peer satisfaction after the interaction. That means in a cross-cultural virtual collaboration participants were more satisfied with their partners if the partners demonstrated more positive reactions and attempted answers. The path coefficient between positive reactions and peer satisfaction is higher than that between attempted answers and peer satisfaction. It suggests that although both types of acts strongly predict satisfaction, positive reactions seem to play a more important role in influencing peer satisfaction.

6 Conclusion and Future Work

This study examined the effects of individual CQ on interaction processes and in turn on affective outcomes in cross-cultural virtual collaboration. The results support that individuals' CQ predicts how many positive reactions and attempted answers they demonstrate in the collaboration, which in turn strongly influence their partners' satisfaction. The effects exist over and beyond the influence of language proficiency. The study provides insight into behavioral outcomes of CQ, which is rarely investigated in prior studies. As proximal outcomes, positive reactions and attempted answers can be leveraged as externally assessed indicators that reflect the level of individuals' CQ. For GVT research, the study highlights that CQ is a strong predictor of individuals' interaction behaviors, which in turn predict affective outcomes in cross-cultural virtual collaboration. GVT managers could leverage the research findings and assign tasks that require intensive cross-cultural virtual communication and collaboration to individuals with high CQ to ensure a positive outcome. Trainings that improve CQ can be designed and recommended to GVT members. Designing technologies to capture and analyze interaction processes, and present the interaction modes (e.g., amounts of interaction acts) may be helpful for GVT members to diagnose and then improve their cross-cultural virtual communication competency.

With data from this study, we are going to break down the interaction acts into subcategories and examine the linkage between dimensions of CQ and specific interaction acts. Relationships between individual CQ and alternative interaction indicators (e.g., dominance, socio- vs. task orientation) are going to be investigated. Based on the further analysis, a more detailed theoretical model can be established to explain the inherent functioning mechanisms of CQ on the interaction processes. In addition, effects of dyad-level CQ on dyad-level interaction (e.g., communication breakdowns) and outcomes (e.g., joint output) will be analyzed to provide a thorough understanding of CQ in the cross-cultural virtual collaboration.

References

1. Powell, A., Piccoli, G., Ives, B.: Virtual teams: a review of current literature and directions for future research. *The DATA BASE for Advances in Information Systems* 35, 6–36 (2004)
2. Martins, L.L., Schilpzand, M.C.: Global Virtual Teams: Key Developments, Research Gaps, and Future Directions. *Research in Personnel and Human Resources Management* 30, 1–72 (2011)
3. Peters, L., Karren, R.J.: An examination of the roles of trust and functional diversity on virtual team performance ratings. *Group & Organization Management* 34, 479–504 (2009)
4. Shachaf, P.: Cultural diversity and information and communication technology impacts on global virtual teams: An exploratory study. *Information & Management* 45, 131–142 (2008)
5. Garrison, G., Wakefield, R.L., Xu, X., Kim, S.H.: Globally distributed teams: the effect of diversity on trust, cohesion and individual performance. *The Data Base for Advances in Information Systems* 41, 27–48 (2010)
6. Goodbody, J.: Critical success factors for global virtual teams. *Strategic Communication Management* 9, 18–21 (2005)
7. Chua, R.Y.J., Morris, M.W., Mor, S.: Collaborating across cultures: Cultural metacognition and affect-based trust in creative collaboration. *Organizational Behavior and Human Decision Processes* 118, 116–131 (2012)
8. Earley, P.C., Ang, S.: *Cultural Intelligence: Individual Interactions across Cultures*. Stanford University Press, Stanford (2003)
9. Ng, K.-Y., Van Dyne, L., Ang, S.: Cultural intelligence: A review, reflections, and recommendations for future research. In: Ryan, A.M., Leong, F.T.L., Oswald, F. (eds.) *Conducting Multinational Research: Applying Organizational Psychology in the Workplace*, pp. 29–58. American Psychological Association, Washington, DC (2012)
10. Li, Y., Li, H., Maedche, A., Rau, P.-L.P.P.: Are You a Trustworthy Partner in a Cross-cultural Virtual Environment?— Behavioral Cultural Intelligence and Receptivity-based Trust in Virtual Collaboration. In: *4th International Conference on Intercultural Collaboration*, pp. 87–96 (2012)
11. Ang, S., Banker, R., Bapna, R., Slaughter, S.A., Wattal, S.: Human Capital of IT Professionals: A Research Agenda. In: *ICIS 2011 Panel* (2011)
12. Webster, J.: Comparing virtual teams to traditional teams: An identification of new research opportunities. *Research in Personnel and Human Resources Management* 25, 181–215 (2006)

13. Ang, S., Van Dyne, L., Koh, C., Ng, K.Y., Templer, K.J., Tay, C., Chandrasekar, N.A.: Cultural Intelligence: Its Measurement and Effects on Cultural Judgment and Decision Making, Cultural Adaptation and Task Performance. *Management and Organization Review* 3, 335–371 (2007)
14. Rockstuhl, T., Ng, K.: The effects of cultural intelligence on interpersonal trust in multi-cultural teams. In: Ang, S., Van Dyne, L. (eds.) *Handbook of Cultural Intelligence: Theory Measurement and Applications*, pp. 206–220. M.E. Sharpe (2008)
15. Beyene, T., Hinds, P.: Fluency As Stigma: Implications of a Language Mandat. In: *Global Work*, Unpublished Ph.D. Thesis (2007)
16. Imai, L., Gelfand, M.J.: The culturally intelligent negotiator: The impact of cultural intelligence (CQ) on negotiation sequences and outcomes. *Organizational Behavior and Human Decision Processes* 112, 83–98 (2010)
17. Koh, C., Joseph, D., Ang, S.: Cultural intelligence and collaborative work: intercultural competencies in global technology work teams. In: *2009 International Workshop on Intercultural Collaboration*, pp. 261–264 (2009)
18. Beck, R., Gregory, R., Prifling, M.: Cultural Intelligence and Project Management Interplay in IT Offshore Outsourcing Projects. In: *ICIS 2008 Proceedings*. Paper 44 (2008)
19. Gregory, R., Prifling, M., Beck, R.: The role of cultural intelligence for the emergence of negotiated culture in IT offshore outsourcing projects. *Information Technology & People* 22, 223–241 (2009)
20. Goldfinch, T., Layton, C., Gardner, A., Thomas, G., Henderson, A., McCarthy, T.: Observing cultural interactions in engineering design projects. In: *Proceedings of the 2011 AAEE Conference*, pp. 184–190 (2011)
21. Bales, R.F.: Definitions of the interaction categories. *Interaction process analysis*, pp. 99–135. Holt, Rinehart and Winston, New York (1970)
22. Shaw, M.E., Ackerman, B., McCown, N.E., Worsham, A.P., Haugh, L.D., Gebhardt, B.M., Small, P.A.: Interaction Patterns and Facilitation of Peer Learning. *Small Group Research* 10, 214–223 (1979)
23. Shwartz-Asher, D., Ahituv, N., Etzion, D.: Modeling the characteristics of virtual teams' structure. *International Journal of Business Intelligence and Data Mining* 4, 195–212 (2009)
24. Richter, S., Lechner, U.: Communication content relations to coordination and trust over time: a computer game perspective. In: *5th International Conference on Communities and Technologies*, pp. 60–68 (2011)
25. Hautasaari, A.: Machine translation effects on group interaction: an intercultural collaboration experiment. In: *3rd International Conference on Intercultural Collaboration* (2010)
26. Dekker, D.M., Rutte, C.G., Van den Berg, P.T.: Cultural Differences in the Perception of Critical Interaction Behaviors in Global Virtual Teams. *International Journal of Intercultural Relations* 32, 441–452 (2008)
27. Kauffeld, S., Lehmann-Willenbrock, N.: Meetings Matter: Effects of Team Meetings on Team and Organizational Success. *Small Group Research* 3, 130–158 (2012)
28. Dyne, L., Van, A.S., Koh, C.: Development and Validation of the CQS. In: Ang, S., Van Dyne, L. (eds.) *Handbook of Cultural Intelligence: Theory Measurement and Applications*, pp. 16–38. M.E. Sharpe (2008)
29. Hardin, A.M., Fuller, M.A., Davison, R.M.: I Know I Can, But Can We?: Culture and Efficacy Beliefs in Global Virtual Teams. *Small Group Research* 38, 130–155 (2007)
30. Fornell, C., Bookstein, F.L.: Two structural equation models: LISREL and PLS applied to consumer exit-voice theory. *Journal of Marketing Research* 19, 440–452 (1982)
31. Falk, R., Miller, N.: *A primer for soft modeling*. University of Akron Press (1992)

On Relationship between Self-construal and Individual Behavior in Video-Mediated Multicultural Group Decision Making

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Abstract. The study of cultural difference is increasingly becoming important in the research of multicultural group work. Most of the existing literatures have focused on the national level of cultural difference (e.g., individualism or collectivism) to explore individual behavior and group performance. There have been few studies identifying the role of individual level of cultural variability (e.g., self-construal) in multicultural group work. This study investigates the relationship between (a) self-construal and individual participation, and (b) self-construal and individual decision change in video-mediated multicultural group decision making. In a laboratory experiment, forty-five participants coming from fourteen countries formed ten multicultural groups. Each group solved a preference decision-making task using a group videoconferencing system. The results indicated a negative relationship between interdependent self-construal and individual participation in video-mediated group decision making. The relationship between self-construal and decision change was not found. Recommendations on increasing the participation of highly interdependent members are proposed.

Keywords: culture, self-construal, group decision making, video-mediated communication, multicultural group.

1 Introduction

Globalization plays an important role in our society and in the business world today. People coming from different cultural backgrounds need to communicate, make decisions, and work together. However, people with different cultural backgrounds tend to vary in their styles of communication and decision making. The complex and challenging nature of multicultural group to practitioners has made it a continuous focus of academic research. One interesting question in the study of multicultural group is how cultural differences influence individual behavior in group work. Most of previous studies have used a general concept such as nationality or specific values

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such as Hofstede's cultural construct (1980) to explain the differences across cultures. They usually used groups of fixed cultural compositions, such as Asian-Caucasian (Li, Karakowsky, & Siegel, 1999), American-Japanese (Oetzel, 1998a, 1998b, 2001), and American-Chinese (Li, Rau, & Salvendy, in press; Zhang et al., 2007). However, most multicultural groups in organizations especially the globally distributed teams have no fixed cultural composition. In this situation, it is not appropriate to use nationality for analysis. Besides, Hofstede's cultural construct is a national level measurement of cultural difference. The requirement of the cultural dimension scale, the Values Survey Module, clearly states that the ideal size for a homogeneous sample is fifty respondents, and sample sizes smaller than twenty should not be used (Hofstede et al., 2008). Thus, for groups composed of people with mixed cultural backgrounds, it is difficult to have sufficient number of participants required for analysis if using Hofstede's construct.

To solve this problem, some researchers moved to look at the individual level of cultural variable when studying multicultural group. Oetzel and his colleges (1998a, 1998b, 2001) found that besides individualism-collectivism, self-construal as an individual level of cultural variable took an important role in culturally diverse groups. In addition, the recent work of Li et al. (in press) has revealed the important role of self-construal on group decision quality. They used five-person mixed American-Chinese groups to study group composition's effect on video-mediated group decision making. They found that besides the effect of group composition, the independent self-construal had a negative effect on group decision quality. They explained that groups composed of members with higher independent self-construal categorize self and others in a much stronger way, which consequently impedes the group interaction. The results of these studies indicate that the focus on individual level of cultural variable may provide us a new way to generate explanations in relation to an individual's attitudes, beliefs, and intentions in multicultural groups.

Thus, in this study, we consider how self-construal affects individual participation and decision change in multicultural group work. Video-mediated communication was used in this study because video-mediated groups have become more common in the workplace, especially for globally distributed teams, due to geographic constraints on group members from different countries. Besides, the study of intercultural collaboration in video-mediated settings represents an important theme in organizational research (Connaughton & Shuffler, 2007).

2 Literature Review

2.1 The Concept of Self-Construal

Markus and Kitayama (1991) first proposed the two distinctive views of the self: the independent self and the interdependent self. People with independent self-construal view themselves as unique individuals. In contrast, people with interdependent self-construal believe that they are connected to other group members. Later on, Cross, Bacon and Morris (2000) extended the work of Markus and Kitayama by proposing two forms of the interdependent self-construal. They argued that the specific form of

the interdependent self-construal may vary across people coming from individualist and collectivistic cultures. They proposed two forms of interdependent self-construal: the relationship-centered conception of interdependence, which emphasizes close relationships to others, and the group-oriented notion of interdependence, which focuses on relationships to in-groups. Integrating the views of previous researchers, Sedikides and Brewer (2001) differentiated among different views of the self and developed the scales to measure independent self-construal, relational-interdependent self-construal, and collective-interdependent self-construal.

2.2 Video-Mediated Communication

Video-mediated communication is currently being widely used for education and learning (e.g., distance learning), health and medicine (e.g., telemedicine), meetings and conferences (e.g., board meetings), personal communication and community building. Although video is a rich media than other electronic-mediated communication media (e.g., E-mail, instant messaging, and telephone), video-mediated communication does not offer the same benefits as face-to-face communication and it is not a seamless substitute for face-to-face communication (Ferran & Watts, 2008). On the one hand, it was found that mental workload is higher in the video-mediated condition than in the face-to-face condition (Ferran & Watts, 2008; Storck, 1995). In the video-mediated environment, it is difficult to maintain eye contact due to resolution limitations and the distance between the camera and the monitor, and it is challenging to interpret body language and gestures, especially as the number of participants increases (Wainfan & Davis, 2004). Thus, the discussion in video-mediated communication tends to be less social and more task-oriented than face-to-face communication (Isaacs & Tang, 1994; McLeod, 1992; Wainfan & Davis, 2004). On the other hand, results showed that compared to face-to-face groups, video-mediated groups take more time for turns, require fewer turns to complete the task, interrupt each other less, and are less satisfied (van der Kleij et al., 2004). Participants in the video-mediated groups feel a lack of “social presence” because the attenuation of visual signals, in particular direction and eye gaze in the video-mediated environment which helps in regulating turn-taking (Bruce, 1996).

3 Research Framework and Hypotheses

In this study, we want to explore the relationship between self-construal and individual behavior in video-mediated multicultural group decision making. The theoretical model is shown in Figure 1.

We predict that self-construal will influence an individual’s participation in group decision making. Individuals with highly independent self-construal tend to be more assertive and have a greater need to express themselves. In contrast, individuals with highly interdependent self-construal tend to value cooperation and relationship among group members. Moreover, compared with face-to-face communication, the video-mediated environment reduces turn taking and disruption during discussion, which

may consequently make individuals with highly independent self-construal participate more and individuals with highly interdependent self-construal participate less.

Hypothesis 1a: The more independent one's self-construal is, the more one participates in video-mediated group decision making.

Hypothesis 1b: The more interdependent one's self-construal is, the less one participates in video-mediated group decision making.

We also predict that self-construal will influence an individual's decision change in group decision making. Individuals with highly interdependent self-construal tend to be more relationship-oriented and motivated to sustain the harmony of the group. Thus, we predict that participants with interdependent self-construal are more likely to change their decisions to align with the decision of the group, especially when consensus is needed. In contrast, individuals with highly independent self-construal are more likely to insist on their own views when working with others. Furthermore, given that video-mediated communication tends to be more task-oriented, which may favor the outcome-oriented independent individuals, and thus the independent individuals might less likely to change their decision in group decision making.

Hypothesis 2a: The more independent one's self-construal is, the less likely one is to change his or her decisions to align with the group in video-mediated group decision making.

Hypothesis 2b: The more interdependent one's self-construal is, the more likely one is to change his or her decisions to align with the group in video-mediated group decision making.

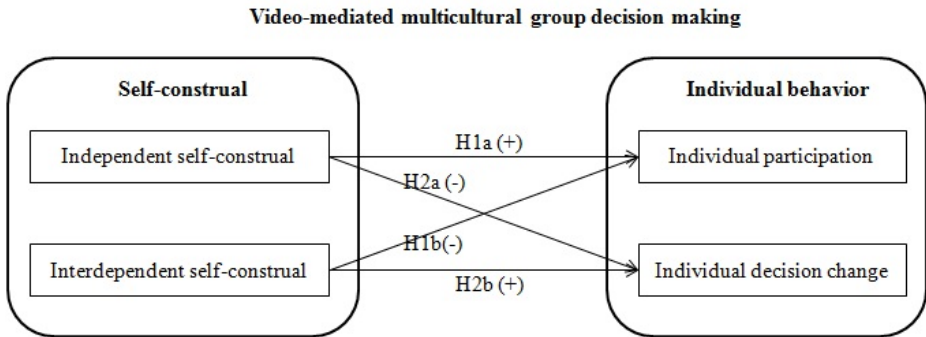


Fig. 1. Research framework

4 Methodology

4.1 Task

A preference decision-making task was used in this study. Groups were required to select, by consensus, a preferred alternative based on contextual norms. The preference

decision-making task has been widely used in the study of group decision making (Li, 1994; Li et al., in press; Roger & Karen, 2003; Zhang et al., 2007). We chose this kind of task because no cultural bias has been found in previous studies. The task presented a hypothetical scenario, described as follows. The participants were act as space crews. The space ship was forced to land at a spot on the moon due to mechanical difficulties, and most of the equipment had been damaged during the crash landing. Participants had to work together to rank the importance of ten given items in terms of their importance for them to arrive at the meeting point on the moon.

4.2 Participants

Forty-five graduate students enrolled in a work organization course at a university in China participated in this study for course credit. The participants were from fourteen countries (twenty Chinese, eleven Germans, two Spaniards, two Indonesians, one France, one Moroccan, one Kazakhstan, one Russian, one Iran, one Thai, one Korean, one Columbian, one Belgian, and one Canadian). The mean age of the participants was 23.13 (SD = 1.84) years. Of the participants, 71.1% were male and 28.9% were female. They were assigned into four-person or five-person groups at the beginning of the class for course projects. At the time at which the experiment was conducted, the students had been working together for two months.

4.3 Measurements

Participant self-construal was measured before the experiment. To measure self-construal, we used the scales developed by Brewer and Chen (2007). Their scale provides a finer distinction between the relational-interdependent self and the collective-interdependent self under the interdependent self-construal. In this study, we focused on the relational-interdependent self because it is a four- or five-person small group and participants have already worked together for two months. *Independent self-construal* was measured by using the individual self-representation subscale (3 items, calculated internal consistency was 0.69). *Relational-interdependent self-construal* was measured by using the relational self-representation subscale (6 items, calculated internal consistency was 0.65). Participants responded to scale items using a seven-point Likert-type scale (7=*strongly agree*, 1=*strongly disagree*).

Individual participation and decision change were collected after the task. *Individual participation* reflects the total duration that each participant talks during the group discussion. Participation was obtained from video recordings. Each individual's participation time was transformed into a percentage of the total time taken by the whole group. *Individual decision change* describes how one's initial decision differs from group's final consensus decision. It was calculated by adding the absolute score difference of all items between the ten decisions made by the individual and the ten decisions based on group consensus.

We also collected participants' extraversion and self-efficacy in communication as control variables before the experiment, because previous studies have indicated the relationship between extraversion and participation (Barry & Stewart, 1997; Myers, 1993; Yellen, Winniford, & Sanford, 1995), and self-efficacy in communication and

individual behavior in group work (Hardin, Fuller, & Davison, 2007; Li, 1993; Li et al., in press). Extraversion was measured by using the introversion-extraversion dimension (12 items) of Eysenck Personality Questionnaire (EPQ-R) (Eysenck, Eysenck, & Barrett, 1985). The calculated internal consistency was 0.80. Self-efficacy in communication was measured by using the scale from Li (1993). Four items were used to measure one's belief in his/her ability to communicate with others. Participants responded to the scale items using a seven-point Likert-type scale (7=*strongly agree*, 1=*strongly disagree*). The calculated internal consistency of the self-efficacy in communication scale was 0.78.

4.4 Apparatus

Five identical computers with Internet access were provided to each group member. Skype™ was used as the communication tool during group decision making. Earphones, microphones, and web cameras were provided for synchronous audio and video communication among group members.

4.5 Procedures

The experiment was conducted in a large, quiet laboratory that was partitioned in a way such that group members were unable to see or hear each other. Each participant was seated in front of a computer. Participants were asked to wear earphones and use a microphone to communicate with the others. After all of the participants had arrived, they were told that the experiment involved performing a group decision making task through a web-based video conferencing software and received a demonstration on using the software. Participants were asked to complete a pre-test questionnaire, after which they were given a general description of the task. First, participants read the scenario and made their own decisions within ten minutes. After that, the group was asked to work together on the same task again and required to reach a group consensus within twenty minutes. All materials used were in English. Participants did not report any problems in understanding the task or the scale instruments.

5 Results

5.1 Inter-Correlations of Member Characteristics

Table 1 presents the inter-correlations of member characteristics. The results indicated a significant positive correlation between extraversion and self-efficacy in communication ($r = .59, p < .01$) and a significant positive correlation between self-efficacy in communication and independent self-construal ($r = .41, p < .01$).

5.2 Testing of Hypothesis 1

We used a hierarchical multiple regression to test the hypothesis. The results of bivariate correlation among participation and member characteristics showed significant

correlations between extraversion and participation ($r = .40, p < .01$) and between self-efficacy in communication and participation ($r = .31, p < .04$). Thus, these two variables were entered into the model as control variables in the first step. Then, we added independent self-construal and relational-interdependent self-construal in the second step using a stepwise method to explore their relationship on participation. Table 2 reports the result of the hierarchical regression on participation. The result indicated that only relational-interdependent self-construal entered the model, and it exerted a significant influence on participation ($\beta = -.32, p < .03; \Delta R^2 = .09, \Delta F_{(1, 41)} = 5.22, p = .028$). Thus, only hypothesis 1b was supported. Extraversion and self-efficacy in communication accounted for 17%, relational-interdependent self-construal accounted for an additional 9%, and the change was significant. These three variables explained 26% of the variation in participation.

Table 1. Inter-correlations of member characteristics

	Mean (SD)	1	2	3	4
1 Age	23.13 (1.84)	-			
2 Extraversion	8.44 (2.99)	.06	-		
3 Self-efficacy in communication	5.74 (0.88)	-.09	.59**	-	
4 Independent self-construal	4.53 (1.02)	.33*	.27	.41**	-
5 Relational-interdependent self-construal	5.44 (0.63)	-.15	.12	.24	-.06

Note: * $p < .05$, ** $p < .01$. $N = 45$.

Table 2. Regression model of participation

	Step 1		Step 2			
	<i>B</i>	<i>SE B</i>	β	<i>B</i>	<i>SE B</i>	β
Constant	0.06	0.09		0.28	0.13	
Extraversion	0.01	0.01	.34	0.01	0.01	.33
Self-efficacy in communication	0.01	0.02	.11	0.02	0.02	.19
Relational-interdependent self-construal				-0.05	0.02	-.32*

Note: $R^2 = .17$, adjusted $R^2 = .13$ for Step 1; $\Delta R^2 = .09$, adjusted $\Delta R^2 = .08$ for Step 2 ($ps < .05$), * $p < .05$.

5.3 Testing of Hypothesis 2

Multiple regression was used to test hypothesis 2. Previous studies did not suggest any other individual level variables that relate to decision change, thus only independent self-construal and relational-interdependent self-construal were entered into the model using a stepwise method to explore their relationship on decision change. The result showed that independent self-construal and relational-interdependent self-construal had no significant influence on decision change. Thus, hypothesis 2 was not supported.

6 Discussion

This study explores the effect of self-construal on individual participation and decision change in video-mediated multicultural group decision making. The results indicate that relational-interdependent self-construal negatively influence an individual's participation in group decision making. When we listened to group conversations, we observed that individuals with highly interdependent self-construal tended to speak only on points that they felt certain about. Their presentation of ideas resembled soft suggestions, and they tended not to defend their opinions unless they found significant contradictions. In terms of individual decision change during group interactions, not as what we have expected, no significant relationship between self-construal and decision change was found. From the recordings, we found that the amount of influence that highly interdependent members had upon the final group decision depended much on the extent to which the other team members listened to their ideas. If the other team members did not listen, then they would remain quiet throughout the rest of the discussion and align with the group's final decision.

Based on the observation during group interaction, we propose two directions for future studies. One direction is about the relationship between self-construal and group effectiveness. We found that there were some groups that took a long time to come to an agreement without a good decision quality. A typical case was a group which composed of three highly independent members and one highly interdependent member. They took the longest time to reach consensus and had the second worst decision quality among ten groups. This was because the highly independent members hold different opinions and they defended and protected their own opinions strongly during group interaction. The only highly interdependent member in this group listened silently most of the time and only spoke when he found significant contradictions. In contrast, we found one group which made the best decision and took the second shortest time. The highly interdependent members in this group well balanced the opinions among all group members which made the discussion much more efficient. Based on these intuitive findings, we wonder if groups having balanced independent and interdependent members will benefit group effectiveness. Future studies might be conducted to further examine the relationship between the composition of self-construal and group effectiveness. Another research direction is the way to express opinions in group work. We found that a person's communication style places an important role. A typical case was that of an extraverted highly independent Chinese group member who was in a group with some Germans. The Chinese member would try to say something forcefully, but a simple comment from one of the Germans was all it took for the Chinese member to stop defending his position. Even though the Chinese group member had a highly independent self-construal, what he considered to be a direct and strong defense of his idea turned out not to be strong in the eyes of the Germans. On the same token, what the Germans considered to be mild and conservative came across as very direct to the Chinese member. Thus, in addition to the self-construal of a person, there may be differences in the ways in which people across cultures express their opinions or in how directly the language is used. This could cause a very real problem for groups working together to reach an

agreement because the same meaning, when expressed differently, could have different effect for people from different cultures.

7 Conclusion

In this paper, we investigate how self-construal influence an individual's participation and decision change in video-mediated multicultural group decision making. The results showed that individuals with highly relational-interdependent self-construal participated less in group interaction. We did not find support on the relationship between self-construal and individual decision change in group decision making. The findings highlight the importance of improving the participation of highly interdependent members in globally distributed teams. Managers and team members should encourage the highly interdependent members to express their opinions and carefully listen to their viewpoints. Besides, a moderation system can be designed which monitors the participation of each member during group interaction, for instance the system will notice the talkative group members to ask opinions of relative salient members and changing the salient members' voice larger when they speak.

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References

1. Barry, B., Stewart, G.L.: Composition, process, and performance in self-managed groups: The role of personality. *Journal of Applied Psychology* 82(1), 62–78 (1997)
2. Brewer, M.B., Chen, Y.: Where (who) are collectives in collectivism? Toward conceptual clarification of individualism and collectivism. *Psychological Review* 114(1), 133–151 (2007)
3. Bruce, V.: The role of the face in communication: Implications for videophone design. *Interacting with Computers* 8(2), 166–176 (1996)
4. Connaughton, S.L., Shuffler, M.: Multinational and multicultural distributed teams: A review and future agenda. *Small Group Research* 38(3), 387–412 (2007)
5. Cross, S.E., Bacon, P.L., Morris, M.L.: The relational-interdependent self-construal and relationships. *Journal of Personality and Social Psychology* 78(4), 791–808 (2000)
6. Eysenck, S.B.G., Eysenck, H.J., Barrett, P.: A revised version of the psychoticism scale. *Personality and Individual Differences* 6(1), 21–29 (1985)
7. Ferran, C., Watts, S.: Videoconferencing in the field: A heuristic processing model. *Management Science* 54(9), 1565–1578 (2008)
8. Hardin, A.M., Fuller, M.A., Davison, R.M.: I know I can, but can we?: Culture and efficacy beliefs in global virtual teams. *Small Group Research* 38(1), 130–155 (2007)
9. Hofstede, G.: *Culture's consequences: International differences in work-related values*. SAGE Publications, Beverly Hills (1980)

10. Hofstede, G., Hofstede, G.J., Minkov, M., Vinken, H.: VSM 2008 (Values Survey Module) (2008), <http://www.geerthofstede.nl/vsm-08> (retrieved December 20, 2012)
11. Isaacs, E.A., Tang, J.C.: What video can and cannot do for collaboration: A case study. *Multimedia Systems* 2(2), 63–73 (1994)
12. Li, J.: Demographic diversity, tokenism, and their effects on group interaction processes. Unpublished doctoral dissertation. University of Toronto, Toronto, Canada (1993)
13. Li, J., Karakowsky, L., Siegel, J.P.: The effects of proportional representation on intra-group behavior in mixed-race decision-making groups. *Small Group Research* 30(3), 259–279 (1999)
14. Li, H., Rau, P.P., Salvendy, G.: The Effect of Mixed American–Chinese Group Composition on Computer-Mediated Group Decision Making. *Human Factors and Ergonomics in Manufacturing & Service Industries* (2012) (in press), <http://onlinelibrary.wiley.com/doi/10.1002/hfm.20391/full> (Online early view retrieved December 20, 2012)
15. Markus, H.R., Kitayama, S.: Culture and the self: Implications for cognition, emotion, and motivation. *Psychological Review* 98(2), 224–253 (1991)
16. McLeod, P.L.: An assessment of the experimental literature on electronic support of group work: Results of a meta-analysis. *Human-Computer Interaction* 7(3), 257–280 (1992)
17. Myers, I.B.: *Introduction to Type*, 5th edn. Consulting Psychologist Press, California (1993)
18. Oetzel, J.G.: Culturally homogeneous and heterogeneous groups: Explaining communication processes through individualism-collectivism and self-construal. *International Journal of Intercultural Relations* 22(2), 135–161 (1998a)
19. Oetzel, J.G.: Explaining individual communication processes in homogeneous and heterogeneous groups through individualism-collectivism and self-construal. *Human Communication Research* 25(2), 202–224 (1998b)
20. Oetzel, J.G.: Self-construals, communication processes, and group outcomes in homogeneous and heterogeneous groups. *Small Group Research* 32(1), 19–54 (2001)
21. Roger, N., Karen, L.H.: The effects of culture and cohesiveness on intragroup conflict and effectiveness. *Journal of Social Psychology* 143(5), 613 (2003)
22. Sedikides, C., Brewer, M.B.: Individual self, relational self, and collective self: Partners, opponents, or strangers? In: Sedikides, C., Brewer, M.B. (eds.) *Individual Self, Relational Self, Collective Self*. Psychology Press, Florence (2001)
23. Storck, J.S.: *Oh Say, Can You See: The Impact of Video Communication on Attention, Workload, and Decision-making*. Unpublished doctoral dissertation. Boston University (1995)
24. van der Kleij, R., Paashuis, R., Langefeld, J.J., Schraagen, J.: Effects of long-term use of video-communication technologies on the conversational process. *Cognition, Technology & Work* 6(1), 57–59 (2004)
25. Wainfan, L., Davis, P.: Virtual collaboration: face-to-face versus videoconference, audio-conference, and computer-mediated communications. In: *Proceedings of the Society of Photo-Optical Instrumentation Engineers (SPIE). Enabling Technologies for Simulation Science VIII*, vol. 5423, pp. 384–873 (2004)
26. Yellen, R.E., Winniford, M., Sanford, C.C.: Extraversion and introversion in electronically-supported meetings. *Information & Management* 28(1), 63–74 (1995)
27. Zhang, D., Lowry, P., Zhou, L., Fu, X.: The impact of individualism-collectivism, social presence, and group diversity on group decision making under majority influence. *Journal of Management Information Systems* 23(4), 53–80 (2007)

Trust and Coordination in Offshore Outsourcing: An Account of Intercultural Collaboration in a Danish and Indian IT Context

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Abstract. This paper reports from an empirical study of one of the largest IT and BPO offshore outsourcing endeavors embarked upon by a Danish company. Based on observations of structured, video-mediated handover meetings and follow-up interviews with the involved stakeholders, it presents an account of how the implementation of handover meetings affected Danish employees' perception of their Indian counterparts in terms of work attitude, competence and reliability – and ultimately how these handover meetings increased the Danish employees' willingness and ability to trust their Indian counterparts. Contemporary research on trust in virtual teams is used to provide a theoretical framing of the empirical findings. The paper furthermore draws on Sabherwal's (2003) categorizations of coordination as being either biased towards organic mutual adjustments or towards a priori structures. Through this perspective the findings suggest that formal coordination can be seen as a catalyst for building trust in virtual teams.

Keywords: Outsourcing, Offshoring, Cross-Cultural Management, Trust, Virtual Teams, Coordination, Intercultural Collaboration.

1 Introduction

Over the last two decades western firms have increasingly offshored IS activities to Asia; and success in such endeavors is significantly dependent upon the participants' ability to work in distributed teams. A large body of research within a variety of fields has been dedicated to understanding the complexities of virtual collaboration. Distance and use of collaboration technologies have been in focus (Olson and Olsen, 2000); shared meaning as well as conflicts in virtual teams (Bjørn & Ngwenyama, 2009; Hinds & Bailey, 2003) have been studied; and attention has been devoted to understanding the inherent difficulties of managing a distributed team (Hambley et al., 2007). Furthermore, the challenge of managing intercultural collaboration; and communicating and collaborating in virtual teams has received a great deal of attention (See Maznevski, 2012 for an elaborate literature review).

Much of this research mentions the importance of *trust* in virtual teamwork, but without making much of it. On the other hand, there exists a large body of research on trust (see Saunders et al., 2010 for an elaborate review), but within trust research only limited attention has been devoted to virtual teams – and even less research has taken on the challenge of doing ethnographic research on trust in virtual teams.

In this paper I take upon me the challenge of looking closer at how a specific coordination practice, namely task handover meetings, contributes to the establishment of trust in virtual teams, seen from the perspective of the client-side employees. Theoretically this paper is a contribution to the trust literature as it empirically explores how formalized coordination activities can affect trust levels positively. Furthermore, the paper aims at inspiring practitioners who are challenged by lack of trust within their virtual teams.

2 Literature Review: Coordination and Trust in Virtual Teams

Over the last 25 years a substantial amount of attention has been given to coordination mechanisms, within IS research as well as other areas (e.g. Daft & Lengel, 1986; Bjørn & Ngwenyama, 2009). Broadly speaking coordination can be regarded as the practice of “integrating or linking together different parts of an organization to accomplish a collective set of tasks” (Van de Ven, Delbecq, & Koenig, 1976; 322). Within IT, coordination is about sharing system knowledge, making sure that the responsibilities are clearly divided and adequately specified and understood by all parties in order to avoid rework and redundant work, among other things. In an article on coordination of outsourced software development projects, Sabherwal finds that coordination mechanisms can be classified into four distinct types, namely standards, plans, formal mutual adjustment, and informal mutual adjustment (Sabherwal, 2003).

Standards and plans both rely on a priori definitions, but differ as standards are defined irrespective of the concrete project or task (such as ISO standards, ITIL and CMMI); and plans are project or task specific (such as project management plans and delivery schedules). Both standards and plans are impersonal and “once they are implemented, their application does not require much verbal communication between participants” (Sabherwal, 2003: 156). In contrast, both formal and informal mutual adjustment rely on interpersonal interaction, where the formal mutual adjustments are characterized by being structured with regards to purpose and frequency (such as status meetings) and the informal mutual adjustments are characterized by being ad-hoc and having a more reciprocal character (such as collocated colleagues talking in office, impromptu communication via e.g. phone, email or chat).

Sabherwal’s (2003) analysis shows that coordination is likely to be increased when uncertainty such as “performance problems, changes in project responsibilities, and unilateral actions or perceived opportunism by the vendor” (p. 178) is experienced. Uncertainty is also addressed by Rosen et al. (2005) who conclude, that it “can have serious and long lasting consequences for the team’s performance” (p. 259) if uncertainty leads to erroneous attribution of the motivation of virtual team members and find that “the quantity and quality of knowledge sharing is influenced by the levels of

trust among team members” (p. 262). Thus, there seems to be two opposing modes in play, where on one hand high uncertainty leads to implementation of coordination mechanisms and on the other hand successful coordination is dependent on a certain level of trust. Paul & McDaniel (2004) state that “trust is a psychological state based on confident expectations and beliefs that another party will act in a certain manner, and that the trusting party must in some way be vulnerable under conditions of risk and interdependency to actions by the other party” (p. 186). Much similar to this Mayer defines trust as “a willingness to be vulnerable to another party based on both the trustor’s propensity to trust other in general, and on the trustor’s perception that the particular trustee is trustworthy” (Lewicki & Brinsfield 2012: 31). Thus, there is a clear similarity between trust and what Sabherwal labels as ‘uncertainty’.

This willingness to trust is what Möllering (2006) calls a “leap of faith”, which very well describes the somewhat paradoxical situation: uncertainty is reduced by implementing coordinative measures, but the success of coordination is dependent on the parties’ ability and willingness to accept risk and uncertainty.

Greenberg et al. (2007) suggest that in order to overcome such barriers in virtual teams it is important that “even before team members first interact, managers need to take steps to create a foundation for trust” (p. 328); or as Schaubroeck et al. (2011) would label it: a sense of psychological safety. Greenberg et al (2007) state that trust traditionally arises in two ways. “One is based on rational or calculative assessments and is called cognitive trust. It is the result of an evaluation of evidence of performance reliability and competence. Cognitive trust has been modeled as a function of the other person’s integrity and ability” (p. 327). Secondly, trust can be affective, characterized by emotional bonds and based on “assessments of benevolence” (ibid). As we see, both types of trust are based on evaluations of attributes of the trustee; and consequently there is an indication that the leader’s role in establishing trust is primarily related to creating a context in which the team members repeatedly are exposed to the integrity, ability and benevolence of their virtual team colleagues.

These fundamental challenges to establishing trust are not solely related to virtual teams, but as Rosen et al. (2005) point out mediated communication “reduces opportunities for virtual team members to have useful conversations, identify common interests, and engage in self-disclosure; all important elements in building trust” (p. 262) and “without the ability to observe reactions of virtual teammates to requests for information, virtual team members may fear that such requests might be seen as indicators of incompetence” (ibid).

3 The Case: Organizational Setup and Task Handover Process

The empirical case is an *offshore outsourcing* (Pfannenstein & Tsai, 2004) engagement between the IT-organization in a large Danish company (from here: The Client) and an Indian service provider (from here: ‘The Vendor’). The engagement was started up in 2006 and has since then grown to be one of the largest IT offshoring endeavours taken on by a Danish company.

The offshore outsourcing engagement is a *virtual captive center* (Lacity & Rottman 2008) in which The Vendor is responsible for the physical setup of the offshore development center (ODC) in India. The consultants work on physical machines provided by The Vendor, which are connected to virtual machines belonging to The Client: this way the consultants work within the client company's technical infrastructure and no data is allowed to be carried outside this infrastructure due to their sensitive nature.

The ODC is a mirrored organization in which the various departments in The Client's organization are replicated in the ODC. This structure cascades down from nine areas directly under the responsibility of The Client's CIO to the various system management areas and development projects. The Indian consultants are allocated to departments and projects where they participate as if they were employees of The Client. Thus, the utilization of the vendor staff resides under the line and project managers from The Client; and Indians and Danes interact directly with each other on a daily basis. The department in which the observations and interviews are conducted consists of 90 Danes and 25 Indians.

As the tasks being performed in The Client Organization vary significantly with regards to type, complexity, size, duration and business importance, the mirrored ODC organization also experiences a significant variance. This, combined with a Danish tradition of self-organization and empowerment (Gertsen & Zølner, 2012) within the various departments residing under the CIO's office, results in a non-standardized collaboration between The Client Organization and the ODC. The programme which the task handover process is a part of is aimed at collecting best practices across the organization and hereby improving the utilization of the ODC.

The purpose of the structured task handover meetings is according to the process description to "ensure common understanding of the content of a task that [the ODC team] is working on; that expectations are aligned; that there is mutual agreement on deliverables; that interaction and means of communication has been agreed upon; and that time lines and dependencies are communicated". It is not a standalone procedure, but rather an amendment to the task management process framework. This framework was implemented some years ago to structure how tasks were handled, but without taking offshore collaboration into consideration.

Thus, the handover meetings were designed with the intention of bridging a coordination and knowledge gap that was experienced when transferring the execution responsibility of tasks from Denmark to India and putting it in the hands of the ODC task manager. After receiving a specific task, this manager would be responsible for assembling a team to handle the task; inviting for a video meeting where both the assigned ODC team and the subject matter experts (SMEs) in Denmark would participate; and finally making sure that the task would be estimated and from here handled according to the already established task management framework.

The cornerstone of this process is thus the formalized handover meeting which is typically attended by two Danish SMEs and three to five Indian consultants. The meetings are always held as video meetings making room for the participants to see each other, and they always follow a standard agenda with predefined topics for discussion, namely 1) a walk-through of the task by the SMEs where they account for

the purpose of the task, lay out what work had already been done, assess criticality, and address the associated risks and 2) discussion and agreement on time constraints and deliverables. After the meeting the minutes, taken by an appointed Indian consultant, are distributed among the participants and subsequently the team of Indian consultants drafts a detailed estimation of the task. From here the task follows the ordinary task management process framework.

4 Methodology, Research Design and Data

The study of the task handover process I am reporting on in this paper succeeds a larger research project on offshoring collaboration. At this time I was an employee of the client company and expatriated to their offshore development center in Bangalore India as a Liaison Officer. I was engaged in the research project alongside two scholars from Roskilde University.

This project led to a company-internal collaboration improvement initiative referred to as *CoP*, which was instigated shortly after I had repatriated to Denmark. CoP is an abbreviation of *Collaboration Project* in which I was, among a vast variety of other responsibilities, charged with the management responsibility of designing and implementing initiatives to better the collaboration between one of the departments in Denmark and their Indian ODC-staff. One of these initiatives is the task handover process.

Thus, the research presented here is an auto-ethnographic account involving “self-observation and reflexive investigation in the context of ethnographic field work and writing” (Maréchal, 2010: 43). The study consists of observations of five instances of a task handover process executed over a period of three weeks. In total seven Danish SMEs and nine Indian consultants participated in the five meetings, as some on both sides participated in more than one meeting.

I was both a driving force in the establishment of these handover meetings, but also charged with the task of evaluating the perception of effectiveness of this initiative among both Danish employees and Indian consultants. More precisely, my role was to observe the discussions and provide guidance to make sure that the formalized agenda points were covered adequately. Furthermore, I was engaged in evaluating the meetings based on subsequent interviews with the meeting participants, where they were asked to reflect on the usefulness of the meetings and on how the agenda could be improved. In total, this led to eight interviews; Four with Danish employees and four with Indian consultants. All interviews were conducted as semi-structured, and the answers were written down during the meeting. Finally, my role was to evaluate these task handover meetings and present to the department director my recommendations on how to proceed.

As a consequence of being an employee of The Client I also had the opportunity to observe in situ the Danish participants, as well as those of the Indian consultants working onsite in Denmark as well as speak with the offshore consultants via a broad range of communication technologies at my convenience; and hereby observe the daily routines in the office and informally discuss the benefits and challenges of the task handover process.

Doing research and at the same time being an employee in the same empirical context with management responsibility in the department and of the pilot, and later on implementation, of the task handover process; and furthermore being a former Liaison Officer in the ODC in India is indeed a special situation.

Like any other kind of ethnography, auto-ethnography is indeed a matter of interpretation (Maréchal, 2010). Drawing on the hermeneutical school of thought Alvesson & Sköldbberg (2000) I acknowledge that one cannot free oneself from past experiences. Thus, this research paper is an interpretation based on what I experienced over the years – and the choice of looking into the role of trust is based on this. Also, there is a risk that my personal positive attitude towards implementing task handover meeting may have resulted in me neglecting negative side effects, simply because I have not had a focus on this. Finally, there is a potential risk that being involved as a manager, may have affected the participants in the pilot test to express a more positive attitude towards the results of the pilot test. However, I have chosen the working “potential risk” deliberately, as it is my clear impression that the meeting participants were both encouraged and used to speak their mind (which I believe the initial reluctance I describe later is a clear sign of) and also that my relationship with them was not characterized by power inequalities in this matter.

5 Empirical Findings

5.1 Pre-implementation Analysis of the Collaboration

The handover meetings were aimed at bridging coordination and knowledge gaps and in line with Sabherwal (2003) constitute an increase in coordination activities as an answer to performance problems and perceived vendor opportunism. But the idea was at first not well received by the Danish SMEs, who found the Indians to be too dependent on asking for advice and pointed to that the level of system knowledge in the ODC was too low. When the new process was introduced to the Danes at a department meeting, one of them argued that *“we don’t have time to spend two hours two persons to explain how to do a simple task that should not take more than forty hours in total”*. Several of his colleagues agreed and one elaborated that *“this means that we have to do our own work in less time”*.

Clearly, there was a notion that aiding the Indian consultants in understanding the complexities of the system portfolio was not a part of their job. But at the same time the SMEs were indeed helpful people that gladly sat down with a Danish newcomer to spend time on getting this person up to speed and they were usually very accommodating when a newcomer came by their desks to ask for clarification.

Among the Danes there was a pronounced insecurity of the Indian consultants’ ability to contribute to solving the department’s tasks. Because of my previous experience of working in the ODC, I was approached on several occasions by Danish colleagues who enquired about whether a graduate degree in IT or engineering from India was worth anything, implying that the Danes did not think much of the skills of the Indian developers. Others would ask if the Indians were *always* having coffee breaks, implying that they thought that the Indians did not put enough effort into their

job. On many occasions such remarks were made in a joking manner, but it was my impression that the Danes had a genuine concern about whether the Indians were able to contribute adequately and if they were at all inclined to do so. On several occasions the Danes proposed that if they were to be sure that a task was handled efficiently and with a good quality they had to attend to it themselves without involving the Indian consultants.

Many Danes were telling that when a task was handed over to India they were constantly disturbed and that “*they [the Indian consultants] are sending emails with questions that they should know the answer to, all the time*”. Some attributed this to lack of competences; some to lack of proactivity; and some to “*a tendency to show off [...] they Cc their manager on every little thing they do*”.

Summing up, in the words of Sabherwal (2003) the coordination prior to the introduction of the handover meetings was based on informal mutual adjustment. Also, the Danes were reluctant to accept the vulnerability of handing over important or urgent tasks to the Indians; and they doubted both the integrity and ability of their Indian counterparts. Thus, drawing on the definition of Paul & McDaniel (2004) the collaboration was characterized by lack of cognitive trust, seen from the Danes’ perspective.

5.2 Outcome of a Pilot Test

From the outset the Indian consultants were supporting the idea of having task handover meetings and voiced the opinion that this could help them significantly. Despite of the Danes’ reluctance, a pilot test of the task handover meetings was agreed upon. Five meetings were to be conducted and evaluated to decide on whether to incorporate the process on a bigger scale. This evaluation had three significant findings: there were indications that redundancy in work was lowered; transparency and efficiency was increased; and the Indian consultants were perceived as more proactive and independent in their approach to the work. The three findings will be elaborated below.

Indications of Lower Work Redundancy. Through the pilot task handover meetings there were several occasions where the increase in coordination activities indicatively catered for less redundancy. For instance, during the discussion at the very first meeting one of the Indian consultants mentioned that there would be a huge task in creating test cases to properly test the change to the system to which one of the Danish SMEs responded that such test cases were already established and that it was merely a question of reusing them. This particular example exhibits how something that the Danes considered common knowledge and therefore had not put in the specification surfaced as a knowledge gap (Madsen et al., 2010). When asked about this particular finding after the meeting, one of the Danish SMEs said that “*we would have caught this eventually anyway*” and thus, it seems that from a Danish point of view that this was not a case of lower redundancy. On the other hand, when asked about the same issue, one of the Indian consultants said that it was very helpful as they would have spent a lot of time looking through and translating the system documentation (which was in Danish) to find out whether such test cases existed “*and would probably have found nothing [because the] documentation is never maintained*”.

Another example surfaced in a meeting, where an Indian consultant questioned whether they could finish within the required time frame as drawing up the architecture would take time. This was countered by a comment by the Danish SME who explained that there were plans to discard the system in near future and thus the solution “*doesn't have to be pretty – it just has to work for now*”.

Increased Transparency and Coordination Efficiency. While the lower redundancy may be contested (as it was by the Danish SMEs) there is a strong indication that the task handover meetings led to a higher level of transparency. The Danes expressed univocally that the meeting had helped them to better understand what the Indian consultants were struggling with, though there were different opinions on whether the challenges that the Indians had pointed to through their questions were reasonable, ranging from complete understanding to rather harsh statements about the lower competences of the Indian consultants. Nonetheless, throughout the meetings the Danish SMEs readily and thoroughly answered the Indian consultants' questions and on several occasions the questions posed by the Indians were discussed among the Danes afterwards. The situation of the Indian consultants sitting more than 7000 kilometers away with limited access to expertise help and with a heavy reliance on documentation, sometimes deficient, sometimes even written in Danish, was acknowledged as being challenging. Also, the Indian consultants' effort to contribute was recognized. The perception of the efficiency of the coordination was equally univocal among the Danes, who all found that the meeting sessions had, if not minimized then at least caused the subsequent email queries to be more to-the-point.

Perception of Higher Proactivity and Independence. However, most remarkable was the Danes' perception of the increased level of proactivity and independent problem solving among the Indian consultants. During evaluations several comments were made relating to this subject. For instance, one Dane explained precisely what he expected to be informed about and what he expected the Indians to solve themselves. It had dramatically reduced the number of mails the Indians send “*to have me [the Danish SME] approve, and this way take the responsibility*”. Several of the Danish SMEs expressed that they felt that the Indian consultants were taking more responsibility now and that they were more 'proactive' thereby referring to a commonly accepted value in the department.

Among the Indians, interviews revealed that the fact that the Danes had spent so much time on explicating what they perceived as important to be kept informed about and what they would rather prefer the Indian consultants to handle themselves had given them a new insight into how the Danes preferred to work, but also established a sense of being important and trusted. As one of the Indian consultants puts it: “*I feel more like a real member of the team now*”.

The most significant sign of a change came about a week after one of the handover meetings, where I overheard two of the Danish SMEs discussing a mistake that one of the Indian consultants had made. They agreed that they had to put in an effort to help him out, because even though they found it to be a stupid mistake, they knew that he was struggling and that they had to help because it was very late in India and he needed to go home to his family.

6 Concluding Remarks and Implications

“Does a failure to make a promised entry in the team’s web archive mean that a teammate is struggling with a complex issue [...] or just slacking off?” (Rosen et al., 2005: 259). This quote coins very well the experience of the Danish SMEs in the case I have been reporting from.

I have exemplified how the Danish SMEs were questioning both the ability and the integrity of their Indian counterparts, and how the implementation of video-based task handover meetings with a formalized agenda improved the Danes’ perception of the Indian’s integrity significantly. The perception of the Indian consultant’s ability also seemed to be improved, however not as remarkable as the Danes’ perception of their integrity.

Indeed a solid trusting relationship cannot be expected to flourish overnight. Bearing in mind that this study is conducted on a pilot test where most of the stakeholders has only participated in one meeting, I conclude that there is an indication that formalized task handover meetings have a positive impact on the level of trust.

Additionally, using the vocabulary of Sabherwal (2003) one can characterize the implementation of task handover meetings as a movement from coordination chiefly relying on informal mutual adjustment towards relying on a standard, namely the task handover process and on formal mutual adjustments, namely the execution of the task handover meetings. Thus, the findings in this paper indicate that a higher level of formalization and standardization in the coordination activities is beneficial for the development of trust between the parties.

Finally, the findings in this paper suggest that management, as Greenberg et al. (2007) point out, has a significant role in establishing the foundation for trust and facilitating the leap of faith (Möllering 2006), as this does not necessarily happen unaided.

Theoretically this paper contributes to the body of literature on trust by exploring how formalized coordination activities can affect trust levels positively. In addition, the paper suggests how practitioners may approach challenges related to negative perceptions of the abilities and the integrity of virtual team members.

Two limitations of this research should be recognized. First of all the case study is limited in both size and duration, and further research is needed to establish a more in-depth understanding of the relationship between coordination activities and trust building. Second, this study has primarily been focusing on the client side and research including the vendor-side would be beneficial.

References

1. Alvesson, M., Sköldbberg, K.: *Reflexive Methodology: New Vistas for Qualitative Research*. Sage Publications, London (2000)
2. Bjørn, P., Ngwenyama, O.: Virtual team collaboration: building shared meaning, resolving breakdowns and creating translucence. *Information Systems Journal* 19(3), 227–253 (2008)

3. Daft, R.L., Lengel, R.H.: Organizational information requirements, media richness and structural design. *Management Science* 32(5), 554–571 (1986)
4. Gertsen, M.C., Zølner, M.: Recontextualization of the Corporate Values of a Danish MNC in a Subsidiary in Bangalore. *Group & Organization Management* 37(1), 101–132 (2012)
5. Greenberg, P.S., Greenberg, R.H., Antonucci, Y.L.: Creating and sustaining trust in virtual teams. *Business Horizons* 50(4), 325–333 (2007)
6. Hambley, L.A., O’Neill, T.A., Kline, T.J.: Virtual team leadership: The effects of leadership style and communication medium on team interaction styles and outcomes. *Organizational Behavior and Human Decision Processes* 103(1), 1–20 (2007)
7. Hinds, P.J., Bailey, D.E.: Out of sight, out of sync: Understanding conflict in distributed teams. *Organization Science* 14(6), 615–632 (2003)
8. Lacity, M.C., Lacity, M.C., Rottman, J.: Offshore outsourcing of IT work: Client and supplier perspectives. Palgrave Macmillan (2008)
9. Lewicki, R.J., Brinsfield, C.: 3 Measuring trust beliefs and behaviours. *Handbook of Research Methods on Trust* 29 (2012)
10. Madsen, S., Bødker, K., Tøth, T.: Knowledge Transfer in Outsourcing – From theory to Tooling in SourceIT: Balancing sourcing and innovation in information system development. In: Hertzum, M., Jørgensen, C. (eds.), Trondheim, Norway (2011)
11. Maréchal, G.: Autoethnography. In: Mills, A.J., Durepos, G., Wiebe, E. (eds.) *Encyclopedia of Case Study Research*, vol. 2, pp. 43–45. Sage Publications, Thousand Oaks (2010)
12. Maznevski, M.: State of the Art: Global Teams. In: Gertsen, M.C., Sørderberg, A.M., Zølner, M. (eds.) *Global Collaboration: Intercultural Experiences and Learning*, pp. 187–206. PalgraveMacmillan, New York (2012)
13. Möllering, G.: *Trust: Reason, routine, reflexivity*. Emerald Group Publishing (2006)
14. Olson, G.M., Olson, J.S.: Distance matters. *Human-computer interaction* 15(2), 139–178 (2000)
15. Paul, D.L., McDaniel, R.R.: A field of study of the effect of interpersonal trust on virtual collaborative relationship performance. *MIS Quarterly* 28(2), 183–227 (2004)
16. Pfannenstien, L.L., Tsai, R.J.: Offshore outsourcing: Current and future effects on American IT industry. *Information Systems Management* 21(4), 72–80 (2004)
17. Rosen, B., Furst, S., Blackburn, R.: Overcoming barriers to knowledge sharing in virtual teams. *Organizational Dynamics* 36(3), 259–273 (2007)
18. Sabherwal, R.: The evolution of coordination in outsourced software development projects: a comparison of client and vendor perspectives. *Information and Organization* 13(3), 153–202 (2003)
19. Saunders, M.N., Skinner, D., Dietz, G., Gillespie, N., Lewicki, R.J.: *Organizational trust: a cultural perspective*. Cambridge University Press (2010)
20. Schaubroeck, J., Lam, S.S., Peng, A.C.: Cognition-based and affect-based trust as mediators of leader behavior influences on team performance. *Journal of Applied Psychology* 96(4), 863 (2011)
21. van de Ven, A.H., Delbecq, A.L., Koenig Jr., R.: Determinants of coordination modes within organizations. *American Sociological Review*, 322–338 (1976)

Part IV
Culture and the Smart City

The Impact of an Actual Visit and Photograph Watching of an Exhibition on Visitor Viewing Experience

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Abstract. This research regarded the exhibition “Unfold a New Vision: To experience the surprises and awe in indigenous living aesthetics” as the subject to examine the impact of the format of the exhibition on the visitors’ satisfaction. The independent variable included the manner of visiting (visiting the exhibition or watching photographs in the exhibition hall) and theme display zone (the entrance, living room, dining room, bedroom, children’s room, and the creel (Sanku) lamp). This research asked three major questions regarding each display zone (the feeling and process of visiting, evaluation of the displayed items, and the overall feeling of the display zones). 156 questionnaires were collected for analysis. The result indicated that the scores of four questions regarding the visiting of the display were higher than that of watching the photographs. The questions of “works and fashion” and “intentions of decorating the living place with the displayed items” scored significantly higher in the group of photograph watching. Regarding the feeling of the display zone’s theme, there was only one question – “feel like sleeping” showed to have significant difference. In the section of the evaluation of the displayed items, there were five questions; overall feeling of the exhibition zones, three questions. Among them, the question concerning the interaction of the manner of visiting and the theme zone’s theme showed to have significant impact on the question of “exciting”. Finally, this research suggests that it is better to include the close-up photographs in the pamphlet of the displayed items in an exhibition. Concerning the materials and styles of the displayed items in the display zones should be consistent to offer visitors marvelous and consistent experiences. In addition, when providing the photographs to people that are unable to visit the exhibition in person, it is better to accompany those photos with music or samples of the displayed items to give them audio and tactile experiences to promote their satisfaction.

Keywords: Visitor’s Experience, Exhibition Visit, Photograph Watch.

1 Introduction

No matter whether it is the marketing of merchandizes by enterprises, promotion of collections in museums, or publicizing of art works by artists, the most frequently

used method is the sponsoring of exhibitions. In 2010, there were about 1,600 exhibitions of various kinds in the UK, with 1,300 of visitors, with the transaction of 1.4 billion pounds (about 63 billion NT dollars) [4]. From a global perspective, there were 30,700 trade fairs in the same year, with 2800 thousand companies and 260 million of visitors [11]. According to related reports, the total transaction value was not mentioned. However, it could be deduced that it could be a very high amount. Furthermore, regarding art exhibition, according to related survey, it indicated that there were 929 exhibitions held by museums worldwide in 2011, with 120 million visitors. For example, the art exhibition “Landscape Reunited – Huang Gongwang in the Fuchun Mountains New Media Arts” sponsored by the National Palace Museum in Taiwan made the record of 8,828 visitors per day on average, next to The Magical World of Escher held by Centro Cultural Banco do Brasil (at the average of 9,677 visitors per day), and Kukai’s World: the Arts of Esoteric Buddhism held by Tokyo National Museum (at the average of 9,677 per day), ranking the third [10]. With a huge market and considerable business opportunities, there is a growing demand of the exhibitions both at home and abroad.

The major function of exhibitions is to serve as platforms for communication. In exhibitions, the curators can create special venues or experiences to communicate certain messages to visitors, who give feedbacks to the curators in return as indicators for the market’s demand. There are four principles that are essential to the building of effective communication channels between curators and visitors: let the visitors participate in the exhibition, the messages intended to be communicated by the curator to visitors must be comprehensible, the messages should be interesting to visitors, and curators should converse with visitors in the “same language”[1]. Therefore, this platform must contain three elements – locutor (curator), message (features of displayed items), and interlocutor (visitors). In an exhibition, the curator’s messages are content dependent; however, they tend to sell, persuade, expose, parade, inform, delight, and enlighten [12]. However, for visitors, in addition to knowing new things and obtaining new knowledge on the day of visiting, they may also expect to obtain spiritual and sensual satisfaction. Therefore, modern exhibitions appeal to visitors’ realistic feelings, not the communication of knowledge guided by the curators. Loomis [7] departs from the messages required by the visitors. He points out that an ideal exhibition should include: the life-like themes of the exhibition, visitors can grasp the main points and messages promptly, and the contents can satisfy the demand of different age groups and attract visitors’ attention. Falk [5] suggests that whether an exhibition satisfies the visitors’ demand or not depending on the expectation before the visit (personal requirement or attractive theme), the experience during the visit (the facilities of the exhibition or interactive process), and the memory after the visit (the acquisition of knowledge or the memory that can be shared with other people). In addition, Pekarik et al. [9] proposes that the process of experience includes the following four perspectives: objective experiences, cognitive experiences, introspective experiences, and social experiences. Regarding the important affecting factors before the visit, expectation is the most because during the visit if the actual experiences comply with the expectations, there will be more delight and higher satisfaction [3]. In addition to

the four perspectives proposed by Pekarik, Packer[8] suggests the domain and the restoration attributes (including the charm of the exhibition site, the degree of detaching from the reality, and the appropriateness) of exhibitions can also affect the satisfaction of visits. Chen and Ho [2] conducted a survey on 25 items regarding exhibitions, such as contents, wording, panel board design, exhibition items, exhibition space, and so forth. It is discovered the three of the first five items that are considered as important by visitors were related to comfort. The other two were the issues of the education values of the interactive exhibition items and the attractiveness of the illustrations. In sum, in addition to the appropriateness and the attractiveness of the exhibition items in exhibitions, the audience also emphasizes much on the feelings during the visit.

With the growing demand for exhibitions, it derives other issues. First, visitors must go to particular locations at particular time to the exhibition site. It lowers visitors' intentions of visit caused by transportation inconveniency and insufficient time. As a result, it weakens the exhibitions' impacts and the terrain of communication. Then, the exhibition items will be removed at the end of exhibitions. The results of the exhibition can hardly sustain. Therefore, how to break through the problem of spatial and temporal limitations to allow the exhibitions sustain so that more people can visit them. In addition, the problem of preserving the elements and atmosphere of the exhibition sites is also important to spread and sustain the sensations after the exhibition. Thanks to the advancement in science and technology, now we can transform actual exhibitions into virtual ones so that exhibitions can get out of the architectural space and time, and the limitation of place by weaving webpages on the exhibitions, augmented reality, and virtual reality. The drawback of these methods is that it requires professional production prior to the exhibitions. Visitors need to browse through those webpages with certain hardware, such as the computers, internet, and so forth. Nevertheless, virtual exhibitions cost less than actual ones. But the effects of exhibition require further evaluations. Horn et al.[6] examined the interactive impacts of actual exhibition items and images of exhibition items on screens. It was discovered that both forms of exhibitions allow visitors understand the themes. However, the interviewees commonly agreed that actual display items were more attractive. They preferred actual exhibitions and were willing to pay more time and money to interact with them.

In addition to transforming exhibitions into virtual ones, taking photos of the exhibition sites is a convenience means because it has the merits of low-cost, minimum hardware requirements, prompt in communication, and long-term preservation. However, the difference regarding the impacts of photographs of the exhibited items and the actual exhibitions are rarely studied. Therefore, this research intends to examine the differences of visitors' experiences regarding watching the photos of the exhibition and going to the actual exhibition themselves, and analyze the consistency of feelings of the same person in different theme zones in the same exhibition.

2 Research Method

This study regarded the visitors of “The Aesthetics of Organic Lifestyle of Taiwan's Indigenous Peoples” in its Taipei exhibition as the subjects. This exhibition was sponsored from October 5 to October 25 in 2012 at Warehouse 1, Song Shan Cultural Park. The theme was the modern products designed with the aesthetics of the traditional lifestyle of the indigenous peoples. Those items were displayed in the manner of spaces in everyday life, giving more rooms for daily life imagination. During the exhibition, this research invited the visitors to filled in the questionnaires, with which the impacts on the experiences of attending actual exhibitions and watching the photographs of the exhibitions. The research method is discussed in details as follow.

2.1 Participants

In this project, there were 46 male and 110 female interviewees, a total of 156. Among the male interviewees, the people at the age of 21-30 had the highest number (18 people, 39%) and the rest were 31-40, 10 people (22%); 41-50, 9 people (20%); below 20, 5 (11%); and above 51, 4 people (9%) Regarding the female respondents, the people at the age of 21-30 had the high number of participants (98 people, 35%), and the rest were below 20, 32 people (29%); 31-40, 21 people (19%); 41-50, 10 people (9%); and above 51, 9 people (8%). Regarding the qualifications of the interviewees, 90% or more of the participants were university graduate or above.

2.2 Independent Variables

This research used the two factors experiment as the method, with the independent variables of “the form of visiting” and “themes of the exhibition zones.” The previous variable was subdivided into two groups: the visitors that attended the exhibitions and the people that watch the photographs of the exhibition. The latter variable was subdivided into six levels: entrance zone, living room zone, dining room zone, bedroom zone, children’s room zone, and creel (Sanku) lamp zone. In the entrance zone, Awe and Respect for the Divinity Area and Lamps Area were installed. In the living room zone, the decorations were user friendly, encouraging visitors to interact with each other. In this area, there were the decorations of pottery plates, pottery pots, leather paintings, wooden chairs, and water lamps. Decorated with wooden tables, wooden plates, bamboo baskets, and black pottery, the dining room zone communicated the atmosphere of family gather and having a nice meal together. In the bedroom zone, objects made with natural materials, such as the shell flower mat, hand woven cloth, floating chairs, glass bead cushions, shale slate side table, and so forth were displayed to communicate the message of relaxing from a day’s toil and surrendering into the embrace of nature. Decorated with boar chairs, lazy bones couch, bows, goats, and shell flower mats, the children’s room zone, the message of allowing the children to play with innocence and happiness was communicated. The creel (Sanku) lamp zone was the last area in the exhibition. In this area, a creel lamp (Sanku) made with a single bamboo was installed to create a relaxing mood. In addition, the souvenir section

was also setup in the zone. Professional photographers were hired to take pictures of each zone. The curator was asked to choose 10 photos from each zone, of which the pictures of the entire zone and close ups were chosen. Then the photos were printed in the size of 4 x 6 inches for the interviewees' watching. The photos of each zone are illustrated in Fig. 1.

2.3 Measuring Variables

This research mainly used a measuring variable questionnaire, except for questions regarding personal information (such as gender, age, occupation, and highest education). In each zone, there were 24 questions covering three major categories. Category 1 was the feelings during the visit (10 questions), including happy, peaceful, depressed, nervous, hopeful, lazy, sleepy, exciting, warm, and browsing. Category 2 was the evaluations of the exhibition items (9 questions), including fashion, attractive, creative, valuable, finely designed, with indigenous implications, easy to use, practical, and intended to use those items for decorative purpose. The last category referred to the overall feeling of the exhibition zone (5 questions), including the feeling of indigenous peoples' aesthetics of everyday life, interesting, homey feeling, comfortable and relaxed, and the satisfaction of the decoration and design of the zone. For each question there were five score levels: 1 (strongly disagree), 2 (disagree), 3 (neutral), 4 (agree), and 5 (strongly agree).

2.4 Study Process

This research was conducted at the exhibition site, where the researchers invited visitors to participate in the survey. First, they explained the purpose of the research and asked for the participants' permission. Then the researcher requested the participant to visit various zone at random and fill in the feeling questionnaire at site. Or they were requested to fill in the questionnaire after watching the photographs at the information desk. Each participant spent about 40 minutes finishing the questionnaires of the six exhibition zones or the photographs of these zones.

3 Results and Discussions

3.1 ANOVA

The Cronbach α coefficient of the analysis of reliability in this questionnaire was 0.87, indicating high reliability. Then, two-factor analysis of variances was conducted. The results indicated that the form factor showed to have significant impacts on 6 of the questions: "happy" ($p < .05$), "sleepy" ($p < .05$), exciting ($p < .05$), "watch the exhibition at will" ($p < .001$), "fashionable items" ($p < .01$), and "intended to decorate the living space with the exhibition items" ($p < .05$). The exhibition theme factor showed to have significant impact on 9 of the questions: "sleepy" ($p < .001$), "fashionable items" ($p < .001$), intended to decorate the living space with the exhibition items"

($p < .001$), “feel the indigenous peoples’ aesthetics of everyday life” ($p < .05$), “homey feeling” ($p < .001$), and “comfortable and relaxing” ($p < .05$). Regarding the interaction between the manner of visiting and exhibition theme, it showed to be significant only on the question of “exciting”. The ANOVA results are indicated in Table 1. From the examination results, it was discovered that different manners of visiting had an impact on the process of the visiting experience, i.e., the degree of interaction between the visitors and the exhibition, without much concern of the exhibition items and exhibition zone. In addition, although this exhibition had a core theme, the visitors had different feelings in different exhibition zones. Specifically, the impact on the evaluation of the exhibition items was the most significant. The feeling of the overall exhibition zones came next. Regarding the feeling of the visiting process showed to be the least significant.

Table 1. ANOVA of the visiting manner and the exhibition themes (items with p value less than 0.05 and F value are listed)

	Manner of visiting	Theme of exhibition zone	Interaction
Feelings of the visiting process			
Happy	4.23*		
Sleepy	6.18*	12.80***	
Exciting	6.29*		2.25*
Visiting at will	55.04***		
Evaluation of the exhibited items			
Fashionable	8.39**	5.78***	
Neat design		2.84*	
Easy to use		2.51*	
Practical		4.89***	
Intended to decorate the living space with exhibited items	5.75*	4.45***	
Overall feelings of the exhibition site			
Feel the indigenous peoples’ aesthetics of everyday life		2.71*	
Homey feeling		5.22***	
Comfortable and relaxed		2.32*	

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

3.2 Impacts of Visiting Manner Factor

In Table 2, the average of the significant items and Duncan grouping regarding the manner of visiting and the exhibition theme zones are listed. From the results of the visiting manner factor, the scores of the feelings of visiting the exhibition site are higher than watching the photographs. It made the visitors happier and they felt like watching the items of their own choices. However, the exhibition site was dimly lit, and visitors might feel sleepy when visiting the exhibition site. Compared with watching photographs of the exhibition, visitors felt more exciting to visit the exhibition site

in person. However, when watching the photos, the participants tended to evaluate the exhibition items higher. They tended to think the items were more fashionable and wanted to decorate their living spaces with these items. Perhaps it might be the reason that visitors browsed through a huge area when visiting the exhibition site. They tended to ignore the details of the exhibition items. However, the items' photos taken by professional photographers were better presented in the realms of angle and lighting. It highlighted the features and details of the exhibition items. Therefore, the participants preferred to watch the photographs of the exhibitions items rather than the actual objects. Hence, when visiting the exhibition site in person, the visitors had more freedom in the viewing process. The participants could choose to watch the items of their preferences and interest. In addition, they could choose the items they wanted to interact with and the duration of watching. As a result, it offered visitors a better visiting experience. On the contrary, watching the photographs of the exhibition limited visitors' perspectives. The participants could not know things happening beyond those pictures, which were two-dimensional and static. The participants could only watch them, without any contact. They could not even fetch and operate the objects, showing to have low interactive value. However, the limited perspective in the photos was also its merit. It allowed the participants to focus on the themes in the photos, which highlighted the items' values. It helped promote the values of the exhibition items.

3.3 Impact of Exhibition Zone Theme

Analyzing the factor of the exhibition zone, there was only one question—feeling “sleepy” during the visit showed to be significant. There were six zones categorized into three groups with Duncan grouping. Among them, the bedroom zone scored the highest. Then it was the children's room zone. The other four zones scored the lowest. In the sleeping room zone, it was decorated with the shell flower mat, bedside stool, glass beads cushions, and more, creating a “relax the fatigue of the day” atmosphere. In the children's room zone, there were three lazy bone couches, giving visitors a relaxed feeling. In other zones, they mainly communicated the images of food and utilities, which did not give people any relaxing or sleepy feelings. It also recalled the scores of the overall exhibition zone. In the bedroom zone, the two questions “homey feeling” and “comfortable and relaxing” were shown to have significant differences when compared to other zones. It is obvious that it is possible to communicate certain emotions with particular images with particular objects. Regarding evaluations, there were 2-3 groupings in five questions of the six exhibition zones. The items displayed in the entrance zone scored the lowest. Meanwhile, the scores of the other three zones showed to be moderate. In the entrance, only “Awe and Respect for the Divinity” and “Tree Lamps” were displayed. Both were huge, with the attributes of sculptures rather than handicrafts. Therefore, participants tended to think that these items were low in practicality. Meanwhile, the creel (Sanku) lamps were huge floor lamps, being functional and beautiful. Therefore, participants thought they were fashionable and practical. Moreover, they were willing to decorate their living spaces with this item.

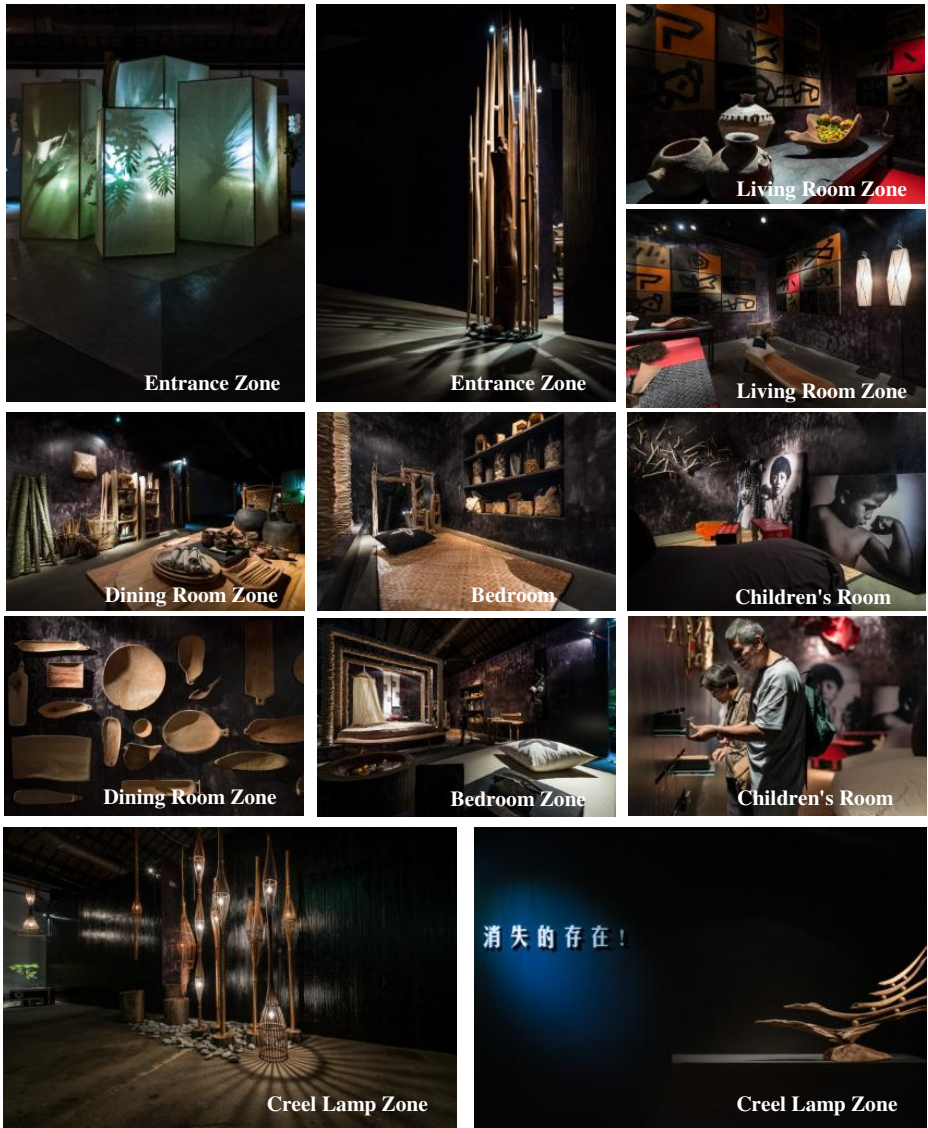


Fig. 1. Photos of each exhibition zone

Regarding the feeling of the exhibition theme of “indigenous peoples’ aesthetics of everyday life”, the average scores of the four zones were similar, except for the children’s room zone and entrance zone that scored lower than average. It was discovered that the living room zone, dining room zone, bedroom zone, and creel (Sanku) lamp zone used a huge quantity of natural materials, such as the floating wood, pottery, glass beads, plant fibers, and hand-woven textiles, in simple and rich forms, natural and simple texture. Comparatively speaking, the children’s room zone mainly used synthetic materials in rather modern forms (such as the huge lazy bones couches and

printouts of people). As to the entrance zone, it used the items as metaphor to communicate the indigenous peoples’ ideals of everyday life and natural environment. The presentation means were rather abstract, with insufficient links to the concept of “daily life”; therefore, visitors could barely figure out the image of indigenous’ peoples’ everyday life.

Table 2. Average of the levels of the visiting manner and themes of exhibition zones (only significant items are listed)

	Manner of visit			Themes of exhibition zones				
	Actual visit	Photo watching	Entrance	Living room	Dining room	Bedroom	Children’s room	Creel lamp
Feelings of the visiting process								
Happy	4.20	4.14	4.16	4.16	4.18	4.19	4.20	4.16
Sleepy	2.37	2.25	2.18^a	2.22^a	2.16^a	2.68^c	2.44^b	2.17^a
Exciting	3.01	2.88	3.03	2.89	2.98	2.90	2.95	2.92
Visiting at will	4.27	4.03	4.12	4.14	4.20	4.16	4.11	4.16
Evaluation of the exhibited items								
Fashionable	3.95	4.06	3.89^a	4.04^{bc}	3.91^{ab}	4.10^c	3.91^{ab}	4.15^c
Neat design	4.15	4.16	4.09^a	4.15^a	4.14^a	4.20^{ab}	4.10^a	4.28^b
Easy to use	4.06	4.06	3.93^a	4.08^b	4.13^b	4.10^b	4.05^b	4.07^b
Practical	4.03	4.05	3.86^a	4.07^b	4.14^b	4.10^b	4.02^b	4.06^b
Intended to decorate the living space with exhibited items	3.93	4.03	3.83^a	4.00^b	3.95^a	4.09^{bc}	3.91^a	4.11^c
Overall feelings of the exhibition site								
Feel the indigenous peoples’ aesthetics of everyday life	4.25	4.29	4.17^a	4.32^b	4.32^b	4.31^b	4.19^a	4.31^b
Homey feeling	4.03	4.08	3.88^a	4.10^b	4.14^c	4.18^c	4.06^b	3.97^a
Comfortable and relaxed	4.21	4.24	4.14^a	4.24^{ab}	4.26^{ab}	4.31^b	4.25^{ab}	4.17^a

Bold items indicate significant different between the levels of these factors. a, b, and c indicate the results after Duncan grouping

4 Conclusion

This research examined the impact of visiting an exhibition and watching photos of the exhibition on the process of visitation, evaluation of exhibited items, and feelings of the exhibition site. The experiment results indicated that different manners of visiting showed to have significant impacts on the process and feeling of visiting the exhibition, with no significant impacts on the feelings of the exhibited items and exhibitions site. Meanwhile, the exhibition process and feeling of each exhibition zone were similar, but it was significant regarding the evaluation of the exhibited items. As actual visit had higher levels of independence, freedom, and interaction, it offered better visiting experience. Regarding the photos of the exhibition, they helped visitors focus on the themes of the photos, which could highlight the items’ values and

promote their evaluation. This research also discovered that it was possible to communicate certain messages with the exhibited items to provoke certain feelings of the visitors. It was better use natural materials, simple and concise form, simple texture, and natural items to allow people feel the implications of indigenous peoples' lifestyles. Abstract and decorative items lowered the works' practicality and evaluation. Finally, this research suggests that it is better to provide a visiting guide with the photographs of the exhibited items in actual exhibition. Moreover, the materials and style of the works should comply with the theme of the exhibition in order to provide visitors with pleasant and consistent visiting experiences. On the other hand, when providing photographs to people that were not able to visit the exhibition in person, it was better to accompany the photos with music and samples of the materials to offer tactile and visual feelings, deepening the visiting experience.

References

1. Blythe, J.: Visitor and exhibitor expectations and outcomes at trade exhibitions. *Marketing Intelligence and Planning* 17, 100–110 (1999)
2. Chen, H.-C., Ho, M.-C.: Design Thinking on the Exhibition Model of Science Museum. *Technology Museum Review* 16, 109–138 (2012)
3. De Rojas, C., Camarero, C.: Visitors' experience, mood and satisfaction in a heritage context: Evidence from an interpretation center. *Tourism Management* 29, 525–537 (2008)
4. Facetime: The Economic Impact of the UK Exhibitions Industry – February 2012. In: Oxford Economics, UK (2012)
5. Falk, J.H.: *Identity and the Museum Visitor Experience*. Left Coast Press, Walnut Creek (2009)
6. Horn, M.S., Solovey, E.T., Crouser, R.J., Jacob, R.J.K.: Comparing the use of tangible and graphical programming languages for informal science education. In: *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*, Boston, MA, USA (2009)
7. Loomis, R.: *Museum Visitor Evaluation: New Tool for Management*. Altamira Press, Lanham (1987)
8. Packer, J.: Beyond Learning: Exploring Visitors' Perceptions of the Value and Benefits of Museum Experiences. *Curator: The Museum Journal* 51, 33–54 (2008)
9. Pekarik, A.J., Doering, Z.D., Karns, D.A.: Exploring Satisfying Experiences in Museums. *Curator: The Museum Journal* 42, 152–173 (1999)
10. Pes, J., Sharpe, E.: Exhibition and Museum Attendance Figures 2011. In: *The Art Newspaper*, pp. 35–43 (2012)
11. Union des Foires Internationales: Global exhibition industry statistics. In: *Global Association of the Exhibition Industry* (2012)
12. Velarde, G.: *Designing Exhibitions: Museum, Heritage, Trade and World Fairs*. Ashgate Publishing Limited, Hants (2001)

Designing Urban Experience for Beijing in the Context of Smart City

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Abstract. This paper will explore the urban experience and design opportunities in the context of smart city. Shaping the ecological, balanced and sustainable way of urban lifestyle is becoming new challenge to designer in China. In related research, the development of smart cities and design urban experience will be explored from the integrated perspectives of theories and methodologies. We regard the city as the social network, living community and connected organism by the support of new information and communication technology. Research will focus on understanding the urban interaction pattern between citizen, media and city based on activity theory. The results of this research will help to transform the smart city design from technology driven to people driven; provide new models and case studies for developing the smart service system and shaping new urban experience in Beijing.

Keywords: Urban experience, Activity theory, Interaction Design, Service design, Smart city.

1 Introduction

In this paper, the methods of designing urban experience will be explored from the theoretical and practical levels. Urban experience can be achieved through urban activities and social network; it is dynamic personal reflection of urban lifestyle, and changed with the time lapse and context transformation.

Designing urban experience usually focuses on exploring physical city and intangible info-structure, probing culture event and lifestyle of the public, collecting scenario data in the field, analyzing people's behavior and activities, combining information architecture and interaction of the urban space, facilitating online involvement and offline participation.

How to develop a research framework for urban experience base on activity theory, what's the new characteristics of human activities in the smart city, how the technologies can support the new urban lifestyle, and what's principles and checklists for conceptual prototype development, these are the foundational issues need to be explored in this research.

1.1 Design New Lifestyle in Beijing

Beijing is the capital of China, often known as the national cultural, political and historical center, currently is undergoing the significant changes in the trends of globalization. These developments create the diverse, pluralistic, multi-perspective and cross-cultural evidences in Beijing. Along with the acceleration of urbanization, Beijing is facing a lot of challenges, such as social, environmental, housing, transportation, and safety problems. How to rethink the urban problems and give new solutions for better urban lifestyle will be the big challenges to designers for a long period of time.

With the support of urban related computing technologies, the sensor, mobile device, vehicle, building, and public space in the urban areas can be connected in a platform to serving people and their cities. Designer can tracing people's behavior based on social media and personal data through sensor or application, the mobile device and context-aware technology can also provide the proper service when people travel in the city. Under such circumstances, designer will need more efficient tools to handle the holistic perspectives of urban experience from the integration of technology and society.

1.2 Related Research Projects

Currently, lots of universities and institutions begin to explore this new field. For example, several research groups and projects of MIT Media Lab are working on how new information technologies and solutions can help citizens to live and interact better with the built environment and nature [1]. Urban informatics research Lab at Queensland University of Technology is revealing the emerging field of urban informatics [2]. Project YOURban at the Oslo School of Architecture and Design investigates tools and means to creating engagement and a sense of ownership and responsibility towards our physical, social and cultural world [3]. Project Urbanflow in Helsinki aims to envision an operating system for cities, and revolves around situated urban screens and their potential uses [4]. European Commission lunch UrbanIXD project, focusing on human activities, experiences and behaviours around the domain of data-rich urban environments. All these researches and projects are starting a new design field in smart city context [5].

2 Motivation and Position

The goal of this paper is to build a research framework for designing the social and cultural experience of citizens. The backbone of this process is to understand the behavior of the citizens, their needs and motivations. In smart city, the built environment would be changed to be perceptual, interactive and transformative, which could better support people's urban activities from more and more sophisticated urban life. On one hand, as an interactive space, the city could effectively realize "what you see is what you think" and fully embodies the collective intelligence to our life. On the other hand, smart city system is built based on the social rules, will be the right mediation between the physical environment and human society habits.

2.1 Related Theories and Design Tools

With the help of new information and communication technologies, we can establish the connections between urban and citizens in the real and digital space to promote civic involvement in public service space. For understanding and shaping urban experience in this new context, we need apply various related theories and design tools to reframe the research. Theories will include system theory, complexity theory, ecological science, cybernetics, communication theory, cognitive science, sociology and psychology. Related design methods includes ethnography investigation, sociological research, information architecture, field research, body storming, storytelling, data visualization, urban life documentary, user scenario modeling, user journey, service touch point and blueprint, experience prototype and design patterns. These diverse approaches can be applied to framing a problem space and expose the challenges in urban contexts.

2.2 Design Interactions in Different Scales

Interaction design shapes interactive experience between people and product to achieve people's goals and expectations. Interaction designer defines the behavior of product to coordinate relationships between people, people and products, people and the environment, people and service under various situations. The big picture of interactions will concentrate on the relationship between people, context of use and systematic solutions. "Small-scale" interaction is usually applied on intelligent interactive products, furniture and clothing. "Large-scale" interaction involves in the spaces of rooms, buildings, streets and cities. Thus interaction design has extended to a new practice area for shaping the experience between people and environment.

2.3 Design Perspectives on Smart City

Smart city is characterized by comprehensive perception, ubiquitous connectivity, pervasive intelligence, and people-centered sustainable innovation which are featured by user innovation, mass innovation, open innovation, and collaborative innovation [6]. Through the structural analysis of the physical facilities and virtual information systems, we can provide the basis for understanding urban life and dealing with city problems. For designing physical space and cities, it should focus on the module, boundary, structure, landscape, usage, intervention and dwellers. For designing information systems and service, it should focus on content, context, identification, activities, behavior, experiences and policies. Design for activity will focus on the people, context of living and intelligent system solutions. City can be seen as the social network, living community and connected organism. Citizen's experience and behavior can only be understood in the context of the socially and culturally interaction with the city, and this point give us an opportunities to involved the activity theory in this research.

3 Urban Experience Informed by Activity Theory

Experience usually refers the feeling and knowledge gained through involvement in or exposure to thing or event. Urban experience is related with human mental activities that emerge, exist and be understood in the interaction of people and the world around them, and the interaction or activities determined by social and cultural factors.

Activity theory was looked as a second-wave, post-cognitivist HCI theory. Designing user interfaces attempted to build an interaction design framework based on combining the checklist of activity theory [7]. Ethnographic approach and Activity Theory also use as participatory design approach to frame the service design process and interpret the complexity of services [8]. Urban experience can be explored from social activities, cultural custom and living environment.

3.1 Overview of Activity Theory

Initiated by Vygotsky, Leont'ev, and Luria, activity theory originates in the cultural-historical psychology. Taking activities as its units of analysis, it examines collective mediated behavior directed towards an outcome [9]. The key elements of activity system include subject, object, tools, rules, community and division of labor. These elements formed four subsystems of production, exchange, consumption and distribution [10]. It also models expertise as an active, collective phenomenon, and provides the understanding of context in which computer-supported activities take place during design and evaluation [7]. Research model informed by Activity theory offers an approach to conceptualize relationships between citizen, city and technologies. (Shown in Fig. 1.)

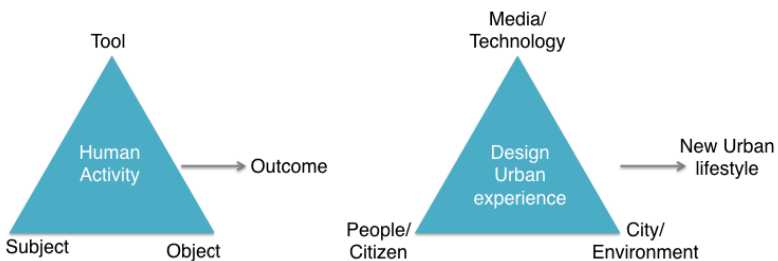


Fig. 1. Research model informed by Activity theory

3.2 Activity Theory Principles for Urban Experience

Activity theory is ideal for analyzing user experience because the assumptions of activity theory are much closed with contextual design. Activity theory is embodied in five major theoretical principles as follow:

- Object-orientedness: There are two kinds of objects, people or things. When we design the urban experience, need find out the social and cultural factors, besides the physical properties of eco-system.
- Mediation & artifact: Tools shape the interaction between people and physical world. Mobile device and social media become new mediation between citizen and smart city. Tool is also can be people's experience and possession and attachment of life.
- Hierarchical structure of activity: There are three hierarchical levels of interaction, i.e. activities, actions and operations between human and the world. Activity is motive-oriented and composed of actions; user's needs leads to the motive. Action is the goal-oriented and motive defines the goal of actions, Action consists of a series of operation. Operation is depended on the condition, the routine operation will be the unconscious actions, but will become conscious action if condition change. This model gives us a dynamic, context-aware structure to define the interaction.
- Internalization and externalization: Internalization help to build the interaction pattern and operation process in mind before people interact with the external world. Internal mental representations will affect the external interaction, and meanwhile, the external interaction process or pattern can also change people's mental representation. The comprehensive metaphors and language in the intelligent environment will promote the urban interaction. Good urban interaction need follow people's cognition, and it also can help people to nurture good behavior and habits.
- Development: It is very helpful to analysis the time-based interaction, because people's behavior and activity will be changed based on different context.

3.3 Activity Evaluation Checklist

The activity checklist is intended to clarify the most important contextual factors of interaction. It can be used at early phases of service system design or for evaluating existing systems. There are two versions of the checklist, the evaluation version and the design version [11]. Below design checklists will be used for this research.

- Means and ends: To identify the main user from citizen, visitor or traveller, and which technology can facilitates and constrains the attainment of users' goals, what are the conflicts between different goals in shaping the sustainable urban lifestyle.
- Environment: To integrate target urban computing, Internet of things and social technology with requirements, tools, resources, and social rules of the environment from the virtual and physical aspects.
- Learning and cognition: To check people's cognitive reflection versus urban interface and service system of activity and support of their mutual transformations with target technology.
- Development: To take the developmental transformation of the urban experience as a whole, and explore the system in a dynamic structure from macro and micro viewpoint.

4 Case Studies

Based on the methodology of research through design, this paper will explore the urban interaction models, i.e., people and people, people and service, people and infrastructure in the different contexts. The design process was conducted in the graduate class under the concept of urban media theory and framework [12][13]. Three different places in Beijing include Sanlitun pedestrian bridge, 751 D-park public squares and Wudako subway hub, are chosen for concept development. (shown in Fig. 2.)The main tasks of these studies are to identify, understand and conceptualize the design opportunities in smart city based on the checklist of activity theory.

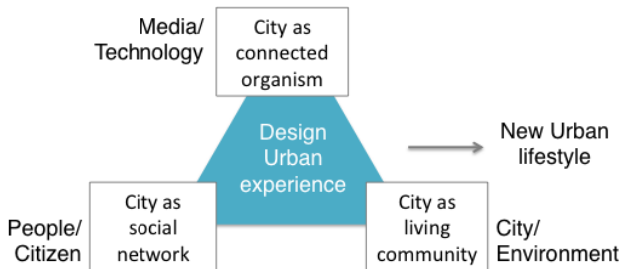


Fig. 2. Practical project fields informed by activity theory

4.1 City as Connected Ecosystem

Sanlitun is a young and vibrant international business district. This case focuses on how people interact with urban infrastructure in their everyday life and how they make connection with the city ecosystem. Based on the design checklist of activity theory, four aspects were used to identify the design opportunities.

Means and ends. People's activities on the pedestrian bridge were regarded as subject. Bridge help people to cross the road safely but also need to shape the good interactive experience.

Environment. The pedestrian bridges in Beijing are very typical physical facilitates but usually have the common faces. A smart, social pedestrian bridge can be a connection between people, vehicle and surrounding environment. Bridges are distributed and collaborative, which could also interact and exchange the data of traffic condition, environmental pollution and emergent security.

Learning and cognition. To change "Chinese style of crossing the road", which referring the tendency of large crowds of people to cross roads in disobedience of red lights, the smart pedestrian bridges need to act as an interface to reflect people's needs, activities and values. Through recharge reward points into pedestrian's public transport card to encourage the good habits to take the bridge for crossing road.

Development. The bridge can be regarded as an dynamic operating system, which can transfer human energy to the night lighting, interact with the pedestrian through sensors, those actions could effectively cultivate the healthy and safe urban lifestyle.

The final conceptual prototype of smart pedestrian bridge shows the context-aware interactions between people, bridge, vehicle and environment. (Shown in Fig. 3.)

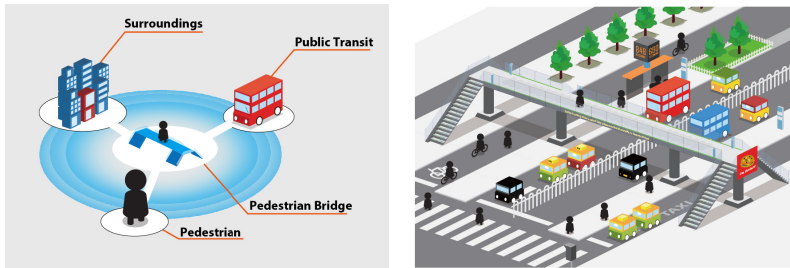


Fig. 3. Smart pedestrian bridge, urban connections and interfaces

4.2 City as Social Network

The 751 D-Park was a factory campus near 798 Art District. Now it becomes a stage for cultural and art related events in Beijing. The design checklist of this case as follow:

- Means and ends. People need to feel their own presence and participation in public venue. People can be attracted by common interest, but it will be a challenge to build ephemeral social network in public event.
- Environment. Citizens can be the sensors to connect with others and environment by ubiquitous computing, Internet of things, etc. A colored wristband was designed to detect the nearby color and change itself color by swinging arms. Then the wristband can create different dynamic groups during the event.
- Learning and cognition. Lots of people came to the music festivals or concerts for social reasons. The social behavior of conformist mentality will shape the co-experience, emotional interaction on site.
- Development. Sharing and exchanging color will be not only for creating atmosphere but also can collect the individual data and present it on big screen in the stage during the whole event. The wristband link people in the ephemeral social network and will create dynamic media system in the public space.
- The final deliverable is conceptual wristband prototype called Co-pulse, which could link and form the emotional-based social network in a public event. (Shown in Fig. 4.)

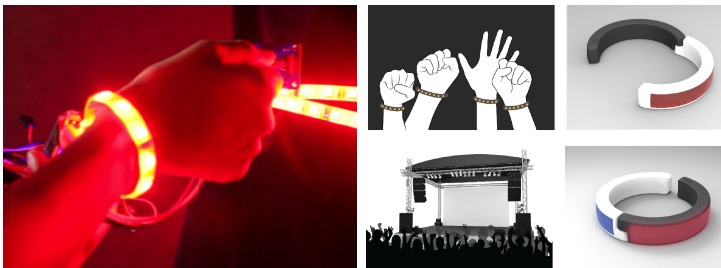


Fig. 4. Co-pulse, social interactive wristband for public event

4.3 City as a Living Community

Wudaokou is a transportation hub in the Haidian District of Beijing. In this project, public transportation service was applied to help citizens to manage every day life. The design checklist of this case as follow:

- Means and ends. This project focuses on urban mobility issues in public life, which is based on the principle of energy flow and energy conservation to become a public service system by linking different service touch points. The prototype is mobile application that provides commuter with personal transportation and encourages people to take healthy ways to workplace. It includes three main parts: route-arrangement, eco-travelling and information sharing.
- Environment. Based on location based service and cloud computing, traffic, weather and personal data can be well integrated to help people arrange their routes efficiently, and encourage people to use healthier ways travel such as bicycles, public transport, walking etc.
- Learning and cognition. The project will analyze the relations between individual behaviors of citizens and groups habits to explore the interaction pattern of balancing comfortable and sustainable transportation.
- Development. The liquidity of information will guide the participatory behaviors of public and shape the holistic urban mobility experience in a long period. The mobile application and smart urban transportation network will record the personal data to keep the traveller go smoothly in his journey.

The final deliverable is conceptual personal urban mobility application called Balance Flow, which could help people to arrange their daily transportation and shape sustainable living habits. (Shown in Fig. 5.)



Fig. 5. Balance Flow, personal urban mobility application

5 Discussion and Future Works

Smart city change the built environment to a sensible, interactive and transferred place, which can support human activities in all levels. New concepts will be needed to effectively support the implementation of the eco-city environment, and intelligently response to the changes of urban lifestyle. Accelerating expansion of urban functions and openness of the urban life make our city became a complex system.

We have to apply design thinking to find out the new solutions, which could better deal with the core problem of smart city.

The smart city is a complex system of the combination of human experience and the built environment. Future research on urban interaction and service design of smart city will mainly focus on the exploration in tangible city and intangible information to find more possibilities of user experience and service innovation after the combination of reality and virtual cyberspace. Activity-based design will enrich the human centered methods, lead to situational, participatory, and pervasive intelligent service in city. A holistic framework and urban interaction design patterns will be developed in the next step research.

6 Conclusions

This paper explored the new perspective of combining the social and cultural activities into physical built environment. It provided the new methods and examples for developing the smart city eco-system and shaping the urban experience. Based on the methodology of research through design, three different contexts in Beijing, including Sanlitun pedestrian bridge, 751 D-park public squares and Wudako subway hub are chosen for concept development. This research method focused on finding the opportunities from citizens' behavior and urban lifestyle, final conceptual deliverables represented the main ideas of city as connected organism, social network and living community. It can also help the planner and manager in Beijing to better understand the planning and renovation of the existing urban system, improve the quality of real city life, and develop new integrated application and service to enhance the urban interaction experience between the people and intelligent city system.

Acknowledgements. The design researches and prototypes in this paper involve the results of postgraduate courses and project of urban media. Many thanks for Mr. Christopher Kirwan to co-conduct the course with me, and for the related students including Xingjian Cui, Junjie Yu, Shen Li, Wang Luobin, Lin Han, Simo Feng, Menglin Ye, Jingli Zhu, and Wei Gong, I express my sincere thanks to their works.

References

1. MIT Media Lab, <http://www.media.mit.edu/research/groups-projects>
2. Urban Informatics Research Lab, <http://www.urbaninformatics.net>
3. YOURban, <http://yourban.no>
4. Urbanflow, <http://helsinki.urbanflow.io/>
5. UrbanIXD, <http://urbanixd.eu>
6. Song, G., Wu, L.: Smart City in Perspective of Innovation 2.0. 0, *Journal of Beijing University of Posts and Telecommunications (Social Sciences Edition)* 14(4), 8–15 (2012)
7. Uden, L., Willis, N.: Designing User Interfaces using Activity Theory. In: *Proceedings of the 34th Hawaii International Conference on System Sciences* (2001)
8. Sangiorgi, D., Clark, B.: Toward a Participatory Design Approach to Service Design. In: *Participatory Design Conference, 2004-07-27/2004-07-31, Toronto* (2004)

9. Vygotsky, L.S.: *Mind and Society*. Harvard University Press, Cambridge (1978)
10. Jonassen, Peck, Wilson: *Learning with technology: A constructivist perspective* (1999)
11. Kaptelinin, V., Nardi, B., Macaulay, C.: The Activity Checklist: A tool for representing the "space" of context. *Interactions Magazine*, 27–39 (July 1999)
12. Fu, Z., Zhang, X.: *Designing for Social Urban Media: Creating an Integrated Framework of Social Innovation and Service Design in China*. In: *HCI International 2011 (the 14th International Conference on Human-Computer Interaction)*, Orlando, U.S.A., July 14-19 (2011)
13. Kirwan, C.G.: *Urban media: a design process for the development of sustainable applications for ubiquitous computing for livable cities*. In: *Proceedings of the 2011 ACM Symposium on The Role of Design in UbiComp Research & Practice*, Beijing, China (September 2011)

A Log Analyzer of Public Transit Guidance Service to Improve a Route Bus Service

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Abstract. We developed a log analyzer for public transit guidance service, and clarified the pattern of the usage of public transit guidance, and actual demand to the public transit service. In recent years, there is a growing demand for public transit guidance for mobile devices, such as smartphones. Therefore the usage of public transit guidance service strongly reflects the demand to the public transit. It is possible to find potential demand to the railway services and route bus services by observing the access to the public transit guidance service. We developed a log analyzer of public transit guidance service as a Hadoop cluster for Bus-net, a popular public transit guidance service in Tottori Prefecture, Japan, and discussed the way to improve public transit service more convenient with the result of the analysis.

Keywords: public transit guidance service, log analyzer, route bus.

1 Introduction

In recent years, there is a growing demand for public transit guidance service to the development of high-speed networks and the spread of mobile devices, such as a smartphones. These services is a web service that suggests the best itinerary to the destination by trains or bus with search criteria, such as origin, destinations, time. Especially, the service is used as a real-time navigation [1] to the destination from the current position using the mobile device with GPS.

In this way, public transit guidance service is becoming strongly associated with real traffic. We think that it is important to understand the relationship between a public transit guidance service and real traffic because of analysis of route bus service from the log data of public transit guidance service.

The paper attempts to improve a route bus service by designing the log analyzer of a public transit guidance service, and implements the analyzer on a public transit guidance service called “Bus-Net”.

2 A Public Transit Guidance Service

There are many public transit guidance services on the web in recent years such as Google Maps [2], Deutsche Bahn [3], and Navitime [4]. The basic functions of these

web services are to provide a route map of public transport, to provide a timetable at a bus stop or a station, and to search for the best itinerary between any stations or bus stops. Usually these services are available for smartphones and PCs. You can use the guidance service from your PC when you are planning your trip with trains or route buses. Also you can use the service on your smartphone when you get lost while you are traveling.

Nowadays, people in the train spend much of their time with their mobile devices, and the close relationship with mobile devices is changing the form of services [5] including the guidance for public transit. Today, most users of the public transit strongly depend on the guidance service while moving with trains or buses especially in advanced countries or large cities. They do not search for the exact itinerary beforehand, instead, they are moving with searching and gazing the screen of the smartphone. As the result, much closer coupling between online services and actual railway and route bus service is going to be important.

With the development of information technology, railway services and route bus services is considered to have a possibility to change their forms of the service to be more useful for the users [6]. In the challenge to improve the service, it is important to understand the demand to the public transit services. There are many techniques to investigate the demand, but as the public transit service is getting to have strong relationship with online service, the method of analysis of online service is also going to be applicable to the survey of public transit service.

In summary, the online public transit guidance service influences to the offline activities of users of public transit service by suggesting itineraries of users. In this way, these services are significantly different typical web services by the point with a strong association with a real traffic. We think it is possible to analyze the use of public transport from the user behaviors of public transit guidance service.

3 Analysis of Activities of Public Transit Users

As discussed in Section 2, it is important to analyze the use of public transport from behaviors of the users of public transit guidance service. The important differences between a general web analysis and the analysis for a public transit guidance services is, that the activity of the user does not end within the online service, but continue to the offline activities such as taking a train. Therefore, it is important to deal with both online and offline activities of users. Also it is important to deal with the actual conditions of public transit services such as the statistics of railway and route bus services, actual delay of vehicles. In the following, we discuss the possible analysis to improve route bus service, and we define requirements for log analyzer of public transit guidance service.

3.1 The Situation of Use

In order to improve the route bus service to understand meanings of the use of public transit guidance service, we examine the relationship between the users of each the

route bus service and the public transit guidance service. Of course, users of the public transfer guidance service are users of public transport almost, but it does not mean that users of the public transport use the public transfer guidance service. For example, it is not considered to search for the route using on a daily basis, such as commuting. In order to understand meanings of the use of public transit guidance service we examine the situation of use.

3.2 The Potential Demand of Users

After examining the relationship between the service and route bus transit service, we need to understand the potential demands of the user in the route bus service. Many people use the route bus to arrive at a given time to a destination, however, there are few buses arrived just that time direct to that destination. We know the time a lot of the user data from the actual use of the bus route, but we could not get a potential demand such as, origin, destination and departure time. Therefore, we investigate the demands of user from the search condition of public transit guidance service, and the coverage of route bus service for demand from the search results. Thus, we identify the points of the timetable to be improved from the coverage of the timetable for high demands of users.

3.3 The Accuracy of Bus Services

Some public transit guidance services are reflected in the search results to get transit information of route buses and trains in real-time. We can create a timetable that is hard to cause suspended service and delay by quantitative analysis of elements for season, weather and day of the week from transit information.

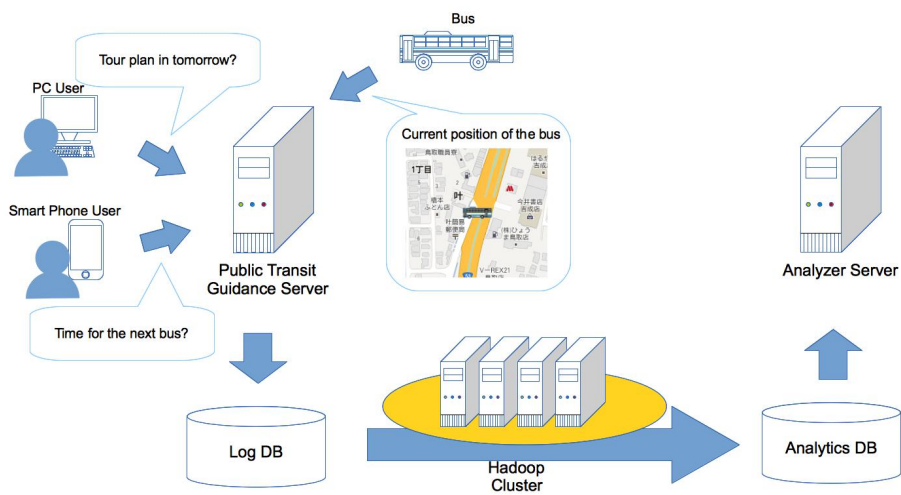


Fig. 1. The system of analyzer

4 Implementation

We implement the log analyzer discussed in chapter 3 of in the public transit guidance service called “Bus-Net”[7,8,9]. As shown in Fig. 1, logging data of “Bus-Net” users’ access and the data of bus location system, and these data is processed using a Hadoop [10] cluster, published analysis results in the “Analytics-Server”.

As shown in Fig. 2, user behavior in the “Bus-Net” is recorded as log in the “Log DB”, and be analyzed by the Hadoop cluster. Analysis result is recorded in “Analytics DB”, therefore, published by the web service in “Analyzer” server.

4.1 “Bus-Net”

“Bus-Net” is one of the public transit guidance service has two features “Timetable Search” function gives you a single view of the timetable of bus routes multiple runs between the bus stops and “Route Search” function to search for the best route to the destination. The “Route Search” function shows the best route to the destination using public transportation of which, as shown figure 1. To assist the movement of the user to the destination in a part of walking, this service shows path using guide map, in a part of bus or train, shows the transit bus stop.

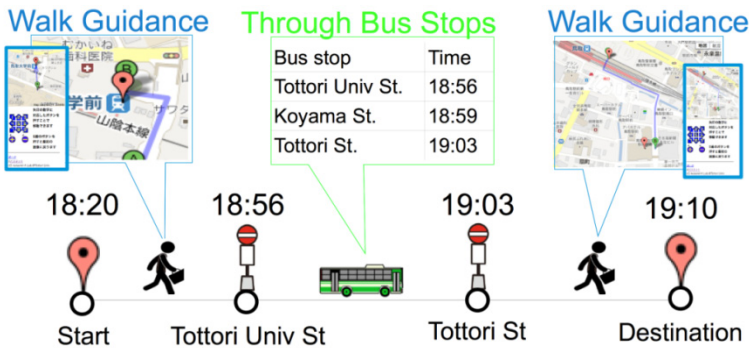


Fig. 2. The example of "Route Search"

4.2 Logger

For analysis of the use of public transit guidance services, we require not only page transition and search conditions but also search result user get.

In addition, the behavior is recorded whether to move to any page from any page, but as the analysis is considered to be what you are, using the available information, such as time of use. Therefore, we propose that the tag as its attributes to each behavior. For example, we will need to enter your departure place in timetable search and route search, by tag named "departure place", can be analyzed without considering the feature pages. In addition, the tag is also useful in terms of maintenance and management because it is easy to add or delete later.

4.3 Analyzer

The analysis of log data are used Hadoop, showed in the web service analysis results. The analyzer shows the analysis results of the Hadoop cluster using charts and maps like Fig. 3, web server will display the data easy to understand for those of the bus company and the developer of the service transit.

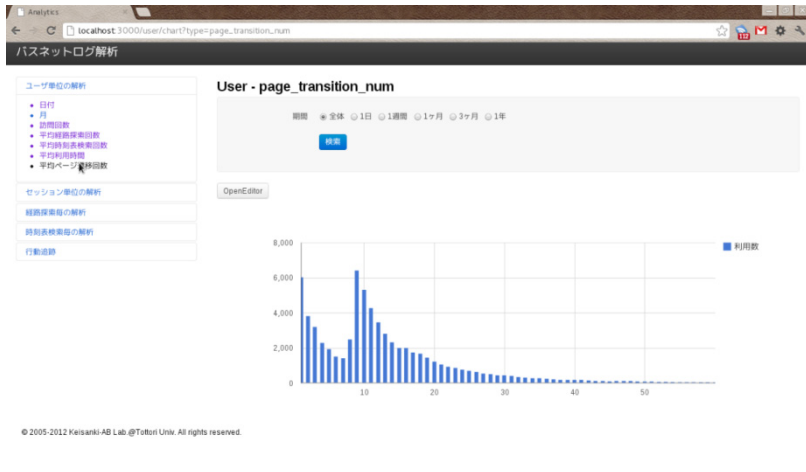


Fig. 3. one of screenshot of the analyzer

5 Analytics Result

We implemented the analyzer of public transfer guidance service "Bus-Net" that we have developed, designed in Section 3. In this chapter, we investigate the use of public transit guidance services using this analyzer and, considering the reality.

5.1 Everyday Use Is More Than the Other

By analyzing the search frequency of each combination of departure place and destination of the route search function, we have to analyze whether it is used for what purpose. As a result, there are few route search to the location where you do not usually like to go for sightseeing, many route search to the location of the many times that you have used, such as for shopping and daily commuting. This is considered to be one of the reasons also that most of the users of the "Bus-Net" is residents of the prefecture, in the case of the used day-to-day, user know what do he get on the bus which routes go any bus stop, but he forget the departure time of the bus.

5.2 Users Tend to Enter Only the Origin and Destination

We have counted the frequency of the “Route Search” of the items other than the starting point and destination, separately from the use of mobile devices and PC. In the route search, it was found that changing the search conditions as small as can be seen from hypotheses, Fig. 4, 5. However, the use of mobile devices has had less change in departure dates compared to the use of from the PC, because it was used while moving, which is provided with because there is no problem has become departure dates the current date considered.

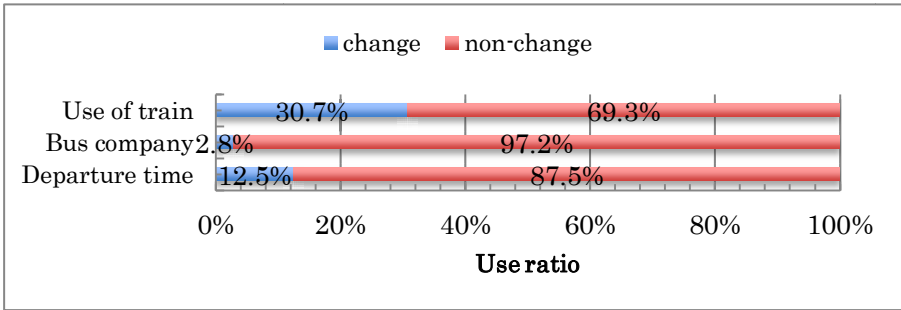


Fig. 4. The number of change conditions (PC)

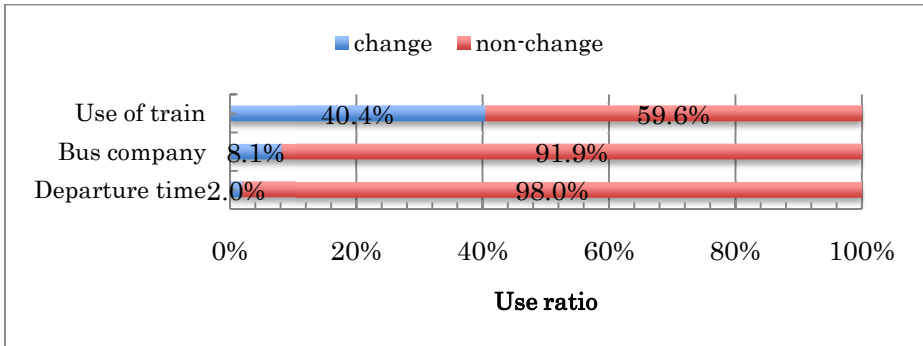


Fig. 5. The number of change conditions (Mobile Devices)

5.3 The Users of Mobile Device More Than PC

As a result, the person who uses mobile phones and smartphones is more than PC. In addition, it is resulted in a transition period from mobile phones to smartphones, appeared on the ratio of the number of each used.

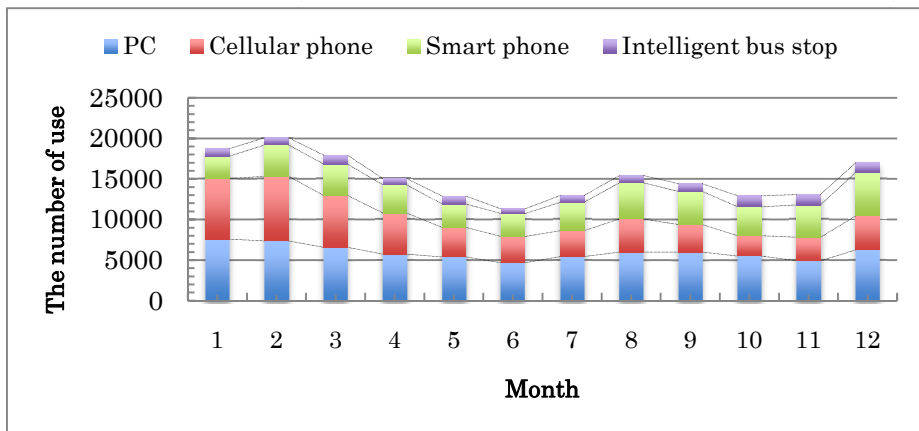


Fig. 6. The ratio of use each devices

6 Conclusion

We build the system for analysis the reality use of public transit guidance such as, “Bus-Net” for the purpose of feedback to the public transportation. In the future, we will validate the movement of user after “Route-Search” from the data of public transit user. Therefore, we investigate the relation between public transit and guidance service, the purpose of the analysis of the intention of the user movement more.

Acknowledgments. This research is supported by Strategic Information and Communications R&D Promotion Programme (SCOPE), Ministry of Internal Affairs and Communications, Japan.

References

1. Baus, J., Krüger, A., Wahlster, W.: A resource-adaptive mobile navigation system. In: Proc. Int. Conf. on Intelligent User Interfaces, San Francisco, pp. 15–22 (2002)
2. Google Maps, <http://maps.google.com/>
3. Deutsche Bahn, <http://www.bahn.de/>
4. Arikawa, M., Konomi, S., Onishi, K.: NAVITIME: Supporting Pedestrian Navigation in the Real World. *IEEE Pervasive Computing* 6(3), 21–29 (2007)
5. Bassoli, A., Brewer, J., Dourish, P., Martin, K., Mainwaring, S.: Mainwaring, Under-ground Aesthetics: Rethinking Urban Computing. *IEEE Pervasive Computing* 6(3) (2007)
6. Camacho, T., Foth, M., Rakotonirainy, A.: Pervasive technology and public transport: Opportunities beyond telematics. *IEEE Pervasive Computing* 12(1), 18–25 (2013)
7. Bus-Net, <http://www.ikisaki.jp/>
8. Kawamura, T., Kusugami, G., Sugahara, K.: Path planning system for bus network including walking transfer. *IPSJ Journal* 46(5), 1207–1210 (2005)
9. Kawamura, T., Sugahara, K.: Practical path planning system for bus network. *IPSJ Journal* 4(2), 780–790 (2007)
10. Apache Hadoop, <http://hadoop.apache.org/>

Urban Phenomenology: Incorporating Dynamic Frames of Reference in the Design of Urban OS

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Abstract. Urban operating systems must incorporate different frames of reference, ranging from the macro to the individual point of view of the end users, each dimension influencing the organizational structure and behavior of the system. In the attempt to create a holistic, interdisciplinary approach to the complex task of designing urban operating systems, this paper applies the philosophical basis of phenomenology, and its schools of thought, to explore a unified theory and approach of the design of cities as living organisms and real-time technological operating systems, integrating human, environmental and technological dimensions.

Keywords: Collective Intelligence, Systems Thinking, Urban Operating Systems, Information Architecture.

1 Introduction

Cities are multi-dimensional, complex organisms, operating on different scales and understood from different perspectives. The physical urban fabric and infrastructure is evolving, requiring constant upgrading to meet the demands of public use and environmental change. Parallel, digital systems are necessary to process urban behavioral data providing critical information to manage operations and achieve sustainable urban systems. Key to how contemporary cities function is the way people are able to interact physically and virtually from both within cities and from outside since cities, now more than ever, are influenced from global patterns and linked to people and information from around the world.

Today, advanced technologies have allowed new possibilities for us to design and optimize the urban operating system, interconnecting the various levels of the system architecture and the convergence of the physical and virtual realms of cities. The intention of this paper is to challenge information architects, urban planners and user experience designers to consider how it may be possible to design complex urban operating systems allowing a holistic multi-dimensional and interdisciplinary approach, interrelating different realms of urban experience in beautiful, functional, and sustainable design solutions. As the theoretical backdrop, I have introduced the underlining concepts of phenomenology, the branch of philosophy that attempts to describe phenomena and how we experience things, to better understand how different dynamic frames

of reference can be factored into the development of the urban operating systems (Urban OS) and the interconnected urban experiences that are both a contributing factor and result of the operating system.

2 Phenomenological Variations

Phenomenology has presented a range of theories that have advanced the Cartesian duality of mind and matter, exploring the complexity of understanding and describing experience from both the objective-empirical and individual-subjective point of view. This epistemological variation is reflected in contrasting investigations of Georg Wilhelm Friedrich Hegel and Edmund Husserl as early proponents of phenomenology. Hegel described what is represented through phenomena as the conscious experience related to the absolute objective understanding of things as a form of gestalt phenomenology. While Husserl explored what is represented as phenomena through consciousness and experienced from the subjective, individual point of view. Later, Maurice Merleau-Ponty defined phenomena as the experience of things unfolding via human intuition and a priori sensing, vis-à-vis the body in space.

Phenomenology has been co-opted for different reasons to describe reality and our perception of how things are experienced, spanning the natural, metaphysical and socio-cultural landscapes of reality. Gaston Bachelard, considered one of the fathers of postmodern thinking and Deconstructivism, challenged the empirical method in science by explaining phenomena through a unique linguistic fusion of scientific theory, mathematics, psychoanalysis and poetry. His works including *La Poétique de L'espace* (The Poetics of Space) inspired a generation of French philosophers and writers including Michel Foucault, Gilles Deleuze, Jacques Derrida, and Paul Virilio each of whom adapted phenomenology to articulate their own socio-cultural manifesto. Foucault argued that each period in history has possessed underlying conditions of truth that constituted what was acceptable as scientific discourse and that these conditions of discourse have changed over time, from one period to another.

The writings of German Philosopher Martin Heidegger, particularly *Being and Time*, have had a major impact on contemporary architectural theory and have influenced architects, planners and theorists including Christian Norberg-Schulz, *Genius Loci: Towards a Phenomenology of Architecture*, Christopher Alexander *A Pattern Language* and Kevin Lynch in *The Image of the City*. A common theme amongst their writings is the extension of phenomenology to the experience of place as the interchange between man, nature and the evolutionary patterns and symbolic form of man-made structures as a seamless, interwoven phenomena uncovered through the process of design.

The definition of phenomenology therefore has evolved from the absolute consciousness in Hegel's belief to the inclusion of the individual perception and subjectivity in Husserl's view, to an a priori embodiment in Merleau-Ponty's *Phenomenology of Perception*, to the Deconstruction of empirical understanding and phenomenology's influence on architecture and urban planning in describing a sense of place and

place-making. This evolution of phenomenological schools of thought has inspired the ideas presented in this paper applied to the understanding of urban phenomenology and a call to designers to incorporate the deeper philosophical framework for how we conceive, understand and describe urban phenomena in the design of urban OS.

3 Dynamic Frames of Reference

Operating systems of cities to-date have primarily been conceived and developed based on functional requirements. Therefore, the frame of reference of the system architecture has been objectified into the categories based on urban functions including security, transportation, energy, etc. From a formal standpoint these systems establish the modus operandi and determine the urban system’s spatial, organizational constructs and system behavior. As an example, civil and structural engineering follows this logic as the urban infrastructure is built based on the empirical understanding of measurable and scientific principles of urban planning, engineering and construction. In the concept of dynamic frames of reference and the phenomenological approach, urban systems are conceived and designed to incorporate a wider and more complex set of conditions, from multiple sources and points of view including the macro system to the individual user experience, and from the physical infrastructure of the city to virtual networks. The system, therefore, must be holistic, functioning via a combination of the orderly categorization of components in gestalt system architecture, allowing the individual nodes to act independently with their own logic, while harmoniously integrated within the larger operating framework.

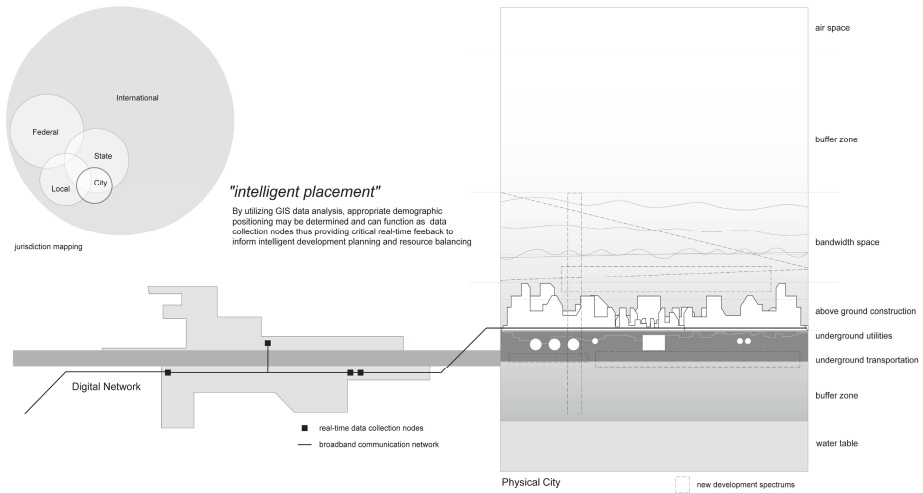


Fig. 1. Urban Spectrum – C. G. Kirwan, 2005

The city can be conceptualized as a metaphorical extension of the representation of the human body and brain¹. The living city has similar requirements to the human body and can be understood as an anatomy represented by the biological functions of the systems i.e., skeletal, circulation, and digestion. Humans have understood and represented systems (cosmic and others) from a human-centric or anthropomorphic view, from early investigations in the Italian Renaissance, notably by Leonardo da Vinci, where man was conceived as the center of the universe and embodied in the advancements from linear perspective to futuristic cybernetic amalgamations. In the 20th century, Norbert Wiener, in his book *The Human Use of Human Beings*, defined the language of the control of animals and machines in the research and definition of cybernetics. Based on a mechanical view of the functional apparatus of the human body, responding to environmental stimuli with the brain as the controller, Wiener extended the anthropomorphic to a cognitive system, introducing a cybernetic process that could be connected to external systems, giving rise to the early computer operating systems.

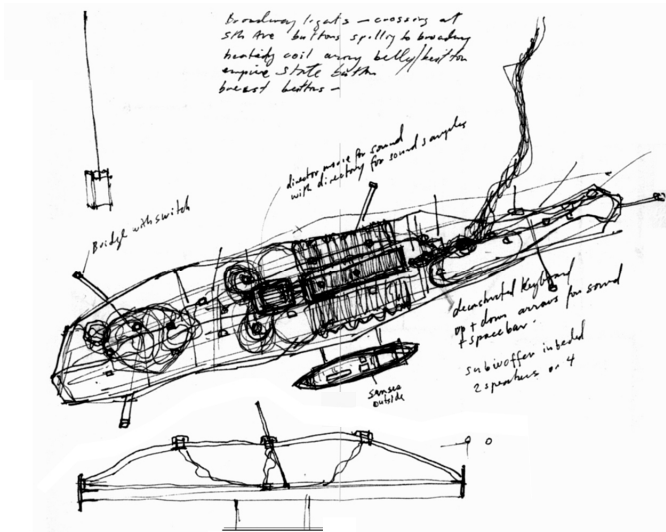


Fig. 2. Manhattan Anthropomorphic Interface – C. G. Kirwan, 1996

The real-time city is not unlike the brain-body relationship in the way that the city responds to empirical data and then adapts and executes actions based on the system logic. This cybernetic process has expanded the physical dimensions of the city to a vast virtual network in which a combination of data sources and public interaction provide real-time feedback, contributing to both the empirical and experiential phenomena of the living organism. The early developers of the ARPAnet understood,

¹ Miele, Paola, Jacques Houis, and Mark Stafford, eds. 2000. *Being Human: The Technological Extensions of the Body*. City: Marsilio Publishers.

centralized, corporeal based systems can be easily attacked and corrupted hence the advancements of decentralized systems that let to the Internet as a vast interconnected web and decentralized form. The comparison of how the physical city has evolved from early requirements of security and transportation and the virtual city has emerged from similar criteria, both represent metaphors of the city as an operating system yet are realized in completely different formal and experiential constructs. Urban OS have the potential to follow a linear-empirical model or a decentralized-rhizomatic model. The greatest challenge in the design of systems is this juxtaposition of the physical and virtual form and behaviors. Are they compatible? Do they represent the same thing? Does one control or supersede the other?

Today's trend in many professional fields is moving towards an integrated approach. This is especially useful in the development of urban operating systems since the system is now being understood from the combination of the system view and the individual users view. The convergence requires a dynamic frame of reference that must factor in the complexities of the city as a living organism that is simultaneously centralized and decentralized, static and dynamic, and responsive to changing patterns of social and environmental behaviors, each with different evolutionary tempos. The ability to shift frames of reference and to incorporate different methods of analyzing and describing the city and urban systems is a challenge since each professional field or area of research has its own logic and point of reference to understanding the operating system and layers of the city. Truly interdisciplinary practice is actually very difficult to achieve due to the objectives and motivators of each discipline. However, the field of architecture has been a good example as a profession that integrates engineering with design and aesthetics. In a similar way, information architects in designing urban operating systems architecture, must factor in a range of disciplines and methodologies from urban planning to user experience design, to address system-wide functions as well as user-centric applications.



Fig. 3. Urban Media Dubai – C. G. Kirwan, 2009

Urban OS incorporate the social (cultural), physical (environmental) and (technological) dimensions of the city as a form of collective intelligence; a system capable of addressing the extensive challenges required to manage and operate a city. In order to achieve this, operating systems must process massive real-time streams of human and environmental behavioral data. As a component of urban OS, urban interface is a layer of the operating system that is combination of data collection and data visualization, both capturing and monitoring data at the same time generating information that can be reprocessed into useful information and distributed to appropriate audiences

and applications². Infostructure, a term I have introduced in 2009, is an example of this concept of urban interface in which public infrastructure: bridges, tunnels and highways are data mined for relevant and critical data to monitor and manage the infrastructure itself. At the same time, this data can be converted or recycled into useful and engaging information that can support the various users of the infrastructure whether operators or end users, allowing interaction to occur at different levels and serving different users requirements.

As citizens (netizens) become more and more active in the evolution of the virtual city, the internet and social media is shaping new urban frames of reference. In the paper *Crowdsensing in the Web: Analyzing the Citizen Experience in the Urban Space*, the authors elaborate on emerging social media frames of the city in which the city has begun to construct a virtual representation of itself with consequential reactions that in turn influence the evolution of the physical city³. Here lies the conceptual and phenomenological potential as dynamic frames of reference of the spatial, linear, physical city converge with the non-linear, rhizomatic, virtual city, combined to create a new hybrid urban reality.

Are there cities that are better at the convergence of the physical and virtual city? Is Seoul, for example, a good example of an integrated city since the city is both the center of the technology industry and at the same time a homogenous culture that has easily adapted to new media not to mention being the center of Smart City research & development? Or is São Paulo better at this convergence, as the city is rapidly emerging as a leading world economy with a growing and diverse population, sprawling urban developments, and with the upcoming FIFA World Cup driving advancements in media, technology and the promotion of the city as a leading destination. In fact, both cities offer different experiential opportunities, for the fusion of the physical and virtual, that uniquely combine dynamic frames of reference of spatial organization, physical architecture, virtual networks and urban media shaping the urban OS and phenomenological experience of the city.

4 Cities as Interdisciplinary Platforms – Design as Catalyst

Design plays a key role in establishing an open source, iterative process that allows for ideas and collaboration to stimulate interdisciplinary solutions that can simultaneously incorporate both macro systemic points of view and micro descriptions within the same framework. This is due to the organic nature of the design process. Unlike many other disciplines, design is able to adapt itself to each scale and context and to form a language inherently connected or drawn from that unique combination of

² Foth, Marcus, Laura Forlano, Christine Satchell and Martin Gibb. 2012, *From Social Butterfly to Engaged Citizen: Urban Informatics, Social Media, Ubiquitous Computing, and Mobile Technology to Support Citizen Engagement*, Chapter 13 *Urban Media: New Complexities, New Possibilities—A Manifesto*, Cambridge, MA: MIT Press.

³ Foth, Marcus, Laura Forlano, Christine Satchell and Martin Gibb. 2012, *From Social Butterfly to Engaged Citizen: Urban Informatics, Social Media, Ubiquitous Computing, and Mobile Technology to Support Citizen Engagement*, Chapter 19 *Crowdsensing in the Web: Analyzing the Citizen Experience in the Urban Space*, Cambridge, MA: MIT Press.

factors. Likewise, System Thinking⁴ is an open-ended approach that the design process can utilize effectively as a methodology to conceptualize relationships and propose comprehensive solutions to complex urban problems. The design of cities and urban operating systems require this comprehensive, open-ended, integrated planning and design methodology that draws from strategies and expertise across different disciplines including urban planning, sustainable design, ecology, sociology & behavioral sciences, computer programming, media and interactive design.

Today, the expanded role of design and the emergence of social media and public interaction are having a profound effect on how cities are understood and planned. Social media has become an important real-time tool for citizens to be engaged and new urban behavioral patterns and lifestyles are forming as a result of urban populations connecting and sharing information via new affordable mobile technologies. The role of interdisciplinary planning and design, incorporating dynamic frames of reference, linking macro system-wide frameworks with the individual subjective user experiences and the physical city with the virtual, is now more possible by the advancements in new media technologies where potential seamless transitions can be delivered through new urban interface applications that combine mapping, streaming data, contextual content, augmented reality, and smart environments delivered via ubiquitous and artificial intelligence systems. Therefore the role of design and the application of a phenomenological approach can function as the bridge between empirical understanding and individual perception, macro-micro scales, and physical virtual dimensions in the design of the urban operating systems.

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References

1. Miele, P., Houis, J., Stafford, M. (eds.): *Being Human: The Technological Extensions of the Body*. Marsilio Publishers, City (2000)
2. Foth, M., Forlano, L., Satchell, C., Gibb, M.: *From Social Butterfly to Engaged Citizen*. In: *Urban Informatics, Social Media, Ubiquitous Computing, and Mobile Technology to Support Citizen Engagement*. In: *Urban Media: New Complexities, New Possibilities—A Manifesto*, ch. 13. MIT Press, Cambridge (2012)
3. Foth, M., Forlano, L., Satchell, C., Gibb, M.: *From Social Butterfly to Engaged Citizen*. In: *Urban Informatics, Social Media, Ubiquitous Computing, and Mobile Technology to Support Citizen Engagement*. In: *Crowdsensing in the Web: Analyzing the Citizen Experience in the Urban Space*, ch. 19. MIT Press, Cambridge (2012)
4. Flood, R.L., Carson, E.R.: *Dealing with Complexity: An Introduction to the Theory and Application of Systems Science*. Springer (1993)

⁴ Flood, Robert L. and Ewart R. Carson, 1993. *Dealing with Complexity: An Introduction to the Theory and Application of Systems Science*. Springer.

Mixed Factorial Analysis of In-Vehicle Information Systems: Age, Driving Behavior, and Task Performance

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Abstract. This study conducted a driving simulation experiment using an aural, visual, or multi-modality in-vehicle information system (IVIS) to investigate the performance and emergency response of 24 younger (age: $M = 23.10$ years, $SD = 1.54$) and 24 older (age: $M = 69.21$ years, $SD = 3.05$) drivers in simple and complex road conditions. All drivers assisted by aural or multi-modality IVIS made significantly fewer errors in response to hazard warnings than those who were assisted by the visual modality system. Specifically, drivers exhibited improved performance for response time and the total number of correct turns in complex driving conditions when using multi- or aural modality IVIS; this effect is particularly salient for older drivers. The IVIS improved the safety of older drivers more than that of their younger counterparts, despite their poor vehicle control and slow response time in hazard situations.

Keywords: in-vehicle information system, age, driving simulator, driving performance, display.

1 Introduction

The number of older drivers in society has increased in conjunction with the aging population, particularly in developed countries. Previous research has shown that 20% of the population in most developed countries is older than 60 years, and that one third of the global population will be older than 60 years by 2050 [1]. In 2009, 2.45 million people (10.7% of the population) in Taiwan were older than 65 years [2], and the population of older adults will continue to increase. The United States Census Bureau forecasted that 12.3% of Taiwan's population will be older than 65 years by 2015. Furthermore, the 65+ age group in Taiwan is the fastest growing group [3]. Previous studies have recommended that the forecasted increase in the number of older drivers over the next 20 y should be addressed by designing in-vehicle human-machine interfaces [4].

Previous studies have shown that aging causes a decline in cognitive function; consequently, the operating of vehicles becomes difficult [5-7]. Furthermore, several studies have shown that older drivers are frequently involved in accidents when exposed to difficult driving conditions [8-10]. The decline in visual field in older drivers

was the most frequent cause of traffic accidents, especially at intersections [11]. Other causes include reduced brake reaction time [8], difficulty making left-hand turns [12], and poor concentration [13-14]. The older drivers experienced difficulty driving and navigating simultaneously, and made more safety-related errors than younger drivers [15]. However, they also showed that a well-designed in-vehicle information system (IVIS) significantly improved the driving performance of older adults. Liu [16-17] reported that performance and task reaction in older drivers were worse than in younger drivers. Furthermore, traffic accidents involving older drivers were more likely to cause injury or fatality.

Visual navigation systems are a commonly used type of IVIS. Furthermore, these systems affect the concentration of drivers [18], and the drivers preferred visual navigation systems that can inform them of their current location [19]. Drivers using visual displays reduced their average glance time on the central road when using a visual display [15]. The drivers with reduced average glance time experienced a reduction in driving control performance [20], and depend on visual modality IVISs for driving-related information might experience visual overload, and compensate by driving slower and more carefully [21]. However, using visual modality displays resulted in more navigation errors than using aural modality systems [22]. Hurwitz and Wheatley [23] employed secondary tasks to compare the effect of visual and aural modality IVISs on driving performance. Their results showed visual modality IVISs caused a greater reduction in driving performance (i.e., steering wheel movement and variation of lateral speed). Aural modality IVISs are potentially superior to visual modality IVISs for presenting navigation and warning information. The audio warnings were effective in improving driver reaction times [24-25]. According to multi-resource theory, aural modality systems could improve the time-share performance in cluttered visual modality environments [26]. Therefore, multi-modal (visual and aural) IVISs could allow drivers to process additional information without increasing their sensory workload.

The current designs of in-vehicle displays are unsuitable for older drivers [27]. Advancements in system or display technologies (i.e., navigation system and IVIS) and changes in population distribution (i.e., aging population) further complicate traffic safety issues. Previous research has shown that a user-centered design of automotive human-machine interfaces such as navigation systems is crucial in addressing the increasing number of older drivers [4]. Thus, these issues require prompt investigation.

2 Methods

2.1 Participants

Twenty-four older adults (20 men, 4 women; age: $M = 69.21$ years, $SD = 3.05$) and 24 students (12 men, 12 women; age: $M = 23.10$ years, $SD = 1.54$) were recruited as the older and younger driver groups in this study. All participants met the following requirements to qualify for this study: 1) have held a valid driver's license for at least 1 year; 2) have driven at least 5000 km per year; 3) have achieved a minimum visual

acuity test score of 0.5 or 0.8 for the older or younger groups, respectively; 4) have passed the Ishihara color blindness test; and 5) have no hearing impairments. Participants were compensated with US\$30.

2.2 Apparatus

This study employed the interactive STI® high-fidelity driving simulator developed by Systems Technology Inc. (Hawthorne, CA, USA). The simulated vehicle (VOLVO 340 DL) was fitted with standard automotive displays and controls (i.e., steering wheel, brakes, and an accelerator) and an automatic transmission system. Driving scenarios were projected onto a 100 in aluminum concave Mocom Power Screen® (width = 200 cm, height = 150 cm, curvature = 900 cm, brightness = 20 gains) situated 3.1 m in front of the driver. The simulation audio was broadcast using stereo amplifiers in vehicle cab.

Driving-related information such as vehicle speed and task instructions were projected onto an approximate 15 in heads-up display (HUD, width = 32 cm, height = 22 cm, resolution = 700 × 600 dpi, icon size = 10 x 10 cm² ~1.8 degrees) situated 2.9 m directly in front of the driver. The vertical projection angle was maintained between 6° and 12° below the driver's horizontal line of vision. Audio information or warnings were generated using the simulation software and a trained female assistant speaking at approximately 150 words per minute. The multi-modal IVIS provided audio and visual information.

2.3 Experimental Design

The following three factors were involved in this mixed-factorial experiment: age (younger versus older groups; inter-participants), driving load (high versus low; individual participants), and IVIS modality (aural-, visual-, and multi-modality; inter-participant). Variables were assigned randomly to participants, but were counterbalanced to prevent any pattern learning or order effect. Dependent variables based on objective and subjective measures are detailed in the following section.

The simulated driving environment scenarios were developed using STI scenario definition language version 8.0 and categorized as low and high load conditions. The driving load condition was manipulated using the factors discussed by Liu and Wen [28]. The high (low) driving load environment was configured as follows: lane width = 3.6 m (4.1 m); speed limit = 90 km/h (60 km/h); number of intersections = 120 (40); and density of roadside buildings = 20 buildings/min (2 buildings/2 min). Each scenario required approximately 20 min to complete.

2.4 Tasks

Driving Task. All participants were instructed to complete the simulated driving course while adhering to all traffic rules and driving safely.

Navigation Task. Navigation task-related information was displayed on the HUD. The visual display interface shown in Fig. 1 was designed and employed according to the layout proposed by Liu and Wen (2004). Audio navigation information was used to ensure that participants received the messages clearly (volume loudness = approximately 75 dB). Participants were requested to follow the system's route guidance information. Because the simulator could not simulate actual turning, participants were instructed to say the name of the road and the direction in which they wanted to turn, and to turn on the left- or right-turning signal as if they were about to turn. Each driving scenario included 20 turns.

Emergency Response Task. The system periodically (approximately 2 min) issued a road danger warning (e.g., road construction or watch for pedestrians) and vehicle monitoring information (e.g., insufficient tire pressure and engine temperature too high). This information was presented for approximately 3 s before disappearing. The participants were instructed to verbally inform the experimenter which type of danger (i.e., road or vehicle) they considered. Each driving scenario included eight warnings (four of each danger type).

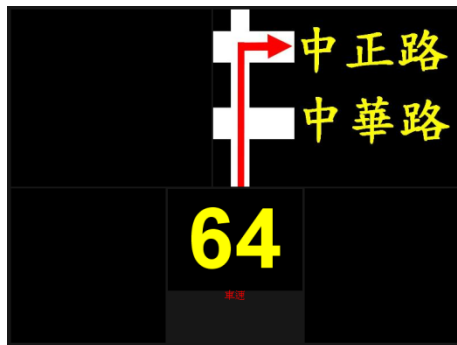


Fig. 1. Example of navigation information on the visual display. Speedometer (64 km/h) and navigation information were displayed. Descriptions of navigation information contained street name before the turn, name of street to turn into, and turning direction (e.g., right-hand turn).

2.5 Procedure

Prior to the experiment, all participants were prescreened to ensure they met the discussed requirements to qualify for this study. The purpose of the experiment was subsequently explained to each participant. After signing an informed consent form, the participants were provided approximately 10 min of driving practice in the simulator to become familiar with the simulator controls and the IVIS modalities. The experiment was conducted following the practice process. During the experiment, participants were allowed a 5-min break between driving loads. All experiments took approximately 60 min.

2.6 Data Collection and Analysis

The dependent measures for assessing the impact of age and IVIS modality display on driving behavior and performance are detailed as follows: 1) driving behaviors (variation in lateral speed, ft/s; mean and variation of longitudinal speed, ft/s); and 2) accuracy when performing specific navigation and emergency response tasks.

Analysis of variance (ANOVA) was performed on the obtained data using SPSS version 19.0, and post hoc analyses were conducting using the Tukey method. The level of significance for all analyses was $\alpha < .05$.

3 Results

3.1 Navigation and Emergency Response Performances

Results show that driving load [$F(1,42) = 14.141, p = .001$], age [$F(1,42) = 16.915, p = .000$], and visual modality [$F(2,42) = 24.549, p = .000$] have a significant effect on navigation and emergency response performance. Two interactions of modality type \times driving load [$F(2,42) = 5.551, p = .007$] and modality type \times age ($F(2,42) = 7.853, p = .001$) also have a significant effect on navigation accuracy and emergency response tasks. Post hoc analyses show that the drivers had lower task accuracy in high driving load conditions (96.875%) than in low conditions (98.363%); furthermore, older drivers (96.057%) had worse performance than younger drivers (99.182%). The visual modality IVIS also achieved the lowest task accuracy (93.862%) and had a significant difference between aural and multi-modality IVISs. The difference in rating between the aural (99.330%) and multi-modality (99.665%) IVIS is non-significant.

Within the younger driver group, the differences in performance for navigation and emergency response task performance between high and low load conditions were non-significant [$F(1,21) = 3.723, p = .067$]. However, there is a significant difference among visual, aural, and multi-modality IVISs [$F(2,21) = 18.021, p = .000$]. Post hoc analyses show that the worst performance of navigation and emergency response tasks occurred using the visual-modality IVIS (97.545%), whereas performances using aural and multi-modality IVISs achieved perfect scores. Among the older driver group, there is a significant difference between high and low driving load conditions [$F(1,21) = 10.43, p = .004$]. These drivers had lower task accuracy in high driving load conditions (94.940%) than in low load conditions (97.173%). Visual modality IVIS (90.179%) resulted in significantly lower task accuracy than when identical data presented using the aural (98.661%) or multi-modality (99.330%) ISIVs [$F(2,21) = 16.060, p = .000$].

3.2 Driving Performance: Mean Speed

Because the participants were instructed to adhere to the speed limit to complete the high and low driving load condition experiments, this analysis is discussed separately by dividing the data into two conditions. The low load condition results show that the impact of age [$F(1,42) = 0.786, p = .380$] and IVIS modality type [$F(2,42) = 0.921,$

$p = .406$] on mean speed is non-significant. Furthermore, two interactions of display modality \times age show no significant effect on mean speed.

The high driving load condition results show that the impact of age on mean speed is non-significant [$F(1,42) = 0.194$, $p = .662$], whereas the effect of modality type on mean speed is significant [$F(2,42) = 16.109$, $p = .000$]. Two interactions of display modality \times age had a significant effect on mean speed [$F(1,42) = 6.084$, $p = .005$]. Further analyses shows no significant difference for the mean speed of younger drivers [$F(2,21) = 2.466$, $p = .109$] among the three discussed IVIS modalities; however, the difference in mean speed among older drivers is significant [$F(2,21) = 13.904$, $p = .000$]. The visual modality IVIS has the lowest mean speed (78.947 ft/s); furthermore, the difference in mean speed between aural (82.458 ft/s) and multi-modality (82.028 ft/s) IVISs is non-significant.

3.3 Driving Performance: Variation in Lateral Speed

The results show that driving load [$F(1,42) = 16.972$, $p = .000$], age [$F(1,42) = 10.793$, $p = .002$], and modality type [$F(2,42) = 4.672$, $p = .015$] have a significant impact on variation in lateral speed. Performance of lateral speed variation for low load conditions (0.545 ft/s) was better than for high load conditions (0.976 ft/s); furthermore, variation in lateral speed was greater for older drivers (1.201 ft/s) than for

Table 1. Effects of age, driving load, modality type on driving performance

Performance measures	Variables		<i>p</i> -value
	Age		
	Younger	Older	
Accuracy of navigation and emergency response (%)	99.182	96.057	.000
Variance in lateral speed (ft/sec)	0.433	0.515	.002
	Driving load		
	Low load	High load	
Accuracy of navigation and emergency response (%)	98.363	96.875	.001
Variance in lateral speed (m/sec)	0.320	0.629	.000
	Modality type		
	Visual	Aural	Multi-modality
Accuracy of navigation and emergency response (%)	93.862A ^a	99.330B	99.665B
Variance in lateral speed (m/sec)	1.339A	0.443B	0.500B

^aValues with the same letter are not significantly different.

younger drivers (0.320 ft/s). In addition, the use of the visual modality IVIS resulted in the greatest variation in lateral speed (1.339 ft/s); furthermore, the difference in lateral speed variation between the aural (0.500 ft/s) and multi-modality IVISs (0.443 ft/s) is non-significant. Two interactions of driving load \times age show a significant effect on variation in lateral speed.

The variation in lateral speed for the younger driver group under low driving load conditions (0.413 ft/s) and in high load conditions (0.227 ft/s) is significant [$F(1,21) = 16.389$, $p = .001$]. Participants using the visual modality IVIS show the greatest variance in lateral speed (0.444 ft/s), whereas the difference between aural (0.291 ft/s) and multi-modality (0.226 ft/s) IVISs is significant [$F(2,21) = 3.587$, $p = .046$].

The variation in lateral speed results is similar to that of the older driver group. There is a significant difference between high (1.538 ft/s) and low (.864 ft/s) driving load conditions. Experiments with the visual modality IVIS (2.234 ft/s) produced significantly higher variances in lateral speed than experiments using identical data on the aural (0.709 ft/s) and multi-modality (0.659 ft/s) TVISs [$F(2,21) = 3.78$, $p = .040$].

4 Discussion

The analyzed results in this study show that age has an effect on behavior while driving (Table 1); furthermore, an inverse relationship between driver age and driving performance was observed. Extant research has indicated that driving-related information from IVISs might cause difficulties for older drivers [4], [15-17], [27]. This study provides additional evidence that supports the assertion that older adults experience greater difficulty than their younger counterparts in processing driving-related information by IVIS, especially in high driving load conditions. This result indicates that IVIS user interfaces should be designed in ways that do not increase the workload of older drivers; furthermore, all information should be presented as simply as possible. Consequently, the older adult demographic warrants particular attention in IVIS design because the number of older drivers continues to increase.

All drivers' aural or multi-modality IVIS made significantly fewer errors in responding to hazard warnings than those of using only the visual modality IVIS. Specifically, driving performance, response time, and response accuracy were better in high load driving conditions when drivers used aural and multi-modality IVISs. This effect is particularly salient for older drivers. The experimental results are consistent with those of previous studies that stated that using only visual modality IVISs might cause distraction, visual overload, increased reaction time, and reduced glance time on the central road and driving controls [15],[18],[20-25].

This study supports the assertions made by [21], [29] that drivers who are highly dependent on visual modality IVISs for driving-related information might experience visual overload; consequently, they tend to compensate by driving slower and more carefully. Although IVIS modality type had no significant impact on mean speed in low driving load conditions, the opposite was true in high driving load conditions. Both age groups performed better when using the multi-modality IVIS; this finding was especially noticeable for older drivers. For older drivers, using the visual

modality IVIS resulted in the slowest mean speed; furthermore, the use of aural and multi-modality IVISs significantly decreased mean speed.

In summary, this study shows that using IVISs while driving causes few negative effects in the older driver group, especially in high driving load conditions. Aural and multi-modality IVISs are suitable for providing warning information because they promote quick driver responses and enhance the information processing capabilities of older drivers. In this study, although drivers using the visual modality IVIS performed poorly in the majority of tasks, older drivers, to some extent, might benefit from IVISs similar to younger drivers.

References

1. United Nations Population Division, World population aging 2009. United Nations, New York (2009)
2. Statistical Yearbook of Interior, Taiwan. The Ministry of Interior (2010), <http://sowf.moi.gov.tw/stat/year/y02-01.xls> (retrieved September 20, 2010)
3. U.S. Census Bureau, international data base, Taiwan (2010), http://www.census.gov/ipc/www/idb/excel_output.php? (retrieved September 21, 2010)
4. Pausie, A.: Ageing Population and Ergonomics of Innovative Communicating Technologies in Driving. *Recherche Transports Sécurité* 81, 203–212 (2003)
5. Kosnick, W., Sekuler, R., Kline, D.: Self-Reported Visual Problems of Older Drivers. *Hum. Factors* 32(5), 597–608 (1990)
6. Emery, C.F., Huppert, F.A., Schein, R.L.: Relationships among Age, Exercise, Health, and Cognitives Function in a British Sample. *Gerontologist* 35, 378–385 (1995)
7. Spirduso, W.W., Francis, K.L., MacRae, P.G.: *Physical Dimensions of Aging*, 2nd edn. Human Kinetics, Champaign (2005)
8. Van-Wolffelaar, P.C., Rothengatter, T., Brouwer, W.: Elderly Drivers' Traffic Merging Decisions. In: Gale, A.G., et al. (eds.) *Vision in Vehicles-III*, pp. 247–255. Elsevier, North-Holland (1991)
9. Marmeleira, J., Godinho, M., Vogelaere, P.: The Potential Role of Physical Activity on Driving Performance and Safety among Older Adults. *Eur. Rev. Aging Phys. A* 6, 29–38 (2009)
10. Lyman, J.M., McGwin Jr., G., Sims, R.V.: Factors Related to Driving Difficulty and Habits in Older Drivers. *Accident Anal. Prev.* 33, 413–421 (2001)
11. Owsley, C., Sloane, M.E., Ball, K., Roenker, D.L., Bruni, J.R.: Visual/cognitive Correlates of Vehicle Accidents in Older Drivers. *Psychol. Aging* 6(3), 403–415 (1991)
12. McGwin Jr., G., Chapman, V., Owsley, C.: Visual Risk Factors for Driving Difficulty among Older Drivers. *Accident Anal. Prev.* 32(6), 735–744 (2000)
13. Lin, D.Y.M., Liu, Y.R.: In-vehicle Navigation Interfaces for Elderly Drivers: Effects of Map Orientation and Hierarchy. *Research in Applied Psychology* 22, 67–86 (2004) (in Chinese)
14. Lin, D.Y.M.: Evaluating Older Adults' Retention in Hypertext Perusal: Effects of Presentation Media as a Function of Text Topology. *Comput. Hum. Behav.* 20(4), 491–503 (2004)

15. Dingus, T.Q., Hulse, M.C., Mollenhauer, M.A., Fleischman, R.N., McGehee, D.V., Manakkal, N.: Effects of Age, System Experience, and Navigation Technique on Driving with an Advanced Traveler Information System. *Hum. Factors* 39(2), 177–199 (1997)
16. Liu, Y.C.: Effect of Advanced Traveler Information System Displays on Younger and Older Drivers' Performance. *Display* 21, 161–168 (2000)
17. Liu, Y.C.: Comparative Study of Effects of Auditory, Visual and Multimodality Displays on Drivers' Performance in Advanced Traveller Information Systems. *Ergonomics* 44(4), 425–442 (2001)
18. Regan, M.A., Oxley, J.A., Godley, S.T., Tingvall, C.: Intelligent Transport System: Safety and Human Factors Issues. Report No. 01/01. Report prepared by the Monash University Accident Research Centre for the Royal Automobile Club of Victoria (RACV), Australia (2001)
19. Streeter, L.A., Vitello, D., Wonsiewicz, S.A.: How to Tell People Where to Go: Comparing Navigational Aids. *Int. J. Man Mach. Stud.* 22, 549–562 (1985)
20. Zwahlen, H.T., Adams, C.C., DeBald, D.P.: Safety Aspects of CRT Touch Panel Controls in Automobiles. Gale, A.G., et al. (eds.) Paper presented at the Second International Conference on Vision in Vehicles, North-Holland, Amsterdam, New York, Oxford, Tokyo, September 14–17. *Vision in Vehicles II*, pp. 335–344, University of Nottingham, England (1987)
21. Waller, P.F.: The Older Drivers. *Hum. Factors* 33, 499–505 (1991)
22. Labiale, G.: In-car Road Information: Comparisons of Auditory and Visual Presentations. In: *Proceedings of the Human Factors Society 34th Annual Meeting*, pp. 623–627. Human Factors Society, Santa Monica (1990)
23. Hurwizt, J.B., Wheatley, D.J.: Using Driver Performance Measures to Estimate Workload. In: *Proceedings of the Human Factors and Ergonomics Society 46th Annual Meeting*, Pittsburgh, PA (2002)
24. Suetomi, T., Niibe, T.: A Human Interface Design of Multiple Collision Warning System. In: *9th World Congress on Intelligent Transport Systems*. CD-ROM, Chicago (2001)
25. Chen, W.H., Lin, C.Y., Dong, J.L.: Effect of Interface Workload of In-Vehicle Information Systems on Driving Safety. *Transp. Res. Record* 1937, 73–78 (2005)
26. Wickens, C.D., Sandry, D., Vidulich, M.: Compatibility and Resource Competition between Modalities of Input, Central Processing, and Output, *Human Factors* 25, 227–248 (1983)
27. Mourant, R.R., Tsai, F.J., Al-Shihabi, T., Jaeger, B.K.: Measuring Divided-Attention Capability of Young and Older Drivers. In: *Traffic Safety 2001: Americans with Disabilities Act; Driver and Vehicle Modeling; Situation Awareness; Licensing; Driver Behavior; Enforcement; Trucks; and Motorcycles* by the Transportation Research Board, National Research Council, Transportation Research Record No.1779, pp. 40–45. National Academy Press, Washington, D.C (2001)
28. Liu, Y.C., Wen, M.H.: Comparison of Head-up Display (HUD) vs. Head-down Display (HDD): Driving Performance of Commercial Vehicle Operators in Taiwan. *Int. J. Hum.-Comput. St.* 61(5), 679–697 (2004)
29. Schlag, B.: Elderly Drivers in Germany: Fitness and Driving Behaviour. *Accident Anal. Prev.* 25, 47–55 (1993)

The Innovative PSS Design of Urban Transportation Based on Sharing Style

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Abstract. The ever-degrading traffic situation has become one of the major factors that check the sustainable development of cities, as well as threaten people's well-beings. Thus, proceeding from the concept of Sustainable PSS, the design of sharing transport system aims at pursuing a holistic measure to ease the traffic tension and create a new fashion of urban commuting. The design was inspired by 'car-pooling' and fuse public transit with the private one, involving the design of the exterior, the interior, the Internet platform, etc. Harboring the idea of 'Social Innovation', our group creates a new urban transit service system by combining the folk wisdom with professional originality and maximizing the current transportation resources.

Keywords: Product Service System, PSS, Sustainability, Transportation Design, Urban Transportation, Sharing Style, Social Innovation.

1 Introduction

'Better City, Better Live', the theme of Shanghai Expo, 2010, echoes the wishes that has long cherished by the urban residents. According to the 'World Census Report' of UNFPA, the current world's population is drawing close to 7 billion, half of which dwell in the urban area, 35 years later, the percentage will rise to 2/3. The urban livability, though widely deemed as the symbol of modern civilization and a highly condensation of intelligence and inventiveness of human, has been losing its glamor of 'the good old days' with the emergence of the various problems that come with the city's development, especially the transportation impasse.

Being the major component of the modern transit system, the vehicle is the basic guarantee of the urban functioning, such as daily commuting, cargo transportation, business operation, etc. The private vehicle, besides boasting the above-said strength, satisfies people's psychological demand of pursuing high speed, freedom, style and the development of individuality to the utmost. However, with the skyrocketing rise of the automobile ownership in the limited urban space¹, the negative aspect has come

¹ The U.S. prestigious journal of auto industry, *Wardsauto*, reported that, according to the number of vehicle registration and vehicle population historical records released by the governments of all countries and regions, the total number of vehicles around the world exceeded 1 billion by August 16th 2011.

under the spotlight. The automobile ownership in China is 104 million, accounting for 10 % of the world's, making China the second largest automobile ownership country only to America, which has 240 million in 2010². And according to William J Mitchell, 2010, with the annual marketing increase ratio maintaining at 3%, China is expected to surpass America in 2030. The corollary of the above-said phenomenon is the inevitable dispute between the increase of automobiles and the limited resources as well as enumerable problems, such as the lasting increase of the consumption of fossil fuels³, the serious pollution, the exacerbated green-house effect⁴, the economic lost caused by traffic congestion⁵, the casualties brought by traffic accident, the debates of the equality of transportation and the according social issues, the unreasonable usage of automobiles, the flamboyant consumption and lifestyle, etc., which pose the vital menace to the city's sustainable development, as well as people's living standard and well-being.

The transit system is the subordinate of the city system, and the improvement of a certain system not just calls for the change of a single party, but the adjustment and the reconstruction as a whole, therefore speaking, to truly solve the traffic problem, we have to combine the design of automobile, the improvement of manufacture techniques as well as the application of the eco-friendly products with the re-plan and re-design of the commuting mode of people as well as the profit modes of the automobile manufacturers, and the intervening of the latter counts more because of the fact that the contribution made by the improvement of the techniques are largely offset by the greater product consumption. For instance, the environmental gain archived through the improvement of car efficiency in the last 15 years (10%) has been more than offset by the increase in the number of cars and by the consequent increase (30%) in the overall number of km covered [European Environmental Agency (EEA), 2008]. Thus speaking, PSS, aiming at deducing the material consumption, improving the ecological interest of the system in a carpeting manner while paying due consideration to the business profits, indicates a brand-new orientation for our design of the transit system.

Based on a long-term research plan and proceeding from sustainable PSS, this project aims at seek the solution of the future transport problems. The design of the Sharing-Move system, which gets inspiration from the 'Car-pooling' activities, counts the most in this project. Harboring the idea of 'social innovation', our group combines

² Data was provided by Traffic Administration of the Ministry of Public Security in November 2012.

³ Currently, the Fuel engine vehicle is taking the dominant position. Around the world, 18 million barrels of oil are consumed by cars every day. China has long way to go to realize the large scale application of clean energy driven cars.

⁴ Annual carbon emissions by vehicles around the world reach 2.7 billion tons, which greatly increases the greenhouse effect. A research in Beijing shows that, the contribution of motor vehicle exhaust emission to the PM2.5 in ambient air has reached 38%, which is listed in the first place among various pollution sources.

⁵ "Annual Report of Beijing Traffic Development in 2011," shows that, the annual economic losses caused by traffic jam in Beijing exceeded 105.59 billion Yuan, equivalent to 7.5% of the GDP of the city.

the folk wisdom with professional originality and makes the most use of the current transit resources to create a new transit service system.

2 PSS Innovation and Transportation Design

PSS (Product Service System) can be interpreted as ‘the result of an innovative strategy that shifts the center of business from the design and sale of (physical) products alone, to the offer of product and service systems that are together able to satisfy a particular demand’ (UNEP, 2002). In other words, a PSS innovation focuses on offering satisfaction rather than selling products and it can be described as an integrated mix of products and services, delivered by one or more socio-economical actors and capable to fulfill a given demand of satisfaction (Ceschin and Vezzoli, 2010). Just as what the consumers need is clean clothes, rather than cleaning machine, what the urban transit system needs is convenient and fast commuting mode, rather than cars, in fact, provided a proper way, PSS can not only reduce the consumption of resource efficaciously and lessen the cost of the enterprise, but also achieve new growth point of profit, which can better answer the consumers' demand. Apparently, the strategy can facilitate the transition of the enterprise to a new profit model and reach the goal of multi-winning (including enterprise performance, environmental protection, consumers' interest as well as social welfare) by solving various kinds of problems (including traffic one) we confronted during the process of city developing effectively.

PSS can be simply classified in to the following 3 categories:

- *Product-oriented services*: It can guarantee the consummate functioning of the product during its life circle and achieve additional benefits, such as after-sale service, which may include maintenance, parts exchange, upgrading, replacement, recycling, etc. To put in other words, the product, which is perfected by the service, still remain to be core.
- *Result-oriented services*: It can provide the customers with terminal service, such as effective transit, heating and power supply, etc. In this way, with the service being the core, consumers don't bother purchasing, maintaining, even operating by themselves before enjoying the best service.
- *Use-oriented services*: It provides customers with a platform on which product, instrument, opportunity, even qualification are available to satisfy people's demand. Car renting is a perfect example, by amalgamating product with service proficiently, the customers can use the product without owning it, and they just need to pay the rental fee according to the agreement.

In fact, the implementation or the planning of trial of the PSS in the traffic field has already become prevalent around the world. For instance, the ever-consummating after-sale service of automobiles, various forms of value-adding services (including the replacement of the old vehicle, the sending of the message of safe driving, fuel saving and traffic jam, etc.), the ever-convenient, fast and economic package commuting service of air, railway and buses, the rental service of cars and bicycles, as well as the 'pooling services', etc. All of the above-said strategies aim at the goal of answering

people's expectation of commuting, improving the efficiency of the urban transportation, as well as lessening the waste of resource and environmental pollution.

The urban transit system possesses many intricate factors and involves different stakeholders, such as car manufacturers, policy-makers, traffic organizers, insurance companies, the suppliers of the transportation equipment, drivers, common users, etc. Therefore, based on PSS thinking and starts from different requirement of the stakeholders, the transportation design comes up with an innovative solution which integrates vehicles and service system to effectively deal with the current transportation problems, meanwhile, the win-win situation will be stricken between the user and all the stakeholder that in the chain of the system. 'Car sharing', originated from daily life, constitutes one of the effective solutions.

3 The Concept Design of Car Sharing

The essence of social innovation is to perceive the collective wisdom and integrating it with the design thinking to solve the existing problems. Car sharing, the carrier of this innovative concept, prevails in some certain areas in China and it releases the traffic tension and lessens the cost of transportation to some degree. Despite its profound potential, it doesn't receive its due popularity and is still labeled as illegal operation for the lack of the effective management, the technical support, as well as the fair pricing system and the credit organism. The following passage analyzes the feasibility of the Car Sharing system design in the aspects of society, economy and technology.

3.1 The SET Analysis of Car Sharing in China

- *Social sphere*: 'Sharing', a social behavior, bears a long history and undergoes a resurgence of popularity in recent years. The main body of sharing ranges from acquaintance, friends, to total strangers, who cherish the major purpose of sharing cost, experience, happiness, as well as expanding and consolidating the social circle. Nowadays, the popular style includes flat sharing, meal sharing, credit-card sharing, car sharing, travel sharing, group-buy sharing, entertainment sharing, etc. The research shows that the majority participating in the 'sharing' activities are the youth aging between 20 and 30, well-educated and familiar with the Internet. Most of them are students, new employees and SOHOs, mostly dwelling in the developed cities like Beijing, Shanghai, Dalian, Chengdu, Hangzhou, etc., they receive medium or low salary and have a stable living style, and are characterized as valuing interpersonal relations, the enjoyment of life, being optimistic and willing to be the forerunner of fashion. Despite the unacceptability of the 'sharing' concept by the Chinese consumers, who underwent the intolerable tough days and still enjoying the phase of completely owning properties, the belief of sharing consumption, led by the youth, is destined to become the mainstream of the society. Thus, the futuristic 'Car Sharing' boasts a promising social foundation.

- *Economic sphere:* The high living cost in the major cities in China has witnessed the fact that the consumption level of the cities like Beijing, Shanghai and Shenzhen has surpassed New York and that the rising price (especially the fuel price) is far outrunning the raise of the ordinary employees' salary⁶, aggravating the burden on the young office workers, however, the choice of sharing a car can greatly ease the tension. Besides, China has become the second on the list of automobile ownership, in Beijing, there are about 3 million automobiles on the roads, 2.4 million among which are occupied by only 1 person, with 1 person taking the space of 5, the traffic congestion, as well as the huge waste of resources is self-evident. In this circumstance, provided the great effort to impel the construction and the organization of the urban bus system, leading the private car owner to apply car sharing, even part of it, can reduce the traffic circulation by millions of vehicles, relieving traffic pressure, as well as lowering economic lost.
- *Technological sphere:* Under the pressure of the concerns of resources and environment and the brunt of the revolution the technology, the automobile technology is incubating an unprecedented revolution. For instance, the mobile Internet and tele-communications is doomed to profoundly influence the car industry, by now, people can enjoy the intelligent info-service such as GPS, GIS, LBS, etc. The mobile communicating technology of American CarCloud, the Sync open platform of Ford and the Audi's Connect are all precursors of this revolution, their daring trials provide the design of the sharing transportation system with reliable technological support. It is foreseeable that the futuristic automobile can not only offer the customers with the "riding" function, the strong human-computer interaction, navigation, entertainment and working, but also make the functions, such as interpersonal communication, etc., prevalent.

3.2 The Definition of the Sharing-Move System

The design of Sharing-Move system pays close attention to the joint of the public transportation and the private one and aims at solving the daily transportation and commuting problems confronted by the young urban office workers. As a package solution, the design will involve the part of info-interactive design of service platform and the part of product design, including the exterior and the interior of the car. The former, whose function includes info-searching, matching, valuing and paying, safety authentication, organization, etc., can connect and register through PC or the mobile terminal; and the latter can pay dual consideration to the two properties of transportation system: the privacy and publicity, adding some certain necessary features when reserving the requirement of an individual or a family.

To solve the major problems in the process of car sharing, such as the compliance of traffic regulations, the safety, the responsibility of the accident, the charging standard, and our group has come up with the corresponding designing principles. (see Fig. 1).

⁶ According to the "Worldwide Cost of Living Survey 2012 city ranking" report issued by Merce, an USresearch institute, Beijing and Shanghai were listed in the 16th and 17th in the world, with a raise compared with previous years. In addition, the living costs of Shenzhen and Hangzhou have exceeded that of New York, and listed in 30th and 31st respectively.



Fig. 1. Function Map

- *Traffic regulation:* According to the current law and regulation, 'Car-sharing' is deemed as illicit behavior. Thus, the Sharing-Move system should cooperate with the government to keep the car-sharing on record, controlling the scope and the quantity of the activity in a coordinated manner. Besides, being a non-profit deed, car-sharing should apply a strict charging standard
- *Safety concerns:* the Sharing-Move system will impose a stringent real-name mechanism and a rigorous authentication of the information of the car that is going to be shared, GPS tracking and inner-seated video surveillance will also be conducted during the process of sharing, which ensures the safety of the customers.
- *The responsibility of the accident:* It has been a conundrum to confirm the responsibility of the traffic accident in the process of car-sharing, which necessitates the intervening of the insurance company. The fare paid by the passages should include the insurance fee.
- *Charging standard:* Only the driving cost of the mileage during car-sharing is required, including part of the fuel fee, system management fee and insurance fee. The car-sharing fare should be cheaper than the taxi fare. The service platform will be in charge of the calculating and paying.

3.3 Service System Design

In the service-design part, Sharing-Move would have a mobile service platform for the users. By referring to the strong database (including consumer registering, car information, road map, fare, credit evaluation, etc.), the users can conduct timely communication with other users to realize their sharing transportation.

The Internet service platform of Sharing-Move possesses 5 major function modes, being 'the detection and matching of the users' information, 'safety organization', 'positioning and navigation', 'valuation and payment', and 'evaluation and feedback' respectively. Based on them, the typical process of the Sharing-Move service system is as follows: (see Fig. 2)

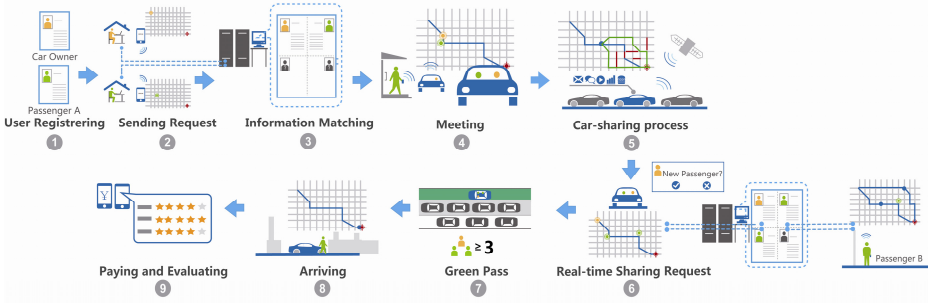


Fig. 2. Sharing-Move Service System Flow Chart

- *Registering:* The users should register on the service platform of the Sharing-Move, the identity authentication, the credit card information, the common-used route and time, as well as other predilections should be included, and the car owner should provide the information of the car. (Such as step①)
- *Sending the request of car-sharing:* The two parties are required to send the sharing request on the service platform (including destination and time), the system will then match the request automatically and provide several choices, the passenger A will make his or her choice according to the route and his or her preference, and a car-sharing agreement will be formed after the car-owner's confirmation. (Such as step②③)
- *Car-sharing process:* The sharing of the car will take place at the arranged time and spot, the two parties can identify each other quickly by the position-searching of their mobile phone, During the journey, the service platform will provide the services such as navigation, route optimization, music, video clips, etc. (Such as step④⑤)
- *Real-time sharing:* By then the passenger sends a real-time sharing request, the system matches his or her request automatically and provides couple of choices. The passenger B make a choice, then the car owner confirm the request after getting the agreement of the passenger A. (Such as step⑥)
- *Priority:* When the number of the car sharers surpasses 3, the car can use the specific green pass (or bus lane) and the toll can also be spared in order to encourage sharing by more people. (Such as step⑦)
- *Arriving:* The cars will arrive at the destinations respectively, by then; the system will automatically calculate the fare of the sharing according to the car-sharing mileage of each and the number of the then passengers. After the car-sharing, the users will evaluate and grade the ride according to the experience and the system will accumulate the credit records of both the car owner and passengers then replenish them in to the database. (Such as step⑧⑨)

3.4 The Exterior and Interior Design

Being one of the components of the Sharing-Move system, the design of the commuting vehicles emphasizes the effective transmitting and interaction of information as well as the reasonable layout of the inner space of the car, which is achieved by the adoption of the single carriage structure. The dual features of private and public endow the vehicle's style with artlessness and simple beauty. The explicit distinction and display of the information also constitutes a curtail feature of the exterior design of the Sharing-Move. (see Fig. 3)

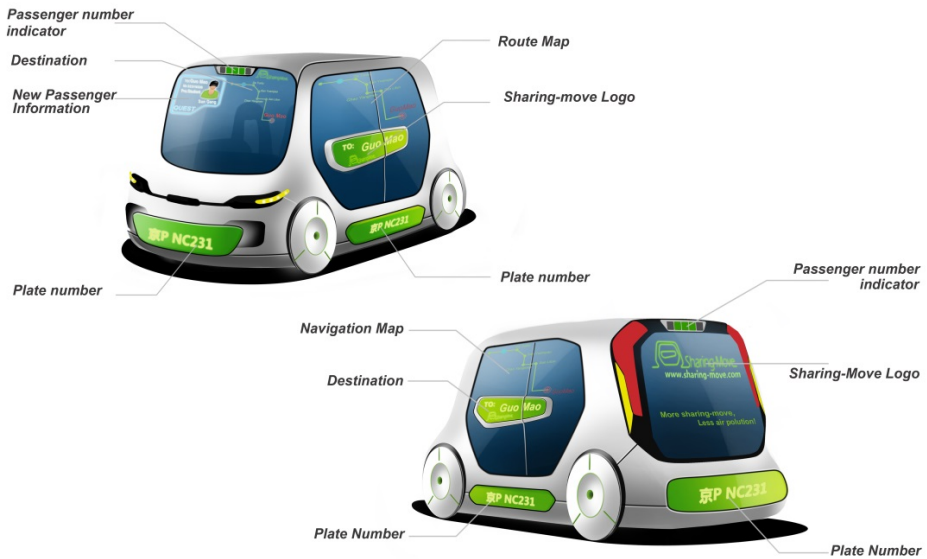


Fig. 3. The Exterior Design

The sense of safety, multi-functioning, and publicity are the key words of the interior design of the car, so the design adopts the latest technology to convert the marginal area of the windscreen into the info-display screen, with the uninterrupted driving vision being the prerequisite, the important information such as navigation, car-sharing request, etc., can be displayed. The inner body will be equipped with a panorama camera, which can supervise the driving situation; and the assembled seats arrangement can be so flexible as to answer the different demand, such as of going on a family trip or of car-sharing. Armed with Wi-Fi reception and the video and music playing facilities, and taking advantage of the sharing mode, the design can also enhance the communication between social members. (see Fig. 4)

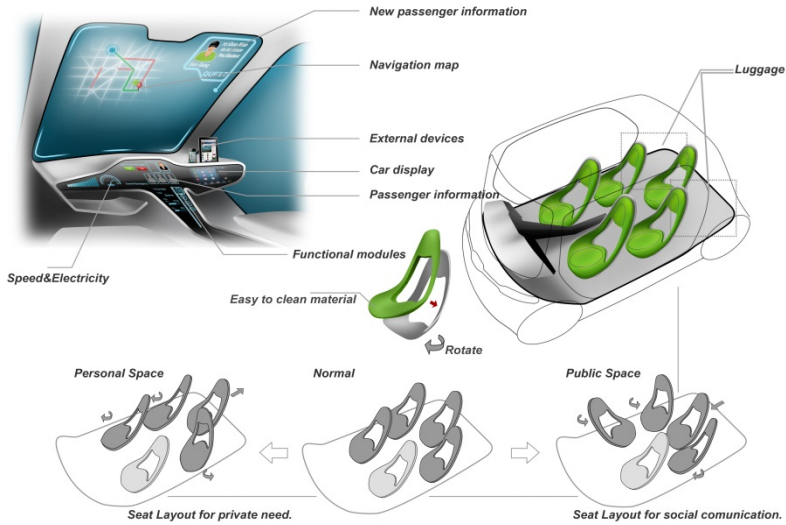


Fig. 4. The Interior Design

4 Conclusion

To solve or ease the problems of urban transportation system, multifarious effort is required, including various kinds of innovative PSS design (Sharing-Move included), the improvement of policies and regulations, the adjustment of the thinking of urban planning, the development of road building, the moderation of the profit mode of the car enterprises, as well as the advocacy of the urban dwellers' green means of transportation and consumption belief.

Nowadays, the transportation designers are facing a problem that is way more complicated than the ones in the past, their work scope is not confined in gracious and dynamic car modeling, eye-catching color combination, original appliance of material or the high-tech and intelligent human-computer interaction, their work has entered a new phase-the challenge of design is the challenge of society (Anne & Paul, 2011) . Therefore, despite all the cluelessness, the designers have to confront the sustainable development of the urban transportation system and find a way to reshape the overly materialistic outlooks of well-being.

The design and the implementation of the sharing PSS require teamwork, especially through the collective intelligence and energy, which are also the belief and methods of Social Innovation and an effective way for the designers to seek role-exchange and breakthrough. There still exist more details about the Sharing-Move design to be perfected in the future.

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References

1. Anne, C., Paul, M.: *Design for Sustainable Change: How Design and Designers Can Drive the Sustainability Agenda*. AVA Publishing, SA (2011)
2. Benny, L., Ezio, M.: *Design Vision: the Sustainable Way of Living in China*. Lingnan Publishing House Ltd., Guangzhou (2006)
3. Carlo, V., Ezio, M.: *Design for Environmental Sustainability*. Springer, London (2008)
4. Ceschin, F., Vezzoli, C.: The role of public policy in stimulating radical environmental impact reduction in the automotive sector: the need to focus on product-service system innovation. *Int. J. Automotive Technology and Management* 10(2/3), 321–341 (2010)
5. Ezio, M.: Small, Local, Open and Connected: Design Research Topics in the Age of Networks and Sustainability. *Journal of Design Strategies* 4(1) (Spring 2010)
6. Gong, M., Lou, Y.: *DESIS-China: A pilot action on networking design schools in China*. In: Justice, L., Lam, Y.Y. (eds.) *Proceeding of Design ED Asia Conference 2010: Culture as Inspiration*. Hong Kong Design Center (2010)
7. Hawken, P.: *The Ecology of Commerce: A Declaration of Sustainability*. Harper Business, New York (1994)
8. Liu, G.: Urgent need to re-understand the origin and primacy: reflection from industry chain. *J. Art Home*, 48–53 (2009)
9. Liu, X.: Current situation and practice of design for sustainability in China. In: Fabrizio, C., Carlo, V., Jun, Z. (eds.) *Sustainability in Design: Now!*, pp. 540–549. Greenleaf, Washington (2010)
10. Manzini, E., Vezzoli, C., Clark, G.: Product service systems: using an existing concept as a new approach to sustainability. *Journal of Design Research* 1(2) (2001)
11. Mercer: The report of Worldwide Cost of Living Survey 2012 - city ranking. HYPERLINK, http://www.mercer.com/costoflivingpr#City_rankings
12. Mont, O.: Clarifying the concept of product-service system. *Journal of Cleaner Production* 10(3) (2002)
13. Mont, O., Lindhqvist, T.: The role of public policy in advancement of product service systems. *Journal of Cleaner Production* 11(8) (2003)
14. William, J.M., Chris, E.B., Lawrence, D.B.: *Reinventing the Automobile: Personal Urban Mobility for the 21st Century*. MIT Press, Cambridge (2010)
15. Tracy, B., Vicky, L.: *Design for Sustainability: a practical approach*. Grower House, Aldershot (2007)
16. United Nations Environmental Program (UNEP): *Product-service systems and sustainability. Opportunities for Sustainable Solution*, Paris (2002)
17. Vezzoli, C.: *System Design for Sustainability: Theory, methods and tools for a sustainable “satisfaction-system” design*. Maggioli Editore, Milan (2007)
18. Xin, L.: State of Arts and Prospects of China’s Education on Design for Sustainability: Curriculum Research based on LeNS Project. In: Yongqi, L., Xiaocun, Z. (eds.) *Cumulus Conference Proceedings*, pp. 227–233. Shanghai,
19. Zhao, J., Zhang, J.: *The Second Truth of Design: Thinking on the Contemporary Sustainable Industrial Design*. Hubei Art Press, Wuhan (2003)

Study on Aggressive Driving Activities at Crossroads in Beijing

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Abstract. The objective of this study is to explore the influence of aggressive driving activities on microscopic traffic flow at crossroads in Beijing. Thus, we performed observations and corresponding statistical analysis to present some of the features. The results indicate that the number of occupying the bus lane and jumping the queue in the period of rush-hour is higher distinctly than those in the period off-peak. And the aggressive behaviors do not only block the microscopic traffic flow, but facilitate the vehicles crossing the crossroads quickly.

Keywords: aggressive driving activities, crossroads.

1 Introduction

The problem of aggressive driving has become a major concern in China. Many studies have indicated an association between aggressive driving and increased risk of automotive vehicle accidents [1], [2], [3], [4]. For aggressive driving, U.S. National Highway and Traffic Safety Administration (NHTSA) defined it as the operation of a motor vehicle in a manner, which make people or property being dangerous or likely to dangerous [5]. Tasca [6] thought that aggressive driving behavior should be “if it is deliberate, likely to increase the risk of collision and is motivated by impatience, annoyance, hostility and/or an attempt to save time.” Generally, aggressive driving activities include: speed, tailgate, fail to yield, weave in and out of traffic, pass on the right, make improper and unsafe lane changes, run stop signs and red lights, make hand and facial gestures, scream, honk and flash their lights [5], [7], [8].

Although many academic studies focus on the psychological perspective, factors contributing to aggressive driving such as situation conditions; personality factors; and demographic background variables [9], [10], [11], [12], [13], [14], [15], [16], aggressive driving still remain largely unknown such as effects of aggressive driving on load capacity. Thus, in this paper, we will observe aggressive driving activities at a crossroad in China and try to summarize some important features that previous research did not address clearly. The aim is to explore the influence of aggressive driving on microscopic traffic flow at crossroads in Beijing and the relationship

between aggressive driving and traffic congestion will be observed. Are there more aggressive driving activities while the traffic is more congested? And reversely, how degree does the aggressive driving influence the microscopic traffic flow?

2 Methodology

If drivers are in impatience, annoyance, hostility or urgency, their driving behaviors will be likely to increase the risk of collision [6]. These behaviors are described as aggressive driving activities. In Beijing, three kinds of aggressive driving behaviors were common, which were occupying a bus lane, weaving in and out of traffic and jumping a queue. Therefore, in this study the behaviors were observed and recorded. The three kinds of activities are described specifically as follows.

- Occupying bus lanes. A bus lane in Beijing is a lane restricted to buses on rush-hour time in a day, which is used to speed up public transport. Consequently, while other lanes are congested, the bus lanes are often unobstructed. So, some private cars often occupy the bus lanes in order to save time in rush-hour time.
- Weaving in and out of traffic. Out of personality, driving habits, or saving time, some drivers change lanes more frequently or cut across multiple lanes. For example, change to another lane from this lane and immediately return to this lane while there is an empty section and change constantly in the course of driving, or change across multiple lanes in a time.
- Jumping the queue. This is the act of entering a queue or line at the front other than the current position. Especially at crossroads, the drivers would change into the empty lane while the current lane is congested many vehicles. And near the crossing, the drivers cut in too close in front of vehicle.



Fig. 1. The observed crossroad in Beijing, China

This study observed aggressive driving activities at a crossroad near the 2nd-Ring in Beijing (see the Fig. 1). The observer was located on the overpass at the crossroad. The section observed included the crossroad and near 200 meters road of one direction. The observation was conducted and recorded by a video camera in Sept. 15th-21st, 2012. In this week, we recorded the traffic situation in three periods, which are 7:00-7:30am, 10:30-11:00am, and 5:30-6:00pm. The three periods represent respectively morning rush-hour, off peak, and evening rush-hour.

3 Results

With the observation and statistical analysis, we could figure out the relationship between aggressive driving and traffic congestion and verify traffic load of the lane significantly.

3.1 Observation 1: Statistical Results of Aggressive Driving Activities at a Crossroad

In this study, the actual data of aggressive driving activities at the crossroads were collected. Through observation and analysis of one crossroad in Beijing, we found that the main aggressive driving activities at crossroads are weaving in and out of traffic, jumping the queue, and occupying the bus lane. The following tables (Table1 to table 3) present the number of the three kinds of aggressive driving activities in the different periods in a day representing rush hour and off peak. In the table 4, the basic statistic results including mean and deviation of the number of three kinds of activities are shown. In order to test that the number of aggressive activities in the different period of time is significantly different, ANOVA tests are conducted. Table 5-7 present the results. Through the result of ANOVA for occupying the bus lane and jumping the queue, we find that the p-value for significance is less than 0.05. The result indicates that means of the number of the activities from different periods are different significantly. For weaving in and out traffic, we find that the p-value for significance is 0.61 more than 0.05. The result indicates that means of the number of the activity from different periods are not different significantly.

Table 1. Number of aggressive driving activities in the morning

Aggressive activities	Sun.	Mon.	Tue.	Wed.	Thu.	Fri.	Sat.
Occupying the bus lane	0	12	7	18	19	19	1
Weaving in and out of traffic	65	159	150	160	157	157	89
Jumping the queue	38	106	114	133	122	89	29

Table 2. Number of aggressive driving activities at noon

Aggressive activities	Sun.	Mon.	Tue.	Wed.	Thu.	Fri.	Sat.
Occupying the bus lane	3	2	0	4	5	8	2
Weaving in and out of traffic	107	136	139	168	164	141	102
Jumping the queue	47	48	68	65	72	63	34

Table 3. Number of aggressive driving activities at nightfall

Aggressive activities	Sun.	Mon.	Tue.	Wed.	Thu.	Fri.	Sat.
Occupying the bus lane	1	2	1	4	7	12	5
Weaving in and out of traffic	75	108	64	111	125	102	114
Jumping the queue	30	50	29	76	79	44	58

Table 4. Descriptive

Period	Occupying the bus lane		Weaving in and out of traffic		Jumping the queue	
	Mean	Dev.	Mean	Dev.	Mean	Dev.
At morning	10.9	8.3	133.9	39.6	90.1	41.1
At noon	3.4	2.6	136.7	25.3	56.7	13.9
At nightfall	4.6	4.0	99.9	22.1	52.3	20.1
Total	6.3	6.2	123.5	33.2	66.4	31.4

Table 5. ANOVA (Occupying the bus line)

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	224.000	2	112.000	3.677	.046
Within Groups	548.286	18	30.460		
Total	772.286	20			

Table 6. ANOVA (Weaving in and out of traffic)

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	5886.095	2	2943.048	3.277	.061
Within Groups	16167.143	18	898.175		
Total	22053.238	20			

Table 7. ANOVA (Jumping the queue)

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	5997.238	2	2998.619	3.938	.038
Within Groups	13707.714	18	761.540		
Total	19704.952	20			

3.2 Observation 2: Loads of Aggressive Driving

As stated above, aggressive driving activities at the crossroad were observed and calculated. Based on the data, then we analyze the influence of the aggressive driving on the microscopic traffic flow. Firstly, we observed and analyze the videos of the crossroad. Then, we counted the number of vehicles that passed during the 10 seconds right after the signal changed red to green.

Motor vehicles can drive at normal speed passing the crossroad unless some other aggressive driving vehicles blocking them. So, firstly we assume that the load of the motor vehicle without aggressive driving is one and the other one is the load with aggressive driving while passing the crossroad. With the assumption, the average number of the vehicles that can pass in a period of green light when there are no aggressive driving activities is calculated. This is average load capacity (ALC). Table 8 is the descriptive statistics we computed ALC from the data.

Table 8. Descriptive for ALC

N	Minimum	Maximum	Mean	Std. Deviation
150	2	6	4.6	.7

While there is aggressive driving at crossroads, the number of vehicles passing is reduced. The reduction in number is caused by the aggressive driving activities. The below formula (1) is displayed for it. When we applied the formula (1) with ALC (4.6), we could obtain Table 9. According to the results, the aggressive driving load (ADL), 0.33, is 67% less than no aggressive driving load (ALC), 1. That is to say, we

considered that the ADL would be larger than the ALC, but the ADL is relative small. Therefore, the aggressive driving activities do not block the microscopic traffic flow in terms of the calculation.

$$\begin{aligned}
 & \text{Aggressive driving load(ADL)} \\
 & = \frac{\text{ALC} - \text{number of vehicles exculding aggressive driving ones}}{\text{number of aggressive driving vehicles}}
 \end{aligned}$$

Table 9. Descriptive for ADL

N	Minimum	Maximum	Mean	Std. Deviation
34	-1.4	1.6	0.33	.62

4 Discussion and Conclusion

Although the problems of aggressive driving and traffic jams have become major concerns in China, especially in Beijing, few of papers study the relationship between aggressive driving and traffic congestion will be observe. Therefore, the aim of this study is to explore the influence of aggressive driving on microscopic traffic flow at crossroads in Beijing. Thus, we performed observations and corresponding statistical analysis to present some of the features.

First, for the behaviors, occupying the bus lane and jumping the queue, the differences between means of morning rush-hour, off-peak, and nightfall rush-hour are significant. Therefore, the number of occupying the bus lane or jumping the queue in the period of rush-hour is higher distinctly than those in the period off-peak. That is, in order to save time drivers occupy the bus lane and jump the queue in the period of rush-hour, especially in the morning much more than in the period of off-peak. Actually, the early positions before stop lines become scarce resource at time of traffic jam. So, through occupying public resource or private resource these drivers take early position. Second, for the behavior, weaving in and out of traffic, the difference between means of morning rush-hour, off-peak, and nightfall rush-hour is not significant. So, we could not consider that the number of weaving in and out of traffic in the period of rush-hour is higher distinctly than those in the period off-peak. But, the absolute amount of the behavior is relative large comparing with the other two kind behaviors. That is to say, no matter whether the traffic is in congestion, the drivers like to change the lanes casually in the process of driving. In addition, the number of occupying the bus lanes is relative fewer than that of the other two kinds of behaviors.

We assumed that aggressive driving activities would block the transportation at crossroads because the activities influence other drivers' driving efficient. But, through the calculating the ADL, we found the aggressive behaviors did not only block the microscopic traffic flow, but also facilitate the vehicles crossing the

crossroads quickly. Although, some studies found that the aggressive behaviors influenced driver safety, this study discovered that the aggressive activities did not affect the efficient in transportation at crossroads. However, it should be noted that ADL's standard deviation is relative large, so further data collection should be done to make this result more credible.

References

1. Dula, C.S., Ballard, M.E.: Development and evaluation of a measure of dangerous, aggressive, negative emotional, and risky driving. *Journal of Applied Social Psychology* 33(2), 263–282 (2003)
2. Chliaoutakis, J.E., Demakakos, P., Tzamalouka, G., Bakou, V., Koumaki, M., Darviri, C.: Aggressive behavior while driving as predictor of self-reported car crashes. *Journal of Safety Research* 33(4), 431–443 (2002)
3. Cook, L.J., Knight, S., Olson, L.M.: A comparison of aggressive and DUI crashes. *Journal of Safety Research* 36(5), 491–493 (2005)
4. Galovski, T.E., Malta, L.S., Blanchard, E.B.: Road Rage: Assessment and Treatment of the Angry, Aggressive Driver. In: xi, p. 250. American Psychological Association, American Psychological Association (2006)
5. U.S House of Representatives: Subcommittee on Surface Transportation, Hearing on July 17. Road Rage, Causes and Dangers of Aggressive Driving (1997)
6. Tasca, L.: A review of the literature on aggressive driving research. In: The Global Web Conference on Aggressive Driving Issues, October 16–November 30 (2000)
7. Ellison-Potter, P., Bell, P., Deffenbacher, J.: The effects of trait driving anger, anonymity, and aggressive stimuli on aggressive driving behavior. *Journal of Applied Social Psychology* 31(2), 431–443 (2001)
8. Goehring, J.B.: Aggressive Driving: Background and Overview Report. In: National Conference of State Legislatures, Environment, Energy and Transportation Program, Washington, DC (2000)
9. Björklund, G.M.: Driver irritation and aggressive behaviour. *Accident Analysis & Prevention* 40(3), 1069–1077 (2008)
10. Deffenbacher, J.L., Huff, M.E., Lynch, R.S.: Characteristics and treatment of high-anger drivers. *Journal of Counseling Psychology* 47(1), 5–17 (2000)
11. Dula, C.S., Ballard, M.E.: Development and evaluation of a measure of dangerous, aggressive, negative emotional, and risky driving. *Journal of Applied Social Psychology* 33(2), 263–282 (2003)
12. Shinar, D., Compton, R.: Aggressive driving: An observational study of driver, vehicle, and situational variables. *Accident Analysis & Prevention* 36(3), 429–437 (2004)
13. Dahlen, E.R., Martin, R.C., Ragan, K., Kuhlman, M.M.: Driving anger, sensation seeking, impulsiveness, and boredom proneness in the prediction of unsafe driving. *Accident Analysis & Prevention* 37(2), 341–348 (2005)
14. Deffenbacher, J.L., Deffenbacher, D.M., Lynch, R.S.: Anger, aggression, and risky behavior: A comparison of high and low anger drivers. *Behaviour Research and Therapy* 41(6), 701–718 (2003)
15. Moore, M., Dahlen, E.R.: Forgiveness and consideration of future consequences in aggressive driving. *Accident Analysis & Prevention* 40(5), 1661–1666 (2008)
16. Davey, J., Wishart, D., Freeman, J., Watson, B.: An application of the driver behaviour questionnaire in an Australian organisational fleet setting. *Transportation Research Part F: Traffic Psychology and Behaviour* 10(1), 11–21 (2007)

Constructing Interaction Scenarios of High-Building Interior in Fire

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Abstract. Many fires in buildings have indicated that behavior of occupants in period of pre-movement is important for the survival. Pre-movement time and pre-movement behavior are currently referred as most important factors during evacuation. The objective of this study is to identify the factors that influenced pre-evacuation time of occupants during an actual fire evacuation and to quantify the factors. This study proposes three kinds of factors influencing the human behavior in the event of fire in period of the pre-movement, which are fire characteristics, building characteristics, human characteristics. Through simulating fire scenes of building interior, this study will investigate occupants' performance in the period of pre-movement. This paper is part of the study, which is to construct interaction scenarios of building interior in fire.

Keywords: Interaction scenarios, evacuation simulation, human behavior, fire.

1 Introduction

Some research indicated that in real evacuations pre-movement time exhausted even more than 20 minutes [1, 2, 3]. The pre-movement time is very more important to escape to a safe place. Furthermore, incident analyses have indicated that there is a connection between a delayed evacuation and a high number of fire deaths or injuries, particularly in residential buildings and hotels [4]. Therefore, pre-movement time and pre-movement behavior are currently referred as key aspects of the evacuation process. In order to achieve a more accurate assessment of the life safety during a fire, a better understanding of occupant behavior during evacuation is required. The objective of this paper is to identify the factors that influenced pre-evacuation time of occupants during an actual fire evacuation and to quantify the factors by stating how much pre-evacuation time was gained or lost due to each factor. Since fire response performance is dependent upon the external environment in which an individual is

present, the research for fire prevention measures should be the interaction between human behavior and the characteristics of the external environment. To obtain adequate fire response performance, this study will investigate occupants' performance in fire in the simulating building interior. This paper is part of the research, which is to construct interaction scenarios of building interior in fire. Further investigation will be conducted based on these circumstances.

2 Methodology

Based on previous research [5, 6, 7, 8, 9], this study proposes three kinds of factors influencing the human behavior in the event of fire in period of the pre-movement. These are as follows: fire characteristics, building characteristics, human characteristics. The first factor is the nature of fire. And the second factor is physically environment which occupants' behaviors are carried out. The two factors are external. The third factor is human nature and is internal factor.

2.1 Building Interior Characteristics

Some research indicated that occupants would stay in home or hesitate to escape from the house, which means that in real evacuations pre-movement time exhausted from five minutes to over 25 minutes [1, 2]. So, one aim of this study is to explore when and how occupants exit the home. Without detailed data about the information that occupants act their behaviors in home while hearing fire alarm, it is important to design the interior characteristics. First, this study presumed that the ordinary family had a two-bedroom apartment located in the middle of high-building. The layout of one floor is shown in figure 1. The interior of the apartment will vary on five parameters according to situation, which are furniture, communication tools, property, and kids and the aged.

2.2 Behavioral Scenarios

Based on previous research, this study proposed that four types of characteristics of the occupants should be investigated, which were demographic information, personality, risk perception, and fire experience.

Demographic Information

Demographic information collects educational level, age, family composition, dwelling house and so on. The participants would be divided into different groups according to different attribution (See Table 1).

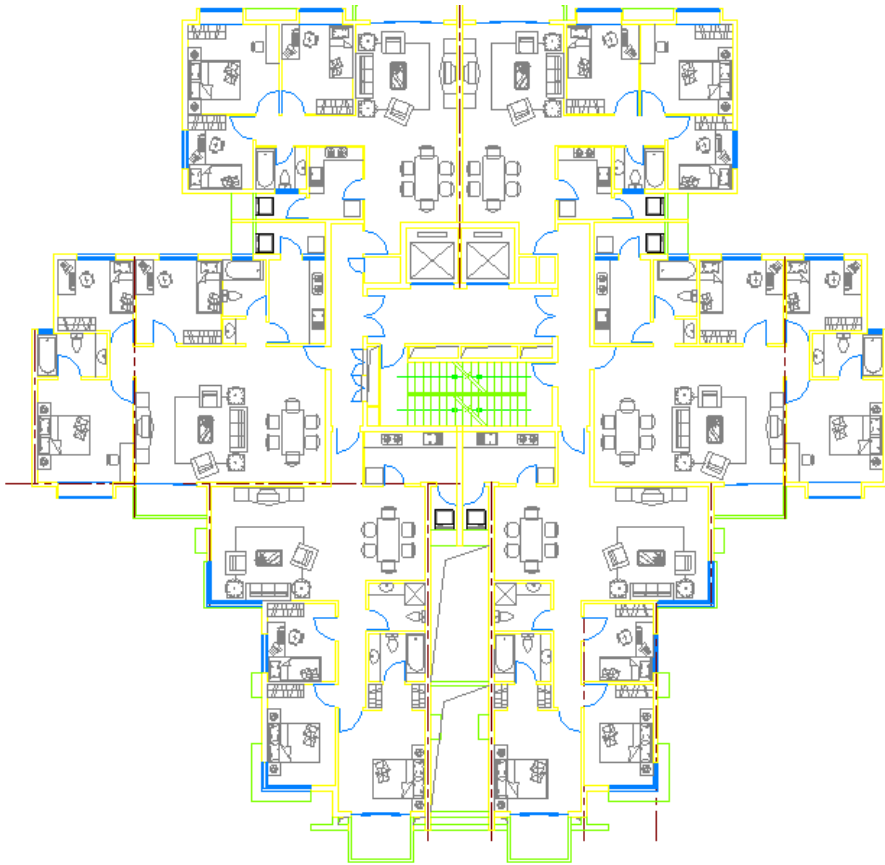


Fig. 1. The layout of one floor

Table 1. People groups

Gender	Age	Family composition	Dwelling house	mobility
Male	<30	Without a child (less than 6 years old) and without an old person (more than 65 years old)	Not more than two-bedroom house	Normal person
Female	30-50	With less than 3 children and old persons (totally)	At least three bedroom house	Reduced motility
	>50	With not less than 3 children and old persons (totally)		

Personality

Personality includes influenced by others, stress resistance and self-efficacy [10, 11, 12]. In the event of fire, most persons follow others. While others escaping they will take action. Another personality trait influencing decision-making is stress resistance.

While fire happens occupants' capacity for processing information is exceeded, so the level of psychological stress will rise. The third trait is self-efficacy. The trait influence occupants' selection, duration and effort while the occupants encounter fail, difficulty or disaster.

Risk Perception

Risk perception is the subjective experience that persons capture the features of the accidents and recognize the severity of risks [13, 14]. Persons have different responses in terms of the different perceived cues. And even the same cues presented, people are likely to respond in different ways [15]. The reason is that persons' actions vary based on the cues perceived, interpretations of the situation, and the decisions [16]. Based on the decision making, occupants will perform the actions. According to previous research [17, 18, 19], this study proposed a questionnaire to investigate risk perception and behaviors in everyday life including five dimensions such as safety and health risk, finance investment risk, entertainment risk, ethical risk and social communication risk.

Fire Experience

Relevant experience is another important characteristic [20, 21]. Commonly, less-endowed members will benefit from the efforts of the more experienced members to bring them to escape, presumably a reason they keep with them. Fire experience of a person includes fire disaster experience, evacuation drills, fire training or other emergency training.

2.3 Fire Characteristics

This factor is the nature of the fire itself. A fire is a process of combustion of materials. With the fire growing the critical factors of the fire are perceived by the occupants. Perceptible characteristics can be sub-divided into elements which can be seen, smelt or heard [22]. And the fire growth rate is another important characteristic in determining fire fatality, since many fatal incidents are characterized by rapid fire development after its initial discovery [23]. The fire alarm system is designed as an emergency alarm communication system. The emergency alarm communication system has the capability to provide automatic pre-recorded messages upon receipt of an alarm signal indicative of a fire emergency. In terms of previous researches, this study proposes four types of characteristics, which are fire's growth rate, emergence of flame and smoke, fire alarm, and fire location in the building (Table 2).

Table 2. Related fire characteristics

Fire's growth rate	Flame and smoke	Fire alarm	Fire location
Low	A little	No	Upstairs
Middle	Some	Vague messages	Downstairs
Fast	A lot of	Clear messages	

3 User Performance

The important issues taken into consideration in this system for simulating occupant evacuation in virtual environment include: navigation, interaction in the virtual environment, investigation participants' thoughts while escaping in the virtual environment (Fig 2).

The participants can navigate freely in the virtual environment as if they walk in the real interior. The navigation is controlled by a mouse. When the user clicking the left button and moving left or right, they will move in that direction in the virtual environment. And moving up and down they can look up and down. Besides navigation, other interactions are also allowed while picking up objects within the virtual environment. While participants picking up the objects, the environment would respond the activities. The objects include furniture, firefighting equipment, properties, and communication tools and so on. After participants completing interactions, questionnaire would turn up that reflecting participants' thought while interacting.



Fig. 2. Visualization of Flame and Spreading smoke in the virtual interior

In order to identify the factors that influence pre-evacuation time and behavior of occupants, the evacuation routes and evacuation time are calculated.

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References

1. Proulx, G., Reid, I.: Occupant behavior and evacuation during the Chicago Cook County Administration Building fire. *Journal of Fire Protection Engineering* 16(4), 283–309 (2006)

2. Averill, J.D., Mileti, D.S., Peacock, R.D., Kuligowski, E.D., Groner, N., Proulx, G., Reneke, P.A., Nelson, H.E.: Federal Building and Fire Safety Investigation of the World Trade Center Disaster: Occupant Behavior, Egress, and Emergency Communications. In: NIST NCSTAR 1-7, NRCC-48362. National Institute of Standards and Technology, Gaithersburg, MD (2005),
<http://wtc.nist.gov/oct05NCSTAR1-7index.htm>
3. Fahy, R.F., Proulx, G.: Human Behavior in the World Trade Center Evacuation. In: Proceeding of the Fifth International Symposium on Fire Safety Science, pp. 713–724 (1997)
4. Purser, D.A., Bensilum, M.: Quantification of behavior for engineering design standards and escape time calculations. *Safety Science* 38, 157–182 (2001)
5. Kobes, M., Helsloot, I., De Vries, B., Post, J.G.: Building safety and human behavior in fire: A literature review. *Fire Safety Journal* 45, 1–11 (2010)
6. Kobes, M., Post, J., Helsloot, I., Vries, B.: Fire risk of high-rise buildings based on human behavior in fires. In: Conference Proceedings FSHB 2008. First International Conference on fire Safety of High-rise Buildings, Bucharest, Romania, May 7-9 (2008)
7. Deloitte, From risk perception to safe behavior. Article on the Safety Institute of Australia Ltd. (2006) website,
http://www.sia.org.au/downloads/SIGs/Resources/From_Risk_Perception_to_Safe_Behaviour.pdf
8. O'Connor, D.J.: Integrating Human Behavior Factors into Design. In: *Fire Protection Engineering*, pp. 8–20 (2005)
9. Proulx, G.: Occupant Behavior and Evacuation. In: *Proceedings of the 9th International Fire Protection Symposium, Munich*, pp. 219–232 (2001)
10. Johnson, C.W.: Lessons from the evacuation of the world trade center, 9/11 2001 for the development of computer-based simulations. *Cognition, Technology and Work* 7, 214–240 (2005)
11. Cornwell, B.: Bonded fatalities: relational and ecological dimensions of a fire evacuation. *Sociological Quarterly* 44, 617–638 (2003)
12. Proulx, G.: A stress model for people facing a fire. *Journal of Environmental Psychology* 13, 137–147 (1993)
13. Communities and Local Government. *Understanding People's Attitudes Towards Fire Risk –Final Report to Communities and Local Government*, Fire Research Series 13/2008. Department of Communities and Local Government, London (2008)
14. Sjöberg, L., Moen, B.E., Rundmo, T.: *Explaining Risk Perception. An Evaluation of the Psychometric Paradigm*, vol. (84). RotundePublikasjoner, Trondheim (2004)
15. Mileti, D.S., Sorensen, J.H.: *Communication of Emergency Public Warnings: A Social Science Perspective and State-of-the-Art Assessment*. Oak Ridge National Laboratory, U.S. Department of Energy, Oak Ridge (1990)
16. Kuligowski, E.D.: *Modeling human behavior during building fires*. NIST Technical Note 1619. National Institute of Standards and Technology, Gaithersburg (2008)
17. Bina, M., Graziano, F., Bonino, S.: Risky driving and lifestyles in adolescence. *Accident Analysis & Prevention* 38, 472–481 (2006)
18. Parker, D., McDonald, L., Rabbitt, P.: Elderly drivers and their accidents: The Aging Driver Questionnaire. *Accident Analysis & Prevention* 32, 751–759 (2000)
19. Wang, P., Rau, P.-L.P., Salvendy, G.: Chinese drivers' risky driving and risky taking in other life situations. *International Journal of Occupational Safety and Ergonomics* 17(2), 155–164 (2011)

20. Marwell, G., Oliver, P.: *The Critical Mass in Collective Action. A Micro-Social Theory*. Cambridge University Press, London (1993)
21. Peacock, R., Kuligowski, E.D.: *Workshop on Building Occupant Movement During Fire Emergencies*. Special Publication 1032. National Institute of Standards and Technology, Gaithersburg (2005)
22. Frantzich, H.: *A Model for Performance-based Design of Escape Routes*, Department of Fire Safety Engineering. Department of Fire Safety Engineering. Lund Institute of Technology, Lund University (1194)
23. Sime, J.D.: An occupant response shelter escape time (ORSET) model. *Safety Science* 38, 109–125 (2001)

SoLoMo User Experience Study Using a Pivoted Parallel Coordinates

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Abstract. With the development of mobile and location-based technology, SoLoMo is becoming the trend for applications in different fields. However, many of the existing applications only take advantage of a very small part of the rich potentials provided by the SoLoMo framework. We introduce in this paper a pivoted parallel coordinates supporting the study of the complex user experiences in SoLoMo applications. We also present a series of studies and designs we did utilizing this coordinates. Hope the approach and tools introduced in this paper can serve as a means for more designers to better position existing applications and for them to identify novel scenarios that are otherwise buried in the numerous factors involved in SoLoMo.

Keywords: SoLoMo, SNS, LBS, Mobile Application, User Experience, Parallel Coordinates.

1 Introduction

SoLoMo is a concept referring to the convergence of Social, Local, and Mobile in the future development of the Web. As a mash-up concept, SoLoMo is considered by some as a buzzword. Existing studies about it are also mostly from the marketing point of view [2][3][4][5]. However, the integration of social network, location-based service, and mobile application does bring many new possibilities that could change our life evolutionarily. Most of its potential application scenarios have also never existed before. Many of the existing applications only touch bits and pieces of SoLoMo without a comprehensive understanding of the overall structure. In-depth study of the intertwining factors involved in SoLoMo is thus important for inventing innovative applications and improving existing ones.

As revealed in its name, multiple dimensions are integrated in SoLoMo, which further form complex combinations. An appropriate method is thus needed to help comb things out. Inspired by the approach used to study high dimensional data, we invented a pivoted parallel coordinates which makes it possible for looking at all of the relevant dimensions in one place and for further consolidating them into a system tailored for the study of SoLoMo use cases and application scenarios.

Using such a coordinate system, we did a series of studies examining existing applications and analyzing how SoLoMo could play a role in different application fields.

We also did design explorations on top of the field analysis. In the following sections we will introduce in detail our design of the coordinate system and our findings from the studies.

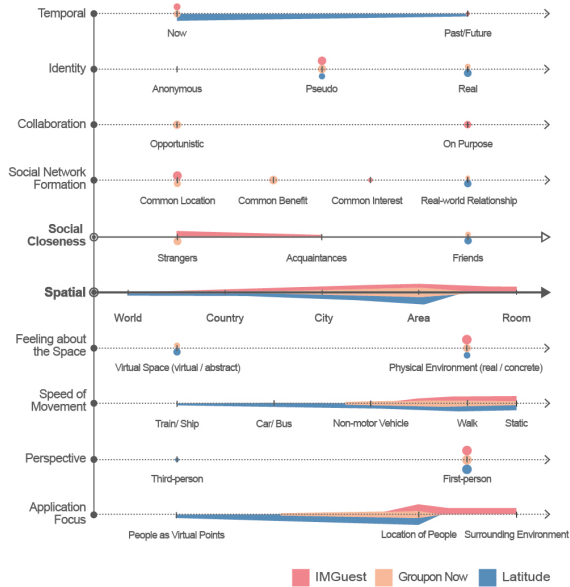


Fig. 1. Analysis of examples of three main types of SoLoMo applications

2 Design of the Pivoted Parallel Coordinates

Literally, SoLoMo involves social, location, and mobile three aspects. For the purpose of fostering design of innovative applications, we further refine the dimensions to study from the following three directions: properties of various aspects of the three fundamental dimensions, focus of design of an application, and users' experience when using an application. During the design of the coordinate system, existing and potential applications are also used as references for the selection of the axes and the definition of the values. As a result, 10 axes are chosen (Fig. 1).

Instead of leaving them as standalone axes like those in normal parallel coordinates, we further organize the axes into a system better supporting the study and design of SoLoMo applications. Out of the three aspects of SoLoMo, Location is the one that bridges the Social and the Mobile. Location links the virtual social network with the mobile applications used in physical environment and brings the development of both aspects to a new stage. As an inseparable concept of location, spaces at different scales are where all the activities carried out no matter it is a physical interaction with the surrounding people and environment, a virtual communication with people world-wide, or an intermediate one of viewing a location-based augmented reality advertisement. Aligning the values on different axes with the Spatial

dimension as a pivot could thus help to present the properties of different applications on top of a framework that already has a meaningful scenario structure encoded. For example, along with the change of the size of the space from a room to an area, a city, a country and the world, people's experience about space changes from a concrete physical environment to a virtual abstract representation such as a map. The way people look at the space also changes from first-person view that cares more about the physical experience to third-person view that sees space as abstract location and sees people as virtual points.

Because of the virtual characteristic of online social connections, the mapping between values on the social-related dimensions and those on the spatial dimension is not always the same in different contexts. However, those social-related dimensions themselves could be well aligned. We thus choose Social Closeness as another pivot axis. Any multivariate relationship between the Social Closeness dimension and the Spatial dimension applies to the other social-related dimensions as well.

As shown in Fig. 1, dots of different sizes and stripes of different thicknesses are used to plot discrete and continuous values on the coordinates. When there is more than one case under study in a plot, different colors are used. When there are multiple values plotted at one spot, dots are lined up vertically, strips are piled up in a way like the ThemeRiver[1] visualization.

As can be seen from the analysis later on, the Social, Location, and Mobile aspects are being realized in each application at different levels of richness, which in turn affects different number of points in the coordinate system. For example, in the check in function in Latitude, locations are mostly taken as virtual points by themselves or as endpoints of path lines; for Groupon Now, besides being a virtual point on the map, a location is also associated with the surrounding environment and the interest-based exploration; location in IMGuest on the other hand starts from the locale where people meet in the first place, then further links to past visit of the same place and future encounter at different places. It is thus obvious that not only the number of aspects an application covers matters, the depth to which it reaches in each aspect and the layers of functions supported are also important for the design of a successful SoLoMo application. For this reason, at the same time of studying the various aspects involved in SoLoMo, we also worked on defining the levels of them. For example, from bottom up, the location aspect could be defined into seven levels: 1) referring to a large area such as a city, 2) referring to a specific point on the map, 3) including multiple points on a path, 4) focusing on the surrounding environment, 5) looking from multiple spatial scales, 6) considering both past and future visit, 7) considering interactions among people and interactions between people and the environment. Size of the dots and thickness of the stripes in the plot represent a combinatory result of the percentage of which one application is at a specific value and the level that application reaches in the corresponding dimension.

3 Study of Three Main Types of SoLoMo Applications

Through a comprehensive survey, we found that exiting SoLoMo applications can be categorized into three main types: Check-in, Elastic Network, and Mobile Group

Buying. Utilizing the pivoted parallel coordinates designed above we first looked at characteristics of each type and then studied the overall pattern revealed through the plot of example applications (Fig. 1).

3.1 Check-in

Check-in-based location information sharing is one of the first types of SoLoMo applications that introduce to users the fresh concept of location-based socialization on mobile devices. As a representative application of this type, Latitude not only has the basic functions of keeping friends posted about one's activities, checking friends' locations, and searching for friends close-by, but also does a good job in keeping a nice balance between people's needs for information sharing and needs for privacy protection through its subtle multi-layered privacy setting mechanism. However, as we can tell from the plot in Fig.1, Latitude (other Check-in applications as well) has a very limited scope in the social closeness and activity aspects and unavoidably has its users taken away by other applications that further take advantage of users' location information for various forms of social network development and collaboration.

3.2 Elastic Network

Elastic network refers to the opportunistic network formed among people based on common location, common interest or common benefit. Different from traditional social network like Twitter or Facebook where fixed (e.g. follow) or long-term (e.g. friend) relationships are needed, the formation of elastic network is normally through a key point, such as a common location, over which the information of users close-by are pushed to each other. They can then interact with each other directly without going through the complex process involved in traditional SNS. The concept of elastic network conforms to the trend of people-centric information gathering and sharing. Both the formation and the dissolving of the network are all around peoples' once a time activity or interest.

IMGuest is an application that successfully targets the user group appropriate for elastic network: travelers looking for partners and social activities at places out of their everyday life circle. When users of IMGuest check in to the same hotel or hotels close-by, they can "see" each other on IMGuest and mark those with similar interest or experience as "like" or "interesting". They can further contact those of interest for face-to-face communication or become partners during later part of the trip. IMGuest can also remember those being checked about, marked or contacted by a user and notify him/her when they signup another time at places close-by. This increases the level of its use of the location information by incorporating both the temporal and the social factors. For the tricky issue of privacy common to all elastic network applications, IMGuest already did a good job by confining its users to those who have more needs for temporary socialization over the needs for privacy protection at the time of using the application. More actions could be taken to improve elastic network applications' user experience in this regard, e.g. revealing only the information critical for the one-time socialization and protecting those unrelated, or opening communication channels only for those who share common interests, etc.

3.3 Mobile Group Buying

Web-based group buying is no longer a new concept. With the development of mobile internet, the real-time location dimension is nicely introduced to group buying. Using applications like Groupon Now (mobile service provided by Groupon, first of the kind in group buying), users can find great local deals that they can buy or use right now. The system can also provide a detailed transaction list based on users' location, which enhances people's feeling about the surrounding place and largely fosters their passion for purchasing at the moment. Groupon Now shows many of the characteristics common to mobile group buying applications such as simple search-based instead of advertisement-based deal suggestion and location-based group buying information pushing and recommendation. It even supports intuitive and customized search by pressing the "I'm hungry" or "I'm bored" button and supports discussion and experience sharing with friends. Made for collective and location specific buying activities, mobile group buying applications cover a pretty broad scope on the coordinates (Fig.1). Considering of the fact that people do group buying are very likely to have similar interest, increasing the level of its social aspect from one-time location or benefit-based elastic network to long-term common interest-based network could make the application more beneficial. For example, instead of having the users do opportunistic collaboration every time, a long-term social network can form among them, which could be further refined over more group buying activities. Similar to the IMGuest function of notifying acquaintances close-by, users could receive notifications about people nearby who had ever done group buying together with them. They may then enjoy some local deals together again.

Besides the three types of applications analyzed above, there are also applications that incorporate the main functions from multiple types. For example, Foursquare has both the ingredient of the check-in service and that of the mobile group buying and experience sharing. Instead of simply running as a combo of two different types of applications, when the functions from both are placed together, new possibilities come into being. For example, the accumulated check-in information can reveal various demographic characteristics of the users. When checking-in at a place, a person could receive deals recommended by the system from venues preferred by people of his/her gender or age group. This is where the potential of SoLoMo is. Under an open framework, SoLoMo applications can expand their functionalities by incorporating more dimensions, developing more in-depth in each dimension, and digging out innovative features through the intersection of different dimensions.

Looking at the plot of the representative applications of the three main types (Fig.1), it is easy to see the following patterns common to existing SoLoMo applications: 1) For the Social Closeness aspect, more attentions could be placed to the group of acquaintance; 2) Even though there may exist practical constraints, making an application available globally could tremendously increase its value; 3) Designing functions for space of small size such as the surrounding environments and for the moving speed of vehicles are where more efforts could be placed; 4) Increasing the level of the temporal dimension, supporting the integration of previous and future social and location-based information with the current ones is a way to increase the SoLoMo level of an application in general; 5) Looking at the world as an abstract environment and looking at people as virtual points from the third-person view is another part of

the SoLoMo landscape which has not been well explored. There could be new applications taking this as the launch point.

4 Existing Application Expansion

Since one of the main purposes of this study is to help with the invention of innovative SoLoMo applications, we present in this section our study of a series of existing applications in light of the SoLoMo concept: which SoLoMo aspects they already have, what actions they are taking to enrich their SoLoMo flavor, and what potential features we would like to suggest them to incorporate.

4.1 Mobile and Local (Get Off Now, Taxi By Me)

Get Off Now and Taxi By Me are two location information-oriented applications. With Get Off Now, users can set their destinations and the type of transportation tools used. When getting close to their destinations, users will be alarmed to get off. Get Off Now prevent users from missing their stops in crowded, noisy or unfamiliar places or when they are in the middle of taking a nap, playing a game or reading some eBooks. Considering of the level concept discussed above, in the mobile aspect, Get Off Now reaches a pretty high level by not only taking the phone as a mobile device but also using it to get the speed of movement. So far, Get Off Now is a widget-like application limited to individual use. Since many of the users using Get Off Now on their way commute to work and back home, the information of individual user's time and location of getting off can actually be collected and used for the formation of elastic social networks. For example, people could see those getting off at the same stop as them around similar time of going to work on a daily basis, who are very likely to work in the same area as them. They can then choose to get to know each other and maybe have lunch together sometime. Similarly, those getting off at nearby stops around similar time back from work may live in the same neighborhood and can contact each other to hangout together after work.

By collaborating with Taxi companies, Taxi By Me shows on the map taxies running in the near vicinity along with their plate number, company, driver's name, and how far they are from the user. One can directly contact drivers displayed on the map or wait to be contacted by sending out a request for taxi to certain destination. Taking advantage of mobile location information sharing, this application solves the problem of having passengers and empty taxies nearby missing each other. Its function can actually be further enhanced by increasing the level of the social aspect. For example, the location-based one-time relationship between the driver and the passenger can be expanded to a long-term common benefit-based elastic network. Passengers can check the availability of drivers in this network when they need taxi in the future. Incorporating drivers' real-world relationship into the system is another way to increase the social level. For example, when drivers received the request broadcast are busy at the moment, they can recommend to the system their friends who are not far away from the place.

4.2 Mobile and Social (Sina Weibo, WeChat)

Sina Weibo is the most popular micro-blog service in China. With the advent of Sina Weibo mobile application, some nice location-based features are introduced. “People Close-by” lets the users see people in near vicinity along with their micro-blogs. With location-based elastic network applications like MoMo, people interact directly with strangers they don’t know much about. “People Close-by” of Sina Weibo on the other hand enables users to know more about people close-by from their micro-blog information accumulated over time and also provides the way for users to interact with other people in the indirect way of following them on the micro-blog. Another function, “Weibo Close-by”, displays recent micro-blog messages posted at places close-by sorted by the distance and time of posting. It is a nice way to introduce to users what’s going on next to them, which provides the context information of the authors and their previous posts at the same time. Both functions take advantage of Sina Weibo’s strength in information sharing, use the rich content, either accumulated over time or posted in real-time, to enhance location-based socialization or to realize location-based information sharing.

WeChat is a mobile application supporting instant communication. It has rich multimedia features such as voice messaging that are not available in its desktop-based predecessor, QQ. In the location aspect, WeChat also introduced the “People Close-by” function. However, unlike that in Sina Weibo, this function doesn’t grow out of WeChat’s essential functionality. There is not much difference between it and the main function of applications like MoMo. WeChat can actually make its location-based socialization function more unique by taking advantage of its strength in having a user group built mostly on top of real world or long-term relationship. For example, the “People Close-by” function can be modified to “Friends Close-by” and returns those in one’s “Friend Circle” and those in the “Friend Circle” of his/her friends’ who agree to be revealed. In this way, the social relationship context unique to WeChat can help increase the elasticity of the location-based network and make the function more sticky.

4.3 Mobile and Cloud (Dropbox)

Mobile cloud computing is a new technology paradigm with great potentials. It empowers mobile devices with infrastructure, platform and software provided through the cloud and makes mobile applications both lightweight and powerful. Dropbox is one such application, which supports cloud-based file, photo, music, and playlist backup, synchronization, and sharing. Following the trend of SoLoMo, Dropbox expands its social capability through group file sharing and through the integration with other applications like Instagram, Flickr, and Facebook (e.g. being tagged on Facebook by a friend can cause the automatic transfer of a Facebook photo to one’s Dropbox). Dropbox also incorporates location-based function of sharing photos uploaded by people within 10 miles. Even though the social and location elements in Dropbox didn’t bring fundamental revolution to its main functions, the direction of combining social and local with mobile and cloud suggested by Dropbox is a very promising one. This could bring the power of SoLoMo applications to a new level, especially in situations where the convergence of social, local, mobile and high performance computing is crucial, such as the SoLoMo game scenarios studied in [6].

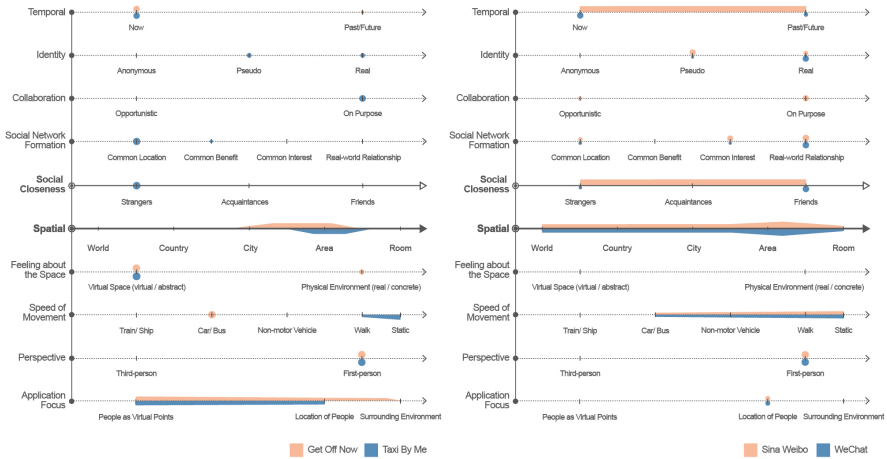


Fig. 2. Analysis of the Mobile and Local and the Mobile and Social applications

5 Analysis by Field

Besides the above study by application, we also analyzed the use of SoLoMo in twelve different application fields: transportation, travel, logistic, medical, advertisement, media, social network, shopping, exhibition and gallery, home and family life, education and academic research, and game. For each field, we plot on the coordinate system representative applications, summarize the overall trends, point out potential needs, and further line out design ideas inspired by the pattern revealed. For example, for the field of transportation, five applications are chosen for study. Car-friendly Connection and Waze are two applications for community-based traffic information sharing and navigation. XQ is a public transportation route-based socialization platform. Uber is a location-based Taxi or private driving service request application similar to Taxi By Me introduced above. Tiramisu is a crowd-powered transit information system. All together, they represent the vivid development of applications over a broad spectrum. They also have a good coverage over the parallel coordinates (plotted above the axes in Fig. 3). However, we still identified from the plot needs that are not well addressed by existing applications (plotted in red color below the axes in Fig. 3), such as needs by passengers on the train or ship and needs for nice transitions between the virtual map and the physical environment. Correspondingly, we designed two applications, OnBoard and CarSNS (first two colors plotted below the axes in Fig. 3).

Staying together in a closed environment for certain period of time, there are many social needs unique to people on the train or ship, e.g. needs for help from professionals such as doctors, and needs for killing time by chatting or playing with others. OnBoard is designed to support the formation of a special elastic social network that can satisfy these needs. For example, doctors can sign up in the “Doctor on Board” section and have their positions and contact information displayed. People can also initiate or join groups for playing different types of games. As an application for this special community of people on the train or ship, we also designed other practical location-based functions for people to locate their friends on the same train/ship,

check information about cities or sceneries on the way, and get alerted when getting close to their destinations.

Considering of driving safety, privacy protection, and the need for smooth virtual-physical transition, we designed CarSNS as an improved social network application for cars. It takes cars instead of drivers as fundamental units in the network and uses augmented reality (AR) display on windshield as interface of the application. In this social network of cars, driver along with his/her mood, interest etc. is just one property of a car. Other properties may include driving destination, whether there is pet or kid in the car, whether grouping with other cars is desired, etc. All these information can be overlaid on cars in the AR display. One can search for cars close-by that have certain characteristics. The result will be displayed through an AR lighten up function. Cars can also ask for or provide help to others only at the car level without the need for the drivers to know each other if they don't feel like or if it is not necessary. This design eliminates a lot of the transitions from real to virtual and then back to real. It also helps to protect privacy by keeping the car-to-car communication with cars as the participating entity. Even though not as practical to realize as smartphone applications, we try to use this as an example to show how the analysis of the overall pattern of SoLoMo uses and needs in one field can help pull the design of new applications out of the confinements from existing examples and can even point out directions for the development of supporting technologies.

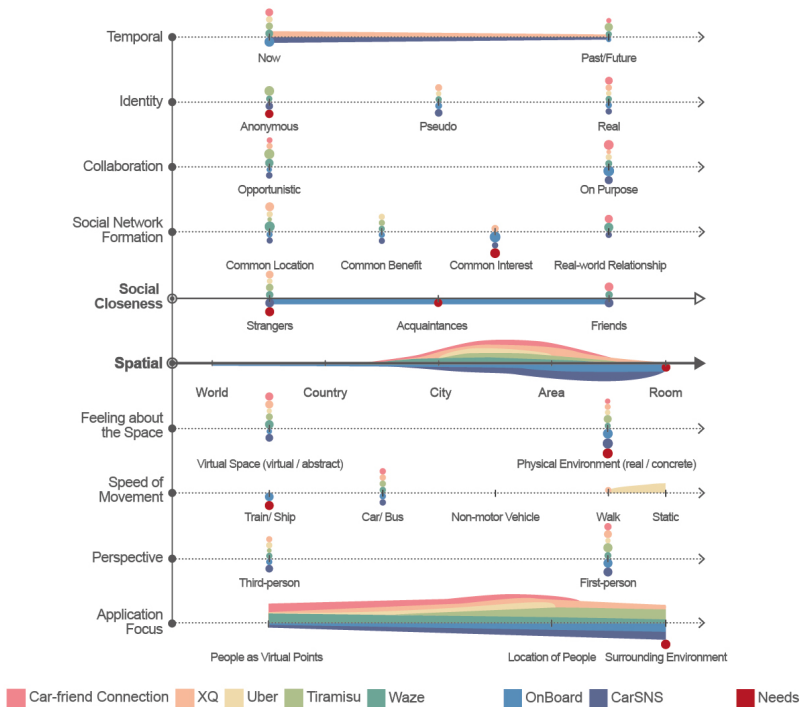


Fig. 3. Analysis and design for the field of transportation

6 Conclusion and Future Work

In this paper, we presented an approach to analyze the rich potentials provided by the SoLoMo framework from the point of view of user experience and application design. In particular, we invented a pivoted parallel coordinates supporting thorough study of all related factors in one place. The analyses of existing applications and different application fields using this coordinates turned out to be informative and are useful for pushing the design of SoLoMo applications to a new level by expanding the coverage in the SoLoMo landscape and by utilizing each element in a high level manner. As part of our future work, we would like to develop an interactive application of the pivoted parallel coordinates, which can support dynamic definition of the dimensions and numerical assignment of the values. This would be helpful for quantitative analysis of more applications and for studies at different levels of focus, e.g. study of the factors involved in a specific topic such as privacy in SoLoMo. We would also like to invent a more systematic way to define and study the levels at which an application reaches in utilizing different SoLoMo dimensions.

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References

1. Havre, S., Hertzler, B., Nowell, L.: ThemeRiver: Visualizing Theme Changes Over Time. In: IEEE Symposium on Information Visualization, pp. 115–123. IEEE Press, New York (2000)
2. Horton, C.: SoLoMo: Time to Get Social, Think Local, and Spend Mobile (2013), <http://engage.synecoretech.com/marketing-technology-for-growth/bid/168919/SoLoMo-Time-to-Get-Social-Think-Local-and-Spend-Mobile>
3. Kemp, S.: SoLoMo: The Future of Marketing? (2012), <http://wearesocial.sg/blog/2012/05/solomo-future-marketing>
4. Murphy, M., Meeker, M.: Top 10 Mobile Internet Trends. KPCB Insights (2011)
5. Reed, R.: The SoLoMo Manifesto: Just About Everything Marketers Need to Know about the Convergence of Social, Local, and Mobile. MomoentFeed (2011)
6. SoLoMo Gaming in 3G, LTE, Cloud, and HTML5 Ecosystem: Market Analysis & Forecast 2012 – 2017. Market Research Report Published by Mind Commerce Publishing (2012)

GeoCity Beijing: Platform of Eco-City Information Visualization and Interactive Narrative Structure

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Abstract. With an aim at resource visualization of eco-city, the present paper puts forward a research framework for narrative structure of cities to enable decision makers and participants of city construction to better understand the relations of elements of eco-city.

Keywords: eco-city, information design, narrative structure, interactive design.

1 Introduction

In the premise of ecological and economic sustainability, the development pattern consisting of collaborative efficiency and mutual dependence is of great importance. Family, street, community, city, district, country and region can be not separated when problems are considered.

With rapid growth of cities, change of each factor has become a dependent variable affecting the entirety. Urban administration is no longer the work only conducted by governments. Participation of intelligent people, application of new technology, grasp of dynamic information, etc. all become the essential factors to maintain development of large cities. Systematic thinking is the only way to solve problems of cities. If an urban information system is established to enable the public to better understand cities and assist City managers in better planning the facilities and services of cities, a sustainable urban ecological system can be better created.

2 Related Works

Prior researches on urban information visualization only rest on the level of information delivery and no relevance consideration is given to data.

Urban Informatics of Marcus Foth focuses on how to use mass data generated by cities each day to develop, record and publish a Live Experience that can bear city vitality¹. The research indicates that integration of virtual and reality in urban space

¹ Marcus Foth, Christine Satchell, Mark Bilandzic, Greg Hearn, Danielle Shelton with Fiona Crawford: *Dramatic Character Development Personas to Tailor Apartment Designs for Different Residential Lifestyles*. (2011).

can be realized if effective urban planning is used in urban information design to analyze different typical personas.

In the research “Bjornetjeneste”, Jeni Paay and Jesper Kjeldskov have pointed out that when people shuttle among urban streets, buildings and squares, the entities of objective existence, they fail to interact with the cities they live in. If urban characteristics, for example, sound, vision, smell, building, and crowd, can be interacted through users and cellphones, it can provide interest and immersion-type interactive experience for daily life of urban residents².

In the project “Copenhagen Wheel” conducted by MIT Sensible City Lab, sensors installed on tail wheels of bikes are used to collect data such as air, noise and road. The data will be integrated in an information platform. This can effectively promote the behavior that individuals make contribution to public service, and collective guidance by system can provide fresh ideas for development of cities with better environment.

Above-mentioned researches all focus on how information can improve perspective of urban life in future urban districts, how information can contribute to existing public service and how information can be used.

Azamat Abdoullaev point out in the coming world, ternary human habitant environment will be formed by ecology, intelligence and social contact. Ecological resources are better used to create an appropriate environment. Technical revolution will promote informationized life style and socialized network can shorten the distance of people³. Real-time updated streaming media with a linear growth such as blog, video, sharing, comment, consumption record, check-in record, and browsing record beyond the individual records all belong to worldstream of mass data⁴. Opinions of David Gellernter have provided a powerful theoretical basis for the coming era of big data, but he failed to point out how to design information and how to use information to benefit existing society.

The paper also puts forward a new solution and its process to overcome shortcomings presented by prior information visualization and interaction. GeoCity, the prototype of designed urban information system, provides a new idea to benefit people.

3 Research Method and Design Prototype

3.1 Design Problem

An urban system of good operation is firstly to select useful information from the mass data and recombine and rearrange the information to make it clear and visualized and then the system will sent the information to different readers (City User and

² Jeni Paay and Jesper Kjeldskov: Bjornetjeneste: Using the City as a Backdrop for Location-Based Interactive Narratives. (2011).

³ Azamat Abdoullaev: Smart World: A Development Model for Intelligent Cites The Trinity World of Trinity Cities. (2011).

⁴ David Gelernter: The End of the Web, Search, and Computer as We Know It. (2013).

City Manager) in accordance with different demands and record new feedbacks accordingly so as to form an orderly information cycling chain. Organic urban operation system is the one to maintain such cycle in a dynamic way.

With such consideration, the research project “GeoCity” was commenced and its works were finally exhibited in Ars Electronica Festival in Linz, Austria in August 2012 and displayed in 2012 Beijing Design Week in Beijing in September.

What is data management of Eco-City? A city is the organic integration of human civilization development and natural bearing capacity and is provided with a unique survival operation system to skillfully balance the communication among human behavior, science and technology, living beings and information and to maintain vital cycling through cultural development, economic growth and environment protection.

Immigration has provided new energy for cities to make their core areas expand continuously.. As the behavior that is most frequently used by people in social activities, economic behavior continues to promote social development of urban area, producing more completion at the same time. Personal perspective has interwoven different social networks within complex area, but connection of those social networks has provided social adaptive system for individuals and groups.

Complexity of urban area develops the unique culture of a city, integrates internal and external energy, balances conflict of new and old culture, provides an expandable space for human civilization, and provides a multi-dimensional civilization development frame from the perspective of individuals, families, groups, societies and cities. Information feedbacks generated by operation of cities reflects survival demands of residents. Such feedbacks provide ideas for urban administration and planning and update the quality of human settlement environment.

Which Real Data of cities require to be visualized? When emergency disaster like the heavy rain comes, City users (residents) may consider whether surrounding area is safe, whether flooded areas will be dredged, and when subway and public transportation can operate again. City managers may focus on how many areas are flooded, what about the rescues conducted by rescuers and where the residents are held up. Due to different problem perspectives and immediate interests, required information and means for obtaining information are also different. Therefore, visualization of urban ecological system should design different contents in accordance with different readers.

It Requires a Visualized Framework with Good Management. Multi-dimensional perspective, equal stress on macroscopic and microscopic view, and combination of virtually and reality are the three-design principle of the project. Information visualization not only presents pictures and images but also carries rich knowledge and interest. Focus of the research and practice is to reveal relations. Through narration of city stories, users or audiences can find out focus from burdensome and enormous data quickly and establish logic and context of data.

3.2 Design of Research Method

During project initiation stage, the group has applied data for narration, infused Scenario on typical users, conducted comprehensive analysis for Stakeholders concerned in each Topic, and established the model Persona.

Through establishment of several models of Persona, stakeholders are identified. Statistics Data and Real Time Data are arranged to become topics. From macroscopic aspect, perspectives of City managers are used to observe trends of groups and from microcosmic aspect, perspectives of urban residents are used to look for personal sense of belonging.

Information Visualization: Information visualization is an interdisciplinary field, aiming at studying the visual presentation of large-scale nonnumeric information resources. Information visualization can transmit abstract information in a direct way. It connects the deep spirit through eyes so that the users can witness, explore and understand vast information immediately. The premise of information visualization is to collect vast data including statistical data, real-time data of sensors, pictures, words, video streaming, audio streaming etc. build the data structure, screen out a logical mainline, change into visual language and percolate easily comprehensive information experience through user interface, new media equipment, intelligent zone and so on.

3.3 Design Prototype

The aim of interactive narration is to explore the integration of Core Mechanics, Interactivity and Storytelling and Narrative on the story level, and to present the narrative design on the practical level. In this project, interactive narration is an interactive presentation with users as the subject and can help users understand and blend in the materials of presentation, get to know the flowing of the urban energy, and let the reader feel the beating pulse of a city.

Three Layers of Narrative Structure. Therefore, while presenting a city, three levels should be considered: physical space, personal perspective and collective behavior. Only in this way can people accurately understand the spiritual outlook and operating state of the city.

Urban data is from citizen activities of physical space. Incidents happened in some geographical location will form certain public opinion guide after transmission, then the new urban topic emerges and the landscape, crowd, streets and so on, surrounding the place become the background of the topic. On-line activities will soon gather and disperse different crowds after transmission. Off-line activities will in turn influence the physical space. And the topics will change the development of two virtual and real communities.

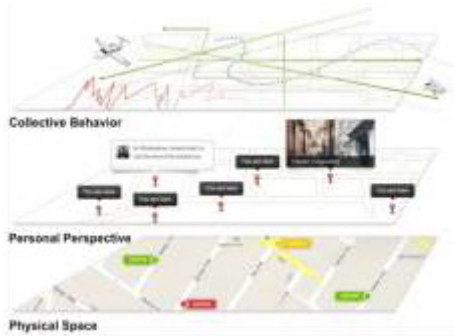


Fig. 1. Three Layers of Narrative Structure

The incidents, which caused the topics, may be traffic jam or air quality that can both be measured. If all data caused by urban operation can be recorded and the connection among all the topics can be found, then the urban problems will be obvious. City users (citizens) will find their own positions on this basis and have sense of belonging in this huge city. City managers (government) will observe the society on this basis, strike a balance between the positive emotions and negative emotions in the society and lead the healthy value orientation.

Three Dimensions of Narrative Structure

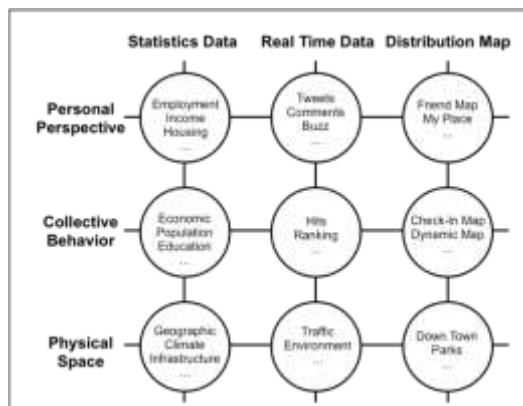


Fig. 2. Three Latitudes of Narrative Structure

Imagine the connection of the flow of real-time road and the data of environmental monitoring, and present it for the citizens in urban streets in the visualization form of dynamic map, then the causal relationship of air pollution caused by trucks will be obvious and lead the crowd to reduce the release of tail gas together through the visualization of historical data. The guide of public participation is far more economical and effective than pasting slogans and issuing policies.

Therefore, the analysis of urban data should consider three latitudes: Statistics Data, Real Time Data and Distribution Map in order to analyse the crucial reason of urban operation.

The Transformation from Narrative Structure to Information Visualization. The study analyses the formation of a city's culture from three levels: physical space, collective behavior and personal perspective and cross creates a mesh narrative structure with three latitudes: Statistics Data, Real Time Data and Distribution Map, which can understand the culture flow of a city from the perceptual perspective but also can find out the trends of a city through macroscopic and microscopic data. Find the connection among all nodes and connect, then it is possible to design a story line to lead the readers understand the pulse of a city.

For net structures, after the linear presentation of the intersection data in the design, a whole city story can be formed. This structure is different from the subjective linear logic of traditional literature, but forms different subjects like transportation, environment, green, river system, and population and so on according to different data. It can also avoid the comprehension difficulty of visualization (multifarious connecting line, intricate change of color, excessive abstract symbols and so on) in data visualization works. With such a structure, the source of driving force (energy) of urban development, the action of energy on cities, and effect of energy on direction of urban development can be better displayed.

4 Construction and Testing of Prototype

The prototype of GeoCity Beijing jointly developed by Design Beijing Lab, Ars Electronica Solution Lab and CMoDA Lab of Tsinghua University has provided new thinking for urban resource management in eco-city. Information display platform of GeoCity can change the static data of the city into dynamic charts, images and pictures through the interaction of Wisdom Pen and books, provide multilevel arrangement, distribution and hotspots according to the map, and insert change information of transportation, weather, municipal administration etc. according to geographical locations.

4.1 Geo-Referenced Interactive Platform

Geo Pulse Beijing is an urban narrative interface made by map and multiple data sets, which gathers information like population, culture, transportation and social media to a dynamic presentation platform and shows the mobility of Beijing in the method of information visualization.

This work visualizes all the numerous and complicated phenomena in the urban region in a global point of view, analyzes the dynamic trends of Beijing through many multidisciplinary perspectives of population map, cultural map, traffic map, environmental map, social map and real time data navigation. The open source system allows the public to put the newly generated data into the system and provides a new thought for the citizens and city managers to understand Beijing.



Fig. 3. The Display Scene of *Geo Pulse Beijing*

4.2 Multi-screen Storytelling System

City story is told in a dynamic way through multi-screen. It supports multimedia content like text, pictures, video, graphics, animation etc., visualize dynamic data, and is connected with Internet data. To click "start", system begins to play in a linear way according to background script. Works backgrounds of 7-screens narrative device are Beijing loop and cable road profile. Seven 21-inch LED screens are set in different geographic positions, and are strewn in well-proportioned way. There are 7 stories such as Beijinger, People Category, Ancient Gate, Foreigner in Beijing, Green Project, Urban Extending, Subway and so on, and each story is about 90 seconds. Interactive equipment is touch screen of wireless connection.



Fig. 4. 7-screens Narrative Device on Exhibition Site

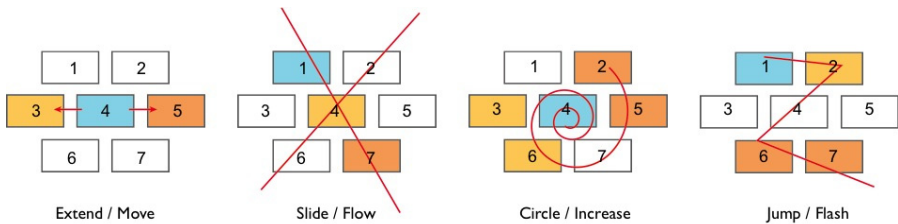


Fig. 5. Playing Mechanism of 7-screens Narrative Device

4.3 Auto-layout Based on Designed Templates

As shown in Fig.5, 7 screen narrative device playing modes can be roughly divided into four kinds: development, sliding, circulation, and jump, which choose different broadcast order according to different data, for example, in story of Urban Extending, Beijing city territory growth process since 1930s uses the developing playback modes, which expands outward continuously from center screen of No. 4, and gradually fill all seven screens.

Irregular playback modes can not only split each screen to display different data independently, but also regard seven screens as a whole picture to show a huge map, which displays in different scales to lead audience to understand macro and micro static data.

4.4 User Testing

Interactive mode of pen and book used by GeoCity Beijing system is easily understood, which can satisfy group requirements with different understanding, including children and the elderly, and has avoided the problem that information visualization system draws back distance from audience because of its complex operation.

Operation of two works' systems is stable, and popularity is larger than expected, however, there still have some regrets. As items placed in exhibition hall, intelligent pens and printing books suffer from many times of falling off and missing, which makes staff at the site replace and debug equipment for many times. If original design has a rope to trap book and intelligent pen words, above situations may be avoided ; it is a big regret that introduction words in books are small, and lamplight in exhibition site is dim, which makes reading inconvenient; the largest regret is multi-screen device; as it has no voice, many viewers did not know what the work used for even after they clicked the "start" There are few people who may leave after watched the seven stories completely, and guide design is not sufficient.

5 Next Step

Through the research project, importance of multidisciplinary overlap for information design is more highlighted. Information design belongs to a new design field, which is difficult to finish the work alone from creation to expression and then to realization. Moreover, the project data volume did not meet expected value, a lot of important data did not access to database, such as one-card data, airport inward & outward information, road surveillance video, etc., did not get API ratification by management departments due to approval procedures and security reasons, which lost more valuable visualization opportunity.

It hopes a good trust relationship will be established with government departments, and all data supporting shall be coordinated by government, to improve quality of public service, and let research results benefits for the Society.

6 Discussions

Future city shall become an interactive space, and ubiquitous sensor of city will make urban infrastructure become a real-time response system, which shall continuously upgrade to meet public use, and percept urban activity changes, and which also has reaction mechanism to deal with city information and to meet demand in real-time. the blending of virtual and reality will become city life's general environment.

An information visualization prototype has been constructed through the project, and then how to convert prototype into practical application, adding interest to life through virtual and reality interaction experience, and helping public service to improve quality shall be considered.

Traffic and atmospheric problem in Beijing now is to reach their limits, which provides a worthwhile challenge subject to design research, reveals relationship among traffic and air pollution, road safety, road congestion through information visualization, triggers thinking in emotional levels for happiness, mood, sense of belonging etc., and guides people to choose low carbon transportation. Games, and applications based on geographical positions should be develop to affect effect mobility in cities and city operating system should be established to gather and disperse city energy from a global point of view.

At the same time, to bring commercial power into research shall also be considered to make research is not only limited to solve problems, but also applied to service through design, which shall give consideration to businessman, users, environment, market other comprehensive factors to make dynamic of urban commercial visualization.

7 Conclusion

After all, urban operation still depends on arousing creativity of every citizen. To gather personal labor together to meet needs of group is the fundamental of city vigor, and packet behavior of information sharing, group wisdom, and network community shall change city innovation mode. Huge data visualization has provided multi-scale observation perspective not only for citizens to grasp the pulse of a city combined with cultural evolution, current dynamic, but also for city managers and decision makers to point out bottleneck encountered in urban development. Multilayer data structure presents relationships among traffic, environment, society, and municipal construction, which provide an idea for further upgrade of cities.

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References

1. Foth, M., Satchell, C., Bilandzic, M., Hearn, G., Shelton, D., Crawford, F.: Dramatic Character Development Personas to Tailor Apartment Designs for Different Residential Lifestyles. In: *From Social Butterfly to Engaged Citizen*, pp. 461–484. The MIT Press, Cambridge (2011)
2. Paay, J., Kjeldskov, J.: Bjornetjeneste: Using the City as a Backdrop for Location-Based Interactive Narratives. In: *From Social Butterfly to Engaged Citizen*, pp. 253–273. The MIT Press, Cambridge (2011)
3. Abdoullaev, A.: Smart World: A Development Model for Intelligent Cities The Trinity World of Trinity Cities. In: *11th IEEE International Conference on Computer and Information Technology* (2011)
4. Gelernter, D.: *The End of the Web, Search, and Computer as We Know It* (2013), <http://www.wired.com/opinion/2013/02/the-end-of-the-web-computers-and-search-as-we-know-it/>
5. Kirwan, C., Travis, S.: *Urban Media: New Complexities, New Possibilities – A Manifesto*, pp. 246–252. The MIT Press, Cambridge (2011)
6. Lerner, W.: *The Future of Urban Mobility – Towards Networked, Multimodal Cities of 2050*. Arthur D. Little, pp. 14–18. International Association of Public Transport (UITP) (2012)
7. *Ecological Cities as Economic Cities Project Brochure*, The World Bank (2012)

Original-Ecology Sounds of Cities' Impression

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Abstract. Sounds appear everywhere. From the natural sound of a primitive society to the mechanical symphony of an industrial society, we are surrounded by sounds. Along with the development of human society, new sounds are produced continually. So the sound history reflects the course of human history. However, due to a lack of awareness to our sound environment, some sounds have faded away while their value not being recognized. Original-Ecology sounds, which are without any processing, trace our ways of living and thinking, and touch on our memories and feelings. Sounds are invisible and intangible. Once gone, the crafts, lifestyle, living conditions and feelings that they used to represent will disappear along with them. Sounds are a part of our cultural heritage and deserve to be studied.

As an important part of human civilization, cities are associated with the development of human society. Today's effervescent cities generate many new sounds while accelerating the demise of traditional ones. We intend to evoke the lost memories of neglected sounds by creating an interactive, emotional-centered experience. More Than Sound, an on-line social soundscape with three major components: a mobile application, a website and a public sound installation, outlining social scenes and life stories, it does not end up at encouraging people to collect and save sounds around cities; it enables people to form a deeper understanding of their living environment through cities' vivid sound portraits.

Keywords: Original-ecology sounds, soundscape, cities, cultural protection, emotional-centered experience.

1 Introduction

Sounds appear everywhere. From the natural sound of a primitive society to the mechanical symphony of an industrial society, we are surrounded by sounds. Along with the development of human society, new sounds are produced continually. So the sound history reflects the course of human history. However, due to a lack of awareness to our sound environment, some sounds have faded away while their value not being recognized. Original-Ecology sounds, which are without any processing, trace

our ways of living and thinking, and touch on our memories and feelings. Sounds are invisible and intangible. Once gone, the crafts, lifestyle, living conditions and feelings that they used to represent will disappear along with them. Sounds are a part of our cultural heritage and deserve to be studied, according to UNESCO, even as intangible cultural heritage¹. Therefore, in recent years, sound protection plans have got social approval and public's support.

As an important part of human civilization, cities are associated with the development of human society. Today's effervescent cities generate many new sounds while accelerating the demise of traditional ones. This design intends to evoke the lost memories of neglected sounds by creating an interactive, emotional-centered experience through a social soundscape. This design, grouping sounds by cities, encourages people involved in cultural protection to collect sounds around a city, creating a global impression by piecing together the different fragments.

More Than Sound, an on-line social soundscape, consists of three major components, a mobile application, a website and a public sound installation. Comparing to the mobile application and the website, we focused more on the public sound installation because of its greater flexibility and stronger sense of engagement.

2 Related Work

In recent years, Britain, Germany, America, Spain, South Korea and other countries have begun sound protection plans on the internet, with Britain's are the most complete and abundant. For instance, the "Save Our Sound" project of BBC² is aim to build a sound map of the world through encouraging people to snapshot sounds in their daily life and share the recordings to its website. While "London Sound

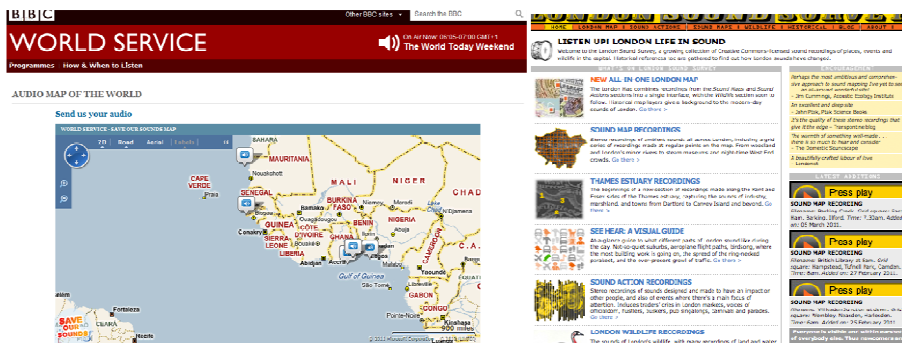


Fig. 1. "Save Our Sound" & "London Sound Survey"

¹ Meri Kytö, Nicolas Remy & Heikki Uimonen, European Acoustic Heritage, published by Tampere University of Applied Sciences (TAMK) & Grenoble: CRESSON 2012.

² <http://www.bbc.co.uk/worldservice/specialreports/saveoursounds/index.shtml>

Survey”³, even though only collecting sounds in London, it has a very detailed classification of sounds, includes social, economic, culture, religion and so on. However, all these projects end up at collecting and uploading sounds, what we hope is to dig into people’s mind to provide a more interactive and emotional way to enhance people’s engagement in experiencing and saving sounds.

3 About Original-Ecology Sounds

3.1 Definition of Original-Ecology Sounds

Original-Ecology is a new phrase. People are talking a great deal of something in the original ecological form, such as “primitive” or “natural” music or performance or painting, etc. In this paper, original-ecology sounds mean sounds without any processing. They are fragments of living spaces, reflecting the most real life state of human beings. Every single, little original-ecology sound of daily life contains many kinds of information like a place, the people who live there, their beliefs, etc. For instance, the sound of a teapot in the morning can be associated with the warmth of family and motherly love. These sounds can connect with our feelings directly.

3.2 Relationship between Original-Ecology Sounds and Human Emotions

Original-Ecology Sounds and Regional Culture. A sound is produced within a physical environment, thus its content is strongly related to its location. Every place is represented by its sounds: shouts from Beijing Hu Tongs or from Guangzhou Teahouses, ringing in Shanghai Linongs, etc. These sounds are marked by the regional culture. Upon hearing these typical sounds, people who come from these places would attach their memory naturally. R. Murray Schafer, a Canadian composer and environmentalist, has put forward a concept of “soundmark”. It is derived from the term “landmark”. A soundmark is a sound which is unique to an area. He said, “Once a Soundmark has been identified, it deserves to be protected, for soundmarks make the acoustic life of a community unique”.⁴

Original-Ecology Sounds and Time characteristics. In addition to the illustrations of regional culture, sounds are characteristic of their times. Different historical periods will produce different sounds. In 1930s and 1940s, it was filled with the roar of war fire sound in China; while in 1950s and 1960s, it was the idolatrous crazy cries because of the Cultural Revolution. Time characteristics are blended into the acoustic impression subliminally.

Original-Ecology Sounds and Human Emotions. A song is touching, because it sings into your heart; a sound is attractive and impressive, because it carries your feelings and memories. Combining above two features, sounds is contagious by its emotional resonance. As Emotional Design mentioned: The objects in our lives are

³ <http://www.soundsurvey.org.uk/>

⁴ R. Murray Schafer, *The Tuning of the World*, published by Univ of Pennsylvania Pr, 1981.

more than mere material possessions. We take pride in them, not necessarily because we are showing off our wealth or status, but because of the meanings they bring to our lives.⁵ This sentence simply explained that our attraction to an item is not the item itself, but because of the related meanings and emotions. Therefore, people have more in common with sounds closely related to their lives. It could be the roar of the train, or shouts from the local farmers market, or the chirping of birds in the morning, etc.

4 Design Concept of a Social Soundscape

Original-ecology sounds carry the culture of different regions and times. Hearing, as a perception, can evoke rich scenes. In observing this, we came up with an idea about establishing an on-line social soundscape which outlines social scenes and life stories. It is named More Than Sound. This design, basing on cities, advocates people to collect sounds around their local areas, creating a global impression of their own city by piecing together the different sound fragments. Therefore, people can understand cities in a whole new way. More Than Sound consists of three major components, a mobile application, a website and a public sound installation.

As science and technology develop, networks will be everywhere. People can exchange information from different devices without any limitation of place and time. From large-scale computers to portable computing devices, from traditional hard disks with limited storage to modern cloud computing with large capabilities, the technological advances have created good conditions for collecting and storing sounds. People can record sound anywhere and at any time by using portable computing devices.

In this way, the mobile application is the fundamental part of the whole system. Given the portability, mobility and versatility of mobile phones, it is easy for people to collect sounds while adding extra information, such as the location and photos. They can upload, share and manage sounds through the network. The website can collect the sounds that were not recorded through the mobile application. It also provides users with additional social features. The public sound installation, getting data from the two basic clients above, allows people to experience sounds in a public space.

5 Design and Development

5.1 Social Research

Share Stories: achieve shared empathy and a common vocabulary.⁶ Sharing stories is a design approach to understand our audiences. According to respondents' descriptions, we can know about their needs and feelings. In this section, I want to proof the below two points:

⁵ Donald A. Norman, *Emotional Design*, published by Basic Books, 2005.

⁶ Banny Banerjee, Stanford University, *Design thinking based co-creation*, 2010.

- There are some cherished sounds in everyone’s memory.
- People are willing to participate in sound protection plans for their cities.

We conducted separate in-depth interviews with 7 people from different background. According to the result of our survey, we found that each interviewee has their own cherished sounds closely related to their living environment. And they were all willing to record and share these sounds.

One of our interviewees said:

“My hometown is a small village in Mongolia. It is a very quiet place. In winter snowing nights, I can hear the snowflakes falling to the ground with a gentle sound. When I think of my hometown, it is the courtyard in the early summer. The wind is blowing the leaves around, rustling. When the wind is becoming weak, I can hear the shouts of traders from so far away, and my dog starts barking. Then, the wind gradually becoming strong again, all that’s left is the rustling leaves sound... Maybe the fact is not so, because memory is always changing. I would like to call it as ‘Heart Sounds’.”

Indeed, sounds become blurred as the years go by, but some of them have imprinted in heart. These sounds can evoke audiences’ strong emotional resonance.

5.2 From Service Blueprint to Sound Tag

Service Blueprint is used to be an effective design approach for constructing service systems, but we would like to use it to explain this soundscape system because of its clear and pragmatic structure. During designing the interaction flow, we need to consider the complete operation of a user behavior. Therefore, it is a chain from a user’s operating behavior to the visual interface and eventually to the background data processing.

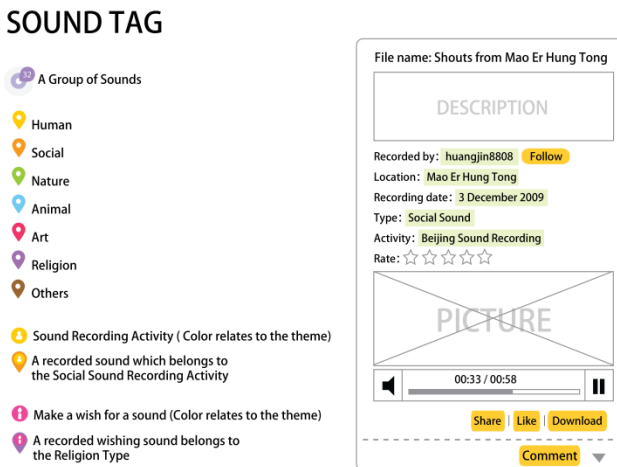


Fig. 2. Sound Tag

After two days classification of blueprint, we found that no matter what user operations are, all are linked to the sound tag attributes. Consequently, as long as the sound tag attributes are sufficiently complete and accurate, the system can meet the needs of users. Below is a sound tag sample with a brief description.

5.3 Specific Design of the Public Sound Installation

Information Framework. As we have mentioned above, the social soundscape consists of three components, a mobile application, a website and a public sound installation. Comparing with the mobile application and the website, the physical installation allows more design possibilities and is more attractive to our audiences by its stronger sense of engagement. We hope to use this medium to enhance people's awareness of their acoustic environment and arouse people's enthusiasm in saving sounds.

There are three sections of the physical installation: Project Introduction, Sound Exploration and "Sound Parcels". Sound Exploration is the core section of this installation, including different cities' soundscapes and "Sound Postcards". Project Introduction is an overview of this sound protection plan, while "Sound Parcels" provides an e-mail service for audiences. People can select their favorite sounds after providing their e-mail addresses, and then the system will send the selected sounds to them.

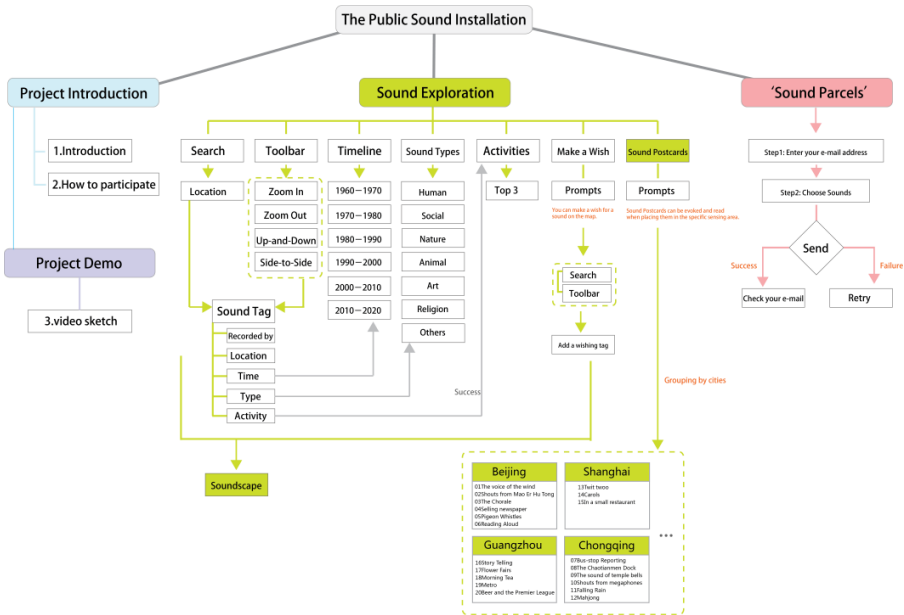


Fig. 3. Information Framework of the Public Sound Installation

Sound Postcards. Postcards which always carry best wishes are not only miniatures of places, but also mediums for people to convey feelings and emotions. In observing

these similar characteristics to original-ecology sounds, we intended to combine the postcard concept to our design, thus formed Sound Postcards. Sounds grouping by cities are bound to separate RFID chips which are inserted into different physical postcards. Once people placing them in the specific sensing area, these postcards can be evoked and read, while the visual content is showed in a related big screen.

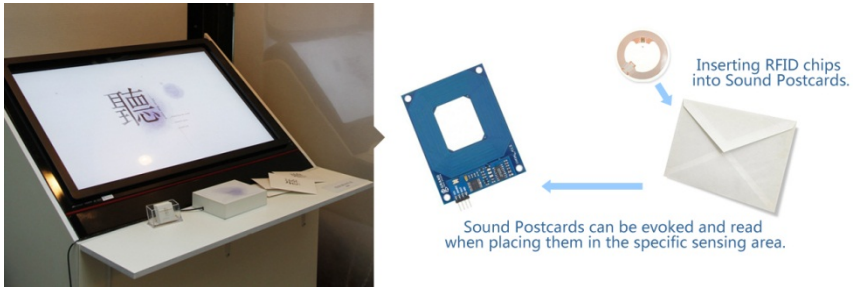


Fig. 4. An Illustration of Sound Postcards

5.4 Visual Design

The interface design is aim to create an immersive atmosphere of listening. Sound as an invisible and intangible media, comparing to the physical form, it is like the ripple which appears after a stone falls into water. Chinese Painting style, as a combination of flowing rhythms and elegant colors, expresses a sense of quiet and harmony. As a result, we combined these two factors to form our final interface design style which leads people into a state of wholehearted listening.



Fig. 5. The Interface Design Style of More Than Sound

6 Conclusion

Original-ecology sounds are like the auditory historical texts, outlining the social scenes and life stories. More Than Sound, it does not end up at encouraging people to collect and save sounds around cities; it enables people to form a deeper understanding of their living environment through cities' vivid sound portraits.

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References

1. Kytö, M., Remy, N., Uimonen, H.: European Acoustic Heritage. Published by Tampere University of Applied Sciences (TAMK) & CRESSON, Grenoble (2012)
2. Murray Schafer, R.: The Tuning of the World. Published by Univ. of Pennsylvania Pr. (1981)
3. Norman, D.A.: Emotional Design. Published by Basic Books (2005)
4. Banerjee, B.: Stanford University. Design thinking based co-creation (2010)

Part V
Cultural Differences on the Web

Comparison of Trust on Group Buying Websites between American and Chinese Young Adults

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Abstract. This study aimed to investigate the difference of trust and purchasing behaviors of group buying websites between Chinese and American participants. The study consisted of two steps: 1) a pre-questionnaire to test the general trust on group buying websites; 2) an in-lab experiment to test the purchasing probability and trust on specific trust situation. 20 Chinese and 20 American university students were recruited to participate in the study. According to the results, Chinese and American participants showed differences in Personality-Based Trust and Institution-Based Trust. Only in Calculative Trust Situation, Chinese participants showed significantly lower trust level than American participants. There were no significant differences of purchasing probabilities between Chinese and American participants.

Keywords: group buying websites, trust, cross-cultural differences.

1 Objective and Significance

Group buying is a new e-commerce model. Group buying websites provide opportunities for businesses to sell large amounts of products and service in short periods of time, but at low prices. Cheapness is the most attractive feature of group buying websites. The world's earliest group buying websites, Groupon, was set up in American in November 2008. The first group buying websites in China was started in 2009. The market of Chinese group buying websites exploded in 2010 and 2011, but this market is experiencing a trust crisis.

According to the previous research of the authors, factors influencing Chinese customers' trust on group buying websites were different from those on B2C websites [3]. Chinese participants showed significantly lower trust but higher purchasing probabilities on group buying websites than on B2C websites. Hence, the current study followed up this previous research and study aimed to investigate the difference of trust and purchasing behaviors of group buying websites between Chinese and American participants.

2 Literature Review

Trust is one of the most important roles in e-commerce [7]. Trust can reduce the perceived uncertainty for both sides of buyers and sells in ecommerce [4, 8]. For the

business model of group buying websites, customers always perceive higher risk. Trust even plays a more important role than traditional e-commerce.

Some researchers defined trust as a multidimensional collection based on context [2, 9]. Five trust dimensions were summarized, i.e. Personality-Based Trust, Knowledge-Based Trust, Cognition-Based Trust, Calculative-Based Trust, and Institution-Based Trust [5]. Institution-Based Trust consisted of two subscales, i.e. Structure Assurance [1] and Situational Normality [11]. Personality-Based Trust consisted of three subscales, i.e. Trust Proposition [12], Humanity Loyalty [4], and Trust Stance [10].

The comparison of trust on group buying websites between America and China seems interesting. America has the earliest group buying website and Chinese has a large market.

3 Methods

For the purposes of the current study, an experiment was designed. The experiment contained two steps: 1) a pre-questionnaire to measure the general trust on group buying websites and self-construal of participants; and 2) an in-lab experiment to measure the trust level and purchasing behaviors in specific trust situations.

The pre-questionnaire did not involve Knowledge-Based Trust, because Knowledge-Based Trust was based on the familiarity of the specific websites and the pre-questionnaire just aimed to investigate the general trust.

In the in-lab experiment, participants should complete four group buying websites corresponding to their own cultures. There were four independent variables in the experiment, i.e. Cognition-Based Trust, Institution-Based Trust, Calculative-Based Trust and culture. Each of the three trust scale variables has two levels, high and low. To reduce the participants' load, the experiment used 2³-1 (=4 treatments) factorial design. Each treatment stood for one kind of trust situation. The cultural variable has two levels, Chinese and American. The in-lab experiment did not involve Personality-Based Trust, because the participants' personality was considered intrinsic which would not change during the experiment. Hence, Personality-Based Trust was a covariant in the experiment. There were two dependent variables in the experiment, i.e. purchasing probability in each treatment and trust on the treatment.

After completing each website, participants should answer a short post-questionnaire to measure their trust on the specific website.

The young people are considered to be the major customers of group buying websites [13]. The current study recruited 20 Chinese university students and 20 American university students as the participants. The participants aged from 18 to 26 years old. The independent Sample t-testing results indicated that there was no age difference between the two samples (Sig. = 0.368). All the participants had the experience of group buying websites. The gender was balanced for both American and Chinese samples to reduce the gender influence.

Table 1. Treatment of each trust situation

Trust scale	Treatment			
	Best situation	Cognition situation	Calculative situation	Institution situation
Cognition trust	+	+	-	-
Calculative trust	+	-	+	-
Institution trust	+	-	-	+

4 Data Analysis

4.1 Reliability Test of the Pre-questionnaire

Cronbach's Alpha testing was used to measure the reliability of the pre-questionnaire. A scale with a Cronbach's Alpha value of higher than 0.60 is considered acceptably reliable [6]. For both Chinese and American participants, the Cronbach's Alpha values of all the subscales were higher than 0.60, except for the subscale of Humanity Loyalty (Chinese: 0.572; American: 0.404). Because of the small sample sizes, the questionnaire was still considered reliable.

4.2 Differences of Trust on Group Buying Websites between Chinese and American Participants

Paired t-testing was used to measure the differences of trust scales / subscales between Chinese and American participants. The detailed results are listed in Table 2.

Table 2. Paired t-testing results of differences of trust scales / subscales between Chinese and American participants

Trust scale / subscale	Nationality	Mean	SD	t	Sig.
Trust Proposition	Chinese	4.83	1.115	-	0.035
	American	5.50	0.811	2.189	
Humanity Loyalty	Chinese	5.35	0.727	2.198	0.034
	American	4.83	0.783		
Trust Stance	Chinese	4.95	1.180	-	0.697
	American	5.08	0.799	0.392	
Cognition-Based Trust	Chinese	4.95	1.075	-	0.222
	American	5.35	0.961	1.241	
Calculative-Based Trust	Chinese	4.83	1.106	-	0.587
	American	5.02	1.011	0.547	
Structure Assurance	Chinese	4.97	0.911	-	0.019
	American	5.58	0.657	2.456	
Situational Normality	Chinese	4.85	0.921	-	0.042
	American	5.40	0.722	2.102	

Result is significant at the 0.05 level (2-tailed).

American participants showed significantly higher Trust Proposition than Chinese participants (Sig. = 0.035) while Chinese participants showed significantly higher Humanity Loyalty than American participants (Sig. = 0.034). Hence, Chinese participants were more intended to consider other people trustable and reliable, however, they were less intended to trust and rely on other people.

American participants showed significantly higher Structure Assurance (Sig. = 0.019) and Situational Normality (Sig. = 0.042) than Chinese participants. Hence, Chinese participants showed lower trust on Institution-Based Trust.

4.3 Differences of Trust on Group Buying Websites between Chinese and American Participants in Specific Trust Situations

Independent t-test was used to analyze the differences of trust in specific situation between Chinese and American participants. The detailed results are listed in Table 3.

Only in Calculative Situation, Chinese and American participants showed significant difference of trust on group buying websites (Sig. = 0.014). One of the reason was that American participants considered that whether the websites could provide some profits and convenience were more important than Chinese participants. Another reason was that Chinese participant trust less on the websites than American participants while Cognition-Based Trust and Institution-Based Trust were both at the low levels.

Table 3. Independent t-testing results of differences of trust in specific situation between Chinese and American participants

Trust situation	Chinese		American		t	Sig.
	Mean	SD	Mean	SD		
Best situation	4.87	0.626	5.169	0.603	-1.543	0.131
Cognition situation	4.45	0.581	4.45	0.630	0.000	1.000
Calculative situation	4.83	0.595	5.31	0.577	-2.563	0.014
Institution situation	4.08	0.487	4.24	0.681	-0.835	0.409

4.4 Differences of Purchasing Probabilities between Chinese and American Participants in Specific Trust Situations

Chi-square testing was used to measure the differences of purchasing probabilities in each trust situation between Chinese and American participants. The detailed results are listed in Table 4.

Although American participants had higher purchasing probabilities than Chinese participants in most situations, there was no significant difference (all Sig. > 0.05). Hence, in the same trust situation, Chinese and American participants had no differences of purchases on group buying websites.

Table 4. Chi-square testing results of purchasing probability

Trust situation	Nationality	No. of purchase	No. of not purchase	Chi-square	Sig.
Best situation	Chinese	18	2	0.000	1.000
	American	18	2		
Cognition situation	Chinese	13	7	0.476	0.490
	American	15	5		
Calculative situation	Chinese	10	10	2.667	0.102
	American	15	5		
Institution situation	Chinese	17	3	3.243	0.072
	American	20	0		

Result is significant at the 0.05 level (2-tailed).

5 Results and Conclusions

Based on the data analysis of the pre-questionnaire, American and Chinese participants showed some differences. Compared with American participants, Chinese participants showed 1) significantly lower Institution-Based Trust; 2) significantly higher Trust Proposition and significantly lower Humanity Loyalty. No significant differences were found between Chinese and American participants in Cognition-Based Trust and Calculative-Based Trust.

Based on the data analysis, only in Calculative Trust Situation, Chinese participants showed significantly lower trust level than American participants (the results are significant at the 0.05 level). Chi-square test results showed there were no significant differences of purchasing probabilities between Chinese and American participants (all Sig. > 0.05).

Chinese participants showed higher internal intention to trust on group buying websites. However, Chinese participants showed significantly lower trust level on general group buying websites and significantly lower trust level on the websites in the same level of trust situations. The differences of trust did not reflect in purchasing behaviors. American and Chinese participants showed no difference in purchasing behaviors.

In the future work, the results of the self-construal questionnaire will be analyzed. The culture factors will be considered to explain the differences of trust and purchasing behaviors between American and Chinese participants.

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References

1. Baier, A.: Trust and Antitrust. *Ethics* (96), 231–260 (1986)
2. Butler, J.K.: Toward understanding and measuring conditions of trust: Evolution of a condition of trust inventory. *Journal of Management* 17, 643–663 (1991)

3. Chen, N., Rau, P.L.P.: The Influence Factors on Trust in Chinese Group Buying Websites. In: Proceedings of the 10th Asia Pacific Conference on Computer Human Interaction, Matsue, Japan, August 28-31 (2012)
4. Gefen, D.: E-Commerce: The Role of Familiarity and Trust. *Omega* 28(6), 725–737 (2000)
5. Gefen, D., Karahanna, E., Straub, D.W.: Trust and TAM in Online Shopping: An Integrated Model. *MIS Quarterly* 27(1), 51–90 (2003)
6. Hair Jr., J., Anderson, R., Tatham, R., Black, W.: Multiple discriminant analysis. *Multivariate Data Analysis with Readings*, pp. 178–237. Prentice-Hall International Inc., Englewood Cliffs (1995)
7. Handy, C.: Trust and the virtual organization. *Harvard Business Review* 73(3), 40–50 (1995)
8. Jarvenpaa, S.L., Tractinsky, N., Vitale, M.: Consumer Trust in an Internet Store. *Information Technology and Management* (1), 45–71 (2000)
9. Kumar, N., Scheer, L.K., Steenkamp, J.E.M.: The Effects of Supplier Fairness on Vulnerable Resellers. *Journal of Marketing Research* 17, 54–65 (1995)
10. McKnight, D.H., Choudhury, V., Kacmar, C.: Developing and Validating Trust Measures for E-Commerce: An Integrative Typology. *Information Systems Research* 13, 334–359 (2002)
11. McKnight, D.H., Cummings, L.L., Chervany, N.L.: Initial Trust Formation in New Organizational Relationships. *Academy of Management Review* 23(3), 472–490 (1998)
12. Rotter, J.B.: Generalized Expectancies for Interpersonal Trust. *American Psychologist* (26), 443–450 (1971)
13. Wu, C.C.: A Study of the Effect of Consumer's Internet Group Buy Motivation, Internet Involvement and Product Involvement on Leisure Experience-An Example of Websites for Group Buy (2010)

How to Make Friends in Social Network Service? A Comparison between Chinese and German

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Abstract. Social network service is very popular all around the world. Global social network service assists Chinese users to have more friends from different countries. Friend-making on social network service is not systematically documented and reported for Chinese. Making friends in social network service and making friends in real life include similar activities such as invitation, knowledge sharing and communication. Almost everything users can do in real life can be done through internet. For example, in social network service E websites such as Facebook users can share a photo with their friends as they do in real life. The difference between making friends in social network service and in real life exits on the way how these activities are done. For example, in real life photo sharing is usually accompanied with a face-to-face talking while in social network service it is mainly the online comments on the photo. Therefore it is interesting to find if Chinese user behavior on social network service is consistent with that in real life.

Thus it is necessary to design social network service with consideration of Chinese usage pattern. For example, as Chinese tend to have more virtual friend social network service websites can recommend. Social network website can use online activity such as “campus star” to require Chinese user to explore other’s home page or use “explore” button to have user randomly go to strangers’ homepage. More virtual communication style can be added to increase ease of use. For example voice and video message can be applied in social network service in addition to text message.

The result indicates that the Chinese participants have more virtual friends than German participants while German users contact their friends more often in real life. There is no big difference between Chinese and German participants on communicating with their friends and sharing information. The result shed light on future research on Chinese friend-making behavior on social network service and user interface design for Chinese.

Keywords: social network service, cultural difference.

1 Introduction

Currently, social networks are being adopted rapidly by millions of users most of whom are young people with a great number of purposes in mind (Lenhart & Madden, 2007).

There are hundreds of social networks with various technological applications serving to a wide range of interests most of which support the maintenance of pre-existing social relations, however, many others help strangers to connect to others' profiles with shared interests, needs, political views etc. (Boyd & Ellison, 2010). Social networks include various people both as authors as well as readers, nonetheless personalized content, information sharing and collaboration are the socializing dimensions of these tools (Bartlett-Bragg, 2006). As Lenhart and Madden suggested, 55% of teenagers use social networks in their daily lives most of whose purposes are limited to communicating with friends, making new friends and sharing personal information and materials (Lenhart & Madden, 2007).

Social networking websites, such as Facebook and RenRen are member-based Internet communities that allow users to post profile information, such as a username and photograph, and to communicate with others in innovative ways such as sending public or private online messages or sharing photos online. In the spring of 2006, Nielsen//Net Ratings reported that the top 10 social networking sites in the U.S. grew in number of users from 46.8 million to 68.8 million during the previous year (Nielsen, 2006). Nowadays Facebook has 630 million daily visitors. Started 15 years ago and now it's ranked second based on daily view (WolframAlpha, 2011). Social networking websites reveal important information about how adolescents and young adults are interacting with one another in the information age.

Social Networking Sites (SNSs) such as Facebook are one of the latest examples of communications technologies. Millions of contemporary young adults use social networking sites. However, little is known about how much, why, and how they use these sites. The purpose of this study was to provide descriptive information about the use of social networking sites by both Chinese and German SNS users.

Social networking sites persuade millions of users each day to adopt specific behaviors. To understand this phenomenon in the context of persuasive technology, the present study analyzed how persuasion takes place in leading social networking sites from two different countries: Facebook in the Germany and RenRen in china. The present study also compared the two services on some specific tasks. Our analysis reveals the differences and similarities in how Facebook and RenRen are designed to influence users toward the achievement of these tasks. These persuasion styles seem to map generally cultural differences between the Germany and China.

2 Literature Review

In the 'Online Persuasion in Facebook and Mixi: A Cross-Cultural Comparison' B.J. Fogg and Daisuke Iizawa from Stanford analyzed the cultural difference between Facebook and Mixi users (Fogg & Iizawa, 2008). About creating a personal profile page, they found out, that Facebook profile creation is a one long step without any initial trust-building period, whereas Mixi's approach is a two stage model. Kim deals with the comparison of American and Korean college students and the way they use social networks (Kim, Sohn, & Choi, 2011). The result was that the motives for using SNSs were identical: seeking friends, social support, information, entertainment and

convenience. But the patterns of usage were very different. Acquistand and Gross-deals's research suggest that age and student status are the most significant factors in determining a Facebook membership (Acquisti & Gross, 2006). The study shows that there is a dichotomy between privacy concerns and willingness to share private information. Wilson indicated that the emphasis was set on user interactions and to show that users tend to interact most of the time only with a small group of friends, thus they have basically no interactions with almost 50 % of their other Facebook friends (Wilson, Boe, Sala, Puttaswamy, & Zhao, 2009). As a result it is shown that interaction activity on Facebook is significantly skewed towards a small portion of each user's social links. This is contrary to the general assumption, that all social friendships have the same meaning. Therefore they introduced a so called 'interaction graph' as a more accurate representation of meaningful friendships on social networks. Kwon and Wen's reserach show the extended TAM based on the conventional TAM with the new perceived constructs and external variables to test the social network service (SNS)(Kwon & Wen, 2010). It chooses seven variables including three individual characteristics which are social identity, telepresence, and altruism; three external determinants which are perceived ease of use, perceived usefulness, and perceived encouragement; and the final variable, actual use. In L. Li's 'Case Study on Facebook and Renren Network' the main focus lies on the comparison between Social Network Sites in the United States and China. One of the result shows that Facebook users diversify their sources of information, while Renren network users have only single sources (Li, 2011). Facebook users are mainly young people, but Renren users are aged between 18 and 34. Facebook has also more widely user groups than Renren. The last result is that on Facebook the men-to-women ratio is pretty much equal wheareas Renren users are mostly women. This may be due to the fact that the two sites provided different application whose attractiveness is different between men and women.

3 Research Framework

The present study concentrated about three principal arguments, invitation, knowledge sharing and trust. The present study concentrated to the typologies of friends have a typical user in the different SNS. The result about the discussion was interesting because the present study realized that Facebook users usually have more friends who are not friends in the real society. This phenomenon is called cyber-friends and in the last 15 years it is in continuo increase in the USA. So our questions are: do typical Renren user have cyber friends? And if he has not, why does not this phenomenon start in Renren SNS?

Hypothesis1: Facebook users have more net friends who are not friends in the real society, while Renren users have more friends who are already friends in the real world.

The second topic about this study was knowledge sharing. The result was that the goal to use SNS for Renren users is to share emotional things and talk about himself, but for Facebook users that is uneasily. In addition Facebook users share more useless

things than Renren users. So the research questions are: do typical Renren user share more simply emotional things than typical Facebook user? And are the topics shared more serious in Renren than Facebook?

Hypothesis2: Renren users share more emotional things and thinking about the society than Facebook users.

The last topic about this study was trust in the two different SNSs. For Chinese people, one interesting argument was that Renren users usually share their argument in a fixed group but for Facebook users that is not usually true. So our questions are: do Renren users usually share their topic in a fixed group? And do Facebook users share their topic in the same way? If not, why?

Hypothesis3: The topics of Renren users are more restrict to a fixed group.

4 Method

To test the hypotheses more accurately, the present study use the method of experiment to collect data. Besides a small questionnaire survey is included in the experiment.

4.1 Experiment Design

This is a controlled laboratory environment, where distraction or external stimuli is avoided. 8 Facebook users from Germany and 8 Renren users from China with comprehensive network (at least 50 friends) were invited to the experiment. The tasks included adding new friend, grouping new friends and answering some questions about their current friends (in a 7-point Likert scale survey, as shown in Table 1). Total experiment time was last for around 120 seconds.

Table 1. The questionnaire

No.	Question description
1	I go to Facebook/Renren to be politically informed.
2	I go to Facebook/Renren to find some entertainment
3	I go to Facebook/Renren to get serious information about my environment.
4	I go to Facebook/Renren to keep in touch with friends.
5	I go to Facebook/Renren to check all the comments/pictures of my friend.

5 Results and Discussions

In a study, a population is the set of all the elements of interest and a sample is a subset of the population. A primary purpose of statistical inference is to develop estimators and test hypothesis about population parameters using information contained in a sample. Our hypotheses are universal hypotheses and therefore the participants of our experiment and survey have to meet several requirements to ensure a valid scientific

analysis. First each participant selected has to be from the population which includes all the social network users worldwide. This criterion is easily met for our experiment because the present study have Chinese and other international students here in Tsinghua University. A second criterion is that the participants are selected independently. Since Facebook is used throughout the whole world, there can be a lot of differences between Facebook users from different cultural backgrounds. So to be able to compare RenRen users with a specific homogenous representative group of Facebook users the present study choose a group of German users. Besides, in order to meet this criterion the present study had to make an assumption. The assumption is that Chinese students are representative for RenRen users and German Students are representative for one user group of Facebook.

5.1 Analysis of Hypothesis1

The that if the friend is just on the list of the participant’s social network, but they meet each other seldom, then The present study consider they are not friends in the real society but net friends. In order to verify our Hypothesis1, The present study should pay attention to the results of all the three tasks. First, Chinese participates add more new friends than German participates;

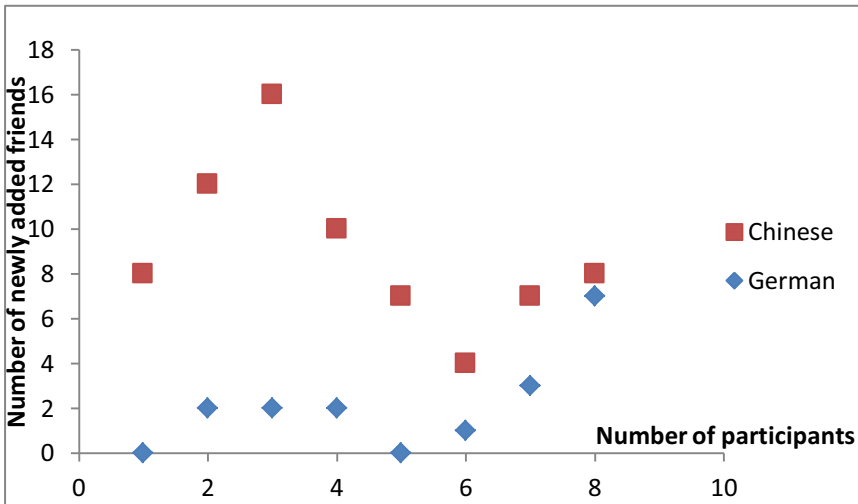


Fig. 1. Number of newly added friends

Second, Chinese participants’ newly added friends mainly belong to the university group and they only add friends from the university and hometown, while German participates have friends in 3 different groups and the three groups have almost the same number distribution of new friends. That means German people’s social network is more diverse than Chinese people’s;

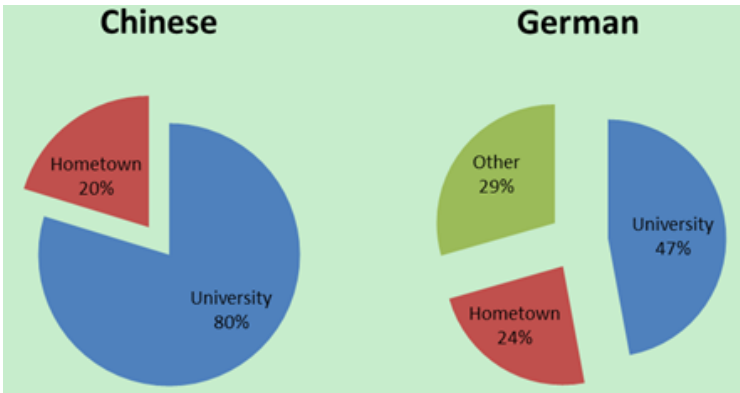


Fig. 2. Diversity of friends for Chinese and German participants

Third, it is shown from the result of task 3 that Chinese participants have more friends on Renren, but the percentage of friends who they can regularly meet in the real life is smaller. The result can be shown in the following figures.

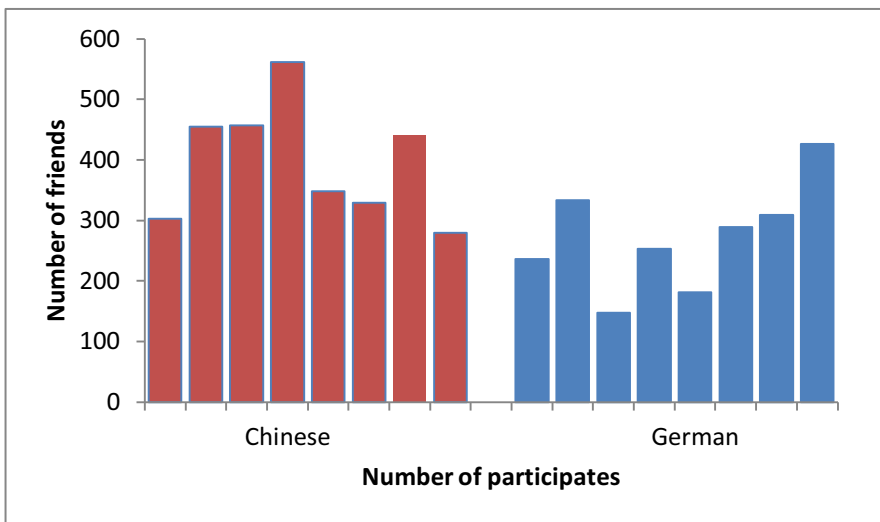


Fig. 3. Total number of friends

These results are basically the other way around than hypothesis 1 states, so it cannot prove our initial hypotheses and on the given information cannot validate hypothesis 1.

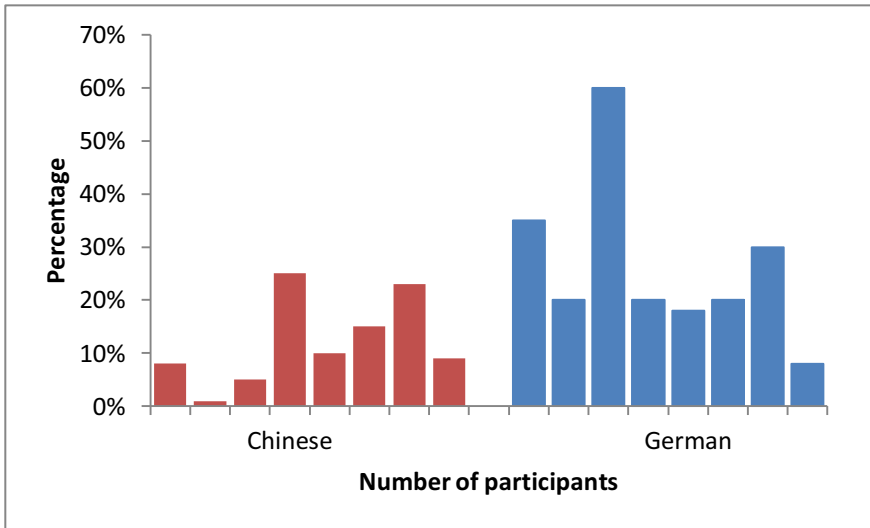


Fig. 4. Percentage of friends regularly meeting

5.2 Analysis of Hypothesis2

To analyze Hypothesis 2, it had to split the hypotheses into two parts: First whether Renren users share more emotional things and second if they share more thoughts about the society. The first part relates to the questions number four and five of our questionnaire. The second part of hypothesis 2 relates to questions number one, two and three of the questionnaire. Mean rating of Chinese participants is 4.625(SD=3.41), and mean rating of German participants is 6.625 (SD=0.268). The t-test result indicate the difference in the answers for all the questions on emotion-related sharing is significantly different between Chinese and German participants (t=2.949, p-value= 0.009).

Here German participants chose a higher value which means that they want to stay more in touch with friends. Statistically it can be proven, that both means (μ) are different. This can be done with the rejection of $H(0)$ with a probability of 95% because the p-value for this question's answers is less than $\alpha(0,05)$. Very peculiar is the fact that the answers of the German for question 4 have a very small variance. This may be due to the fact that all Germans understood this question in the same way, whereas Chinese maybe didn't understand the question in the same way. Since this statement can be seen as a motto of SNS the German participants maybe were influence by the media, which often states that SNS's main purpose is 'to stay in touch with friends'. Maybe the variance in the answers of Chinese people is due to the fact that they are not yet influenced by the media and by publicity concerning SNS. This result maybe can also be explained by the fact, that Facebook is not limited to Germany and that Facebook users can have a lot of international friends. Most people build up a more or less international network of friends in Facebook. RenRen users don't have this possibility, because RenRen is pretty much restricted to China and to Chinese users. So

the fact, ‘to stay in touch with friends over physical boundaries of countries’, is an issue for Facebook users, but not for RenRen users. This is the only significant difference that could be found during the analysis of the data. Otherwise it cannot be verified, that RenRen users share different things than Facebook users. This counts for emotional topics as well as serious conversation about society and politics. Both SNS users have the same attitude and share the same values, except for the international fact.

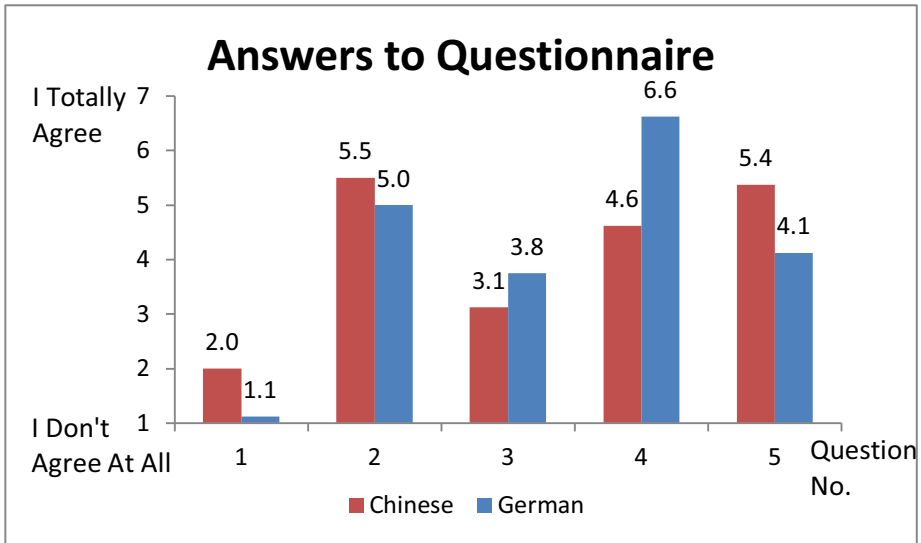


Fig. 5. Answers to Questionnaire

5.3 Analysis of Hypothesis3

To analyze Hypothesis3 the present study used the data about task 2 in the experiment. The experiment gave us how many friends each participant added to each group. For analyzing this data the present study summed for each participant the friends added in all groups. In average, Chinese participants add 9.25 (SD=12.78) friends in one group and German participant add 2.13(SD=4.98) in one group. The t-test result indicates there is a significant different between Chinese and German participants (t-value = 1.782 and p-value = 0.000) We are looking for evidence to conclude that μ (Chinese) is greater than μ (German) so the difference between the two population means $\mu(c)-\mu(g)$ will be greater than zero. The present study can see that The present study can prove our hypothesis because The present study can reject $H(0)$ with 95% of probability because p-value is less than $\alpha(0,05)$. The p-value is very small because as The present study can see the two mean estimator values are very different.

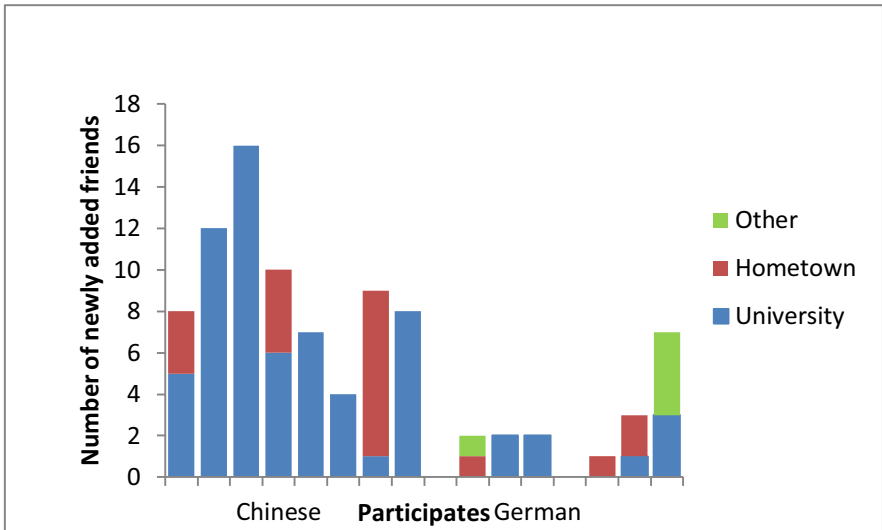


Fig. 6. Group of friends

It is also shown that Renren users added more friends than Facebook users in groups like university and hometown but this is not true for other group and the results for groups like work or hobbies are the same.

6 Conclusions

Although the present study conducted the experiment, questionnaire and following statistical analysis very thoroughly it is almost impossible to make a statistically safe statement, because the number of participants was very scarce. Still it is possible to see some very interesting tendencies and to draw some conclusions from that. To sum up, the present study observed one can say that these Chinese SNS users have more net friends than German SNS users, but German users see their friends more regularly in real life. There is no significant difference between Chinese and German SNS users in terms of communicating with their friends and sharing information. For our research participants it can be seen that the Chinese participants are more restricted to people from university – this being a cultural difference - and to people from China - this would be a structural aspect, because Renren is only in Chinese.

References

1. Acquisti, A., Gross, R.: Imagined communities: awareness, information sharing, and privacy on the facebook, Cambridge, UK. Paper presented at the Proceedings of the 6th International Conference on Privacy Enhancing Technologies (2006)
2. Bartlett-Bragg, A.: Reflections on pedagogy: Reframing practice to foster informal learning with social software (2006) (retrieved March 20, 2007)

3. Boyd, D.M., Ellison, N.B.: Social network sites: Definition, history, and scholarship. *IEEE Engineering Management Review* 38(3), 16 (2010)
4. Fogg, B., Iizawa, D.: Online Persuasion in Facebook and Mixi: A Cross-Cultural Comparison (2008)
5. Oinas-Kukkonen, H., Hasle, P., Harjumaa, M., Segerståhl, K., Øhrstrøm, P. (eds.): *Persuasive Technology*, vol. 5033, pp. 35–46. Springer, Heidelberg
6. Kim, Y., Sohn, D., Choi, S.M.: Cultural difference in motivations for using social network sites: A comparative study of American and Korean college students. *Computers in Human Behavior* 27(1), 365–372 (2011)
7. Kwon, O., Wen, Y.: An empirical study of the factors affecting social network service use. *Computers in Human Behavior* 26(2), 254–263 (2010)
8. Lenhart, A., Madden, M.: Teens, privacy & online social networks: How teens manage their online identities and personal information in the age of MySpace. *Pew Internet & American Life Project* Washington (2007)
9. Li, L.: Social network sites comparison between the united states and China: Case study on facebook and renren network. In: 2011 International Conference on Paper presented at the Business Management and Electronic Information (BMEI) (2011)
10. Nielsen (2006), NIELSEN//NETRATINGS, <http://www.nielsen-netratings.com>
11. Wilson, C., Boe, B., Sala, A., Puttaswamy, K.P.N., Zhao, B.Y.: Paper presented at the Proceedings of the 4th ACM European Conference on Computer Systems (2009)
12. Wolfram|Alpha, *webanalysis* (2011)

Smart Mobile Devices in Lifestyles under Transformation: A Comparative Study of Smart Communication among Youth in Hong Kong and Beijing

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Abstract. Social and individual lifestyle patterns are undergoing rapid change in the 21st century. The globalisation of the culture, economy and technology requires ‘global’ design. Globalisation shapes culture and trends in a more integrated way, and Internet technology enables designers to deliver their services and practices without regard for geographical borders. However, diverse regional and local cultures and individual preferences still significantly affect design practice. In China, with its diverse and developing cultures, the trend for smart communication has generated new lifestyle choices, creating marketing opportunities and challenges. We observed the use of smart mobile devices among young people in Hong Kong and Beijing, and compare and discuss the differences in preferences and use scenarios for smart mobile devices in a first to analysing data from users and attempting to trace a new cross-cultural design pattern for smart communication. We conclude that a holistic perspective on smart mobile products and services is needed to solve the problems brought about by the information age in cross-cultural contexts.

Keywords: Chinese lifestyle, Cross-cultural, Smart mobile devices, Smart communication.

1 Introduction

This paper is based on a case study of smart communication design among Hong Kong and Beijing youth. Smart communication is communication that is digital, intangible, fast and effective, and is no longer communication in the traditional sense. The case study aimed to gain a better understanding of Chinese people and their lifestyles and how this relates to design through observation of the use of smart mobile devices among young people — users — in Hong Kong and Beijing. The study analysed users’ communication behaviour to compare and discuss differences in user preferences and use scenarios. The aim was to find suitable methods to analyse target users and to generate new ideas for cross-cultural design patterns for smart communication.

The case study used questionnaires and field study, and looked at both the current market and the potential and future markets. The study also explored the involvement of product designers in the Chinese design process for mobile digital products to determine whether and how the user-centred design of smart mobile devices fits the newly transformed Chinese lifestyles. Beijing and Hong Kong were chosen for comparative purposes. Beijing is the capital of China, and has the most mobile Internet companies, start-ups and universities. Zhongguancun High-Tech Zone in Beijing is known as China's Silicon Valley. Three Chinese mobile phone operators – China Mobile, China Unicom and China Telecom – have the widest wireless network coverage in Beijing. In contrast, Hong Kong has 4G (LTE) networks and the fastest mobile network in China, which is an important feature for smart device users. The Wi-Fi hotspot coverage in Hong Kong is also extensive. As a special administrative region of China, Hong Kong has two cultural backgrounds, Eastern and Western, and is thus an interesting city to study.

2 Method

To understand the differences in the lifestyles of Hong Kong and Beijing youth, the study used qualitative research approaches to comparative their culture, behaviour and preferences. Questionnaires were used to determine the general situation, and field study was then adopted to observe and interview target users. Inductive and deductive qualitative analysis methods can be used to identify and articulate interactive design patterns (Baggetun, 2004).

2.1 Questionnaire

Standardised questionnaires are typically used to uncover the similarities among groups of people by comparing their answers to the same set of questions (Zeisel, 1981). This research aimed to understand the usage of smart mobile devices among young users in Hong Kong and Beijing. The most appropriate general survey method is the questionnaire, as such quantitative research allows the status of respondents to be understood very quickly and can be used to define the qualitative research.

Questionnaires were distributed in Hong Kong and Beijing, and 50 responses were received from each city, respectively, giving 100 responses in total. This generated general data about how young people use smart mobile devices, including the kind of smart mobile devices that they use, the most important reason for choosing a particular smart mobile device and how smart mobile devices have changed their lifestyle. The questionnaire is shown in Appendix 1. Based on the questionnaire survey results, we devised and initiated interviews and focus groups and generated typical 'personas' for users in each city.



2.2 Field Study

The field study of young smart device users was conducted in different environments in Hong Kong and Beijing. Young people between the ages of 18 to 40 were observed and interviewed in their natural environments to learn about how they use smart mobile devices and how these devices have changed their lifestyle.

Observation and Interview. The observations were made in different locations, including in the subway, at bus stops and in shopping malls, restaurants, cafes, and college canteens. Interviews were conducted three young people each in Hong Kong and Beijing. The interviews were used to clarify points of interest raised in the observations and to learn more about activities that could not be observed, such as phone use at home or in private. The interviewees were given cameras, audiocassette recorders and diaries to record their smart device related activities. The field observation collected data to generate the hypotheses and theories. Like other qualitative techniques, field observation is more concerned with description and explanation than it is with measurement and quantification (Wimmer & Mominick, 2006).

Table 1 shows the different behaviour of the young people in the two cities' subways. In the Hong Kong subway, where there are fewer people, most young people use smart mobile devices in idle times. In the Beijing subway, which is always crowded, some young people use smartphones or tablets in idle times, but others choose to read newspapers. This finding demonstrates the different user preferences and uneven economic levels in Beijing. Beijing culture also combines the traditional and the modern, which is reflected in varied ways of obtaining information, with some people choosing traditional media such as newspapers and magazines and others choosing new media based on mobile Internet.

Table 1. Different scenes in the Hong Kong and Beijing subways

Location	Hong Kong Subway	Beijing Subway
Scene		
Behaviour	Using smartphones in the subway	Using different smart mobile devices and reading newspapers in the subway

Smart mobile devices make people communicate in more diverse ways, and change the way in which people respond to their friends. For instance, using voice messages to chat with friends is very popular nowadays, and in both Hong Kong and Beijing young people use a popular app called 'WeChat' to communicate. Figure 1 shows a young person using WeChat voice messaging to chat with a friend. This kind of smart communication does not require the inputting of text, and allows users to easily chat with friends even in crowded streets and when they are busy.



Fig. 1. A young person using voice messaging to chat on a Hong Kong street

The field observation did reveal the real behaviour of young people using smart mobile devices, but because this method has many limitations the observation was built around existing smart device products and also could not reveal specific user behaviour characteristics. Such data would only be obtainable by examining users' conversations, records and unconscious actions. Products generally correspond with typical behaviour trends, but product users are always under the influence of the relationships around them and display specific behaviour.

Generating Personas. User-centred design requires the study of user characteristics, and the generation of 'personas' so that commonly desired features are included in the design. These personas should be based on research and can be described in narrative form. Personas are commonly used in user experience design and in design for all, but were first introduced by Alan Cooper in 'The Inmates Are Running the Asylum' (1988), in which Cooper play-acted fictitious characters to help solve design questions.

We used the data from 100 informants from Beijing and Hong Kong to generate a persona of young smart mobile device users for each city (Figures 2 and 3).

We can draw several conclusions from the personas.

1. Both are keen to adopt new technology, especially where they feel that it matches their lifestyle and reflects their image.
2. Their needs span both work and their personal life, which tends to be more compartmentalised than other segments and includes multiple but not deep relationships.
3. Due to these needs, their smart phones need to be the "latest and greatest" across all aspects of design, and features.
4. They are strongly attracted to prominent, well-respected brands but want to have a 'new and different' model before others get it.


Name: Elaine		Criteria: <i>As a phone:</i> 1. Function 2. Appearance 3. Light <i>As a tool:</i> Everything, manage my work and life. <i>Family & friends:</i> • Phone calls • Whats app • SMS • Facebook <i>Work:</i> Email, Dropbox, Pages, Keynote <i>Fun and entertainment:</i> Book movie tickets, search restaurants <i>Lifestyle:</i> Simple, relaxed and love culture and arts
Age: 26		
Gender: Female		
Occupation: Project manager		
Location: Hong Kong	Relationship with technology: Enjoy study IT products, only started to use an iPhone recent years. Not a normal life without smartphone.	
Smart mobile device: iPhone 5		
Affinity with phone: iPhone 5, iPhone 4, Nokia E72, Nokia 6300		
Role of phone: • SMS • Social Networks • Schedule • Email		

Fig. 2. Hong Kong persona


Name: Stacey		Criteria: <i>As a phone:</i> 1. Appearance 2. Function 3. Battery time <i>As a tool:</i> Camera <i>Family & friends:</i> • Phone calls • Wechat • SMS • Fetion • QQ • Sina weibo <i>Work:</i> Schedule, alarm <i>Fun and entertainment:</i> Rarely <i>Lifestyle:</i> Modern day renaissance girl
Age: 24		
Gender: Female		
Occupation: Student		
Location: Beijing	Relationship with technology: Focusing on the industrial design of a 3C product. Product appearance and function are both important to her.	
Smart mobile device: iPhone 4s & iPad 2		
Affinity with phone: Nokia 9300, Nokia E71, Sharp, HTC G7, iPhone 4s		
Role of phone: • Mostly phone call • Wechat • Social Networks		

Fig. 3. Beijing persona

The user-centred approach as a means to achieve a particular end can be simulated as a ‘funnel’. When the user-centred approach is the goal, the design process is presented from beginning to end based on an existing idea. Each user thinks not only of his or her own situation as a user, but also of the process as a whole, which leads to a result that was partially predicted. During the concept generation stage, the research methods used in this study can inform user-centred design research, which is a more effective means of design than traditional methods. Structured design research that focuses exclusively on user experiences helps designers to acquire an in-depth understanding of user needs and preferences, and to obtain an accurate design direction through examining real-world use.

3 Findings and Discussion

Design investigation is a complicated process. Some of the basic processes, such as project identification and the definition of requirements are not easy to define. Although existing design methods greatly improve efficiency, they do not show users’ real behaviour, feelings and thoughts. For the smart device users in this study, the most important features were the network speed and network charges. The questionnaire results showed that most of the young people in Beijing and Hong Kong cared most about the speed and cost of the mobile network, but this issue was more obvious in Beijing.

Young people choose different kinds of smart mobile devices depending on mobile data charges. For example, they prefer to use smartphones in Wi-Fi environments to save money. In Hong Kong, there are five mobile phone operators — Peoples, SmarTone, 3, CSL and PCCW Mobile – competing for a market of 7 million people. It is easy to swap providers without changing cell phone numbers in Hong Kong, and as a result cell phone charges are very cheap. Table 2 shows that mobile data charges in Hong Kong are much cheaper than in Beijing, and all operators offer unlimited mobile data packages for young people, allowing them to use their smart mobile devices more conveniently.

Table 2. Mobile phone operator charges in Hong Kong and Beijing

Mobile phone operators	Hong Kong					Beijing		
	Peoples	SmarTone 3	CSL	PCCW		China Mobile	China Unicom	China Telecom
Mobile data charges (lowest)	68HKD/month (unlimited)	68HKD/month (unlimited)	68 HKD/400M	87 HKD/1GB	119 HKD/1GB	WLAN:0.1 RMB/M GPRS: 0.01RMB/KB	GPRS:0.03 RMB/KB 3G: 0.01RMB/KB	3G: 0.003 RMB/KB 0.3072 RMB/M

In Beijing, there are three Chinese mobile phone operators: China Mobile, China Unicom and China Telecom. The number of China Mobile users exceeds that of China Unicom and China Telecom. Competition is relatively weak, and thus cell phone charges in Beijing are more expensive than in Hong Kong. Smart device users spend more money on data transmission, which is a bigger component of carrier revenues from young people than voice traffic.

When people feel bored, such as on the road, in the toilet, waiting in line, and before sleeping, they use their smart mobile devices to surf the Internet (Figure 4). In such situations, people feel that time is passing slowly, and their attention is considered to be ‘high-quality attention’. It is for this reason that building advertising, corner advertising and subway advertising was developed. In competition with these forms of media, mobile Internet allows users to choose to use their phone when bored to play games, watch videos, read the news or engage in micro blogging.

The interviews revealed that the young people in both cities like playing on smart mobile devices on the subway or on the bus. Smart mobile devices thus provide a diversion in idle times as well as being useful, and allow users to escape into their own world.



Fig. 4. Young people play with smartphones when they are bored (before meals, before sleeping, on the subway, waiting)

4 Conclusion and Further Research

This study attempted to investigate the lifestyle of young people in Hong Kong and Beijing through quantitative and qualitative research approaches to compare their culture, behaviour and preferences in the use of smart mobile devices. Questionnaires from 100 informants in Hong Kong and Beijing gave a general picture of the status of smart mobile device use among young people. Field study among target users

revealed the scenarios in which they use smart mobile devices. Cultural differences are evident across modern Chinese lifestyles, and different cultures lead young people to develop different ways of communicating. Beijing culture is a combination of traditional and modern, whereas Hong Kong culture is a mix of West and East.

Smart communication has generated a host of changes.

1. Smart communication has changed people's lifestyles, resulting in a more intelligent life.
2. Smart communication has changed people's social relations, which are more diverse and 'smart'.
3. Smart communication has changed design, moving it away from being strictly function orientated to generate better and exciting experiences for interactive smart mobile devices.

This research is the first step towards comparing Chinese lifestyles among young Hong Kong and Beijing smart mobile device users. The research is ongoing, and the results cannot be presented in a single paper. A new cross-cultural design pattern for smart communication will be explored as more results are produced.

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References

1. Baggetun, R., Rusman, E., Poggi, C.: Design patterns for collaborative learning: From practice to theory and back. In: Cantoni, L., McLoughlin, C. (eds.) Proceedings of the World Conference on Educational Multimedia, Hypermedia and Telecommunications, pp. 2493–2498. AACE, Chesapeake (2004)
2. Cooper, A.: The origin of personas (2008), http://www.cooper.com/journal/2008/05/the_origin_of_personas.html (retrieved May 15, 2008)
3. Cooper, A.: The inmates Are running the asylum. Sams, Indianapolis (2004)
4. Persona (2013), http://en.wikipedia.org/wiki/Persona#cite_note-20 (retrieved February 7, 2013)
5. Schadewitz, N.: Design patterns for cross-cultural collaboration. The Open University, Milton Keynes (2009)
6. Wimmer, R.D., Mominick, J.R.: Mass media research: An introduction. Thomson/Wadsworth, Belmont (2006)
7. Zeisel, J.: Inquiry by design: Tools for environment-behavior research. Cambridge University Press, Cambridge (1981)

Appendix

Questionnaire responses of the young people in Beijing and Hong Kong (questionnaire designed by the authors).

Questions	Options	Hong Kong	Beijing
1. Gender	A. Male	26	23
	B. Female	24	27
2. Occupation	A. Student	10	7
	B. Teacher	4	1
	C. Institutional staff	10	4
	D. Corporate staff	14	34
	E. Soldier	0	0
	F. Freelance	6	2
	G. Other	6	2
3. What kind of mobile smart device do you use? (Multiple choices)	A. Smartphone	50	50
	B. Tablet (e.g., iPad)	18	23
	C. E-book	16	1
	D. PDA	2	0
4. Which system do you use?	A. iOS	30	25
	B. Android	22	25
	C. Windows	8	3
	D. Symbian	0	6
	E. Others_____	0	4
5. How much does your smart mobile device cost?	A. Below to RMB 2000 (HKD 2500)	0	5
	B. RMB 2001-3000 (HKD 2501-HKD 4000)	6	15
	C. RMB 3001-4000 (HKD 4001-HKD 5000)	12	12
	D. RMB 4001-5000 (HKD 5001-HKD 6000)	20	17
	E. Up to RMB 5000 (HKD 6000)	12	5
6. What was your main reason for purchasing your smart mobile device?	A. Appearance	4	12
	B. Price	2	5
	C. Function	24	30
	D. Design fit my taste	10	12
	E. Others' opinion	2	0
	F. Brand, a status symbol	8	4

7. What is the most worrying problem with using smart mobile devices? (You can choose more than one option)	A. Quality	18	11
	B. Short battery life	28	29
	C. Soon out of fashion	8	4
	D. Radiation emissions	2	7
	E. High fees for data transmission	2	25
	F. Slow Internet speed	6	27
8. How satisfied are you with your smart mobile device?	A. Very satisfied	12	7
	B. Satisfied	36	37
	C. Unsatisfied	2	5
	D. Totally unsatisfied	0	1
9. What is your favourite mobile social app for communication? (You can choose more than one option)	A. WeChat	34	40
	B. Sina micro blog	20	35
	C. RenRen	2	12
	D. WhatsApp	38	4
	E. Facebook	24	3
	F. LBS	0	1
	G. Mi-talk	0	0
	H. Momo	0	2
	I. Kaixin001	0	1
	J. E-mail	22	20
	K. Other_____	Line, Viber	QQ, Kakao Talk
10. How long do you spend on your smart mobile device each day?	A. Less than 1 hour	4	1
	B. 1-3 hours	30	19
	C. 3-5 hours	8	13
	D. 5-8 hours	6	8
	E. More than 8 hours	2	12
11. How would you describe the role of your smart mobile device in your life?	A. Not a normal life without it	20	13
	B. Uncomfortable without it	18	31
	C. Dispensable	12	4
	D. Happier without it	0	2
12. What do you think of the development of smart mobile devices?	A. Very optimistic, products are updated very quickly	32	37
	B. The market is saturated	8	7
	C. Do not care	10	6
13. How would you like to interact with your smart mobile device in the future? (You can choose more than one option)	A. Touch	32	19
	B. Voice control	16	21
	C. Gesture	6	13
	D. Eye control	14	5
	E. Telepathy (brain waves)	10	22
14. What form would you like smart mobile devices to take in the future?	A. A general form	34	23
	B. More ornaments	14	17
	C. In the body	2	7
	D. Telepathic	4	15

15. What kinds of features would you like to be added to smart mobile devices in the future?	Open Question	Can enlarge or shrink in size as I want, Device payment ability, Remote control, Invisible keyboard, Drive car, Wireless charger, Physical examination, replace keys.	Private secretary, Remote monitoring, Security features, Electronic identity cards, Cooking, 3D display, Physical interaction, Physical examination, No charging, Projector.
16. What is the greatest influence that smart mobile devices have had on your life?	A. Made life more convenient	40	28
	B. Ubiquitous communication	12	30
	C. Reduced privacy	6	8
	D. Extended entertainment time	4	9
17. What do you mainly use your smart mobile device for? (You can choose more than one option)	A. Communication	46	39
	B. Entertainment	26	26
	C. Socialising	30	25
	D. Work	22	26
	E. Getting information	34	24
	F. In public	16	2
	G. At home	6	5

Incorporating Culture in Website Design: A Comparison of Taiwanese and Australian Website Characteristics

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Abstract. This paper explores issues related to user interface design and experience, including culturally preferred design elements. A local website audit was conducted to compare and analyze websites in Taiwan and Australia. The web design attributes for effective communication (usability) that are considered include: visual representation, navigation, links, layout and multimedia. Significant differences in culturally preferred design characteristics were found in each of the web design categories. Results from this study can contribute to help web developers and designers develop website designs that are culturally appropriate. Based on the methodology structure in this research, this investigation is the first phase in identifying cultural preferences of two cultures, and future research will evaluate the web experiment design to test if the cultural preferences are incorporated in the web, and to determine if such an approach can improve usability.

Keywords: cultural preference, usability, effective communication.

1 Introduction

The world has become a global marketplace. Globalization affects computer-based communication, and this is particularly obvious in web design applications, which can be accessed globally. Under the context of globalization, Hofstede [4] suggests that web developers can accommodate the diverse cultural market by applying localization as an alternative strategy to develop the global market. Google is a good example of an international company adapting their web interface design in Taiwan and Hong Kong to fit the needs of specific cultures, in order to extend their global market. In 2007, Google set up testing in the new homepage, “igoogle”, for Taiwan, Hong Kong and South Korea. The site's new design is very different, compared with Google's conventional identity of simplicity, directness, and minimalism. Google found the response of Taiwan, Hong Kong, and South Korea users to the new website designs to be quite positive. However, it raises the intriguing issue that some cultures do not react as positively as the North American and Europeans to minimalism. It implies that audiences from different cultures have different requirements, expectations,

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mental models and preferences. Cultural diversity makes it impossible for designers to depend on instinctive knowledge or personal experience. Therefore, there is a need to investigate the requirements and preferences of local target-culture users.

2 Culture and Cultural Model

Hofstede's [5] definition of culture and Hall and Hall's cultural theories [6] are applied in this paper. Hofstede [5] states that everyone carries this/her own patterns of thinking, feeling and behavior which are accumulated during their lifetime. These patterns are mostly accumulated during childhood and define the ways of feeling, thinking and mental programming; these vary as much as the social environments in which they were acquired. Hofstede examined IBM employees in 53 countries from 1978 to 1983 and defined patterns of differences and similarities among the replies of employees through statistical analysis of a variety of data. The five dimension culture theory was thus formulated from the results of an analysis of the data. The five cultural dimensions are introduced as follows:

Power Distance: This refers to the extent to which less powerful members of society expect and accept unequal power distribution within that society. Countries with higher power distance cultures have features such as hierarchical structures in organizations, with the relationships between superiors and subordinates being stricter than in countries with low power distance. Low power distance cultures have characteristics such as more equal relationships between superiors and subordinates, and a flatter structure of organization [5] [7].

Individualism vs. Collectivism: Individualism in culture implies loose ties where all are inclined to take care of themselves or their nuclear family, and usually tend to be independent of other people. A collectivist culture tends to value group welfare more than the individual's, and believes in group relationship, where loyalty is the dominant factor. Individualistic countries value the individual's accomplishments while collectivistic countries emphasize the benefits of working in a group [5] [7].

Masculinity vs. Femininity: This refers to gender roles within a culture. Countries with strong masculine cultures tend to emphasize challenge, social recognition and the pursuit of welfare. On the contrary, countries with less defined masculine cultures tend to collapse gender distinction and overlap gender role, and emphasize security, care of others, and the environment [5] [7].

Uncertainty Avoidance: This refers to the extent to which people want to avoid uncertain conditions. People with low uncertainty avoidance cultures are more comfortable with uncertain situations. On the other hand, people from cultures with higher uncertainty avoidance tend to prefer rules and reject change since uncertainty may result in anxiety [5] [7].

Long-Term Orientation vs. Short-Term Orientation: Long-term orientation plays an important part in Asian countries that have been influenced by Confucianism. People from these countries believe strongly that an unequal relationship is required to keep a society stable. A clearly defined hierarchical relationship is needed to keep

family and society in harmony. Virtuous behavior is identified by hard work and perseverance. On the contrary, cultures with short-term orientation have opposite attributes [5] [7]. According to Hall and Hall [6], “A high context communication or message is one in which most of the information is already in the person, while very little is in the coded, explicit, transmitted part of the message. A low context communication is just the opposite”. The attributes reflected in high and low context cultures are introduced as follows.

Thought Pattern: People from a high context culture tend to use an implicit approach in their communication, rather than stating the subject directly. People from a low context culture tend to achieve their aims directly by applying logical straightforward communication [6] [7].

Polychronic & Monochronic Time Perception: People from high context cultures tend to be polychronic in time perception and think that everything will happen when the right time comes, while people from low context cultures tend to be monochronic in time perception and believe in carrying out a job on time [6] [7].

Communication Pattern; People from high context cultures countries tend to have more confidence in their non-verbal communication, while people from low context cultures are inclined to express their thinking by content and oral language [6] [7].

Indirectness; People from high context cultures tend to use harmonious ways to communicate, while people from low context cultures tend to express meaning in a straightforward way [6] [7].

3 Culturability

Barber & Badre [1] use the word “culturability” which combines the two words “usability” and “culture”. They constructed a cultural marker approach which is a kind of systematic usability method to examine hundreds of websites, and then defined cultural markers such as colors, fonts, icons, metaphors, geography, sounds, motions, flags, language, preferences for text and graphics, directionality of how language is written, help features and navigation tools in order to facilitate users’ performance.

Sun [12] examined how cultural markers (cultural preferences) affect web usability by interviewing target culture people about their experiences; she concluded that people prefer interaction interface with cultural markers from their own cultures; she found that the usability of the web can be strengthened by cultural markers. Based on Baber and Badre’s cultural marker approach, Smith et al. [11] found the culturally preferred design elements in Taiwanese and Indian cultures, and defined these design elements as cultural attractors. These cultural attractors are the interface design attributes of the websites which reflect their denotations matching the expectations of the local culture. Cultural design preferences can map directly into culturally appropriately design elements for a website, but are usually inclined to be stereotypical. If the cultural design preferences are applied successfully in a website, they can markedly increase the usability of a websites and thus address the needs of the target culture

audience. As Sun has stated, if a company knows what type of cultural markers can be used for a particular culture, exhaustive studies will be saved.

4 Web Attributes for Effective Communication

According to Smart et al. [10], it is essential to identify several categories (i.e., typography, site structure and cognitive design, medium use, message content, appeal, accessibility) of web design characteristics that are vital in helping the designers convey desired meaning and making it easier for users to obtain the intended meaning. Based on the aim and requirement of this research, the key components of web for effective communication are illustrated as below.

Visual Presentation: This includes images, photos, symbols, icons and graphics. The attributes of visual representation can efficiently transmit a message to the viewer in an attracting manner. Russo & Boor [9] state that images are the visual language of a culture and they are similar to words; thus images do not always translate. The images, symbols and icons we recognize in our culture may have no meaning or even contrary signification in another culture.

Navigation: This refers to different kinds of navigational tools, menu formats, links, and search capabilities. Users may get lost when moving in a website without a precise and assisted way for attaining information. Marcus & Gould [8] declare that culture influences the navigation in web design. Audiences from cultures with a high uncertainty dimension tend to prefer a navigation structure intended to prevent them from getting lost, while cultures with a low uncertainty dimension are inclined to prefer less control in navigation.

Links: In other works by Sun, she investigated users from America, Germany, China and Brazil with regard to their design preferences, and found that different preferences existed. It was discovered that the German audience prefers links in the navigation bar, which can be set up in alphabetical order, but that this preference is not favored by Chinese and Brazilian users. Based on the above literature review, it can be seen that preferences for links differ across cultures.

Layout: This is the display structure that directs scanning information and reflects the orderly flow of tasks. If the layout is properly designed, it makes it easier for the viewer to access information and comprehend the information within a contextual and structural model, facilitating the communication between the user and the system [13]. According to Barber & Badre's study [1], users from different cultural backgrounds have different preferences for orientation and layout structure in web pages.

Multimedia: This refers to sounds, animation, moving text and streaming video. If the multimedia can be used properly, it can enrich the experience of the user. Integrating multimedia into web interface design can be a very powerful means for transmitting information beyond that of text, visual representations, still images and pictures; it may also prove to be an effective means to mislead and distract the audience [2].

Not all audiences expect or prefer the use of multimedia. This depends on the cultural background of the users.

Based on the above research related to cultures and web interface design attributes, it can be assumed that web design preferences for visual presentation, navigation, links, layout and multimedia differ across cultures. Five hypotheses are formulated as follows;

Hypothesis 1: Preferences for visual presentation vary between Taiwanese and Australian users.

Hypothesis 2: Preferences for Navigation vary between Taiwanese and Australian users.

Hypothesis 3: Preferences for Links vary between Taiwanese and Australian users.

Hypothesis 4: Preferences for Layout vary between Taiwanese and Australian users.

Hypothesis 5: Preferences for Multimedia vary between Taiwanese and Australian users.

5 Methodology

The cultural categories used in this study are based on national culture and are operationalized using websites from Taiwan and Australia. Taiwan and Australia are selected because they possess distinctly different cultural attributes, as based on Hofstede's country cultural dimensions [5] as presented in Table 1.

Table 1. Hofstede's country cultural dimensions

Cultural dimension	Power Distance		Individualism & Collectivism		Masculinity & Femininity		Uncertain Avoidance		Long term & short term time orientation	
	Rank	Score	Rank	Score	Rank	Score	Rank	Score	Rank	Score
Australia	41	36	2	90	16	61	37	51	15	31
Taiwan	29/30	58	44	17	32/33	45	26	69	3	87

Based on Table 1, Australia is ranked 41, while Taiwan is ranked 29/30 in power distance among 53 countries; Australia is ranked 2nd, and Taiwan 44th in individualism vs. collectivism; Australia is ranked 16, and Taiwan 32/33 in masculinity vs. femininity; Australia is ranked 37, and Taiwan 26th in uncertain avoidance; and finally, Australia is ranked 15th, and Taiwan 3rd in long-term orientation vs. short-term orientation.

5.1 Local Government and City Website Selection for Audit

Government websites were chosen for audit in this study. Local county and city government sites offer sufficient sample sizes for each country and this type of website was selected to avoid the influence of corporate branding or company images. It was expected that the websites chosen in this study would be less influenced by external designers or other cultures.

5.2 Stages of Procedure in the Audit of Local Websites

The first stage was to use focus groups to define five aspects of interface design. Members of the focus groups had many years of experience in the areas of web design, localization, computer science and international culture, and were able to discuss the previous research related to localization and design characteristics to identify website characteristics that could be easily compared and assessed by researchers. The focus groups determined five categories of website characteristics in this research: visual presentation, navigation, links, layout and multimedia.

The second stage was to concentrate on designing an instrument to evaluate website characteristics based on initial results from the focus groups. All the categories and specific attributes that were identified by the focus groups were incorporated into a questionnaire. Each characteristic was given 0 (not present) or 1 (present) for categorical questions. For example, if the homepage of the sites had a search feature, the expert would add a 1 for that categorical variable.

For the third stage, two design experts were invited to be evaluators in the local web audit, one, a Taiwanese, undertaking a PhD in HCI research at Chungking University with 5 years' experience at a website design company in Taipei and the other an Australian, an interface designer in a multimedia company for 8 years in Taichung City. Each expert reviewed thirty local government web homepages from his own country, providing ratings by nations. The analysis tool, SPSS, was applied to perform cross-tabulation comparisons to check whether there were significant differences between the two cultures in each category. The results of all categories of variables are presented in Tables 2 to 6.

6 Results

The results of all categories of variables are presented in Tables 2 to 6. In each variable, the actual counts are presented, and the number of the site that has the variable present is noted.

Table 2. Visual representation

Variable	Actual count		Expected count	Chi-square	Degrees of freedom	Sig. Level
	Taiwan	Australia				
Iconic symbols	19	5	12	13.611	1	.000
Government identity symbols	27	29	28	1.071	1	.301
Images of leader	22	6	14	17.143	1	.000
Photo of Accomplishment	17	2	9.5	17.330	1	.000
Images of group	14	4	9	7.937	1	.005
Images of daily life	0	17	8.5	23.721	1	.000
Images of Animal/Plant	3	7	5	1.920	1	.166
Images of landscape	12	6	9	2.857	1	.091
Cute style illustration	15	2	8.5	13.871	1	.000
Banner within color shape	2	12	7	9.317	1	.002
Banner within local city image	25	13	19	10.335	1	.001

Hypothesis 1 was supported. As demonstrated in Table 2, there were eight significant preferences for visual representation variables across both cultures. Iconic symbols were found in many more of the Taiwanese websites. Iconic symbols are used almost four times as much in Taiwan as in Australia. The images of leader feature were found in 70% of Taiwanese websites, but in only 25% of Australian websites. Photo of accomplishment is used eight times as much in Taiwan as in Australia. Taiwanese websites show a much higher occurrence of images of groups than do those of Australian sites. None of the Taiwanese websites had images of daily life, while such images were present in nearly 60% of Australian websites. The cute style illustrations are highly popular in Taiwanese local government websites, with half of Taiwanese websites utilizing this. Only 2 Australian websites used this. Only 2 Taiwanese websites had banner within color shape, while 40% of websites in Australian did. Taiwanese have a strong preference for banner within local city image; 25 Taiwanese websites had banner within local city image, while this was true of less than a half of Australian websites.

Table 3. Navigation

Variable	Actual count		Expected count	Chi-square	Degrees of freedom	Sig. Level
	Taiwan	Australia				
Horizontal menu	27	28	27.5	.218	1	.640
Vertical menu	28	24	26	2.308	1	.129
Return to home button	27	24	25.5	1.176	1	.278
Search	20	27	23.5	4.812	1	.028
Accessibility icon	26	3	14.5	35.306	1	.000
Accessibility on text	0	11	5.5	13.469	1	.000

There is support for Hypothesis 2. An analysis of the results from Table 3 yields the following observations. There are three significant differences between Taiwanese and Australian cultures. Specifically, more than 80% of Taiwanese websites have accessibility icons, while only 10% of Australian websites have these. No Taiwanese websites have accessibility on text, while nearly 40% of Australian websites have this feature. Search functions occur frequently on Taiwanese and Australian sites: 90% of Australian websites have this attribute, and it is also found on 67% of Taiwanese websites.

Table 4. Links

Variable	Actual count		Expected count	Chi-square	Degrees of freedom	Sig. Level
	Taiwan	Australia				
Popup a new window	16	2	9	15.556	1	.000
Dynamic button	12	1	6.5	11.882	1	.001
Color change	25	23	24	.417	1	.519
Mouse over (underlined)	8	22	15	13.067	1	.000

Hypothesis 3 was also supported for diverse preferences links. Based on Table 4, link characteristics differ significantly across the two cultures. “Popup a new window” is used eight times as much in Taiwanese websites as in Australian websites. 12 of the Taiwanese websites had a dynamic button, whilst only one Australian website had this. Color change is widely highly used in both cultures. The mouse over (underlined) characteristic is used nearly three times as much in Australia as in Taiwan.

Table 5. Layout

Variable	Actual count		Expected count	Chi-square	Degrees of freedom	Sig. Level
	Taiwan	Australia				
Single-column	0	2	1	2.069	1	.150
Two-column	8	18	13	6.787	1	.009
Three-column	22	10	16	9.643	1	.002
Vertical menu on left	19	12	15.5	3.270	1	.071
Vertical menu on right	7	12	9.5	1.926	1	.165
Flexible width design	1	15	8	16.675	1	.000
Horizontal menu on top	1	12	16.5	5.455	1	.020
Information guide on bottom	3	11	7	5.963	1	.015

In support of Hypothesis 4, layout preferences vary between Taiwan and Australia. Two-column, three-column, flexible width design, horizontal menu on top and information guide on bottom differ across cultures. Only 27% of Taiwan websites had two-column, while 60% of Australian websites had this. Three-column is found in many more Taiwanese websites. More than 70% of the studied Taiwanese sites had this, while this applied to only 33% of the Australian websites. Flexible width design is exhibited in many more Australian websites. Only 3% of Taiwanese websites had this, compared to 50% of Australian websites. Only one Taiwanese website had horizontal menu on top, while 40% of Australian websites had this. Of Taiwanese websites only 10% had information guide at the bottom, while 37% of Australian websites had this.

Table 6. Multimedia

Variable	Actual count		Expected count	Chi-square	Degrees of freedom	Sig. Level
	Taiwan	Australia				
Sound	3	0	1.5	3.158	1	.076
Stream video	16	3	9.5	13.017	1	.000
Flash animation	16	1	8.5	18.468	1	.000
Moving picture	23	1	12	33.611	1	.000
Moving text	10	0	5	12.000	1	.001
Opening	10	0	5	12.000	1	.001

Hypothesis 5 was strongly supported. Results in Table 6 lend strong support to the fact that multimedia characteristics differ across the two cultures; Multimedia are used to a greater extent in Taiwan than in Australia. Preference differences for stream video, flash animation, moving picture, moving text and opening were statistically significant between the two cultures. Specifically, over 80% of Taiwan sites used moving picture and over 60% of Taiwan websites used stream video and flash animation. As far as Australian sites were concerned, only 3 websites had stream video and only 1 website had flash animation. None of the thirty Australian websites had moving text and opening, while 30% of Taiwanese websites had both of these characteristics. The use of sound did not differ significantly across cultures and this attribute was seldom used in two cultures.

7 Discussion

This research contributes to studies related to the web design characteristics and hence preferences which are popular in Taiwan and Australia. Results of this study reveal that there are significant websites design differences between the two cultures.

Most hypotheses lend support for Würtz's [14], Sun's [12], Marcus & Gould's [8] premises that web designers need to adapt interface attributes for culturally diverse users. Various preferences exist between Taiwan and Australia users. Particularly, most Taiwan sites use moving picture, stream video and flash animation in websites, while few Australian websites incorporate stream video and flash animation. It shows that Taiwanese culture greatly prefers using multimedia in websites, whereas Australian culture prefers static text and pictures. One possible explanation for this difference is that Taiwan is considered a high-context culture, while Australia is considered a very low-context culture. High context cultures (i.e., Taiwan) will seek to assimilate human presence on their websites, and flash animation and text in motion have the potential to provide this. On the contrary, low context cultures prefer direct, explicit communication patterns, quickly getting results and reaching goals. Flash animation or text in motion would lead to distraction for low context cultures (i.e., Australia).

There is evidence of different preferences for layout and links between Taiwan and Australia, Taiwanese culture greatly prefer three-column, popup a new window, dynamic button while the Australian culture tends to use mouse over (underlined) and two-column layout. One possibility for the cultural difference is that Taiwan culture with long-term time orientation tends to be patient in attaining results and reaching goals. In Australian culture, with short-term time orientation, there is the desire to quickly get results and reach goals. There also exist differences in visual representation between the two cultures. Culture with collectivism (i.e., Taiwan) have preferences for images of a leader, photo of an accomplishment and images of a group. Australians, with their emphasis on individualism, are inclined to take care of themselves, enjoying their lives, and usually remaining independent of other people tend to prefer images of daily life. The result also echo Marcus and Gould's [8]. It is surprising that Taiwanese sites use cute style illustration a lot and that kind of style is not consistent with the identity of a city government.

8 Conclusions and Future Work

This research has the potential to help web developers and designers to develop a web interface design that is culturally appropriate. In sum, this research provides statistically significant evidence to support that web design preferences vary across cultures. This finding supports the importance for the localization of web design and provides some directions related to specific cultural preferences. The implication of this investigation formulates the following questions: “Since different cultural preferences for web design characteristics exist, how can the culturally preferred design characteristics be applied to increase usability?” and “Do users perform better in websites which incorporate culturally preferred design characteristics?”

The results of this study would be applied to a web experiment, which could be conducted to test the next related hypothesis: “If these cultural differences are incorporated in web design, they can improve web usability and facilitate effective communication.” Based on the differences in culturally preferred design characteristics, subsequent research could evaluate web usability with such characteristics embedded into the interface of a web prototype.

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References

1. Barber, W., Bardre, A.: *Culturability: The Merging of Culture and Usability*. In: Proceedings of the 4th Conference on Human Factors and Usability (1998), <http://zing.ncsl.nist.gov/hfweb/att4/proceedings/barber>
2. Brinck, T., Gergle, D., Wood, S.D.: *Designing Web sites that work: usability for the Web*. Morgan Kaufmann Publishers, San Francisco (2002)
3. Cyr, D., Trevor-Smiths, H.: Localization of Web design: An empirical comparison of German, Japanese, and United States Web site characteristics. *Journal of the American Society for Information Science and Technology* 55(13), 1199–1208 (2004)
4. Hofstede, N.: Global Issues, local Concerns. *Technical Communication*, Second Quarter, 145–148 (1999)
5. Hofstede, G.: *Cultures and Organizations: Software of the Mind*. McGraw-Hill, London (2005)
6. Hall, E., Hall, M.: *Understanding cultural differences*. Intercultural Press, London (1990)
7. Hsieh, H.C., Holland, R., Young, M.: A Theoretical Model for Cross-Cultural Web Design. In: Kurosu, M. (ed.) *HCD 2009*. LNCS, vol. 5619, pp. 712–721. Springer, Heidelberg (2009)
8. Marcus, A., Gould, E.W.: Cultural Dimensions and Global Web User-Interface Design. *Interactions*, 33–46 (July/August 2000)
9. Russo, P., Boor, S.: How fluent is your interface? Designing for international users. *Human Factors and Computer Systems*. In: Proceedings of 4th Conference on Human Factors in Computing Systems, pp. 342–347. Addison-Wesley, Boston (1993)

10. Smart, K.L., Rice, J.C., Wood, L.E.: Meeting the Needs of Users: Toward a Semiotics of the Web Technology & Teamwork. *IEEE*, 593–605 (2000)
11. Smith, A., Dunckley, L., French, T., Minocha, S., Chang, Y.: A process model for developing usable cross-cultural websites. *Interacting with Computers* 16(1), 63–91 (2004)
12. Sun, H.: Building a culturally-competent corporate web site: an exploratory study of cultural markers in multilingual web design. In: *Proceedings of the 19th Annual International Conference on Computer Documentation*, pp. 95–102 (2001)
13. Yu, B., Roh, S.: The effects of menu design on information-seeking performance and user's attitude on the Web. *Journal of the American Society for Information Science and Technology* 53(11), 923–933 (2002)
14. Würtz, E.: A cross-cultural analysis of websites from high-context cultures and low context cultures. *Journal of Computer-Mediated Communication* 11(1), article 13 (2005), <http://jcmc.indiana.edu/vol11/issue1/wuertz.html>

Localization of Web Design: An Investigation of Culturally Preferred Web Attributes in Taiwan and the UK

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Abstract. Cultural diversity makes it unrealistic for designers to rely on intuition or personal experience to develop web interface design under the context of globalization, it is important to explore the cultural requirements and preferences of a target culture if a company wants to develop a website which can appropriately map that target culture. Although there is increased research related to culturally preferred design attributes, there are few studies that systematically examined such preferences across cultures. Therefore, the aim of this paper is to investigate culturally preferred design characteristics in Taiwan and the UK, and the local website audits were conducted to identify the cultural preferences of each culture. Significant differences of culturally preferred design attributes were found across both cultures. Results from this study can contribute to help web developers and designers to develop the design for websites as culturally appropriate.

Keywords: globalization, local website audits.

1 Introduction

In the context of globalization, Hofstede [12] suggests that web developers can accommodate the diverse cultural market, “Localization, a strategy that specifically addresses cultural differences, is an alternative to globalization.” Marcus [16] also echoes that companies that want to do international business on the web should take a country’s culture into consideration in their web communication, content and tools. Many researchers apply current cultural models to develop their studies, but web designers and developers should be careful that the established cultural model might be too stereotypical and not really fit the target culture market. As Del Galdo [7] suggest, web designers should get directly involved in the target culture.

In Sun’s study [21], she interviewed with target culture users about their experiences how culturally preferred design characteristics such as visuals, language and colors affect web usability and stated that cultures continue to develop and interact,

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and they are not ontologically objective. It reminds web developers and designers to maintain practical observation of the target culture users, because culture is constantly changing, particularly in the internet era.

Therefore, it is important to explore the cultural preferences for a target culture if a company wants to develop a website which can appropriately map that target culture. The aim of this paper is to investigate the culturally preferred design elements in Taiwan and the UK, to identify the cultural preferences of web design attributes in the two cultures.

2 Globalization and Localization

Baumgartner [2] defines globalization as “an umbrella term that refers to all the issues involved in designing or modifying products for audiences worldwide...we can also say that globalization combines all aspects of internationalization and localization.”

Internationalization refers to the process of creating a base design that can be modified for audiences from different countries. According to Sun’s definition [21], internationalization refers to the process of designing an application which can be adapted to different markets worldwide without engineering changes.

Localization refers to the process of adapting an internationalized product to make it usable in a particular region, culture, or market. True localization not only considers graphics, colors, symbols, terminology, date/time/currency formats and many other technical aspects of a product, but also takes into account language, customs, culture and other characteristics of the target culture market. Based on Gribbons’s study [10], usually two sub-levels need to be carried out in the localization process. These sub-levels comprise a surface level, the modification of the attributes of the web artefact including translation, dates, punctuation, measurements, currency, and so on, to reflect the conventions and needs of the target users, and a cultural level, the modification of the visual representation, colors, structure, layout, functionality, and communication patterns to accommodate the target users. This research focuses on the cultural level.

3 Culture, Web Attributes, and Related Hypotheses

3.1 Hall and Halls’ High and Low Context Culture

Hall & Hall [11] classified two kinds of contexting, “high context” and “low context”. “High context or low context refers to the amount of information that is in a given communication as a function of the context in which it occurs”. According to Hall and Hall [11], Kaplan [15], Chen and Starosta [4], and Choe [5], high context cultures tend to be implicit, indirect, ambiguous, harmony seeking, polychronic cultures, and have specific thought patterns, whilst low context culture have the opposite characteristics. The attributes that are related to high context and low context cultures are introduced as follows.

1. Polychronic & Monochronic Time Perception: This refers to the perception of time varying across cultures. People from high context culture countries tend to be polychronic in time perception and think that everything will go smoothly when the time comes; people from low context culture countries tend to be monochronic in time perception and believe in executing a task based on schedules.

2. Thought pattern: A non-linear way is used to explore something to uncover the truth. Rationality is not necessarily confined to countries with a high context culture. People from a high context culture tend to use indirect strategies in their communication, usually not state the subject directly. People from a low context culture have a strong belief that there is one objective truth which can be reached by linear exploration, so they want to meet their aims directly by applying logical and rational thinking.

3. Communication pattern: People from high context cultures countries are inclined to have more confidence in their non-verbal communication, and a high number of gestures, body language, silence, and symbolic behavior are preferred and expected by them. People from low context cultures, such as Germany and the UK, are inclined to express meaning depending on content and oral language.

4. Indirectness: People from a high context culture tend to use ambiguous, indirect and harmonious ways to communicate. People from low context cultures tend to express themselves in a more direct way to make sure that the listener understands completely.

3.2 Hofstede's Cultural Dimension

Based on Hofstede's (2005) study, there are five dimensions in his cultural theories. The details of each dimension are presented as follows.

Individualism and Collectivism: This refers to the extent to which individuals incorporate within a group. Collectivist cultures (e.g., Taiwan and China) tend to prioritize group welfare over individual welfare. Individualistic cultures (i.e. USA, Australia) are inclined towards loose ties, where everyone is expected to look after him/herself.

Masculinity and Femininity; This refers to gender roles within a culture. Countries with Masculine cultures (for example, Japan) tend to present assertive, competitive qualities. On the contrary, countries with feminine cultures (e.g., the Scandinavian countries) tend to blur gender distinction and present tender roles.

Uncertainty Avoidance: This refers to the degree to which people are comfortable with uncertain conditions. Cultures with high uncertainty avoidance (e.g., Japan and China) tend to prefer rules and reject change since uncertainty may result in anxiety; cultures with low uncertainty avoidance ((e.g., the USA and the UK) are more comfortable with uncertain situations.

Power Distance: Cultures with high power distance (e.g., Malaysia and Mexico) are characterized by hierarchies in organizations and autocratic leadership. On the contrary, cultures with low power distance (e.g., Austria and New Zealand) have opposite characteristics.

Long-Term Orientation vs. Short-Term Orientation: Long-term time orientation plays a crucial role in Asian countries (e.g., Taiwan and China) that have been influenced by Confucianism. People in these countries believe strongly that accomplishments can be attained by hard working, and that virtuous behavior is characterized by diligence and perseverance. People in countries with short-term time orientation (e.g., the UK and USA) tend to prefer attaining goals based on schedules.

3.3 Culture and Web Usability

Barber & Badre [1] recommend a “culturability” approach which combines two words “culture” and “usability”. This approach is a systematic method used to examine hundreds of websites, and then to define cultural markers (preferences in a specific area) such as colors, fonts, icons, geography, sounds, motion, flags, language, preferences for text and graphics, directionality of how language is written, and so on.

Based on Barber and Badre’s [1] cultural marker approach, Smith et al. [20] show that it is essential to examine: (1) the different signs or symbols in a target culture to better understand how to create a website that is appropriately pitched to the target culture users, (2) the usage of signs based on the context, and (3) how the target culture audience interprets these signs. This can be achieved by conducting an audit of local indigenous sites.

3.4 The Hypotheses and Website Design Characteristics

Links: Sun [21] analyzed users from America, Germany, China, and Brazil for design preferences, and found different preferences in navigation among these countries. It was discovered that the German audience prefers links in the navigation bar, set up in alphabetical order, but this is not expected by Chinese and Brazilian users.

H1: Preferences for links differ between the UK and Taiwan cultures.

Multimedia: If multimedia can be applied appropriately, it can enrich the users’ experience. Incorporating multimedia into web interface design can be a very powerful method to convey a message beyond that of text, still images, but it is also an effective means to distract an audience [3]. Not all audiences expect or prefer the use of multimedia. Such preference depends on the cultural background of the users.

H2: Preferences for multimedia vary between the UK and Taiwan cultures.

Visual Presentation: Many images that do not transmit the same meaning in all cultures have been discovered in many previous studies [8]. Russo and Boor state, “Some users will recognize an image, but they will not associate it with the originally intended concept.” Web designers must comprehend differences among cultures in order to recognize images that are culturally specific [18].

H3: Preferences for visual representation vary between the UK and Taiwan cultures.

Layout: According to Barber & Badre’s study [1], people with different cultural backgrounds have particular preferences in orientation and layout structure on web

pages. Sun [21] suggests that a user from a low context culture (for example, Germany) would prefer a logical structure, while a user from a high context culture (for example, Japan) would prefer a paralleled structure and visual representation for information.

H4: Preferences for layout differ between the UK and Taiwan cultures.

Navigation: According to Marcus & Gould [17], Audiences from cultures with a high uncertainty dimension tend to prefer a navigation structure which can prevent them from getting lost. Simon [19] regards navigation and interaction as parts of the web communication interface. The diverse characteristics of web interface design have been examined, and it has been found that Asian and South Americans prefer navigation aids to change the appearance of the site without any concern for movements spatially.

H5: Preferences for navigation vary between the UK and Taiwan cultures.

4 Method

The cultural categories used in this research are based on national culture. Taiwan and UK were selected because they possess distinctly different cultural features, as based on Hofstede's cultural dimensions [12]. The UK is ranked 42/44, while Taiwan is ranked 29/30 in power distance among 53 countries; the UK is ranked 3rd, and Taiwan 44th in individualism vs. collectivism; the UK is ranked 9/10, and Taiwan 32/33 in masculinity vs. femininity; the UK is ranked 47/48, and Taiwan 26th in uncertain avoidance; and finally, the UK is ranked 18th, and Taiwan 3rd in long-term orientation vs. short-term orientation.

Local city government sites were chosen because they offer sufficient sample sizes for each culture. Generally, local government websites are mostly designed by local designers, and the design elements which are applied by the local designer will be an unconscious indication of the customs, norms, values, biases and preferences of the local culture. This kind of selection avoids the influence of corporate branding or company imaging.

In this local website audit stage, the cultural markers approach [1] is adopted. There are three steps in the procedure for identifying culturally preferred attributes.

Step 1: Foraging websites. Thirty local city government websites in each country were selected. Thirty county government websites in Taiwan and the top thirty populated city council websites in the UK were selected.

Step 2: Determining categories of web design characteristics and each variable. Firstly, previous research related to localization and design characteristics was consulted, such as that of Barber & Badre [1], Sun [21], Cyr & Trevor-Smith [6], and Würtz [23]. Secondly, the observation of the real features in the selected websites were integrated. Finally, five categories of website characteristics in this research were determined as visual representation, multimedia, navigation, links, and layout.

Step 3: Inspection and identification of culturally preferred design attributes. Each variable of all websites was inspected manually by two experts, one from Taiwan and the other one from the UK. As mentioned in the previous section, all va-

riables are divided into five categories. If the characteristic is not present in the web page, it will be given a 0 for categorical variables, but if the characteristic is present, it will be given a 1. The Taiwanese expert is undertaking a PhD in HCI design research at National Yunlin University of Science and Technology. The English expert has been running a multimedia company in Taipei for 6 years. Each expert reviewed 30 local government web homepages from his own country, providing ratings by nations. The analysis tool SPSS was used to carry out the cross-tabulation comparisons to examine if there were significant differences between the UK and Taiwan in each category. The results of all categories of variables are presented from Tables 1 to 5.

5 Results

All of the results of this local websites audit is listed in the following tables.

Table 1. Links

Variable	Actual count		Expected count	Chi-square	Degrees of freedom	Sig. Level
	Taiwan	United Kingdom				
Popup a new window	16	0	8	21.818	1	.000
Dynamic button	12	1	6.5	11.882	1	.001
Mouse over (color change)	25	17	21	5.079	1	.024
Mouse over (underlined)	8	21	14.5	11.279	1	.001

Hypothesis 1 was strongly supported. Results in Table 1 lend strong support that characteristics differ across two cultures. “Popup a new window” was found in more than 50% of Taiwanese websites, while none of the UK websites had these. Mouse over (underlined) characteristic was used in 70% of the UK sites, while only 26% of Taiwan sites had this feature. Color changed links were frequently used in both cultures, particularly among Taiwanese sites where more than 80% met this criterion. Dynamic button were found in 12 of Taiwanese websites, but in only one British website.

Table 2. Visual representation

Variable	Actual count		Expected count	Chi-square	Degrees of freedom	Sig. Level
	Taiwan	United Kingdom				
Iconic symbols	19	1	10	24.300	1	.000
Government identity symbols	27	27	27	.000	1	1.00
Image of leader	22	2	12	27.778	1	.000
Photo of accomplishment	17	0	8.5	23.721	1	.000
Images of group	14	2	8	12.273	1	.000
Images of daily life	0	16	8	21.818	1	.000
Photo of Animal/Plant	3	4	3.5	.162	1	.688
Photo of building	5	11	8	3.068	1	.080
Photo of landscape	12	4	8	5.455	1	.020
Cute style illustration	13	1	7	13.416	1	.000
Banner within color shape	2	9	5.5	5.455	1	.020
Banner within local city image	25	17	21	5.079	1	.024

Hypothesis 2 was supported. As demonstrated in Table 2, there were 9 significant preferences for visual representation variables across two cultures. Iconic symbols were found in many of the Taiwanese websites (63%), while only 1 of the UK website had this. Images of leaders were found in 73% of Taiwanese websites, but in only 25% of the UK websites. Photos of accomplishments are used in 60% of Taiwanese sites, but in none of the UK sites. Images of groups were used in 50% of Taiwanese sites, while only 2% of the UK sites had this feature. Surprisingly, none of the Taiwanese websites had images of daily life, while they were present in nearly 60% of the UK websites. The cute style illustrations are quite popular in Taiwanese local government websites, with 43% of Taiwanese websites utilizing this, but present in only one of the UK websites. Only 2 Taiwanese websites had banners within color shape, while nearly 30% of websites in the UK had these. Taiwanese have a strong preference for banners within local city image with 80% of Taiwanese websites having this, but only half of the UK websites utilized this.

Table 3. Multimedia

Variable	Actual count		Expected count	Chi-square	Degrees of freedom	Sig. Level
	Taiwan	United Kingdom				
Sound	3	0	1.5	3.158	1	.076
Stream video	16	0	8	21.818	1	.000
Flash animation	16	0	8	21.818	1	.000
Sliding pictures	16	21	18.5	1.763	1	.184
Moving picture	23	2	12.5	30.240	1	.000
Moving text	10	1	5.5	9.017	1	.003
Opening	10	1	5.5	9.017	1	.003

Hypothesis 3 was strongly supported. Results in Table 3 were consistent with the hypothesis that multimedia characteristics differ across Taiwan and the UK.

Multimedia are used to a greater extent in Taiwan than in the UK. Preferences for moving pictures, stream video, flash animation, moving text and opening features were statistically significant between the two cultures. Specifically, nearly 80% of Taiwanese sites used moving pictures and nearly 60% of Taiwanese websites used stream video and flash animation, while none of the UK websites contained stream video and only 1 website had flash animation. More than 30% of Taiwanese websites have both of these features, while only 1 of the UK websites had the moving text and opening features. The use of sound and sliding pictures did not differ significantly across cultures.

Table 4. Navigation

Variable	Actual count		Expected count	Chi-square	Degrees of freedom	Sig. Level
	Taiwan	United Kingdom				
Horizontal menu	27	24	25.5	1.176	1	.278
Vertical menu	28	23	25.5	3.268	1	.071
Home button	27	28	27.5	.218	1	.640
Search	20	29	24.5	9.017	1	.003
Accessibility icon	26	10	18	17.778	1	.000
Accessibility on text	0	14	7	18.261	1	.000

In general support of Hypothesis 4, an analysis of the results from Table 4 yielded the following findings. There were significant differences between Taiwan and the UK cultures. Specifically, more than 85% of Taiwanese websites had accessibility

icons, while only 10% of the UK websites had these. None of the Taiwanese websites had accessibility on text, while nearly 50% of the UK websites had this feature. Search functions are prevalent in Taiwan and in the UK; among the UK sites, 97% sites used the search function and it is also found in 67% of Taiwanese websites.

Table 5. Layout

Variable	Actual count		Expected count	Chi-square	Degrees of freedom	Sig. Level
	Taiwan	United Kingdom				
Two-column	8	12	10	1.200	1	.273
Three-column	22	14	18	4.444	1	.035
Multi-column	0	4	2	4.286	1	.038
Vertical menu on left	19	17	18	.278	1	.598
Vertical menu on right	7	6	6.5	.098	1	.754
Flexible width design	1	7	4	5.192	1	.023
Horizontal menu on top	21	21	21	.000	1	1.000
Information guide in bottom	3	10	6.5	4.812	1	.028

In support of Hypothesis 5, four preferences for layout vary between Taiwan and the UK. The three-column, flexible width design, multi-column, and information guide on the bottom differed across cultures. The three-column format was found in many of the Taiwanese websites (73%), but in only 18% of the UK websites. Flexible width design was exhibited in many more of the UK websites. Only 1% of Taiwanese websites had this feature, compared with 23% of the UK websites. Of all Taiwanese websites 10% had the information guide in the bottom, whereas the percentage increased to 33% in the UK websites. None of Taiwan websites had multi-columns, while 13% of the UK websites did.

6 Discussion and Implication

The results of the audit provide statistically significant evidence to support the hypotheses that design preferred characteristics differ between Taiwan and the UK. Results of this investigation were consistent with most hypotheses and lend support to the previous studies [12] [21] [23] that web designers need to carefully adapt interface features for culturally diverse users.

Various preferences exist between Taiwan and the UK, significantly in three categories of web features: links, multimedia and visual representation. Pop up a new window, and dynamic button are used frequently on Taiwan sites, while mouse over (underlined) are found in 70% of the UK sites. With regard to multimedia, specifically, moving picture, stream video and flash animation aspects of multimedia are very popular on Taiwan websites, while none of the UK websites contained stream video and only one website had flash animation. One possible explanation for this difference is that Taiwan is oriented to a high-context culture, while the UK is considered a very low-context culture based on Hall and Halls’ theories. High context cultures (i.e. Taiwan) seek to assimilate human presence on their websites, and flash animation, text in motion has the potential to provide a sense of human representation; they prefer many sidebars and menus, with the opening of new browser windows for each new page. On the contrary, low context cultures prefer few sidebars and menus, constant opening in same browser window, and quick solutions. Flash animation or text in motion would lead to distraction for low context cultures (i.e. the UK).

As far as visual representation is concerned, iconic symbols were found in many Taiwanese websites (63%), while only one site had this attribute in the UK. Images of

leaders, photos of accomplishment, and images of groups were highly popular on Taiwanese websites, while very few of the UK sites used these. None of the Taiwanese websites had images of daily life, while they were present on nearly 60% of the UK websites. The speculation for the significant difference is that Taiwanese culture, with collectivism and high context, tends to be implicit and ambiguous, while the UK with low context culture tends to be explicit and clear. Thus, people from a high context culture (i.e. Taiwan) have preferences for images to help promote values characteristic of collectivist societies. People in the UK, with low context culture and individualism are inclined to take care of themselves and enjoy their lives, and usually tend to be independent of other people, preferring images that promote values characteristic of individualistic societies.

With regard to navigation and layout, none of Taiwanese websites had accessibility on text, while nearly 50% of the UK websites had this feature. More than 85% of Taiwanese websites had accessibility icons, while very few of the UK websites had this feature. The three-column format is found on many of the Taiwanese websites (73%), but on only 18% of the UK websites. One possible interpretation for the cultural preferences is that Taiwanese culture has a long-term time orientation and the UK has a short-term time orientation. Taiwanese users like to navigate in a parallel structure and read information shown in a pop up window and polychromic structure, while the UK users prefer to navigate in a monochromic structure and tend to want to quickly get results. These findings are consistent with the findings in the anthropological literature of Hofstede [12] and Hall and Hall [11].

Over all, this study implies that different kinds of culturally preferred attributes should be applied on websites to target different context cultures. Implicit culturally preferred design elements (i.e. graphics, images, color, moving text, stream video and flash animation) should be applied in high context culture, collective culture, long-term time orientation culture, while explicit culturally preferred design elements (i.e. logical and structured layout) should be applied in low context culture.

7 Conclusions and Looking Ahead

The results of this study have shown the need of localization; as such, they have the potential to help web developers and designers develop their web products as culturally appropriate. Also, the results of this study could be used in the construction of website experiment in further research, where the culturally preferred design elements would be incorporated in websites to test if the web reflects the user's culture can be more effective in communication. The communication effectiveness (usability) may be evaluated within six aspects: learnability, efficiency, minimal errors, satisfaction, comprehension, and desirability. Further, English and Taiwanese participants would be selected to participate in the web communication effectiveness (usability) test.

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References

1. Barber, W., Bardre, A.: *Culturability: The Merging of Culture and Usability*. In: *Proceedings of the 4th Conference on Human Factors and Usability (1998)*, <http://zing.ncsl.nist.gov/hfweb/att4/proceedings/barber>

2. Baumgartner, V.J.: A Practical Set of Cultural Dimensions for Global User-Interface Analysis and Design (2003), http://mavas.at/val/downloads/ValBaumgartner_PracticalSetOfCulturalDimensions.pdf
3. Brinck, T., Gergle, D., Wood, S.D.: *Designing Web sites that work: usability for the Web*. Morgan Kaufmann Publishers, San Francisco (2002)
4. Chen, G., Starosta, W.: *Foundations of Intercultural Communication*. Allyn and Bacon, Boston (1998)
5. Choe, Y.: Intercultural conflict patterns and intercultural training implications for Koreans. In: *The 16th Biennial World Communication Association Conference*, Cantabria, Spain (2001)
6. Cyr, D., Trevor-Smiths, H.: Localization of Web design: An empirical comparison of German, Japanese, and United States Web site characteristics. *Journal of the American Society for Information Science and Technology* 55(13), 1199–1208 (2004)
7. Del Galdo, E.: Culture and Design. In: Del Galdo, E., Nielsen, J. (eds.) *International User Interfaces*, pp. 74–87. John Wiley and Sons, Inc., Chichester (1996)
8. Fussell, D., Haaland, A.: Communicatin with pictures in Nepal: results of practical study used in visual education. *Educational Broadcasting International* 11(1) (1978)
9. Nielsen, J.: *Usability Engineering*. Academic Press, San Francisco (1993)
10. Gribbons, W.M.: Designing for the Global Community in *Proceedings of IEEE International Professional Communication Conference*, Salt Lake City, UT, pp. 261–273 (1997)
11. Hall, E., Hall, M.: *Understanding cultural differences*. Intercultural Press, London (1990)
12. Hofstede, N.: Global Issues, local Concerns. *Technical Communication*, Second Quarter 1999, 145–148 (1999)
13. Hofstede, G.: *Cultures and Organizations: Software of the Mind*. McGraw-Hill, London (2005)
14. Hsieh, H.C., Holland, R., Young, M.: A Theoretical Model for Cross-Cultural Web Design. In: Kurosu, M. (ed.) *HCD 2009*. LNCS, vol. 5619, pp. 712–721. Springer, Heidelberg (2009)
15. Kaplan, R.: Cultural thought patterns in intercultural education. *Language Learning* 16, 1–20 (1966)
16. Marcus, A.: Human Communications Issues in Advanced UIS. *Communication of the ACM* 36(4), 101–109 (1993)
17. Marcus, A., Gould, E.W.: Cultural Dimensions and Global Web User-Interface Design. *Interactions*, 33–46 (July/August 2000)
18. Russo, P., Boor, S.: How fluent is your interface? Designing for international users. *Human Factors and Computer Systems*. In: *Proceedings of 4th Conference on Human Factors in Computing Systems*, pp. 342–347. Addison-Wesley, Boston (1993)
19. Simon, S.J.: The Impact of Culture and Gender on Web Sites: An Empirical Study. *The Database for Advances in Information Systems* 32(1), 18–37 (2001)
20. Smith, A., Dunckley, L., French, T., Minocha, S., Chang, Y.: A process model for developing usable cross-cultural websites. *Interacting with Computers* 16(1), 63–91 (2004)
21. Sun, H.: Building a culturally-competent corporate web site: an exploratory study of cultural markers in multilingual web design. In: *Proceedings of the 19th Annual International Conference on Computer Documentation*, pp. 95–102 (2001)
22. Sun, H.: Exploring Cultural Usability. In: *Proceedings of IEEE International Professional Communication Conference*, Portland, OR, pp. 319–330 (September 2002)
23. Würtz, E.: A cross-cultural analysis of websites from high-context cultures and low context cultures. *Journal of Computer-Mediated Communication* 11(1), article 13 (2005), <http://jcmc.indiana.edu/vol11/issue1/wuertz.html>

Communication and Social Network Requirements of Chinese Elderly People for Mobile Services

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Abstract. This paper explores Chinese elderly people's communication and social networking requirements on mobile services. Interviews, observations and questionnaires provided insight into elderly people's requirements. The result of data analysis illustrates the relationship between social, family, personal factors and elderly people's requirements. Personal and family factors are significantly related to elderly people's requirements. Social factor needs to be well-quantified in the further studies.

Keywords: Elderly people, communication requirement, social network requirement, mobile phone.

1 Introduction

Population aging is a hot topic which gains more and more attentions all over the world. Scientists begun to devote more efforts to study elderly people's psychological requirements, rather than their physical requirements. At the same time, social network services grow sharply in the world extension; more and more young people enjoy their digital life with SNS. Therefore, the communication and social network requirement of elderly people is a meaningful and potential topic.

In western countries, scientists and designers have been working on design tools to help elderly people live healthier and safer for more than 20 years. Technologies offer more comfort for the elderly and allow them to live independently.

Most devices were designed with the concentration on healthcare and live assistance. In US and Japan, there emerged many tools to monitor the situation of elderly chronic disease and keep in touch with the community healthcare center. Also some devices possess the ability to help seniors controlling all household electrical appliances in their home with one controller. What's more, Mesh networks of multiple sensors monitor energy (heating, cooling, lighting) as well as provide automatic meter readings and respond to ambient conditions, which ensure the safety of seniors. All of

these devices are designed based on an assumption that elderly people have some physical limitations, so we need to design some tools to help them to live safely and healthily. In Maslow's hierarchy of needs (**Fig.1**), current tools only fulfill their needs on the second level. In last 10 years, some researchers began to collect their attentions to elderly people's third level needs.

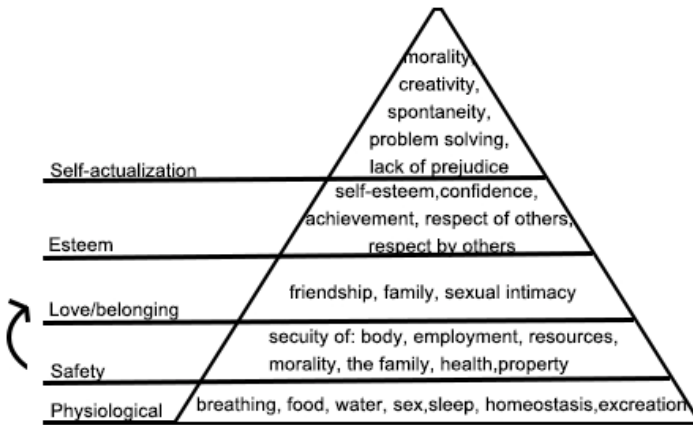


Fig. 1. Maslow's hierarchy of needs

However, such as Eons and iYomu[1], there was no much success about the technology meets elderly people's social network need, until the emerge of Facebook. According to the research of Jason Brandt [2], there are fifteen million seniors on Facebook, which is 11% of all users, and that represents 1,448% year-over-year growth in that segment. Women from 55 to 65 years old are the fastest-growing segment on Facebook. 40% seniors connect with family and old friends, 30% of them use photo sharing, 20% for social gaming, and 10% for contests and promos. Although the research has not refer the clear definition of the age of seniors, we still could see the trend. Also according to the research revealed in August by the Pew Research Center's Internet & American Life Project[3], the number of people 65 years of age and older using social networks doubled to 26 percent from early this year. The research showed that older social network users were inclined to reconnect with people from the past, potentially creating support networks for jobs after retirement. Always been mentioned together with Facebook, Twitter faced the similar condition. According to Alexei Oreskovic from Reuters [4], the most active age group on Twitter is 45-54 which could indicate the trend. On the other hand, Robin Laurain[5], Yahoo! Contributor Network, argued that the health benefits of social networking to the elderly are important. Social networking keeps the brain active which is said to slow down the progression of dementia. The friendships help alleviate boredom and isolation which decreases the chances of depression. In China, there is not much research and related work about the social network and communication requirements of elders, which makes it a necessity to collect Chinese elderly people's communication and social network requirement and design some services to help them live a happier life.

2 Related Works

2.1 Elderly People Interact with Mobile Phone

The research about elderly people's interaction with mobile phone date back to the beginning of 21 century. There were many influential technology acceptance models lighted the road for researches worked out the model for elderly people's technology acceptance. Judy van Biljon [6] investigated factors that affect elderly people's adoption of mobile phone. By summarizing and modifying the influential acceptance models, such as TAM(Technology acceptance model) and UTAUT(Unified Theory of Acceptance and Use of Technology), he established a model for elderly people with Social influence(SI), Perceived ease of use (PEU), Safety and security, Organization, Information as 5 dimensions. Renaud and Van Biljon [7] proposed the senior technology acceptance model (STAM) based on a study of existing technology adoption models, an investigation of older users' context, and some empirical research with such users, arguing that the perceived usefulness, social influence, facilitating conditions and Ease of learning are significant for the acceptance of elderly people. Helene Gelderblom [8], although finally have not refined the STAM model, pointed out that most samples have not reached full adoption but have not rejected the technology either. However, all of them only focus on the acceptance of elderly people, rather than the needs of elderly people.

Problems of the Elderly can be categorized coarsely into Cognition, Motivation, Physical and Perception [9]. Many researchers and designers devote their efforts to design assistance devices for elderly people to overcome physical and perception problems, including some mobile phone applications. M. Mikkonen [10] stated that the most beneficial services for the elderly in the future will be those by which they can maintain their social relationships, health and ability to live at home. Health and ability have been almost well- studied, so the next stop of researches should be open the door of elderly people's social network.

2.2 Communication and Social Network Requirement of Elderly People

In modern societies elderly people are increasingly isolated and under-stimulated, both physically and psycho-socially. This situation results in accelerated cognitive decline and the suffering associated with loneliness and confusion [11]. Seppo Malleinius implemented the classical model-- UTAUT model, concluding that the service for the communication with relatives and emergency and health are important mobile service for elderly people [12]. In 2009, AGNES project was suggested to build a social network for elderly people with not only relatives, neighbors, but healthcare worker and community staffs, which could alleviating the negative impact. Also Siân E. Lindley argued that there are 2 reasons why the relationships of elderly people was need attention [1]. Firstly, many technologies designed for elders are in some way

related to relationships, especially family relationships. Secondly, relationships are known to be an important contributing factor to wellbeing in old age. He also brought up a new idea that assumptions about symmetry being inherent in family ties can be misleading; that asymmetry is often a better way of accounting for older people's attitudes to their families; and that asymmetry offers better basis for design.

SNS services also could play some important roles in elderly life. According to Raymundo Cornejo's research, one of the biggest barriers in maintaining strong emotional ties is that elders are disassociated with events related to their relatives 'everyday life [13]. Therefore, a digital frame could be designed to integrate non-computer older adults into their family's SNS, providing them everyday knowledge about their relatives 'life lightweight information. He also pointed out the characteristic of elderly people's interaction style. The elderly people's newsgroup was less dense than that of teens, but also with an unequal distribution of power and a high dependency on critical members of the group.

No one can deny that the communication and social network have close relationship. But in the research field, they were more independent than combined. A report has shown that often communication requires a practical pretext to happen— people, especially males, communicate little for social purposes although these are the types of communications they value most [14]. Elderly people's communication requirement often come from they need to keep in touch with children. So connecting a family with awareness system is good for elderly people. And in the awareness system, the mobile technology plays an important role. On the other hand, the students of Carnegie Mellon University opened a new door for elderly people's communication with relatives and peers. They argued that what technology can provide is a richer shared context between the elderly and their families and peers rather than an artificial companionship [15].

3 Methodology

3.1 Interview

Three factors, social factors, Family factors, and personal factors, are chose as the variables that influence elderly people's communication and social network requirements. A structured interview was conducted to collect the preliminary data for seeking potential requirements and the relationship between factors and requirements. 7 participants were randomly sampled from Haidian, Chaoyang, and Xicheng, three different districts in Beijing. The age range of them is from 66 years old to 76 years old. The result shows that children are the most important group for elderly people in China. Healthy is a potential part in their requirement. All participants are suffering some kinds of chronic diseases. Although there is not much information about their communication with healthcare staff, it is a potential requirement. What's more, their attitudes to activities are complex. Some of them mentioned that the reason why they

do not want to attend activities is they do not want to obey rules. They are tired about all rules when they work in the young ages. After retiring, they are not willing to be interrupted others. Also, there are some potential markets of mobile phone for elderly people, but their children, who pay for mobile phones, play important roles.

3.2 Observation

Directly observation were selected to be implemented, and 10 participants were randomly chose in Beijing.

The result shows that elderly people show a strong desire to know the conditions of their children and keep in touch with them. However, many of them mentioned that children were busy for work, they were not willing to interrupting their work. Most of them do not have many hobbies, they all walk every day, and watch TV, cook and shopping. And walking is a preferred exercise. There are some elderly people’s spouse has passed by, so there may need live alone, or live with children. This factor is also important for elderly people’s communication and social network requirement.

3.3 Questionnaire

A questionnaire is developed to collecting more quantitative data about elderly people’s requirement and to investigating the relationship between requirements and factors. There are 117 participants from three different groups, students of Beijing normal university elderly university, elderly people randomly selected in parks and random families in Beijing.

Pearson correlation, regression and structured equation model (SEM) were applied to analyzed quantitative data. There are two kinds of variables in SEM model, observed variable and latent variable. In this SEM model (**Fig.2**), there are 3 exogenous latent variables, and 2 endogenous latent variables. **Table 1** shows all variables in this model.

Table 1. SEM Model variable list

Latent Variable		Observed Variable	
Exogenous	Endogenous	Exogenous	Endogenous
Social Factor	Communication	Community Service	Media
Family Factor	Requirement	Community Type	Frequency
Personal Factor	Social network	District Economic Index	Content
	Requirement	Spouse Condition	Participant
		Relative distance	Social Searching_Friend
		Family Economic Index	Social Search-
		Health Condition	ing_Relative
		Education	Social Browsing
		Age	

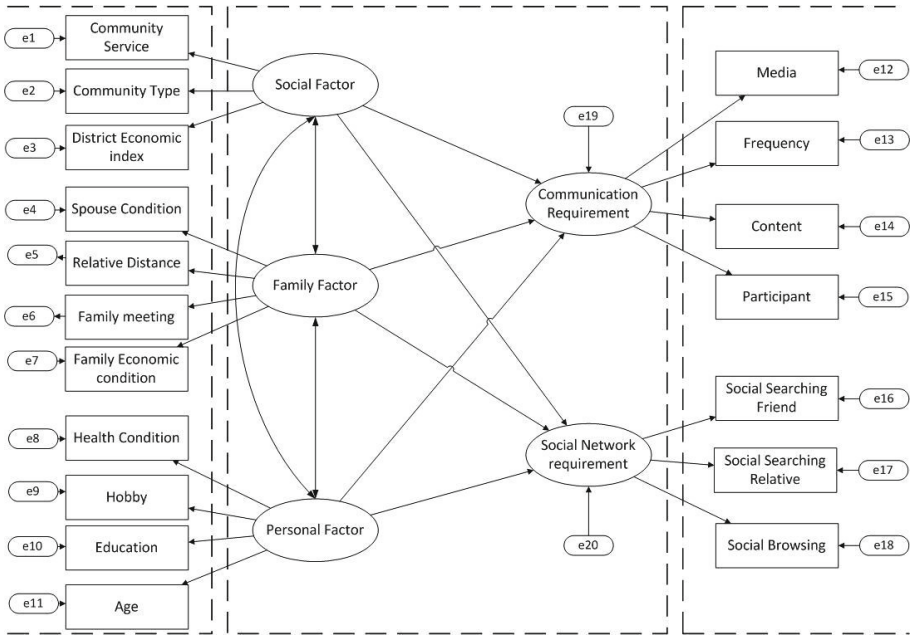


Fig. 2. SEM Model route graph

4 Data Analysis

Based on the results of Correlation analysis, we found out that the social factor does not have much correlation with other factors, and social and communication requirement are correlative. There are some relationship between personal and family factors and there are significant related to communication and social network requirements. **Table 2** shows the detail information about correlations between each part.

Table 2. Correlation table

	Social Factor	Family Factor	Personal Factor	Communication Requirement
Family Factor	Low			
Personal Factor	No	Low		
Communication Requirement	Low	Low	Low	
Social network Requirement	Low	Low	Middle	Low

Since we care about the relationship between factors and requirements, I use regression to test how different factors affect each requirement. From **Fig.3**, we could see that all p-values are smaller than 0.05, so both personal and family factor are significantly influence communication requirements. At the same time, we found the relationship between factors and SNS requirement is similar with that of communication requirements, which we could refer from **Fig.4**.

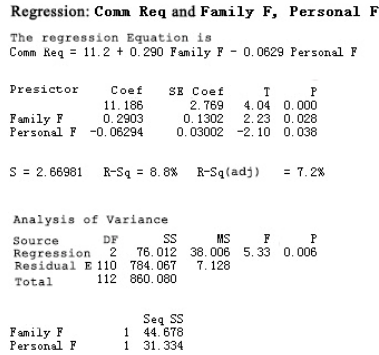


Fig. 3. Regression result of communication requirement

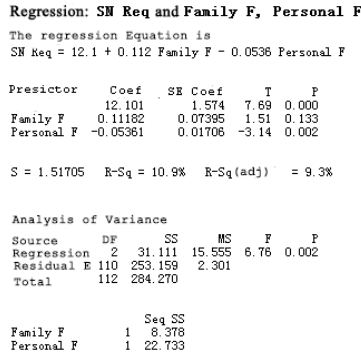


Fig. 4. Regression results of SNS requirement

SEM model is ready for testing, and IBM SPSS 19 is used to do the SEM analysis. Based on the software, the Chronbach’s coefficient is 0.712, which is larger than 0.7, so the reliability of model is acceptable. **Fig.5** shows the original route graph of model. With several rounds refining, we obtained the final result of model, which was shown in **Fig.6**.

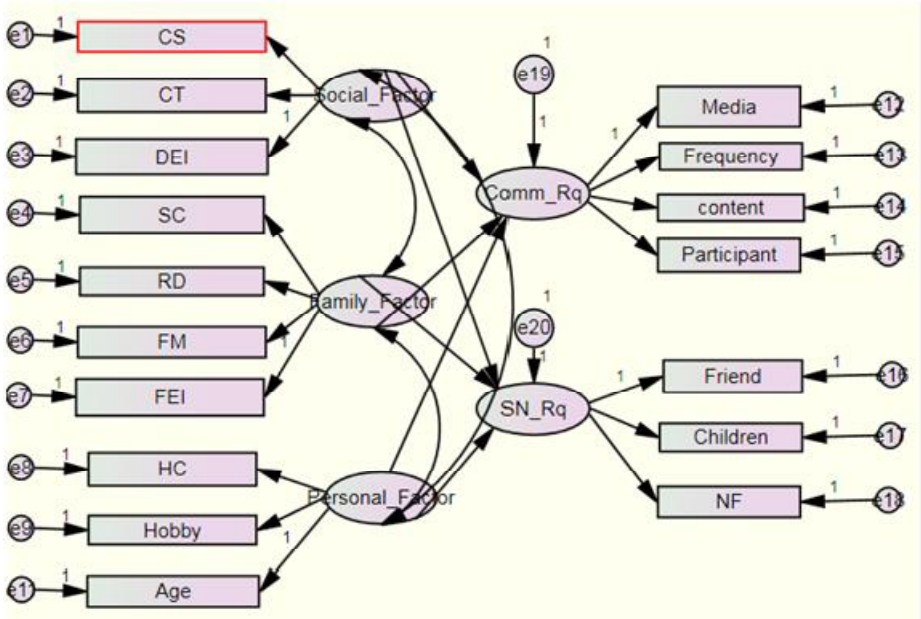


Fig. 5. SEM model route graph

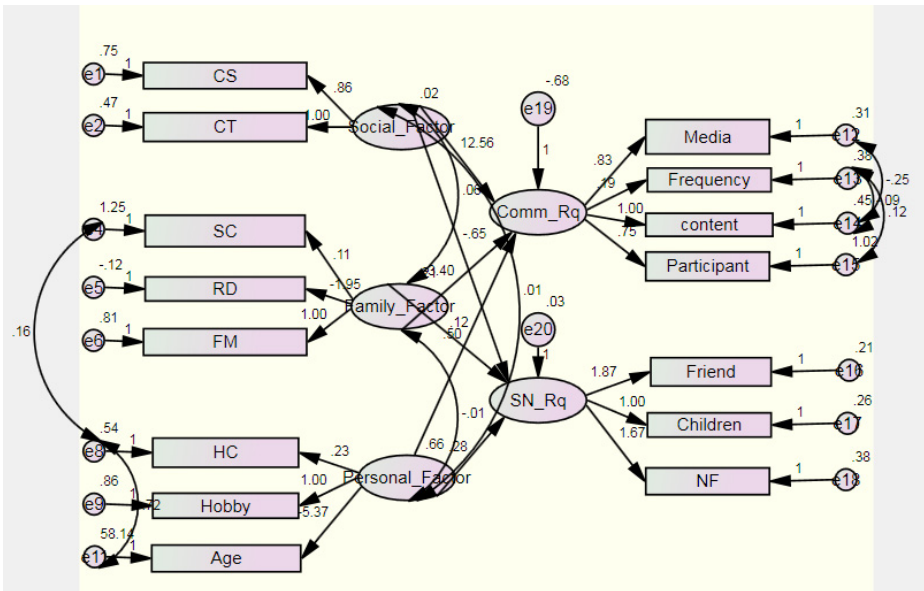


Fig. 6. Result of modified model

There are some results listed below. The social network requirement and communication requirement are correlated. The one who have a higher communication requirement is also enjoys a higher social network requirement. So if there will be some further research about these two requirements, maybe more attention should be paid on their synergic relationship, not their independence. Personal factor are significant to two requirements, health condition and hobby are positive to the requirements, and age are negative towards requirements. So the target group for the new social network service for elderly people should be the one who is just retired from work, not the one are over 80 years old. Family factor are low significant, but still have some effect of two requirements. Relative distance and spouse condition are positive to requirements. Actually there are still many aspects that children affect elderly people's life, but the measurement of them need to be refined. So there some further researches are needed to study the family factor. Social factor is not that significant in the model. One reason of it is some measure matrix need to be developed to measure social factor more properly.

5 Conclusion and Discussion

Elderly people's communication and social network requirements is a potential area where researchers need to devote more efforts to. The result of this study shows the personal and family factors reveal their influences on elderly people's communication and social network requirements. This is a valuable topic for cross culture design, because the family fact is weighed differently in Asia and Western counties. Some cross culture researches in the future will make more precious contribution to the field. In addition, communication and social network requirement are correlated, services and products need to take both into consideration in their design for elderly people. Social factor, although is not significant in this study, still need to be studied in the further researches. Coping with the complexity of quantifying social factor, researchers may also put some efforts on qualitative method.

For the future study, the measure matrix need to be refined to measure each factor and requirement better. At the same time, a larger sample size is need to fulfill the requirement of SEM model and to improve the reliability and validity of the model. SEM is a powerful tool to evaluate relationships in the graph-structured model.

References

1. Lindley, S., Harper, R., Sellen, A.: Designing for elders: exploring the complexity of relationships in later life. In: BCS-HCI 2008: Proceedings of the 22nd British HCI Group Annual Conference on People and Computers: Culture, Creativity, Interaction, vol. 1. British Computer Society (September 2008)
2. Brandt, J.: Technology and Elderly Care. Message posted to (February 14, 2011), <http://www.pixelsandpills.com/2011/02/14/technology-elderly-care>

3. Madden, M.: Older Adults and Social Media. Message posted to (August 27, 2010), <http://pewinternet.org/Reports/2010/Older-Adults-and-Social-Media.aspx>
4. Oreskovic, A.: Twitter older than it looks. Message posted to (March 30, 2009)
5. <http://blogs.reuters.com/mediafile/2009/03/30/twitter-older-than-it-looks/>
6. Laurain, R.: Can the Elderly Benefit from Facebook and Twitter? Message posted to (January 3, 2011), http://www.associatedcontent.com/article/6176248/can_the_elderly_benefit_from_facebook.html
7. van Biljon, J., Renaud, K.: A Qualitative Study of the Applicability of Technology Acceptance Models to Senior Mobile Phone Users. In: Song, I.-Y., Piattini, M., Chen, Y.-P.P., Hartmann, S., Grandi, F., Trujillo, J., Opdahl, A.L., Ferri, F., Grifoni, P., Caschera, M.C., Rolland, C., Woo, C., Salinesi, C., Zimányi, E., Claramunt, C., Frasinca, F., Houben, G.-J., Thiran, P. (eds.) ER Workshops 2008. LNCS, vol. 5232, pp. 228–237. Springer, Heidelberg (2008)
8. Renaud, K., van Biljon, J.: Predicting Technology Acceptance by the Elderly: A qualitative study. Paper presented at the SAICSIT 2008: Riding the Wave of Technology. George, South Africa (2008)
9. Gelderblom, H., van Dyk, T., van Biljon, J.: Mobile phone adoption: Do existing models adequately capture the actual usage of older adults? In: SAICSIT 2010, Bela Bela, South Africa, October 11-13 (2010)
10. Holzinger, A., Searle, G., Nischelwitzer, A.: On Some Aspects of Improving Mobile Applications for the Elderly. In: Stephanidis, C. (ed.) HCI 2007. LNCS, vol. 4554, pp. 923–932. Springer, Heidelberg (2007)
11. Mikkonen, M., Väyrynen, S., Ikonen, V., Heikkilä, M.O.: User and Concept Studies as Tools in Developing Mobile Communication Services for the Elderly. *Personal and Ubiquitous Computing* 6(2) (2002)
12. Waterworth, J.A., Ballesteros, S., Peter, C., Bieber, G., Kreiner, A., Wiratanaya, A., Polymenakos, J., Wanchoo, S., Capobianco, M., Etxeberria, I., Lundholm, L.: Ageing in a Networked Society – Social Inclusion and Mental Stimulation. In: PETRA (June 2009)
13. Mallenius, S., Rossi, M., Kristina, V.: Factors affecting the adoption and use of mobile devices and services by elderly people – results from a pilot study (2007), <http://www-marshall.usc.edu>
14. Cornejo, R.: Integrating Older Adults into Social Networking Sites through Ambient Intelligence. In: GROUP 2010, Sanibel Island, Florida, USA, November 7-10 (2010)
15. Romero, N., Markopoulos, P., van Baren, J., de Ruyter, B., IJsselstein, W., Farshchian, B.: Connecting the family with awareness systems. *Pers. Ubiquit. Comput.* 11, 299–312 (2007)
16. Chen, C.Y., Kobayashi, M., Min, L.: Oh Share Comp: Sharing for Companionship. In: CHI 2005, Portland, Oregon, USA, April 2-7 (2005)

Arabic Website Design: User Evaluation from a Cultural Perspective

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Abstract. The cultural background of web users may play a key role in the way they interact with and perceive the usability and usefulness of websites. Twenty Arab participants evaluated and compared 2 websites from 2 countries within their culture to identify their preferences and expectations of the design of Arabic websites in order to examine whether these preferences are consistent with their cultural-specific attributes as described and predicted by Hofstede's model of cultural dimensions. The results suggest that these participants showed an overall preference for one website over the other.

Keywords: Web design, User Evaluation, Arab countries, Culture, Hofstede.

1 Introduction

One of the key objectives for any website is to enable its users to experience success and satisfaction [3, 10]. As such, it is argued that the accommodation of users' attributes into the design process is essential for the usability and usefulness of the web [11]. The cultural background of users is considered one of the attributes that might affect users' performance and satisfaction while interacting with websites [12]. The bulk of the research investigating this domain has employed Geert Hofstede's cultural model [4, 5], based mainly on the interpretation of Marcus and Gould [8]. In his model, Hofstede assigned comparative scores for 50 individual countries and three regions on five cultural dimensions. In the case of the three regions, one of which is the Arabic-speaking region, several countries had been grouped together based on the assumption of having similar cultural traits. The Arabic-speaking region comprised Egypt, Lebanon, Libya, Kuwait, Iraq, Saudi Arabia and the United Arab Emirates. This group has been frequently applied in cross-cultural interface design studies to different extents [1, 2, 13]. However, assuming Arab users have similar needs, expectations, and preferences on the web, without acknowledging possible individual differences across countries, can create potential problems in Arabic interface localization. In this study, we investigate how web users from an Arabic country that is excluded from Hofstede's model of culture perceive and evaluate two websites, one from their own country and the second from an Arabic country that is included in the model. This is one part of a larger study that aims to investigate whether users' expectations and preferences match those described for Arab countries in Hofstede's cultural dimensions.

2 Arab Countries in Cultural Design Studies

Cultural similarities and differences in web design have been discussed at length in the literature. However, Arab countries have received limited attention in this research area, despite the fact that 19% of the overall Arab population uses the internet and therefore could potentially benefit from this research. Some studies that did opt to include web pages from Arab countries limited their country choices to as few as two countries. For example, in a study that included systematic inspection of design elements that are possibly preferred within a particular cultural group, Barber and Badre [1] selected websites only from Lebanon and Saudi Arabia, which were initially chosen by Hofstede himself. Their findings indicate that these websites had a high frequency of right-to-left orientation and high frequency of flags in the government genre, relating to Uncertainty Avoidance and Long-Term Orientation dimensions respectively.

Zahir, Dobbing, and Hunter [13] selected national web portals also from two countries, Egypt and Morocco. Their results showed that websites from Egypt had a strong focus on the Egyptian culture, reflecting a high Power Distance characteristic. While websites from Morocco had a good presentation of women's issues and non-Islamic reference, relating to the Masculinity and Power Distance dimensions respectively.

Callahan [2], on the other hand, analyzed a total of 20 interfaces from the group of seven Arab countries included in Hofstede's model in her study of cross-cultural differences in the design of university websites. Although the number of websites from each country was not specified, the results pertaining to the Arab countries overall suggest that most of the design elements on their interfaces match their description on Hofstede's cultural dimensions.

In a study conducted by Marcus and Hamoodi [9], the researchers analyzed Arabic educational websites from Jordan, Egypt, and the United Arab Emirates aiming to determine whether or not the websites reflect Arabic culture. The results of this study show again that most of the design elements on these interfaces correspond to their characteristics on Hofstede's cultural dimensions.

As can be noted from the studies mentioned here, the methodology focused on conducting content analysis of Arabic websites, but did not involve actual users. Involving users and understanding their preferences and expectations could be incorporated in the design process that could potentially lead to design improvements for all users.

3 Methodology

3.1 Participants

Arab internet users living in Jordan are the population for this study, where 20 native-Arabic speakers ranging from 20-65 years old took part in evaluating the design of two Arabic websites. These participants were recruited by one of the researchers through personal contacts in Amman and Al-Salt cities in Jordan. During the first meeting, each participant was given a brief description of the purpose of the study and was asked to set a preferred date and venue for the evaluation to take place. In the second meeting, each participant conducted the evaluation, completed two questionnaires, and received a small financial compensation for taking part in the study. The study was in compliance with all ethical guidelines used by the researchers' university.

3.2 Tasks and Websites

The main objective of this study is to investigate how people from an Arabic country that is excluded from Hofstede’s model of culture compare and evaluate a website from their own country with another from an Arabic country that is included in the model. Therefore, we randomly chose one government website from Jordan and matched it with the equivalent website from Lebanon. Using the Ministry of Health’s websites in these two countries (see figures 1 and 2), each participant was handed a paper with questions asking her/him to find a list of public hospitals and contact information for each ministry.

These tasks were chosen for the evaluation because they were consistent across the two websites, and because they require the participants to perform some searching and/or browsing through the websites to find the answers, especially for finding the lists of public hospitals.

The main difference that was initially noticed between the two websites is that the Jordanian website is provided entirely in Arabic supported by a separate English version, while the Lebanese website is provided solely in English with some content in Arabic.

There were 80 tasks in total on both websites, 40 for each. The main objective of these search tasks was to expose the participants to the website, therefore there was no time limit to finish the tasks and they were encouraged to review the websites while answering the post-task questionnaire if needed. The start time for each task was noted when the participant read the question aloud and started navigating through the website. The end time was noted when the participant opened the page that included the right answer to the question. At that point, she/he was asked to write down the answer to each question. In one instance, a participant self-reported the time it took him to finish each task as he preferred to perform the evaluation at his convenience.



Fig. 1. Ministry of Health, Jordan



Fig. 2. Ministry of Public Health, Lebanon

3.3 Analysis

A post-task questionnaire inquired about what the participant thought of the design of these two websites. The general questions included in this questionnaire were adapted from Marcus and Alexander [7]; for example, how would the participants describe the imagery of the websites, would these websites appeal to people from their country, and what content is missing. The more specific questions that aimed to discover the relationship between the design elements and Hofstede’s cultural dimensions based on the interpretation by Marcus and Gould [8] were derived by the researchers based on our previous work [6].

Statistical analyses were performed using SPSS program based on the specific level of measurement for each variable for the quantitative aspect of this study. Descriptive statistics were used to describe continuous variables such as time for searching and completing tasks. Chi-square test was used for categorical variables, while T-test was used for continuous variables.

4 Results

The participants of our study are all native-Arabic speakers living in Jordan, 55% of which are females and 45% are males. With regards to age, 60% were between 20-30 years old, gradually decreasing the percentage up to age 60. The educational level also varied between participants as 10% hold a diploma, 60% a bachelor degree, and 30% a graduate degree. 20% of them have been using the computer between 4 and 8 years, 55% between 9 and 15 years, and 25% for more than 16 years.

Of the 80 tasks that were undertaken, four (5%) were unsuccessful, divided equally between the two websites. Two tasks were not completed while searching for the list of public hospitals in Jordan, and another two while searching for the list on the

Lebanese website. The overall average time for searching both websites was 74.4 seconds ($SD=90.9$). While the mean time for the searches on the Jordanian website was less than the mean time recorded for the Lebanese website, the T test ($t(74) = -1.29$, ns) indicates no statistically significant difference between the two times.

The mean time for the 18 completed tasks for finding the list of public hospitals on the Jordanian website was lower than the one for the Lebanese website, but the difference was not statistically significant ($t(34) = -1.62$, ns). The mean time for searching the contact information on the Jordanian website was also lower than its counterpart on the Lebanese website, but again the difference was not significant ($t(38) = -0.27$, ns).

The participants were asked to rate how much they liked the design of each website on a 5-point Likert scale, 1 being the lowest and 5 the highest. The mean score for Jordan's website was slightly higher than that of Lebanon's website with 3.60 and 3.25 respectively. This result is consistent with how these participants felt about which website they found easier to use and prefer to use, as a significant majority preferred to use Jordan's website ($\chi^2(1) = 5.00$, $p = .025$) and found it easier to use ($\chi^2(1) = 9.80$, $p = .002$), but they did not think it was much faster to use ($\chi^2(1) = 3.20$, ns) which was confirmed by the actual results of search times.

Among the reasons why these participants thought Jordan's website was easier to use are "the easy access to information", "the simple design", and "because it is provided in Arabic". The participants who favored the Lebanese website credited it to "better information mapping", "intuitive menus", and one participant mentioned "being offered in English".

The Arabic interface and easy access to information were also mentioned as reasons for preferring to use Jordan's website, besides providing more relevant information for them as Jordanians. On the other hand, those who preferred Lebanon's website said "it has more visually appealing design" and "more comprehensive and informative content". Although there was no significant difference in terms of search times on both websites, those who thought they were faster on Jordan's website also credited it to its simple design and language, while those in favor of Lebanon's website said it has better design for menus, a search box for faster searching, and the learning curve from searching the previous website helped them find the information.

When asked what they thought of the imagery on both websites, some participants described the images on Jordan's websites as "expressive", "reflecting the purpose of the website", "clear", "normal", "very formal", "traditional", to "boring and poorly designed". The description for the images on Lebanon's website varied as well from "expressive", "eye-catching and beautiful", "better than those on Jordan's website", "good quality", to "not truly reflecting the Lebanese society", and "not culturally appropriate" for one image in particular that was used for a breast cancer campaign.

Overall, the participants thought that both websites would appeal to people from their country as Jordan's website got 84% positive responses out of possible 19 answers, while Lebanon's website got 83% out of possible 18.

The second part of the post-task questionnaire asked the participants to rank on a 5-point Likert scale, 1 being the lowest and 5 the highest, how important was it for them to have specific design elements on any website, these elements were previously

identified as culturally specific markers [1]. As shown in Table 1, participants thought it was very important to have keyword searching, a supporting second language version of the website, and site map, while customization and animated images were slightly less important.

Table 1. Importance of specific design elements

Element	N	Mean	SD	Min.	Max.
Customization	20	3.70	1.34	1.00	5.00
Second Language	20	4.60	.99	1.00	5.00
Keyword Searching	20	4.75	.72	2.00	5.00
Site Map	20	4.25	1.16	1.00	5.00
Animated Images	20	3.25	1.45	1.00	5.00

They were also asked about their general preference for simple vs. complex menus, where a simple menu does not contain any submenus while the complex one opens up submenus when the user selects a choice. Even though 55% of the participants preferred simple menus, the difference between the two choices was not statistically significant ($\chi^2(1)=.20$, ns).

5 Discussion and Conclusion

The 20 participants compared and evaluated two websites from two Arab countries, Jordan and Lebanon. Our main objective of this study was to explore how people from a country that is excluded from Hofstede's model (i.e. Jordan) perceive and compare a website from their country with another one from a country that is included in the model (i.e. Lebanon). This is one part of a larger study that aims to explore whether users expectations and preferences of Arabic web design match the Arabic cultural-specific attributes which are described and predicted by Hofstede's model of culture.

The participants of this study performed the tasks and found the answers relatively faster on the Jordanian website, although the difference between the two websites was not statistically significant. The participants themselves thought that their performance on both websites did not differ much, even though they preferred to use Jordan's website which they also found much easier to use. When asked about the reasons why they preferred the Jordanian website, they said it was more relevant to them as citizens of the country, had a simpler design with easier access to information, and most importantly it was offered in Arabic, even though the majority of them stated that they have no problem searching for information on the internet in English. Marcus and Gould [8] associated the simple design with limited choices in the country's native language to Hofstede's fourth dimension high Uncertainty Avoidance. This association will be further investigated in relation to Arabic web design for these two countries.

As to the images, the ones used on Jordan's website were described as expressive, reflective of the society, clear, very formal, traditional, and sometimes poorly designed. On the other hand, the images on Lebanon's website were described as eye-catching and beautiful, good quality, yet not truly reflecting the Lebanese society and unacceptable for the conservative Arabic culture, for one breast cancer campaign image in particular. This description for images could be explained by two of Hofstede's dimensions, Power Distance and Masculinity. Images depicting high Power distance would include more images of authority figures, while those depicting Masculinity would portray more traditional gender roles [8]. This association will also be further investigated in relation to Arabic web design for these two countries.

Enforcing some restrictions on information access is something expected on websites with high Power Distance; even though a few participants favored such restrictions considering the type of website used, the majority of the participants preferred more freedom to roam and navigate websites without any restrictions. Websites with high Individualism (i.e. low Collectivism) are more likely to offer the user the ability to customize the interface in terms of font size or background color. Our participants did not think that customization is an essential component of a website, which was also the case for the presence of animated images that are an indicator of Masculine websites. Yet they highly favored websites with intuitive design, clear and simple menus that expected to be provided in Arabic language supported by a second language, which matches the description of Arabic culture on Hofstede's Uncertainty Avoidance dimension.

Arabic-speaking group in Hofstede's model did not have a score on the fifth dimension, Long- vs. Short-Term orientation which is reflected in the presence of search engines and site maps [5]. Yet, the participants thought that site-searching tools which help speed up the search process are very important on any website, even though only three participants actually used them while undertaking the tasks. Once again, these associations need to be further investigated and validated in relation to Arabic web design based on the interpretation of Hofstede's model made by Marcus and Gould [8].

This study poses a number of limitations that might have affected the results and should be taken into consideration for future research. First, there were only 20 participants who took part in the evaluation process of the two websites; a higher number is needed to calculate significant statistical differences. Second, the participants were recruited solely in Jordan, whereas the study might be more representative if users from other Arab countries participated, particularly in this case from Lebanon. Finally, the evaluation involved just two government websites, which could have influenced the design of the website [1], and hence users' perception of this design. Future research will take these limitation into consideration and investigate users' preferences and expectations in regards to Hofstede's model.

References

1. Barber, W., Badre, A.: Culturability: the merging of culture and usability. In: 4th Conference on Human Factors and the Web (1998), <http://research.microsoft.com/users/marycz/hfweb98/barber/>

2. Callahan, E.: *Cultural Differences in the Design of Human-Computer Interfaces: A Multi-national Study of University Websites*. Published thesis, Indiana University (2007)
3. Fernandes, T.: *Global interface design: A guide to designing international user interfaces*. AP Professional, Boston (1995)
4. Hofstede, G.: *Culture's Consequences: International Differences in Work-Related Values*. Sage Publications, Beverly Hills (1980)
5. Hofstede, G.: *Culture's Consequences: Comparing Values, Behaviors, Institutions, and Organizations Across Nations*. Sage Publications, Thousand Oaks (2001)
6. Khashman, N., Large, A.: Measuring cultural markers in Arabic government websites using Hofstede's cultural dimensions. In: Marcus, A. (ed.) *HCI 2011 and DUXU 2011, Part II*. LNCS, vol. 6770, pp. 431–439. Springer, Heidelberg (2011)
7. Marcus, A., Alexander, C.: User validation of cultural dimensions of a website design. In: Aykin, N. (ed.) *HCI 2007*. LNCS, vol. 4560, pp. 160–167. Springer, Heidelberg (2007)
8. Marcus, A., Gould, E.: Cultural Dimensions and Global Web User-Interface Design: What? So What? Now What? In: *Proceedings of the 6th Conference on Human Factors and the Web (June 2000)*, <http://www.amanda.com/resources/hfweb2000/hfweb00.marcus.html> (retrieved September 25, 2008)
9. Marcus, A., Hamoodi, S.: The Impact of Culture on the Design of Arabic Websites. In: Aykin, N. (ed.) *IDGD 2009*. LNCS, vol. 5623, pp. 386–394. Springer, Heidelberg (2009)
10. Nielsen, J.: *International Use: Serving a Global Audience*. In: *Designing Web Usability*, pp. 315–344. New Riders, Indianapolis (2000)
11. O'Connell, T., Murphy, E.: The usability engineering behind user-centered processes for website development lifecycles. In: Zaphiris, P., Kurniawan, S. (eds.) *Human Computer Interaction Research in Web Design and Evaluation*, Idea Group Pub., Hershey (2007)
12. Shneiderman, B.: Universal usability: Pushing human-computer interaction research to empower every citizen. *Communications of the ACM* 43(5), 84–91 (2000)
13. Zahir, S., Dobing, B., Hunter, G.: Cross-Cultural Dimensions of Internet Portals. *Internet Research* 12(3), 210–220 (2002)

Two Sites, Two Voices: Linguistic Differences between Facebook Status Updates and Tweets

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Abstract. Facebook and Twitter, two of the most popular social networking sites, have different network structures and communication purposes. To examine how their differences affect users' language use, we conducted a comparative analysis on the linguistic pattern of Facebook status updates and tweets. Differences were found in word categories indicating verbal immediacy, emotionality, topic, and colloquialism. Results show that Facebook status updates are more emotional and interpersonal, while tweets are more casual, explicit, and concerned about impression management.

Keywords: Twitter, Facebook, Linguistic feature, LIWC, social media.

1 Introduction

The rise of social media has greatly influenced interpersonal communication. In particular, Facebook and Twitter, two of the most popular social networking sites nowadays, have deeply embedded into the daily life of millions of people. They allow individuals to post messages that are brief, public, and social [1]. However, the two sites have different network topology [2] and user motivation [3]. User communications on the two sites are likely to be influenced by their characteristics. While research has examined the content on these sites to understand users' psychological state [4], emotional experience [5] and social strategies [6], little is known about how language use differs between the two sites.

Therefore, the current research aims to examine language patterns of Facebook status updates and tweets. We hypothesized that users on the two sites would exhibit different language styles, as the function and social network structure of Facebook and Twitter are different.

1.1 Facebook vs. Twitter

Facebook has reached more than one billion monthly active users in December 2012 [7], with more than 300,000 status updates published every minute [8]. A status update allows users to write up to 60,000 characters about their feelings and experiences. Twitter has reached 140 million active users in 2012, with 340 million messages (i.e., tweets) published every day [9]. Each tweet contains a maximum of

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140 characters. Users mainly use Twitter to talk about daily routines, carry out conversations, report news, and share information [10, 11].

While Facebook status updates and tweets are both communication channels for information sharing and self-disclosure, they differ in several aspects. First, social connections on Facebook are bidirectional. They are established based on mutual consent. However, social connections on Twitter can be either directional or unidirectional [12]. Second, connections on Facebook are mainly comprised of existing friends in real life [13], whereas users on Twitter do not need to reveal their true identity and the majority of connections on Twitter are strangers [14]. Third, Facebook status updates are usually only accessible to one's own friends, while tweets are public by default, unless the user restricts their visibility to a private social network. Finally, users on Facebook and Twitter might be different in terms of their motivation and personality [3]. Studies have shown that individuals using Facebook have higher sociability, extraversion and neuroticism than those using Twitter [3]. Twitter usage is correlated with need for cognitive closure and conscientiousness. This suggests that users use Facebook for social connectedness [13, 15], while using Twitter for information exchange [14].

1.2 Linguistic Features

Language plays an important role in human society. It facilitates the transfer of knowledge and ideas [16, 17]. The pattern of language use is an indicator of people's cognitive, social and psychological characteristics [18, 19]. A text analysis software program—Linguistic Inquiry and Word Count (LIWC) [20] has been widely used to capture linguistic characteristics by computing the frequency of words in psychologically meaningful categories. There are approximately 70 word categories in LIWC dictionary. Function words, emotion words, and content words are three primary word clusters that can capture language variation [19].

Function words, including pronouns, prepositions, articles, conjunctions, and auxiliary verbs, can reflect attentional focus [25]. The use of first person singular suggests self-focus, and second and third person pronouns imply social engagement or awareness [26]. Some function words signal cognitive complexity. For example, conjunctions, negations and certain prepositions are found to occur in complex cognitive processing [25]. Certain function words can reflect psychological closeness and intimacy. Specifically, more first-person singular pronouns, short words, discrepancies, present tense verbs and fewer articles indicate high immediacy and occur in engaged social interaction [21].

LIWC has also been used to measure verbal expression of emotion [22]. Recent research on social media has used it to monitor everyday life affect and happiness by analyzing the usage of emotion words on Facebook [4, 5] and Twitter [23, 24].

Content words, including categories such as home, money, and leisure, indicate topical themes [25]. A study showed that participants used more content words in story-telling than emotional writing [20]. Compared with findings on function and emotion words, findings on content words are inconclusive, due to the variety of topics in communication [19].

1.3 Hypotheses

Given the functional and structural differences between Facebook and Twitter, we hypothesized that the language pattern of Facebook status updates and tweets are different.

We hypothesized that there would be fewer emotion words, especially negative ones, on Twitter than on Facebook. Existing studies have shown that emotional expression often occurs between intimate friends [26-29]. As social connections on Twitter tend to be more open and comprise more strangers than those on Facebook, it is likely that Twitter users would share less emotion. Furthermore, people tend to present themselves in a modest manner in front of their friends, but express their emotions in a socially desirable manner when facing strangers [30, 31], because impression management is more concerned when establishing new relationships with unfamiliar others [32]. Positive emotion has been found to be more socially acceptable than negative emotions [33]. Hence, tweets are likely to contain more positive emotion words than Facebook status updates, while status updates would contain more negative emotional words.

We also hypothesized that Facebook status updates would contain more immediacy words than tweets because users focus more on social interaction on Facebook than Twitter. The information seeking need would be stronger on Twitter than Facebook, and therefore tweets are expected to have greater use of cognitive complexity words, particularly exclusive and causal words, which are associated with diverse, integrative, and appraisal thinking style [34].

2 Method

We retrieved the most recent 100 status updates from 127 Facebook users and 100 tweets from 102 Twitter users. All users are Singaporean college students. Before LIWC analysis, we processed the tweets and status updates by removing embedded URLs, timestamps, retweets (contents originally posted by others but shared by the participants), and replacing common emoticons with corresponding emotion words so that LIWC can recognize them. We then applied LIWC2007 to our samples. Multiple t-tests were carried out to compare the frequencies of each word category between the two samples.

3 Results

Results show a number of significant differences between status updates and tweets (see Table 1). First, emotion was expressed differently. Status updates included more emoticons than tweets, while tweets included more affective words. When combining emoticons and affective words, there is no significant difference between the two samples. This suggested that users on Facebook did not express more emotion than those on Twitter; they just tended to express their emotion via non-verbal cues. Results also show that tweets contained more positive emotion words than status

updates, whereas status updates had more negative emotion words than tweets, including anger and sad words. This supports our hypothesis that Twitter users would express less negative emotion than Facebook users due to impression management.

Comparing with tweets, Facebook status updates exhibited greater verbal immediacy—fewer longer words, more discrepancies, more first person singular pronouns. This supports our hypothesis that status updates afford more psychological closeness between the author and audience. Facebook and Twitter users used similar amount of second and third person pronouns, suggesting that users on both sites had similar social engagement. Status updates and tweets had similar amount of present tense words, probably because both Facebook and Twitter allow users to post messages in real time.

Overall, the use of function words did not differ between the two writing samples, suggesting that composing status updates and tweets required similar cognitive complexity. However, tweets had more exclusive and cause words than status updates, suggesting that Twitter users were more likely to employ a diverse, integrative, and appraisal thinking style.

Results of contents words showed that status updates and tweets covered different topics. Status updates included more words about body, health and space, while tweets included more words related to work, money and leisure. Additionally, Facebook users were more likely to talk about biological processes, while Twitter users talked more about perceptual processes. This suggests that users on the two sites favor different topics.

Although it is not our focus, we found that tweets contained more assent words and Singapore colloquial English (SCE) than Facebook status updates, suggesting that users on Twitter utilized more spoken language than those on Facebook. In addition, Facebook status updates contained more words than tweets, likely due to the word limit on Twitter.

Table 1. Mean comparison of word frequencies between Facebook status updates and Tweets

Linguistic features		Facebook		Twitter		<i>t</i>	Cohen's <i>d</i>
Category	Example	<i>Mean</i>	<i>SD</i>	<i>Mean</i>	<i>SD</i>		
Word count		1433.60	489.49	1085.54	265.65	6.85***	.97
Words>6 letters		14.56	2.66	15.88	3.77	-3.00**	-.45
Total function words		43.59	6.41	43.38	6.19	.25	.03
Total pronouns	I, them, itself	12.06	2.57	11.10	3.01	2.61**	.35
Personal pronouns	I, them, her	8.37	2.13	7.34	2.50	3.37***	.45
1st person singular	I, me, mine	5.48	1.65	4.35	1.87	4.87***	.65
1st person plural	We, us, our	.53	.41	.48	.39	.88	.12
2nd person	You, your, thou	1.57	.94	1.65	1.00	-.67	-.09
3rd person singular	She, her, him	.50	.47	.51	.47	-.11	-.01
3rd person plural	They, their, they'd	.29	.22	.35	.30	-1.61	-.24
Impersonal pronouns	It, it's, those	3.70	1.04	3.76	1.04	-.49	-.07
Articles	A, an, the	4.50	1.27	4.74	1.47	-1.34	-.18
Common verbs	Walk, went, see	12.95	2.23	12.43	2.62	1.63	.22
Auxiliary verbs	Am, will, have	7.36	1.51	7.10	1.76	1.20	.16
Past tense	Went, ran, had	1.93	.63	2.05	.87	-1.17	-.17

Table 1. (continued)

Linguistic features		Facebook		Twitter		<i>t</i>	Cohen's <i>d</i>
Category	Example	Mean	SD	Mean	SD		
Present tense	Is, does, hear	9.11	1.65	8.78	2.16	1.29	.19
Future tense	Will, gonna	.95	.40	.84	.37	2.14*	.29
Adverbs	Very, really, quickly	4.44	1.03	5.04	1.42	-3.58***	-.54
Prepositions	To, with, above	10.06	1.75	10.48	2.26	-1.57	-.23
Conjunctions	And, but, whereas	4.58	1.04	4.38	1.18	1.35	.18
Negations	No, not, never	1.70	.51	1.76	.81	-.60	-.09
Quantifiers	Few, many, much	2.15	.60	2.15	.58	-.08	-.01
Numbers	Second, thousand	.63	.32	.65	.30	-.41	-.05
Swear words	Damn, piss, fuck	.43	.44	.35	.38	1.52	.20
Social processes	Mate, talk, they	7.32	2.15	7.18	2.01	.53	.07
Family	Daughter, husband	.29	.28	.31	.37	-.32	-.04
Friends	Buddy, friend	.29	.23	.23	.19	2.09*	.28
Humans	Adult, baby, boy	.81	.38	.75	.39	1.22	.16
Affective processes	Happy, abandon	9.66	2.58	9.81	3.37	-.37	-.05
Positive emotion	Love, nice, sweet	6.11	2.05	7.00	2.84	-2.66**	-.40
Negative emotion	Hurt, ugly, nasty	3.34	1.15	2.54	1.11	5.31***	.71
Anxiety	Worried, fearful	.34	.19	.33	.27	.39	.05
Anger	Hate, kill, annoyed	1.42	.74	.95	.58	5.37***	.71
Sadness	Crying, grief, sad	.78	.41	.53	.40	4.64***	.62
Cognitive processes	cause, know, ought	12.80	2.26	13.04	2.28	-.81	-.11
Insight	know, consider	1.85	.62	1.90	.65	-.49	-.07
Causation	because, effect,	1.30	.46	1.52	.58	-3.14**	-.42
Discrepancy	should, would, could	1.48	.45	1.33	.54	2.16*	.29
Tentative	maybe, perhaps,	1.90	.56	1.93	.68	-.35	-.05
Certainty	always, never	1.28	.50	1.21	.52	1.15	.15
Inhibition	block, constrain,	.54	.24	.51	.28	.81	.11
Inclusive	And, with, include	3.26	.93	3.09	.98	1.34	.18
Exclusive	But, without	2.14	.60	2.36	.84	-2.26*	-.34
Perceptual processes	Observing, heard	2.19	.64	2.38	.79	-2.00*	-.27
See	View, saw, seen	.84	.37	.98	.47	-2.53*	-.34
Hear	Listen, hearing	.45	.28	.56	.40	-2.44*	-.33
Feel	Feels, touch	.70	.30	.63	.34	1.58	.21
Biological processes	Eat, blood, pain	3.15	1.09	2.25	1.09	6.21***	.83
Body	Cheek, hands, spit	1.03	.50	.73	.50	4.6***	.61
Health	Clinic, flu, pill	.80	.40	.55	.36	5.04***	.67
Sexual	Horny, love, incest	.74	.57	.37	.33	5.82***	.77
Ingestion	Dish, eat, pizza	.67	.45	.69	.53	-.32	-.04
Relativity	Area, bend, exit	13.46	2.54	13.60	2.82	-.38	-.05
Motion	Arrive, car, go	1.78	.55	1.90	.91	-1.21	-.16
Space	Down, in, thin	4.61	.99	5.39	1.52	-4.46***	-.69
Time	End, until, season	7.25	1.67	6.42	1.90	3.53***	.47
Work	Job, majors, xerox	1.96	.92	2.22	1.06	-2.01*	-.27
Achievement	Earn, hero, win	1.50	.55	1.75	.84	-2.77**	-.37
Leisure	Cook, chat, movie	1.29	.50	1.70	.86	-4.25***	-.69
Home	family	.42	.24	.39	.30	.77	.10
Money	Audit, cash, owe	.67	.37	1.00	1.32	-2.72**	-.36
Religion	Altar, church	.41	.57	.24	.24	2.75**	.37

Table 1. (continued)

Linguistic features		Facebook		Twitter		<i>t</i>	Cohen's <i>d</i>
Category	Example	<i>Mean</i>	<i>SD</i>	<i>Mean</i>	<i>SD</i>		
Death	Bury, coffin, kill	.23	.23	.16	.17	2.59*	.34
Assent	Agree, OK, yes	1.16	.72	2.73	2.02	-7.43***	-1.35
Nonfluencies	Er, hm, umm	.21	.20	.26	.26	-1.49	-.20
SCE	Lah, shiok, sia	.25	.24	.44	.47	-3.99***	-.53
Emoticon); ^^; @@	2.24	1.64	1.43	1.25	4.25***	.57
Affect without emoti- con		7.42	1.53	8.38	2.64	-3.26**	-.53

4 Discussion

4.1 Language Style Varies Across Media

The current research demonstrates how Facebook status updates and tweets differ in language style. Given the different social network structure and usage purposes, the language used on the two sites showed their unique patterns.

The more frequent use of positive emotion words in tweets than status updates suggests that users on Twitter tend to present a positive social image. According to Hogan's notion of self-presentation in social media [35], when facing a mixed audience, users express themselves in a normatively acceptable way to avoid leaving a negative impression on important others. Alternatively, Facebook users might be less emotionally stable than Twitter users, as a recent study found that the preference to Facebook over Twitter is correlated with neuroticism [3]. This may lead to a higher rate of negative emotion expressed on Facebook.

Findings on verbal immediacy imply that social interactions on Facebook are closer than those on Twitter. As status updates usually are not directed to a specific audience [6] and tweets often involve direct conversation between users, it is likely that Facebook users use more immediate words to engage others. In addition, information exchange on Twitter may lead users to engage in more cognitive processes, causing more frequent use of exclusion and cause words in their tweets.

Content words and perceptual words further demonstrate the divergent focuses between Facebook and Twitter users. Research has suggested that connections on Twitter tend to be built on common interests while those on Facebook derived from real-life relationship [36]. Thus, it is reasonable that Twitter users wrote more interest-related topics such as work, leisure, and money. This is also consistent with the finding that Twitter usage is associated with conscientiousness [3]. In contrast, Facebook status updates reveal more sensational and perceptual topics.

The differences in spoken language and use of emoticons were unexpected. Although both Facebook and Twitter are platforms to share daily experiences, results show that tweets contain more informal and explicit expressions.

4.2 Implications

While an accumulating body of research has investigated computer-mediated communication in the past decade, how people's communication style changes in different

media remains unclear [37]. It is of great importance to understand what and how people communicate through social media. The current work illustrates an approach to study this issue by examining psycholinguistic features of communication.

Practically, understanding user differences across media is insightful, as it would help business to make better use of social media to accommodate user needs. For example, features on Facebook should be designed to promote social connectedness, whereas those on Twitter should facilitate information dissemination. Commercial entities on different social platforms may follow corresponding user norms to show affinity and closeness to the target customers.

4.3 Limitation and Future Work

Our sample only contains college students in Singapore. Future research may examine social media in other cultures to validate our findings. In addition, the mere mean comparison on word frequencies cannot preclude alternative interpretations for what causes the differences in linguistic patterns. Therefore, future studies may employ qualitative methods to examine the underlying causes.

Also, future study may leverage other psycholinguistic approaches to understand user behaviors in social media. One possible extension is to utilize computational linguistic analysis, such as meaning extraction method [38, 39] or latent variable model [40], to further understand the content and themes in social media.

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References

1. Naaman, M., Boase, J., Lai, C.-H.: Is it really about me? Message content in social awareness streams. In: Proceedings of the 2010 ACM Conference on Computer Supported Cooperative Work, pp. 189–192. ACM Press, New York (2010)
2. Kwak, H., Lee, C., Park, H., Moon, S.: What is Twitter, a social network or a news media? In: Proceedings of the 19th International Conference on World Wide Web, pp. 591–600. ACM Press, New York (2010)
3. Hughes, D.J., Rowe, M., Batey, M., Lee, A.: A tale of two sites: Twitter vs. Facebook and the personality predictors of social media usage. *Computers in Human Behavior* 28, 561–569 (2012)
4. What's on your mind?, <http://www.facebook.com/notes/facebook-data-team/whats-on-your-mind/477517358858>
5. Kramer, A.D.I.: An unobtrusive behavioral model of “gross national happiness”. In: Proceedings of the 28th International Conference on Human factors in Computing Systems, pp. 287–290. ACM Press, New York (2010)
6. Bazarova, N.N., Taft, J.G., Choi, Y.H., Cosley, D.: Managing impressions and relationships on Facebook: Self-presentational and relational concerns revealed through the analysis of language style. *Journal of Language and Social Psychology* (2012)
7. Facebook news room, <http://newsroom.fb.com/Key-Facts>

8. Pring, C.: 100 social media statistics for (2012), <http://thesocialskinny.com/100-social-media-statistics-for-2012/>
9. Twitter truns six, <http://blog.twitter.com/2012/03/twitter-turns-six.html>
10. Java, A., Song, X., Finin, T., Tseng, B.: Why we twitter: Understanding microblogging usage and communities. In: Proceedings of the 9th WebKDD and 1st SNA-KDD 2007 Workshop on Web Mining and Social Network Analysis, pp. 56–65. ACM, San Jose (2007)
11. Naaman, M., Boase, J., Lai, C.-H.: Is it really about me?: Message content in social awareness streams. In: Proceedings of the 2010 ACM Conference on Computer Supported Cooperative Work, pp. 189–192. ACM Press, New York (2010)
12. Google+ vs. Facebook vs. Twitter vs. ... Part 2: The danger of a one-way fast lane, <https://lithosphere.lithium.com/t5/science-of-social-blog/Google-vs-Facebook-vs-Twitter-vs-Part-2-The-Danger-of-a-One-Way/ba-p/29868>
13. Ellison, N., Steinfield, C., Lampe, C.: The benefit of Facebook “friends”: Social capital and college students’ use of online social network sites. *Journal of Computer-Mediated Communication* 12, 1143–1168 (2007)
14. Huberman, B., Romero, D., Wu, F.: Social networks that matter: Twitter under the microscope. *First Monday* 14 (2008)
15. Köbler, F., Riedl, C., Vetter, C., Leimeister, J.M., Krcmar, H.: Social Connectedness on Facebook—An explorative study on status message usage. In: Proceedings of 16th Americas Conference on Information Systems (2010)
16. Maynard, D.W., Peräkylä, A.: Language and social interaction. In: DeLamater, J. (ed.) *Handbook of Social Psychology*, pp. 233–257 (2006)
17. Krauss, R.M., Chiu, C.Y.: Language and Social Behavior. In: Gilbert, D., Fiske, S., Lindzey, G. (eds.) *Handbook of Social Psychology*, vol. 2, pp. 41–88. McGraw-Hill, Boston (2007)
18. Pennebaker, J.W., Graybeal, A.: Patterns of natural language use: Disclosure, personality, and social integration. *Current Directions in Psychological Science* 10, 90–93 (2001)
19. Pennebaker, J.W., Mehl, M.R., Niederhoffer, K.G.: Psychological aspects of natural language use: Our words, our selves. *Annual Review of Psychology* 54, 547–577 (2003)
20. Pennebaker, J.W., Booth, R., Francis, M.: *Linguistic Inquiry and Word Count* Erlbaum, Mahwah, NJ (2007)
21. Cegala, D.J.: A study of selected linguistic components of involvement in interaction. *Western Journal of Communication* 53, 311–326 (1989)
22. Kahn, J.H., Tobin, R.M., Massey, A.E., Anderson, J.A.: Measuring emotional expression with the Linguistic Inquiry and Word Count. *The American Journal of Psychology*, 263–286 (2007)
23. Dodds, P.S., Harris, K.D., Kloumann, I.M., Bliss, C.A., Danforth, C.M.: Temporal patterns of happiness and information in a global social network: Hedonometrics and Twitter. *PLoS One* 6, e26752 (2011)
24. Golder, S.A., Macy, M.W.: Diurnal and seasonal mood vary with work, sleep, and day-length across diverse cultures. *Science* 333, 1878–1881 (2011)
25. Chung, C.K., Pennebaker, J.W.: Counting little words in big data: The psychology of communities, cultures, and history. In: László, J., Forgas, J., Vincze, O. (eds.) *Social Cognition and Communication*. Psychology Press, New York (in press)
26. Rimé, B., Mehdi-zadeh, S., Philippot, P., Boca, S.: Beyond the emotional event: six studies on the social sharing of emotion. *Cognition and Emotion* 5, 435–465 (1991)

27. Rimé, B., Philippot, P., Boca, S., Mesquita, B.: Long-lasting cognitive and social consequences of emotion: Social sharing and rumination. *European Review of Social Psychology* 3, 225–258 (1992)
28. Pennebaker, J.W., Zech, E., Rimé, B.: Disclosing and sharing emotion: Psychological, social, and health consequences. Psychological, social, and health consequences. *Handbook of Bereavement Research: Consequences, Coping, and Care*, 517–543 (2001)
29. Rimé, B., Finkenauer, C., Luminet, O., Zech, E., Philippot, P.: Social sharing of emotion: New evidence and new questions. *European Review of Social Psychology* 9, 145–190 (1998)
30. Tice, D.M., Butler, J.L., Muraven, M.B., Stillwell, A.M.: When modesty prevails: Differential favorability of self-presentation to friends and strangers. *Journal of Personality and Social Psychology* 69, 1120–1138 (1995)
31. Vohs, K.D., Baumeister, R.F., Ciarocco, N.J.: Self-Regulation and self-presentation: Regulatory resource depletion impairs impression management and effortful self-presentation depletes regulatory resources. *Journal of Personality and Social Psychology* 88, 632–657 (2005)
32. Chester, A., Bretherton, D.: Impression management and identity online. In: Joinson, A.N., McKenna, K., Postmes, T., Reips, U.-D. (eds.) *The Oxford Handbook of Internet Psychology*. Oxford University Press, New York (2007)
33. Ekman, P., Friesen, W.V.: The repertoire of nonverbal behavior: Categories, origins, usage, and coding. *Semiotica* 1, 49–98 (1969)
34. Tausczik, Y.R., Pennebaker, J.W.: The psychological meaning of words: LIWC and computerized text analysis methods. *Journal of Language and Social Psychology* 29, 24–54 (2009)
35. Hogan, B.: The presentation of self in the age of social media: Distinguishing performances and exhibitions online. *Bulletin of Science, Technology & Society* 30, 377–386 (2010)
36. Bontcheva, K., Rout, D.: Making sense of social media streams through semantics: A survey. *Semantic Web Journal* (2012), <http://www.semantic-web-journal.net/sites/default/files/swj303.pdf>
37. Walther, J.B.: Theories of computer-mediated communication and interpersonal relations. *The Handbook of Interpersonal Communication* 4, 443–479 (2011)
38. Chung, C.K., Pennebaker, J.W.: Revealing dimensions of thinking in open-ended self-descriptions: An automated meaning extraction method for natural language. *Journal of Research in Personality* 42, 96–132 (2008)
39. Pennebaker, J.W., Chung, C.: Computerized text analysis of Al-Qaeda transcripts. In: Krippendorff, K., Bock, M. (eds.) *Content Analysis Reader*. Sage, Thousand Oaks (2008)
40. Danescu-Niculescu-Mizil, C., Gamon, M., Dumais, S.: Mark my words!: Linguistic style accommodation in social media. In: *Proceedings of the 20th International Conference on World Wide Web*, pp. 745–754. ACM Press, New York (2011)

Do We Need a New Internet for Elderly People? A Cross-Cultural Investigation

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Abstract. This paper describes the development of a culturally sensitive instrument for assessing user needs related to Internet usage. The resulting instrument, which encompasses four questionnaires used to obtain empirical data, was validated in a pre-study and experimental study in Germany and South Korea, and provides a quantitative and qualitative differentiation of the Internet needs of different groups. In a computer-based test, it was shown that the questionnaire tool allowed certain aspects of Internet usage to be predicted.

Keywords: Internet inclusion, age differences, cultural differences.

1 Introduction

The Internet is increasingly becoming an essential medium for every-day social interaction. However, the vision of the Internet as a universal medium accessible by anyone has still not been realized. Despite a steady increase in the number of elderly Internet users, statistics indicate that elderly people access the Internet for less time and to a lower extent compared to younger Internet users [1], [2]. Although these studies provide detailed data on Internet use, they mainly describe the current status. Therefore they resemble a snapshot of Internet use, quantifying the number of users having access to and using the Internet, frequency of use and the use of functions. In contrast, little empirical research has systematically examined users' needs and wishes (motivation) that cause people to adopt the Internet or to increase the extent of use. Particularly analyses that focus on the question of why elderly people do not adopt the Internet often refer to general aspects of technology acceptance and related attitude towards new technologies. The link between cause and effect, that being needs and Internet usage, is still unknown with respect to elderly people's Internet use. For example, needs can be inherent to different aspects of Internet use such as its context and content [3]. Therefore, explanations of Internet adoption should relate to both the *context* of Internet use and the *content* offered in the Internet. A further methodological point of interest is connected to the role of needs for Internet adoption. In the literature a plethora of qualitative methods is available for assessing needs, e.g. interviews, group discussion, shadowing and case studies [4]. Qualitative

approaches deliver rich data (e.g. behavior, attitudes, etc.) due to open interaction possibilities. However, they provide challenges for cross-cultural research, which makes it difficult to implement discussion groups due to time and cost aspects and also due to language and cultural differences in interaction and communication. Hence, Pincus [5] suggests tackling needs assessment by collecting responses on a so-called needs fulfillment scale. This approach requires needs to be consciously available for the questionnaire designer as well as the respondents. However, we believe that needs regarding Internet usage are not explicit. Therefore survey-based needs assessment should provide relevant *context* and *content* items that are instantiations of factors like needs and motivations.

1.1 Needs and Motivation

In psychology, the concept of needs refers to the desire to fulfill a perceived lack [6]. Murray [7] suggests classifying needs into *manifested needs* activated by cues and *latent needs* that lie dormant due to a lack of stimulation by the environment. Needs that are not fulfilled operate as a stimulus that elicits motivation to show a certain behavior [8]. Respectively, needs assessment in behavior (market oriented) research is considered to reveal information on motivational concepts that affect behavior. Needs indicate deficiencies, which consumers endeavor to overcome. At the same time, they embody the target for industry: to sell products and to elicit further needs, which leads to a cyclic process where needs are the starting as well as the target point. Looking at media consumption, media science studies have investigated the question of why people become involved in a particular type of mediated communication. According to Gratification theory [3], people select media based on their perceived needs and on their mood. Thus, different dimensions of needs are presumed to influence media selection behavior, such as *Cognitive Needs* and *Affective Needs*. Based on the dichotomy of manifest and latent needs, one can conclude that established markets refer to manifest needs and latent needs provide potential for discovering new markets. Accordingly, latent needs are of major interest regarding innovative product development since they can become manifest needs if they are aroused [9]. By this means, they can turn into drivers for demand and related consumption. Whereas manifest Internet needs can be quantified via usage statistics of Internet based services like Email or online banking, latent needs are obviously not measurable.

1.2 Age and Internet

Although statistics show that Internet use in Germany is steadily growing, there is still a difference between age groups. Currently 95.8% of young people between 14 and 29 years use the Internet. The trend for middle-aged adults from 30 to 49 years shows a similar development, with an 87.1% Internet usage rate. Also the number of elderly users over 50 years accessing the Internet has constantly risen up to 49.6% in 2010 [1]. However, van Eimeren and Frees [10] demonstrated that only about 21.0% of the elderly population access the Internet on a daily basis. Moreover, Egger and van Eimeren [11] revealed that the actual online time for the elderly is restricted to 14

minutes, which equates to about two percent of this group's overall media usage per day. At the same time, low user satisfaction with Internet providers' service indicates a certain amount of unmet needs with respect to Internet use [10].

However, despite many initiatives aimed at fostering Internet adoption in Germany (e.g. Internet for all [12]) and Europe (e.g. e-inclusion [13]), the number of elderly Internet users (i.e. age >50 years) is only increasing slowly. In order to determine the reasons for this, it might help to look at countries investing even more in stimulating Internet adoption. In contrast with Germany, South Korea proclaims to be at the leading edge of the digital revolution [14]. In recent statistics the OECD [15] revealed that South Korea has the highest penetration of broadband Internet worldwide, with more than 95.0% households obtaining broadband connectivity. Overall, 77.8% of South Koreans over 3 years old surf the Internet [16]. Whereas 96.6% of younger people between 3 and 49 years old surf the Internet, this figure reduces to only 38.0% for people over 50 years old. These numbers reveal that neither the availability nor the high connectivity alone seem to motivate elderly people to adopt the Internet. Therefore, it seems rational to expect a difference between younger (age <50) and older (age ≥50) Internet users with respect to their needs.

1.3 Culture and Internet

So far we have outlined that a comparable amount of elderly Germans and Koreans use the Internet. However, despite the similar numbers, there are large qualitative differences between elderly Internet users of both countries. For example, elderly German Internet surfers focus on services like Email (75.0%), employing search engines (72.0%) and home banking (30.0%) [2]. This shows that only a small subset of available Internet services are used and high usage potential is revealed with regards to more elderly specific contents. In contrast, elderly South Koreans turn out to be more active using the medium than Germans. 58.0% of them access the Internet on a daily basis. Besides e-mailing and home banking, 66.0% spend time uploading user-generated content, and about 30.0% use Social Networking Services [16]. Studies exploring these effects of culture on Internet diffusion and adoption across countries are rare [17]. However, cross-cultural psychology aims to expand the compass of psychological research by proposing cultural factors that affect human attitudes and behavior. Models for defining the construct culture in order to conduct cross-cultural research are numerous. Yet, Hofstede's five dimensional typology is mostly applied. Comparing Germans and South Koreans, Hofstede and Hofstede [18] report large differences between both cultures with respect to all five dimensions Individualism/Collectivism, Masculinity/Femininity, Power distance, Uncertainty avoidance and Long-term orientation. In line with this theoretical classification, Castells' [19] study revealed that compared to all Americans, a higher percentage of Asian-Americans are connected to the Internet, despite their lower income. Still there is no empirical research concerning the impact of culture on needs that are associated with the Internet. Therefore, we propose the following hypothesis: There is a difference between German and South Korean Internet users regarding the needs associated with the Internet.

In order to explore both hypotheses (age and cultural differences), we chose a two-step procedure. First we developed the Internet Needs Assessment (INA) questionnaire. Second, we used this questionnaire in an empirical investigation to a) test the reliability of its factor structure and b) its predictive power regarding simulated Internet usage.

2 Questionnaire Design

The development of the Internet Needs Assessment (INA) questionnaire started in Germany with a preliminary version containing 186 items of various Internet related domains (context, design, security, types of contents, etc.). Items and categories were determined in an inductive (i.e. brainstorming) and deductive (i.e. examining similar tests) approach. The preliminary version employed a 4-point Likert-type scale (from $-2=$ *absolutely do not agree* to $2=$ *absolutely agree*). Additionally, a *don't know*-option was included for each item, taking into account that inexperienced users may not be able to answer certain questions. Next, the South Korean version of this preliminary item pool was developed in two steps: First the German questionnaire was translated into English language using a team translation process [20]. Then the English draft was localized for the South Korean survey context using a team translation process in co-operation with Korean students from Seoul National University. Finally the preliminary 186 item pool was delivered in pencil and paper format to the respondents of both countries. Items were randomly interspersed within the questionnaire. A total of 208 subjects (108 Germans, 100 South Koreans) completed and returned the survey. Of the German sample 40 elderly adults (age $M=64.9$, $SD=12.4$) and 68 younger adults (age: $M=37.0$, $SD=7.8$) were surveyed. A similar distribution appeared for the South Koreans, where 40 elderly (age $M=57.3$, $SD=5.3$) and 60 younger (age $M=33.5$, $SD=8.5$) subjects participated.

2.1 Analysis

The total bicultural data set revealed an interpretable structure of factors only if all four groups (young German, elderly German, young Korean, elderly Korean) were investigated separately. Accordingly, item selection and factor analysis was conducted for each of the four groups. For the item selection the normal distribution of each item was verified based on the Shapiro-Wilk-Test and the graphical observation of its frequency diagram. Then item difficulty was analyzed based on the mean value. Items with a mean value outside the range of -1 to 1 , items exceeding the curtosis value of 7 as well as those with a skewness value greater than 2 were also excluded from further evaluation [21]. Based on these criteria the following item number remained for the respective groups: elderly Germans with $n_1=132$ items, younger Germans with $n_2=122$ items, elderly Koreans with $n_3=152$ items and younger Koreans with $n_4=132$ items. For further item selection, the *item total correlation* and *Cronbachs alpha if item deleted* (α) were analyzed. The item total correlation describes the correlation between the item score and the overall assessment score. The

items selected for the final analysis had item-total correlations above $r=0.4$ whereas Cronbach's α exceeded $\alpha=0.9$ [22]. For the remaining items ($n_{elderlyGermans}=37$, $n_{youngGermans}=27$, $n_{elderlyKoreans}=18$, $n_{youngKoreans}=17$) the Kaiser-Meyer-Olkin (KMO) measure was computed to assure sampling adequacy. It can vary between 0 and 1. A low value indicates a high specific partial variance for items, which means that the explorative factor analysis is likely to be inappropriate. Therefore, data sets with KMO values smaller than 0.5 are barely acceptable and should be excluded [22]. The KMO shows that the sampling adequacy of the data was limited for elderly Germans (KMO=0.5) and reasonable for young Germans (KMO=0.7) as well as for the elderly (KMO=0.7) and young Koreans (KMO=0.8). According to the Bartlett tests, all groups were suitable for factor analysis ($ps<0.001$). For factor extraction, the Minimum-Average-Partial Test [23] was applied. The final pool of items for each group was included in a factor analysis with promax rotation. As shown in table 1, factor analysis revealed 21 items in a five-factor structure for elderly Germans and four factors with 15 items for young Germans. Factor analysis for elderly Koreans converged in a two-factor model with 10 items. A three-factor structure was discovered for the young Korean sample, including 9 items. Table 1 presents the factors, their final number of items, the amount of variance (σ^2) that they explain and Chronbach's alpha (α) for each group and subscale.

Table 1. Factors, items and explained variance for each questionnaire and their subscales

		Age	
Culture		Elderly adults (≥ 50 years)	Young adults (< 50 years)
German		5 factors, 21 items ($\sigma^2=67.2\%$) N=40 1. Dangers and fears in the Internet $\alpha=0.9$, $\sigma^2=21.3\%$ (6 items) 2. Uncertainties and unknown $\alpha=0.8$, $\sigma^2=15.8\%$ (6 items) 3. Age and technology $\alpha=0.9$, $\sigma^2=15.2\%$ (6 items) 4. Internet 50Plus no α , because it is a single-item factor, $\sigma^2=8.5\%$ (1 item) 5. Getting in contact with others $\alpha=0.7$, $\sigma^2=6.4\%$ (2 items)	4 factors, 15 items ($\sigma^2=51.0\%$) N=68 1. Exchange experiences and opinion $\alpha=0.9$, $\sigma^2=15.1\%$ (6 items) 2. Information on close people $\alpha=0.7$, $\sigma^2=14.8\%$ (4 items) 3. Brain- and knowledge training $\alpha=0.9$, $\sigma^2=12.3\%$ (3 items) 4. Knowledge exchange $\alpha=0.9$, $\sigma^2=8.8\%$ (2 items)
	South Korean	2 factors, 10 items ($\sigma^2=44.2\%$) N=40 1. Motivation to surf the Internet $\alpha=0.8$, $\sigma^2=22.5\%$ (4 items) 2. Preventing aspects of Internet surfing $\alpha=0.7$, $\sigma^2=21.7\%$ (6 items)	3 factors, 9 items ($\sigma^2=63.1\%$) N=60 1. Exchange information $\alpha=0.9$, $\sigma^2=24.3\%$ (4 items) 2. Provide knowledge $\alpha=0.9$, $\sigma^2=21.0\%$ (3 items) 3. Contact/communication $\alpha=0.8$, $\sigma^2=17.8\%$ (2 items)

Note: Explained variance (σ^2) measures the proportion to which a model accounts for the variation, Chronbach's alpha (α) is a measure of reliability, and N is the number of subjects.

Depending on the group, questionnaires explained between 44.2 and 67.2 percent of subjects' answers. Reliability varied between 0.7 (acceptable) and 0.9 (excellent).

All four questionnaires assess the strength of overall Internet needs for each group. However, each questionnaire measures the strength of Internet needs associated with each subscale. Therefore, the separate instruments allow a quantitative description of the magnitude of Internet needs regarding different aspects of context and content separately for young and elderly Germans and South Koreans. Hence, the quality of needs differs as reflected in the different factor structure of each questionnaire.

2.2 Discussion

Instead of one instrument, the questionnaire design resulted in four questionnaires with rather distinct factors and items for each group. Regarding the proposed age effect, the instruments for elderly people of both countries included negative and mostly context-based factors such as *Dangers and fears* or *Preventing aspects of Internet surfing*. In contrast, factor analysis revealed only positive and content-based factors for younger Internet users. Regarding the cultural effect, we found that the majority of the items were related to contextual aspects for Germans. Instead, for Koreans there were only two items assessing the context of Internet use. Therefore the results support the existence of age and cultural effects with respect to Internet needs. Moreover, reliability as well as explained variance was acceptable for all measures.

3 The Experiment

3.1 Objectives, Procedure and Participants

The aim of the experiment was twofold. First, we wanted to see if we could replicate the factor structure of the INA tool in a different sample. Second, we tested whether the assessed strength of needs corresponds with Internet selection behavior, in other words, if the INA need scores are valid predictors of behavior. In terms of the replication of the INA structure, we aimed to mimic its development as closely as possible, and therefore this second study was conducted in the same two countries, Germany and South Korea. Before the experimental task, participants filled in the INA questionnaire that contained the items of all four groups. We used that data to see whether confirmatory factor analyses reveals the same factor structure as in the INA development phase. Then participants took part in a computer-based test in which subjects observed a list with contents that resembled a snippet from the real world Internet. The content that was presented to the participants matched the factors of the INA tool. Factors that were shared by groups (e.g. Exchanging Knowledge) were merged into one category. Nine categories with different content (*To Get in Contact, Internet 50Plus, Age and Technology, Unsecure and Unknown, Dangers and Risks, Exchanging Knowledge, Experiences and Opinion, Brain- and Knowledge training, Contact with close people*) remained for the computer-based test. Participants were asked to select one of the nine categories. Then they could watch a two-minute video that explained important aspects of this domain. Afterwards they

could choose another category. Subjects were instructed to read all nine category names and descriptions, before choosing one of them. The main dependent variable was the category that participants chose *first*.

A total number of 65 participants (30 Germans, 35 Koreans) were included in the experiment. Of the German sample 16 elderly adults (age: M=68.6, SD=9.4) and 14 younger adults (age: M=28.6, SD=3.2) were surveyed. A slightly different distribution appeared for the South Korean sample, with 17 elderly (age: M=65.7, SD=4.2) and 18 younger subjects (age: M=27.2, SD=3.0). The majority of the German and Korean younger participants were students from different fields whereas elderly subjects in Germany were gathered from senior institutions or private contacts. In South Korea they were recruited from the public elderly society Korean Association for Retired Persons. Recruited subjects in South Korea received financial compensation (elderly subjects: 20 \$, young subjects: 10 \$).

3.2 Replication of the INA Structure

Since the number of participants (N=65) was too small for factor analysis [24], the data set was bootstrapped [25] to match the initial sample size of the questionnaire design phase (N=208). Just as in the INA development phase, factor analysis was conducted for each of the four age and culture groups.

Table 2. Replicated factors and explained variance (σ^2) for each of the four questionnaires

		Age	
Culture		Elderly adults (≥ 50 years)	Young adults (< 50 years)
German		4 factors ($\sigma^2=72.9.0\%$, $\alpha=0.8$) N=16	4 factors ($\sigma^2=83.2\%$, $\alpha=0.7$) N=14
		1. Dangers & fears in the Internet $\alpha=0.9$, $\sigma^2=31.8\%$	1. Exchange experiences & opinion $\alpha=0.9$, $\sigma^2=26.9\%$
		2. Uncertainties and unknown $\alpha=0.7$, $\sigma^2=11.6\%$	2. Information on close people $\alpha=0.8$, $\sigma^2=12.3\%$
		3. Age and technology $\alpha=0.7$, $\sigma^2=16.4\%$	3. Brain- and knowledge training $\alpha=0.9$, $\sigma^2=11.3\%$
South Korean		2 factors ($\sigma^2=56.0\%$, $\alpha=0.6$) N=17	3 factors ($\sigma^2=71.9\%$, $\alpha=0.7$) N=18
		1. Motivation to surf the Internet $\alpha=0.8$, $\sigma^2=40.2\%$	1. Exchange Information $\alpha=0.9$, $\sigma^2=15.9\%$
		2. Preventing aspects of Internet surfing $\alpha=0.2$, $\sigma^2=15.8\%$	2. Provide knowledge $\alpha=0.8$, $\sigma^2=33.2\%$
			3. Contact/Communication $\alpha=0.3$, $\sigma^2=22.8\%$

Note: Explained variance (σ^2) measures the proportion to which a model accounts for the variation, Chronbach's alpha (α) is a measure of reliability, and N is the number of subjects.

Bartlett tests revealed that all samples were appropriate for further analysis (ps<0.001). KMO values were 0.3 (German young), 0.4 (German elderly), 0.4 (Korean young) and 0.6 (Korean elderly). For the elderly Germans, factor analysis produced a four-factor solution. The one-item factor 4 *Internet 50Plus* was not

included. In contrast, the four-factor-structure associated with the young Germans was replicated. For the elderly Koreans again a two-factor structure was elicited. Finally, factor analysis revealed a three-factor structure for the young Koreans. Table 2 presents the factors, their number of items, the amount of variance (σ^2) that they explain and Chronbach's alpha (α) for each group and subscale. Depending on the group, questionnaires explained between 56.0 and 83.2 percent of subjects' answers. Instrument reliability varied between 0.6 (questionable) and 0.8 (acceptable).

3.3 Relationship between INA Scores and Internet Selection Behavior

We examined the association between the INA scores (strength of subjective internet needs) and the actual Internet selection behavior of all $N=65$ subjects by applying the multinomial logistic regression analysis [26]. By this means it was investigated if it is possible to predict participants' first selection of the list of contents with the z -standardized INA score, describing the magnitude of needs associated with the Internet. The method is preferably applied when the categorical dependent variable obtains more than two levels (as it were nine levels in the current study). For the comparison of the different outcome options a reference group needed to be defined. We chose the category *Internet 50Plus*, since it was selected most frequently in the test. On this basis, it was found that respondents providing higher INA scores are more likely (probability=80.0%) to select *Internet 50Plus* instead of *Exchange Experience and Opinion* ($p=0.01$). Moreover, it was found that respondents with higher INA scores tended to select the topic *Age and Technology* ($p=0.08$) compared to the category *Internet 50Plus* (probability=68.0%).

3.4 Discussion

The experiment firstly aimed at replicating the factor structure of the INA tool in order to test the instrument's construct validity. Secondly, it was investigated if subjects' Internet Needs Assessment measures (INA scores) are associated with the Internet topic selection behavior. Regarding the questionnaire replication, the four-fold questionnaire structure was replicated as well as the majority of the factors of each questionnaire. For the elderly Germans, four of five factors of the original questionnaire could be elicited. Only the one-item factor *Internet 50Plus* dropped out. However, it was possible to exactly replicate all other questionnaires. With respect to the predictive validity of the questionnaires, only few relationships emerged. Differences between subjects in the questionnaire construction phase and the experiment might be responsible for the missing relationships.

4 General Discussion and Conclusion

The present work focused on designing a questionnaire that reliably and validly assesses needs structures related to Internet use. One main result was that not one but four distinct questionnaires – one for each of the investigated groups (elderly and

young Germans, elderly and young Koreans) – were elicited. This reliable 4-way questionnaire solution indicates that the configuration of Internet needs varies among age groups and cultures. For example, whereas questionnaires for the young samples included items which were all related to *content* aspects of the Internet, elderly samples' questionnaires contained a second category, a *context*-related dimension. That is why we conclude that age impacts the Internet needs pattern as well as culture. With respect to the predictive power of the INA score, we found that it is limited regarding the actual Internet selection behavior. However, the limitation of the item performance in terms of low item-total correlations in the second sample and the missing predictive power of the INA score might be caused by differences in the samples used for the questionnaire design phase compared with those used for the experiment. The analysis of demographic variables like *Computer and Internet experiences* revealed a significant influence of some items for the experimental subjects but not for the sample in the questionnaire construction phase. Hence participants of the experiment had more experience and thus different needs compared to the relatively inexperienced subjects of the questionnaire development. This finding supports the understanding of needs development in marketing, which says that once needs are satisfied new ones are generated [27]. Hence we found support for the cyclic process introduced earlier in this paper: where needs are the starting as well as the target point. In other words, this finding indicates that the more experienced a person is with the Internet, the more the spectrum of needs grows towards content-related categories. Hereby, a dynamic progress with regards to Internet use is revealed: It suggests that underlying needs concepts are not static but may change if triggered by experiences, certain events or over time.

References

1. Initiative D21: (N)ONLINER Atlas (2010),
<http://www.initiatiived21.de/wp-content/uploads/2010/06/NONLINER2010.pdf>
2. van Eimeren, B., Frees, B.: Fast 50 Millionen Deutsche online- Multimedia für alle? Media-Perspektiven 7-8, 334–349 (2010)
3. Blumler, J.G., Katz, E.: The uses of mass communications: Current perspectives on gratifications research. Sage, Beverly Hills (1974)
4. Langdridge, D., Hagger-Johnson, G.: Introduction to Research Methods and Data Analysis in Psychology. Pearson Education, Harlow (2009)
5. Pincus, J.: The consequences of unmet needs: the evolving role of motivation in consumer research. *Journal of Consumer Behaviour* 3, 375–387 (2004)
6. Heckhausen, J., Heckhausen, H.: *Motivation und Handeln*. Springer, Berlin (2006)
7. Murray, H.A.: *Explorations in Personality*. Oxford University Press, New York (1938)
8. Hull, C.L.: *Principles of behavior*. Appleton-Century-Crofts, New York (1943)
9. Durgee, J.F.: Qualitative methods for identifying latent needs for new consumer technologies. *Change Management and the New Industrial Revolution* 20, 219–226 (2001)
10. van Eimeren, B., Frees, B.: Der Internetnutzer 2009 – multimedial und total vernetzt? Media-Perspektiven 7, 334–348 (2009)

11. Egger, A., van Eimeren, B.: Die Generation 60plus und die Medien: Zwischen traditionellen Nutzungsmustern und Teilhabe an der digitalen (R)evolution. *Media-Perspektiven* 11, 577–588 (2008)
12. Bundestag, D.: Maßnahmen zur Überwindung der digitalen Spaltung innerhalb Deutschlands. In: *Deutscher Bundestag: Globalisierung der Weltwirtschaft: Schlussbericht der Enquete-Kommission*, pp. 274–275. Leske + Budrich, Obladen (2002)
13. European Commission Information Society: e-Inclusion, http://ec.europa.eu/information_society/activities/einclusion/index_en.htm
14. Kim, P.: Is Korea a strong internet nation? *The Information Society* 22(1), 41–44 (2006)
15. OECD: Households with broadband access (2010), <http://www.oecd.org/sti/broadband/39574039.xls>
16. Korea Internet and Security Agency: Survey on the Internet Usage (2010), <http://isis.kisa.or.kr/eng/board/index.jsp?pageId=040100&bbsId=10&itemId=314&pageIndex=1>
17. Gong, W., Li, Z.G., Stump, R.L.: Global Internet use and access: Cultural considerations. *Asia Pacific Journal of Marketing and Logistics* 19(1), 57–74 (2007)
18. Hofstede, G., Hofstede, G.J.: *Cultures and Organizations - Software of the Mind*
19. McGraw-Hill, London (2005)
20. Castells, M.: The Digital Divide in a Global Perspective. In: Castells, M. (ed.) *The Internet Galaxy: Reflections on the Internet, Business and Society*, pp. 247–274. Oxford University Press, Oxford (2002)
21. Harkness, J., Braun, M., Edwards, B., Johnson, T., Lyberg, L., Mohler, P.P., Pennel, B.E., Smith, T.W.: *Survey Methods in Multinational, Multiregional, and Multicultural Contexts*. John Wiley and Sons, New Jersey (2010)
22. Curran, P.J., West, S.G., Finch, J.F.: The robustness of test statistics to nonnormality and specification error in confirmatory factor analysis. *Psychological Methods* 1, 16–29 (1996)
23. Bühner, M.: *Einführung in die Test- und Fragebogenkonstruktion*. Pearson Studium, München (2006)
24. O'Connor, B.P.: SPSS and SAS programs for determining the number of components using parallel analysis and Velicer's MAP test. *Behavior Research Methods, Instruments and Computers* 32(3), 396–402 (2000)
25. Kline, R.B.: *Principles and Practice of Structural Equation Modeling*. The Guilford Press, New York (2005)
26. Thompson, B.: Exploring the Replicability of a Study's Results: Bootstrap Statistics for the Multivariate Case. *Educational and Psychological Measurement* 55, 84–94 (1995)
27. Schafer, J.L.: Multinomial Logistic Regression Models, <http://www.stat.psu.edu/~jls/stat544/lectures/lec19.pdf>
28. Schumpeter, J.A.: *Theorie der wirtschaftlichen Entwicklung*. The European Heritage in Economics and the Social Sciences 1, 5–59 (2003)

Developing a Contextual Network for Indigenous Communities in Mexico

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Abstract. This paper presents the development and results of the Contextual Network project, which took place in two impoverished communities in Mexico. The Contextual Network (CN) project is comprised by a contextual study followed by a usability study of a prototype designed to help these communities in underprivileged circumstances. This paper also includes the results of a study about exposing indigenous users to unfamiliar new technologies and the way in which those developments could be appropriately applied to benefit their community.

Keywords: Cross-cultural design, usability, user interfaces, vulnerable communities, Design for social development.

1 Introduction

Cultural diversity is an important heritage of countries like Mexico. However, current media policies and strategies regarding television, radio and the Internet fail to address and represent the interests, concerns and issues of a large number of minorities and social groups. Such lack of access and representativeness is a key causal factor behind social exclusion, discrimination and the weakening of the social fabric in general.

There is a need for the ideation, development and deployment of new breakthrough knowledge-based services for cultural diversity [3, 4]. Due to the importance of context in cultural diversity, this project proposes an innovative context-sensitive platform aimed at enabling access and rich representativeness of cultural manifestations in Mexico. We called this context-sensitive platform “contextual network”.

To exemplify its feasibility and applicability we selected one specific group of people as a case study: indigenous communities in the Mexican states of Oaxaca and Michoacán. These groups represent different social, economic, geographic and cultural contexts of Mexico encompassing a complex web of needs and requirements for this project. Also, in the case of Oaxaca and Michoacán they share a large number of indigenous inhabitants, and a high degree of marginalization in their communities.

The locations where the studies took place were Santos Reyes Yacuná, Oaxaca and Capula, Michoacán. These towns belong to different indigenous communities (Mixteco, the first, and Purhepecha the latter), with no historic interference among them. In the case of the Oaxacan community the study was centered in a group of middle-aged women, and in the Michoacán side the focus was in a group of artisans.

This paper is focused in the work done in the State of Oaxaca, although a brief introduction to the Michoacán deployment is shown. (The Michoacán phase is scheduled to be finished in May of 2013).

2 Project Background

The CN was born amidst the celebration of a workshop was held in June 2011, where a multidisciplinary and multi-sector group including representatives of the studied social group convened for identifying current problems, social mores, socio-cultural beliefs and current communication media used by this population. Throughout the workshop several scenarios were built of use of the Contextual Network for creating low-fidelity prototypes in support of this problem. Also work was made in leveraging current available funding with the support of different institutions and the government.

In that workshop it was established that the two ideal locations for the project were Oaxaca and Michoacán, due to their large indigenous population, easy access to the towns and previous contact of the researchers with the community leaders.

3 Methodology

The objective of the Contextual Network project is to develop a useful application for its users and in order to assure its usability, a User Centered Development was used, which involves putting into operation various techniques and methodologies aimed to know the user and his/her needs, likes and wishes. Its first part consisted of the development of a Contextual Study.

User Centered Design (UCD) is a product development approach that focuses on the end users of a given object. The basic philosophy of this technique is that the products are to conform to the users, instead of the user having to adapt the product [1]. There are three principles of the UCD: perfectly understand users and their tasks, development of empirical measures of product usage, and the use of an iterative design [5]. These principles are fundamental to the development of our project, as the CN depends on an adequate understanding of users and all their requirements in order to have a system to give them a technology-based tool to help them have a better way expression in the current context [6].

In the CN project defined two stages of implementation in states of Mexico, one in Oaxaca and one in Michoacán. Choosing both places was due to high levels of marginalization, ready access to sample populations, and researchers' previous contacts with locals. In Oaxaca and Michoacán were applied the same techniques of UCD for the project. It was a time of population ethnographic research, requirements analysis,

development of people, prototyping of high and low fidelity, and finally in-situ testing of the prototypes.

This project included three stages, which were replicated in each state: an ethnographic study, in-situ deployment of the different prototypes that were made, and a Wizard of Oz test with high fidelity prototypes. Next up, we describe the implementation of each stage, beginning with the Oaxacan part.

4 First Phase of the Project

In the first stage, the CN was deployed in the southern state of Oaxaca. Oaxaca truly exemplifies the paradox that Mexico is: a land with great cultural diversity, a rich and varied geography and excellent weather year round, but with some of the lowest levels of Human Development in the nation (currently occupying the 30 of 32 spots in Mexico [7]).

A team belonging to one of the universities to where this article authors belong to, Universidad Tecnológica de la Mixteca (UTM) had been working with the community of Santos Reyes Yucuná (population 1332 inhabitants [8]). This fact gave us a lot of leverage in determining the needs of the population. After that, the UTM team taught a Human Development course to the women participants, which evolved into a Productive Project (the Ita-Viko project). Currently, the participants in the Ita-Viko project successfully produce diverse types of flowers and earrings made of cornhusks.

All of these women are bilingual (Spanish/Mixtec), but the eldest ones possess a very low level of Castilian comprehension. Generally they are mothers of families with an average of six children who work as homemakers, with the exception of one. Together with their families they look for economic income alternatives in other states of the republic in various periods of the year, but they always return due to family ties, customs, traditions, and the care for their personal assets.

Once the necessary aptitudes of the women from this community have been developed the team members will have to gradually separate themselves, due to the fact that the projects must be handed over to its participants. In this way the predicament to be resolved by means of Contextual Network is created: How shall the women of Ita-Viko continue forward with their project without the help and presence of the UTM team?

4.1 Project Definition

With the information provided by the UTM team and after a debate, the group of researchers from the project of Contextual Network defined the gradual separation of the UTM team from the women of the community as a problem, the indigenous women of Ita-Viko were defined as users and the community of Santos Reyes Yucuná was established as context. To reach a complete solution to the predicament encountered, the development of a base prototype of low fidelity was outlined and then handed over to the members of the UsaLab (Usability Laboratory) for their subsequent development in the Mixtec region previously described. The said interface would permit

the women to continue their training, education and communication with the SIFE team despite the fact that they were no longer in their community.

4.2 Identification of Objectives and Users

To continue the development of the project, a methodology that allows us to define the objectives and the type of users that would normally make use of the system was employed[2]. In this way, we can set the specific tasks that the users would desire to carry out themselves, and posterior evaluation will show us what we can improve.

It was necessary to observe the users in their respective contexts of use. For this reason, an ethnographic study was elaborated in two places, in the community of Santos Reyes Yucuná, Oaxaca (to observe the users in their respective contexts of use) and in the city of Oaxaca (to observe the users making use of technology similar to that which would be implemented in the project and that we could not carry to the community). The studies were realized from 21 to 29 July 2011.

Also five on-site interviews were conducted in the community inside the users' houses. The users were asked to show us the technology they use daily and to utilize an iPad. See Figure 1 below.



Fig. 1. Users interacting with the iPad in the community of Santos Reyes Yucuná, Oaxaca, Mexico. She was given a simulation with a printed magazine to show her how to use it.

4.3 Contextual Study Results

From the observations made and the subsequent interviews that were conducted, the following conclusions that guided the successive development of the system were defined:

- The users use and accumulate domestic technology (television sets, stereos, cellular phones) in their daily life.
- The users have not seen the technology that is intended to be used.

- Although they are not familiar with the proposed technology, there is no rejection, rather a careful approach to it, awaking considerable interest.
- The utilization of videos for instruction is feasible, besides the fact that the use of headphones for individual activities is equally useful for a greater understanding.
- The layout of a table top interface welcomes the interaction of multiple people in a task, while in the vertical arrangement, the users expect to use contents.
- Due to the fact that the users do not know how to read or write or their primary language is Mixtec, the use of interfaces without text is recommended.

4.4 Development of Usability Tests

Two designs of the sought after system interfaces were developed based upon the previous conclusions. In order to assure that the appropriate system was being developed, they were shown to the users in the community by means of an iPad and they were asked what significance they would give to each graphic element. This was developed 20 August 2011. The first design towards iconographic use that we thought the users would recognize was obtained from its environment and from the activities carried out daily.

4.5 Results of Usability Tests

Using the obtained results a functional Flash prototype was created and Wizard of Oz tests were designed, where one of us performed the functions of the computer. Due to the fact that the project made use of an interactive table, a 40" Samsung LCD, Full HD 1080p was utilized, connected to a laptop utilizing Windows 7. We asked the users (in groups of three or four, depending on the previously considered demographic characteristics) to make use of the equipment. The tests were completed in the communal lounge of Santo Reyes Yucuná on 29 August. The following images (2 and 3) show the development of these tests and the prototype evaluated:



Fig. 2. User evaluation of the prototype through the Wizard of Oz method in their community center



Fig. 3. Main screen of the system tested, after repeated improvements

5 Second Phase of the Project

During the last quarter of 2011 formally began the implementation phase Contextual Network in Michoacán. Through meetings with various governmental and state educational defined three potential sites for our study: Capula, Zinapécuaro and San Nicolás Obispo.

These three towns have a long tradition in pottery craft, each with its own style. Moreover, geographically located near Morelia (San Nicolás Obispo and Capula belong to the municipality of Morelia). After evaluating factors such as accessibility, feasibility study and implementation of recognition outside of their craft, they chose to work with artisans of Capula.

Capula, Michoacan is a town located in the municipality of Morelia, about 20 minutes from the metro area. It is considered to be located on the edge of the area of influence of the Purepecha region, founded in 1550. This town is known for its pottery production, primarily utilitarian (dishes, pots, etc.) Capula's population in 2010 was about five thousand inhabitants [10].

The situation of pottery in this population is going through a critical stage. Traditionally dependent on two key dates for the sale of their products: Easter and Christmas. In those seasons was common tourist arrivals and buyers of wholesale merchandise who made the journey by road to Capula. However, the uncertainty in the national roads has made many of those trips are canceled. To this must be added the overwhelming arrival of foreign goods, mostly from China, which has reduced its sales further.

Despite all this, Capula artisans still working and looking for new ways of marketing, mainly at craft fairs. All this is done with resources primarily funded by the artisans themselves.

It is noteworthy that the exhibition and sale of their products through electronic media is virtually nonexistent (although artisans are aware that it exists).

Up until early 2013, all the usability test have been done, replicating the test that were applied to the Oaxacan women. We expect to finish this project in May 2013.

6 Conclusions

As previously mentioned, the proposed development was very close to that which the users need to resolve their needs once the UTM team has left the locality. Their approach to the technology was as expected and their reactions were of surprise and happiness.

Developing projects for marginalized communities, and consequently, managing to directly assist these people, has always been the primary interest of our university, and therefore, of our laboratory.

For this reason, our participation in the Red TIC's Contextual Network project has been one of the occasions on which we pride ourselves, not solely because of the development achieved, but due to the fact that the project was carried out in a community in Oaxaca.

We profoundly thank the women of the Ita-Viko project from the community Santo Reyes Yucuná, as well as all the Red TIC researchers, the members of the SIFE teams, the UsaLab and the KadaSoftware participants in this project. Special thanks to the Universidad Tecnológica de la Mixteca.

References

1. Courage, C., Baxter, K.: Understanding your users, a practical guide to user requirements. Morgan Kaufmann, Amsterdam (2005)
2. Crespo García, D.: 'Mobile phones' potential to address information and communication needs of healthcare workers in isolated rural areas in Peru, working paper (2008), <http://www.gg.rhul.ac.uk/ict4d/workingpapers/crespo.pdf>; (accessed on February 15, 2011)
3. Cultural, D.: Cuéntamelo Todo / Movimiento Nacional por la Diversidad Cultural
4. http://www.diversidadcultural.mx/index.php?option=com_content&view=article&id=53:cuenta-portada&catid=40&Itemid=60
5. Del Álamo, Ó.: IIGC, Esperanza tecnológica: Internet para los pueblos indígenas de América Latina (2010), http://www.quadernsdigitals.net/datos/hemeroteca/r_1/nr_510/a_7070/7070.pdf
6. Gould, J.D., Lewis, C.: Designing for usability: Key principles and what Designers Think. Communications of the ACM 2, 300–311 (1985)
7. Harindranath, G., Sein, M.K.: Revisiting the role of ICT in development. In: Proceedings of the 9th International Conference on (2007)
8. Social Implications of Computers in Developing Countries. São Paulo, Brazil
9. Information and Communication Technologies for Development
10. <http://www.ict4d.org.uk/>; (accessed on April 13, 2011)
11. Programa de las Naciones Unidas para el Desarrollo, México. Informe sobre Desarrollo Humano México 2011 (2011), http://www.undp.org.mx/IMG/pdf/Informe_sobre_Desarrollo_Humano_Mexico_2011.pdf
12. Secretaría de Desarrollo Social. Catálogo de localidades. Capula, Municipio de Morelia, Michoacán, y Santos Reyes Yucuná, Oaxaca, [http://www.microrregiones.gob.mx/catloc/LocdeMun.aspx?tipo=c](http://www.microrregiones.gob.mx/catloc/LocdeMun.aspx?tipo=clave&campo=loc&ent=16&mun=053)

A Study of Cross-Culture for a Suitable Information Feeding in Online Social Networks

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Abstract. Online Social Networks (OSNs) such as Facebook, Google+, Twitter play a significant role in communication. People use space and services provided by the OSNs to share interests, exchange information and maintain relationship each other. However, there are two issues in the OSNs. First is an information overload problem. The OSNs feed excessive information to social network page (SNP) without recognized user's situation and desire. This problem causes missing important information and makes the user annoy. Second is a culture difference problem. Feeding the information should depend on the culture because culture behavior of each country is different. Hence, information feeding mechanism of the OSNs should realize these issues. In this research, we investigate which features and factors have an impact on the user and should be considered in feeding the information. Furthermore, we study difference of culture between Japan and Thai. We believe our results can alleviate these two problems, when they are applied to the information feeding mechanism. Also in the future the user can get rich communication by serving the relevant information according to the user's situation and desire.

Keywords: Online Social Networks, Information Feeding Mechanism, Information Filtering, Culture differences.

1 Introduction

Nowadays, OSNs have rapidly grown for 10 years. The OSNs are an important media in communication. They change our societies to become closely because they allow us to provide huge of information to others. At the same time, we can receive unlimited information on the SNP. Moreover, we have freedom in connect to whom they would like to contact anytime and everywhere. Recently, Facebook has widely used in many countries such as America, Japan and Thailand. Moreover, the number of Facebook users has increased dramatically, reaching 835 million users in 210 countries [1].

In the OSNs, user has two statuses: owner of post and audience. The owner of post means the user who creates a post and broadcasts it into the OSNs whereas the audience refers to the user who gets a large number of posts from the owner of post. This research focuses on the audience side.

From many advantages mentioned above, we found weak points occurred in existing information feeding mechanism of the OSNs. Most of them do not emphasize the real need of the audiences. Two main problems in existing information feeding mechanism should be considered and solved.

1. Information overload is a problem that the audience's SNP contains excessive information. This information might be un/interesting, as well as un/important information. The problem causes from feeding the information without recognized audience's current situation and desire. Therefore, consequence problem is that the audience loses privacy (solitude) [2] because the information comes to the audience at inappropriate time. They are annoyed and try to reduce activities in the OSNs such as friend block, un-friend and so on. Moreover, this problem leads to missing important information. The audience might lose an opportunity to get necessary information, which is embedded some part of the SNP.
2. Culture behavior is one important problem that existing OSNs do not realize, when feeding the information to the audience. The audiences in different countries have own culture behavior and criteria in receiving the information. There are many factors indicating culture difference such as career, age, and so on. For example, in reading any posts, most of Japanese audiences consider current situation of the audience as the most important, while most of Thai audiences significantly realize topic of this post. The OSNs cannot apply same feeding information mechanism to each culture. It should depend on culture behavior of each country.

We think information feeding mechanism is important part in the OSNs because which kind of information will be perceived by the audiences relies on this mechanism. Information filtering technique should be applied to the information feeding mechanism for removing the unwanted information before displaying to the audience. A well information feeding mechanism helps the audiences receive enough information on the SNP.

Our ultimate goal is to develop new type of the information feeding mechanism for the audience. To do this end, in this research, we use a questionnaire to investigate the features and factors that have influential on receiving information of the audience when he/she is in different current situations and desire. These influential features and factors are used as criteria in information filtering, which is a part of information feeding mechanism. Finding the influential features and factors is important process. Not only it helps reduce amount of information to serve to the audiences, but also the information appeared on the SNP is consistency with the audience's current situation and desire. This is because the audiences do not want to know and cannot perceive all of the information at the same time [3]. Also, we aim to study and compare difference of culture behavior between Japan and Thai. This indicates that existing OSNs should not use same information feeding mechanism for different countries. We found that several existing OSNs do not realize importance of culture differences. Nonetheless, our research does not find the influential features and factors to filter dangerous information like spam text or virus.

This paper is organized as follows. In section 2, we review previous works on the information filtering techniques and cross-culture behavior. In section 3, we describe the features and creating the questionnaire. We analyze the results from questionnaire in section 4. Section 5 presents discussion about the results of Japan and Thai. Finally, section 6 concludes our research and future direction.

2 Background and Related Works

Generally, OSNs composes of owner of post side and audience side. Several researches focus on the owner of post side such as information access control [4], privacy concern in OSNs [5] and so on. There are few researches about the audience side although it has importance in the OSNs. We think information filtering and difference of culture behavior are main components for information feeding mechanism.

For information filtering component, usually some information should be filtered out in order to reduce the total amount of information and serve only relevant information to the user. Several researches use features in filtering. Nakamura et al. [3] take account into user's preference and user's timetable to block the content that tends to spoil a user's enjoyment, while Loeb et al. [6] handle information overload and missing information by using specific context (location, time), mood and social context as features. Vanetti et al. [7] try to filter unwanted information in the OSNs by using flexible rule-based approach as well as machine learning in automatically categorized content of the post as key components. They help user restrict the post on his or her SNP.

For difference of culture behavior component, several previous works have studied cross-culture behaviors in many areas such as communication, education, m-commerce and so on. Tsoi et al. [5] study culture effect on Hong Kong and France users' behavior in social network sites (SNS), with degree of privacy concern, trust of user, and the use of SNS. French users tend to not disclose personal profile information and not post personal content to others in SNS. Vasalou et al [8] present the culture differences among US, UK, Italian, Greek and French users in Facebook use. They analyze the effect of culture on true commitment. The US and UK users give priority to groups, while the Italian users rate groups, games and applications as most important. Kim et al. [9] find difference in motivation and pattern in the use of SNS between US and Korean students. They find that size of networks between US and Korean students leads to a big difference in relationship maintenance. From literature review above, we can conclude that the culture difference is important factor in the OSNs. The culture affects behavior, attitude and relationship.

3 Reseach Methodology

3.1 Candidate Features

From our objectives, we propose seven features [10] for studying on the audience's decision and the culture difference between Japan and Thai.

- **Audience’s current situation (n_0)** This feature refers to current activity is being done by the audience e.g. “working”, “private time”, “shopping”, “travel”, “party”, “meeting”. When the audience is performing any activity, he or she might need different information on the SNP. This activity can be found many ways for example the audience inputs the activity directly, or the system observes the audiences context.
- **Topic of post (n_1)** Topic of post relates to text category. This feature has association with the audience’s preference. If the topic of post matches the audience’s preference, the audience tends to increase interesting level of post. The post is classified into its category such as “sport”, “music”, “advertisement”, “travel”, “private story”, and “game”.
- **Type of relationship between audience and owner of post (n_2)** It indicates type of relationship between audience and creator of the post such as “boss”, “co-worker”, “friend”, “family”. For example, if the owner of post is a “boss” of the audience, then this post might be about project task, meeting and so on. Therefore, the audience can use this feature to make decision to read this kind of post. Using this feature makes differ from existing OSNs that every member has same relationship as friend.
- **Affinity between audience and owner of post (n_3)** [11] This feature presents how familiar the audience and owner of post are or how often they have interaction each other. We define it as three levels: “high”, “medium” and “low”. High affinity level means the audience and the owner of post frequently have interacted every day. Medium affinity level indicates that they have usually interplayed every week or month. Low affinity level presents the audience have not visited page of owner of post for one year.
- **Affinity between audience and a person commenting (commentator) (n_4)** This feature stands for how strong relationship between the audience and commentator is. It can be used when any posts have same owner of post and popular level. For example, post A and B appear on Alice’s SNP. Both of them are created by Bob who is co-worker of Alice. These two posts have 100 comments and 50 like button pressing. However, they have different groups of commentators. Post A gets comments and like button pressing from friends, and post B obtains from co-workers. Therefore, Alice can make decision by using this affinity which the post will be selected to read. This feature also has three levels, which are described in feature n_3 .
- **Post’s Popularity (n_5)** This popularity can refer to top news or talk of the town story that is presently being interested by many commentators. Therefore, it is possible that the audience might want to be up to date from reading this post. However, the post’s popularity does not depend on comment or like button pressing, but it also rely on what kind of interaction that commentators have done on the post [11]. Videos, photos, and links are generally considered to have the highest weight.
- **Time Decay (n_6)** [11] Time decay is mentioned as how up to date the post is. If the post has just been created, it tends to be interested by the audience due to its newness.

3.2 Questionnaire

We create a questionnaire to simulate situation when the audience is in different current situation and faces kind of post shown on the audience's SNP. Our questionnaire consists of two parts: demography and question. For demography, the number of examinees for experiment is 161, which are 51 Japanese and 110 Thai. All of them are asked about age, gender, career, interesting, OSNs service and frequency of OSNs service usage. Each demography term is called as factor. Most Japanese who do the experiment have around 23-29 years of age while Thai examinees' age ranges from 26-30 years of age. Most examinees are student, IT officer, engineer. For question, the questionnaire consists of 45 questions. We provide different scenarios randomly. This scenario contains seven features (n_0 - n_6). Each examinee needs to imagine the scenarios and answers the question that "If the examinee sees a post with the different scenarios 10 times in the examinee's SNP, how many times does the examinee review this post?" We also supply multiple choices that indicate the number of times. An example scenario is described below.

There is a post about sport (team e.g. football, volleyball) fed into your SNP. Owner of this post is a friend from university and you have usually interacted with your friend every week or every month. 10-30 people comment or press a like button on this post. You and a person commenting on this post have regularly interacted every day. This post has just been created. After that, each examinee is asked that "Will you allow this post to be fed into your SNP?" The examinee makes decision either "Allow" or "NOT Allow". In this question, the examinee assumes that the examinee is in current situation (n_0) shown in the scenario. From question above, it needs the examinee to imagine the scenario for 10 times. This means that the examinee will face this kind of scenario that has different contents but still in the same topic. For example, the topic of post is sport team. The examinee can imagine that the post might be football or any kind sport team; however the main topic of post remains the sport.

4 Data Analysis

We investigate the culture differences between Japanese and Thai examinees using WEKA [12]. Ratikan et al. propose Thai data analysis We compare result of Thai examinees from Ratikan et al. research [10].

4.1 Influential Features and Factors on Japanese and Thai Examinee's Decision

We use the feature selection tool in the WEKA to find which the features and factors have influential on the examinee's decision whether or not the examinee will allow a post to be fed into the SNP. Result shows that top two factors of both countries are same that are the number of times which a post is reviewed by the examinee and age. Also, we have found Japanese and Thai examinees

give an important to each feature unequally. The first three influential features on Japanese examinees are n_0 , n_1 and n_6 with influential value 0.0124, 0.0114 and 0.0011 respectively. Feature ranking of Thai examinees are n_1 , n_0 and n_2 with influential value 0.0182, 0.0154 and 0.0037 serially. Although the n_6 and n_2 features are the third ranking of both countries, the influential value is quite far from the first and second ranking. However, this indicates that most of Japanese examinees emphasize current situation than other features whereas most of Thai examinees point to topic of post as the most important.

4.2 An Effect of Feature n_0 and n_1 on Japanese and Thai Examinee's Decision

From section 4.1, the n_0 and n_1 features have influential on the Japanese and Thai examinees' decision. Therefore, we investigate which kind of posts will be interested by the examinees, when they are fed into the SNP during different current situation of the examinees.

For Japan, the result shows that no matter what the examinee's current situation is, the topics of post, which are "music", "sport", "travel", "advertisement about online business", "personal story about own interest sharing and the self-promoting", do not affect them. Around 89% of Japanese examinees on average do not desire to read the "advertisement about discount price", when they are "meeting with 5-15 co-workers" and "working about getting a requirement from a customer, product analysis and code programming". Moreover, we listen to Japanese examinees' opinion from interview. Some examinees state they often skip unwanted posts. For example, if they are during travel, they will disregard the "advertisement about discount price" immediately. However, if it is fed during "shopping", they feel this post is useful and increases an opportunity to buy something. Therefore, this group of the examinees express if the post can be shown according to current situation, it might increase interesting level to that post.

For Thai, two kinds of post that most of Thai examinees are not strongly interested are the "advertisement about part-time job" and "game". Clearly around 91.38% of them on average ignore the "advertisement about part-time job" during "meeting with 5-15 co-workers", "private time", "travel" and "working about getting a requirement from a customer and product analysis". About 84.02% of them state post about "game" often makes them annoy. They try to skip it. We sample three Thai examinees to ask the opinion about how n_1 and n_0 features have an impact on allowing the post to be fed into their SNP. Two of them report that they contact customers or co-workers via the OSNs during meeting. This is common use in their team project. Showing the post inappropriate time might make them depress. For example, they need to relax by making a trip. They check updating news or any story from the OSNs during travel and then see the post about a project task. They are worried about that. One said that she are bored the post which her friends always narrate self-promoting. Moreover, she think that reading many posts on the SNP can compare to finding interesting posts.

4.3 An Influence of the Number of Times Which a Post Is Reviewed by the Examinee (No.Times) on Japanese and Thai Examinee’s Decision

From the questionnaire, we have asked the examinee that “If the examinee sees a post with the different scenarios 10 times in the examinee’s SNP, how many times does the examinee review this post?” for investigating whether or not the No.Times factor has effect on the examinees’ decision. From Fig.1, we can notice that the pattern of both Japanese and Thai examinees is different. Most of Japanese examinees tend to answer “Allow” when the No.Times increases. This result is reasonable. The No.Times factor has association with examinee’s interest for Japan. However, Japanese result might not be applied to Thai. Thai examinees are more likely to answer “NOT Allow”, although they are interested in the kind of post and will read this post for 10 times. Some Thai examinees state that they have concern about privacy, because they do not want to reveal preference and excessively seeing this kind of post on the SNP makes them bore.

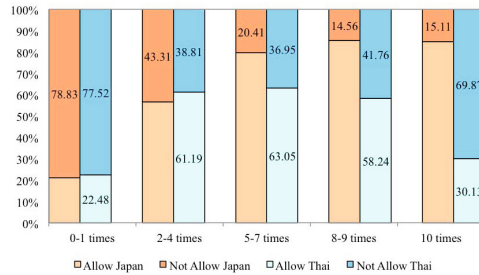


Fig. 1. An influence of No.Times on Japanese and Thai examinee’s decision

4.4 An Influence of Age on Japanese and Thai Examinee’s Decision

We attempt to analyze age factor. It has an impact on the examinees’ decision. Figure.2 shows that behavior of both counties is quite similar that when age of examinees increases, they tend to give an answer “NOT Allow”. Clearly, Thai examinees who have age more than 30 years old have ratio of answer “NOT Allow” higher than Japanese examinees.

Table 1. Percentage of the examinees with more than 25 years of age giving an answer “NOT ALLOW”, when considering in n_0 and n_1 features

n_0 (audience’s current situation)	n_1 (topic of post)							
	Ads_Online business		Ads_Part-time job		Ads_Discount price		Game invitation	
	Japan	Thai	Japan	Thai	Japan	Thai	Japan	Thai
Meeting_5-15 Co-workers	75.75 %	87.96 %	89.19 %	93.22 %	90.48 %	74.93 %	87.5 %	76.1 %
Work_Program Analysis	80 %	55.87 %	69.57 %	86.55 %	94.59 %	59.26 %	76 %	80.51 %
Private_One’s self	21.43 %	69.67 %	56 %	84.3 %	62.5 %	54.86 %	44.44 %	66.82 %
Other(shopping, party and during travel)	42.31 %	52.42 %	92.31 %	82.43 %	75 %	56.1 %	65.22 %	39.72 %

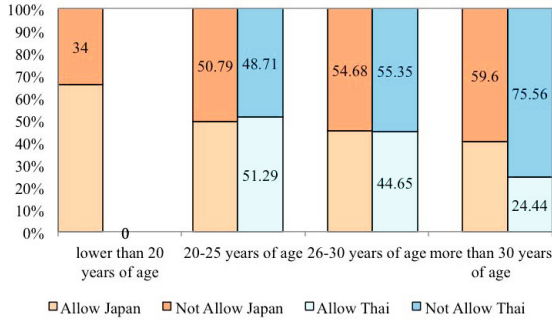


Fig. 2. An influence of Age on Japanese and Thai examinee’s decision (no Thai examinee who has lower than 20 years of age)

We investigate a reason why the examinees with more than 25 years of age are more likely to not allow because the number of answer “NOT Allow” is high. We use the n_0 and n_1 features as mentioned in section 4.1 that they have influential on the examinees’ decision. Among other topics of post, the “advertisement” and “game” make the examinees trouble. From Table. 1, the result clearly shows around 86% of Thai examinees on average do not favour to read the “advertisement about part-time job” at any time. Also it should not be appeared on the SNP while Japanese examinees are “meeting with 5-15 co-workers” and doing other activities (“shopping”, “party”, “travel”). Moreover, the “advertisement about discount price” is viewed as spam when over 90% Japanese examinees see this kind post during “meeting with 5-15 co-workers” and “working about program analysis”. Accordingly, we can conclude that the OSNs should emphasize feeding the “advertisement” and “game” into the SNP might be annoyance to the audience who have more than 25 years of age, when audience’s current situation is different.

Further, we attempt to interview the examinees from both countries. Some of Thai examinees express it relates to preference. When they get older, they have own interests more specifically. This differs from teenagers that have own interests more generally, therefore they open to receive post. Sometimes, the teenager’s preference can change according to time. Some Japanese examinee who has 60 years old said she is a newbie for the OSNs. She tries to use them for several purposes such as finding new friends, contacting others without using cell phone. However, she does not like her SNP contain a lot of posts. This makes her lose time to read and skip some posts.

4.5 Further Analysis

From the results in the section 4.1-4.4, we attempt to describe the important features and factors in detail that indicate culture differences. Nevertheless, we found some factors which might impact the examinees’ decision but are not so much when compare to the sections above. We analyze three careers:

“engineer”, “student” and “IT”. We found that the n_0 feature has extremely impact on Japanese and Thai examinees from adding each feature to careers and investigating the result. Most of them restrict to receive the post during “meeting” and “working”. This is because they quite have same daily life and background experience and respect in a job. Most of Thai students pay attention to seminar with 15 laboratory members for discussing their research. For matching between the examinee’s preference and the n_1 feature, most of Japan and Thai have the same culture behavior that if their preference relates to post appeared on the SNP, around 60-70% of them allow that post to be fed into their SNP. Moreover, some of them state if arranging post on the page is important thing because several times they do not read the post seriously. They find the post that matches their interests. For gender, it is not much effect on Japanese and Thai examinees’ decision.

5 Discussion

Our results show differences and similarities between Japanese and Thai cultures. The n_0 and n_1 features are the most influence on the Japanese and Thai examinees’ decision respectively. When analyzing in detail, we found that most Japanese and Thai examinees give “meeting” and “working” as important. However, there is some difference between both cultures. A job in Japan is quite stricter than those in Thai and most of Japanese respect company’s discipline. Meeting in Japanese style, bottom up is listening to and sharing co-workers’ opinions fairly, while meeting in Thai style, top down is that most of them are an executive level such as a project leader, a manager and so on. Therefore it is necessary for understanding culture in working place. However, the n_1 feature is also importance, especially Thai examinees. This feature relates to the examinees’ preference. Thus, if the post is fed by recognized the n_1 feature and preference, the post will be increase attraction to read. The No.Times factor is an indicator that Japanese and Thai examinees are difference in attitude. If the No.Times factor increases, most of Thai examinees state that they do not want others to immoderately know their preference from seeing the post on their SNP. Also excessively seeing this kind of post on the SNP makes them bore. The age factor shows difference of Japan and Thai that when “age” increases, the use of OSNs might change according to preference and purpose.

6 Conclusion and Future Works

We present two main problems of the OSNs in audience aspect, which are information overload and culture differences. These two problems are not realized by the OSNs when they feed the post to the audience’s SNP. Therefore, we create the questionnaire for Japanese and Thai to find the influential features and factors and analyze them so that they will be used as knowledge in the information feeding mechanism. We believe that if the information feeding mechanism emphasizes which the features and factors have an impact on the audience and

understand the culture differences of each country, it helps reduce the overload information problem and feeding the post to the audience's SNP will be more efficient. Therefore, in near future, the audience can use the OSNs without worry and get rich communication. For future works, we plan to simulate the information feeding mechanism that uses the results of this research. We need to extract the post into meaningful feature and find an appropriate algorithm to learn the result. After that we evaluate satisfaction of the audience.

References

- [1] Facebook users in the world, <http://www.internetworldstats.com/facebook.htm>
- [2] Boyle, M., Neustaedter, C., Greenberg, S.: Privacy factors in video-based media spaces. In: *Media Space 20+ Years of Mediated Life*, pp. 97–122 (2009)
- [3] Nakamura, S., Tanaka, K.: Temporal filtering system to reduce the risk of spoiling a user's enjoyment. In: *Proceedings of the 12th International Conference on Intelligent user Interfaces, IUI 2007, Honolulu*, pp. 345–348 (January 2007)
- [4] Carminati, B., Ferrari, E., Perego, A.: Rule-based access control for social networks. In: Meersman, R., Tari, Z., Herrero, P. (eds.) *OTM 2006 Workshops. LNCS*, vol. 4278, pp. 1734–1744. Springer, Heidelberg (2006)
- [5] Tsoi, H.K., Chen, L.: From privacy concern to uses of social network sites: A cultural comparison via user survey. In: *PASSAT/SocialCom 2011, Hong Kong*, pp. 457–464 (October 2011)
- [6] Loeb, S., Panagos, E.: Information filtering and personalization: Context, serendipity and group profile effects. In: *IEEE Consumer Communications and Networking Conference, CCNC, Las Vegas*, pp. 393–398 (January 2011)
- [7] Vanetti, M., Binaghi, E., Carminati, B., Carullo, M., Ferrari, E.: Content-based filtering in on-line social networks. In: Dimitrakakis, C. (ed.) *PSDML 2010. LNCS (LNAI)*, vol. 6549, pp. 127–140. Springer, Heidelberg (2010)
- [8] Vasalou, A., Joinson, A.N., Courvoisier, D.: Cultural differences, experience with social networks and the nature of “true commitment” in facebook. *Int. J. Hum.-Comput. Stud.* 68(10), 719–728 (2010)
- [9] Kim, Y., Sohn, D., Choi, S.M.: Cultural difference in motivations for using social network sites: A comparative study of american and korean college students. *Comput. Hum. Behav.* 27(1), 365–372 (2011)
- [10] Ratikan, A., Shikida, M.: Feature selection based on audience's behavior for information filtering in online social networks. In: *7th International Conference on Knowledge, Information and Creativity Support Systems, Melbourne*, pp. 81–88 (November 2012)
- [11] Facebook EdgeRank and GraphRank Explained, <http://blog.involver.com/2011/10/25/facebook-edgerank-and-graphrank-explained>
- [12] WEKA Data Mining Software, <http://www.cs.waikato.ac.nz/ml/weka>

A Cross-Cultural Study of User Experience of Video on Demand on Mobile Devices

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Abstract. The objective of this study is to investigate the cross-cultural differences of user experience on mobile VOD service between Chinese and German users. The goal was to provide insight for culturally adaptive mobile VOD service design. This study focused on two aspects of user experience, which are content preference and interface preference. A questionnaire survey was conducted with 20 respondents to find out what kind of content users prefer (i.e. content preference), and a user experiment was carried out with 8 participants to explore users' preference of VOD interface on mobile devices (i.e. interface preference). The results indicated that Chinese users spend more time on videos uploaded by individual users than German users. Besides, users from both cultures prefer the interface with more literal description to interface full of pictures. At last, suggestions for VOD service providers in both cultures are provided.

Keywords: Video on demand, user experience, mobile device.

1 Introduction

Video on demand (VOD) is the service that aims at providing videos according to users' choices at anytime and anywhere as long as hardware and Internet are available. The essential hardware can be computers, cell phones, tablets or devices installed in public transportations such as taxis and airplanes. VOD service allows users to make use of their trivial time by watching their favorite clips while waiting or commuting. Currently, many countries have more than one provider of VOD services. For instance, popular local VOD websites in Germany include Maxdome, Videoload, RTL and MyVideo, and international VOD websites also join the competition, such as YouTube and Hulu. The user experience of VOD service is playing a significant role in attracting users and maintaining market share. And since user experience of VOD service is influenced by users' culture and therefore differs among countries, service providers should design specific service for users from different background. For example, VOD service is regarded as entertainment in some culture, but in others, VOD may be considered as an information source and should be serious. Cross-cultural influences on user experience have long been discussed regarding website,

TV and mobile phone. But few studies have been conducted on the user experience of VOD service, not to mention VOD service on mobile devices.

This study aims to explore the cultural differences of user experience of VOD service on mobile devices between Chinese and German users. Two research questions were proposed based on two aspects of user experience respectively: content preference (i.e. what kind of videos users prefer on VOD service) and interface preference (i.e. what kind of interface users prefer on VOD service). As an exploratory study, this study aims to provide suggestions for VOD providers to improve mobile VOD service.

2 Literature Review

Culture has a significant impact on users' cognitive and mental model, which influence the interaction experience between users and product/service. Many researches have discussed the cross-cultural difference in interface design. Xie & Rau, et al. [14] investigated the impact of cultural diversity on communication effectiveness with different communication styles and to apply the results in the field of user interface design. The results showed that high context people had better communication effectiveness in comprehending nonverbal clues than low context people, while low context people had better communication effectiveness in verbal communication. Rau, Choong and Salvendy [2, 12] have done two studies on the effects of cultural differences on computer performance of Chinese and American users, and provided suggestions on interface design for Chinese users. They found that for Chinese participants, both in Taiwan and in Mainland China, advantages were associated with concrete representation and with the thematic structure in terms of initial performance time.

Besides, Choong and Salvendy [1] investigated the impacts of cultural differences in cognitive abilities between the US and Chinese users on their performance with icon displays. The results indicated that American users were better when it came to alphanumeric and combined modes, while Chinese users showed a preference to pictorial and combined modes. Evers, Kukulska-Hulme and Jones [4] also conducted a small-scale study to investigate cultural influence on understanding the website of a virtual campus. And they concluded that the differences in expectations and understanding were due to users' knowledge of everyday life and real world experience.

In addition, many researches focused on cross-cultural influence on the user experience of websites. Fang and Rau [5] carried out experiments to examine the cultural effects on users' perceived usability and search performance of portal websites with both Chinese and US users. The results indicated that the cultural differences between US and Chinese users had significant impact on their perception and usage of the portal website. Marcus and Gould [9] applied Hofstede's cultural dimension theory to analyze the web interface of differences cultures, and provided suggestions on global website development.

Previous researches on VOD mainly focused on improving the technology of VOD service by user behavior analysis [11, 13, 15] and popularity analysis [6, 10]. This

study will explore the cultural differences of VOD user experience and shed light on user experience study of mobile VOD service.

3 Research Question

A VOD company usually provides various kinds of video programs, such as funny autodyne, latest movies and serious documentaries, in order to satisfy as many users as possible. But a large amount of programs not only leads to large expenses, but also impacts the user experience, because it will increase the difficulty of finding users' objective videos. And there will never be enough programs to satisfy all the users. Therefore, it is necessary to investigate what kind of videos users like to watch on VOD service, and thus to provide valuable suggestions for VOD providers. In addition, VOD companies which aim to extend their business to other countries also need to know their customers.

This study compared the preference differences between Chinese users and German users. As a result, the first research question is proposed as follows: what kind of video users prefer in VOD service, is there any cultural difference in users' content preference between Chinese and German users, and how should VOD companies make use of this result.

The second research question focuses on the interface preference of VOD service on mobile devices. Choong and Salvendy's study [1] shown that Chinese people performed better with pictorial-mode interface, compared to alphanumeric-mode interface, but American subjects performed better with alphanumeric-mode interface than with pictorial-mode interface. Whether the same results can be found in VOD interface or not? The second research question dealt with users' performance with pictorial-mode interface or alphanumeric-mode interface. Do users from different cultures perform differently on different interfaces? Do Chinese users perform better with pictorial display than alphanumeric display? And do German users perform better with alphanumeric display than pictorial display?

4 Methodology

A questionnaire survey and a user experiment were carried out to investigate the research questions. The questionnaire aims to find out users' preference of video programs on VOD service. The questions can be divided into five parts: basic usage of VOD on mobile devices, time spent on different kinds of programs, confidence in different kinds of programs, comments on VOD service, and demographic information. 20 master students participated in the survey; including 10 Chinese students are 10 German students.

The user experiment examined Chinese and German users' performance on pictorial display and alphanumeric display and therefore discovered whether there were cultural differences in interface preference of mobile VOD service. The independent variables are cultural background and interface types (Figure1). The dependent variables are finishing time, click number and satisfaction.

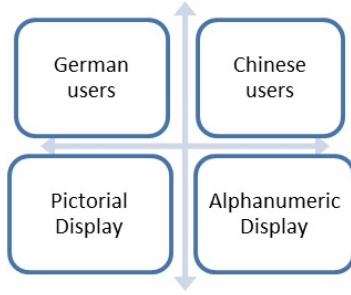


Fig. 1. 2 variables * 2 levels experiment design

Two VOD websites were chosen to present pictorial and alphanumeric display, which are Vudu.com (www.vudu.com) and Instant Video of Amazon. Vudu.com is a typical pictorial display because its interface is full of pictures but contains little text. In contrast, Amazon Instant Video provides a more literal description for each video beside the image. The experiment was done on an iPad 1, and the VOD websites were displayed in Safari, so participants could click and slide on the screen with their fingers.

Four Chinese and four German students, aged 23-26, 5 males and 3 females, participated in the experiment. All of them had sufficient experience of VOD service but never heard of Vudu.com and Amazon Instant Video. During the experiment, participants were asked to finish three tasks on both websites, which are all common operations when using VOD service. The tasks are 1) find a specific video by searching function; 2) find a specific video without searching function; 3) find a documentary about nature that you are interested in.

5 Results

5.1 Survey Results

The results of the questionnaire survey lead to three findings about the usage of VOD service. Firstly, three of four participants from German had used VOD on mobile devices, but only one participant from China had such experience. This result indicated that VOD service on mobile devices was a new idea in China and had not been widely accepted by many users. Besides, the speed of mobile internet is much lower in China, which restricts the spread of mobile VOD usage. In the open questions, almost all the participants complained of low internet speed and long buffering time.

Secondly, most users were used to watching VOD programs for entertainment, such as TV shows, movies, music and individual autodyne. Chinese participants spent a higher proportion of time on videos uploaded by individuals than German participants, while German participants spent relatively more time on official videos, such as TV shows, movies and official news. Since China has a more collectivistic cultural background, Chinese people tend to rely on each other and be easily influenced by

others. So Chinese users would like to pay more attention to other people's opinions and as a result spend more time on other users' videos. Besides, there is a popular activity in China recently that many VOD users carry around a video camera and shoot any scene that is worth sharing. These people are so-called "shoot-off" ("拍客" in Chinese). This phenomenon may increase the proportion of time spent on individual videos among Chinese VOD users.

At last, Chinese participants showed more confidences in videos uploaded by individual than German participants did. One of the reasons is that Chinese users have a collectivistic culture background, and they tend to believe other people's opinions and try not to be different.

5.2 Experiment Results

Both Chinese and German participants performed better (spent less time and less clicks) on Amazon Instant Video than Vudu.com, which means that alphanumeric display design is superior to pictorial display design for mobile VOD service. Since mobile devices usually have small screens and low resolution, too many pictures in the screen would be difficult to recognize and thus causes confusion. And descriptive information will help to gain better understanding of each video and facilitate the location process. On the other hand, interface with more pictures takes more time to download and requires longer buffering time, which leads to longer performance time and lower satisfaction. Sometimes when a page did not show up for a few seconds, users may get anxious and jump to other pages, which will lead to more click and longer performance time.

During the experiment, Chinese participants clicked more times than German participants. This result should be due to the language issue, i.e. both websites are in English. German students are more proficient in English than Chinese students, resulting in shorter performance time and less clicks. No other cultural differences are concluded from the experiment.

6 Discussion

The results of the questionnaire survey indicated that VOD service was widely used as an entertainment tool in both countries. And Chinese participants spent more time on videos uploaded by individuals than German participants. What's more, as for serious topics such as news reports, Chinese students showed more confidence in individual videos than German students. This argument needs to be verified in further researches and the explanation for it should be carefully considered.

The results of the user experiment showed that both groups performed worse on the VOD interface with pictorial display. Because pictures alone cannot provide enough information, and too many pictures on a small screen may cause confusion. Besides, interfaces with more pictures require longer buffering time.

According to the results of this study, three suggestions are presented for VOD providers as follows.

1. VOD service aiming at entertainment should encourage users to upload more videos. Relevant designs such as rapid upload icon and rewards for uploading could be carried out. Besides, more efforts should be made to encourage commenting and to improve communicating experience. For example, VOD service can highlight video comments, provide a hot key to enter a discussion room, and allow rapid evaluation for each video. In addition, the interface design should be friendly to users, which makes them feel comfortable to comment and to exchange opinions.
2. VOD service providing serious programs should be designed in a different way. More official videos with higher authority should be provided with explicit source, and less comments be displayed. And the design style of interface should be relatively serious to enhance authoritative feelings.
3. Mobile VOD interface should provide literal descriptions for each program, especially when mobile devices are used in places with low internet speed. This suggestion is due to the fact that mobile devices have different sizes and will be used in different situation. For example, when VOD programs are displayed on a mobile device with a small screen, interface with many pictures will be either full of small pictures that can hardly be recognized, or consisted of only several large pictures and the target one is not included. Therefore, literal description is more suitable for VOD interface on mobile devices. This statement needs further verification, and cultural difference in interface design should be emphasized.

The results of this paper are limited in several ways. Firstly, the language issue is not included. Both websites used in the experiments are in English, so users' proficiency in English may distort the results, even though we have chosen participants who were able to understand oral and written English well.

Secondly, the impacts of users' experience of accessing similar interface and video programs are not well controlled. During the task of finding a specific movie on VOD websites, participants who are familiar with the movie poster spent significantly less time and less clicks. Besides, the results will be influenced by the participants' usage experience of iPad or similar devices. Prior experience in VOD websites or even online shopping websites which have a similar navigation structure may also affect participants' performance and satisfaction.

At last, the small sample size in both questionnaire survey and user experiment impacted the validity of the results significantly. But as an exploratory study, the results discussed some interesting research questions, presented possible explanation and provided suggestions for further study.

In further studies, it is worthwhile to explicitly control the influence of language and past experience, in order to find out more facts on cross-cultural differences in VOD service on mobile devices. And as last detailed instruction on interface design for specific users can be proposed regarding VOD service on mobile devices. Besides, we only recruited students as participants in this study. Further studies should extend to larger groups and consider more situations.

In addition, there are other influential factors that cause the differences between Chinese and German users when using mobile VOD services. This paper tried to explain the differences from cultural perspective. There may be other reasons that influence user preference and practical action.

References

1. Choong, Y.Y., Salvendy, G.: Design of Icons for Use by Chinese in Mainland China. *Interact. Comput.* 9(4), 417–430 (1998)
2. Choong, Y.Y., Salvendy, G.: Implications for Design of Computer Interfaces for Chinese Users in Mainland China. *Int. J. Hum-Comput. Int.* 11(1), 29–46 (1999)
3. Evers, V.: Cross-cultural Understanding of Metaphors in Interface Design. In: *Cultural Attitudes towards Technology and Communication*, London (1998)
4. Evers, V., Kukulska-Hulme, A., Jones, A.: Cross-cultural Understanding of Interface Design: A Cross-cultural Analysis of Icon Recognition. In: *The International Workshop on Internationalisation of Products and Systems*, Rochester (1999)
5. Fang, X., Rau, P.L.P.: Culture Differences in Design of Portal Sites. *Ergonom.* 46(1-3), 242–254 (2003)
6. Griwodz, C., Bär, M., Wolf, L.C.: Long-term Movie Popularity Models in Video-on-demand Systems: or the Life of an On-demand Movie. In: *The Fifth ACM International Conference on Multimedia*, pp. 349–357. ACM Press, New York (1997)
7. Hofstede, G., Bond, M.H.: Hofstede's Culture Dimensions. *J. Cross-cul. Psych.* 15(4), 417–433 (1984)
8. Jagne, J., Smith-Atakan, A.S.G.: Cross-cultural Interface Design Strategy. *Univ. Access. Inf. Soc.* 5(3), 299–305 (2006)
9. Marcus, A., Gould, E.W.: Crosscurrents: Cultural Dimensions and Global Web User-interface Design. *Interact.* 7(4), 32–46 (2000)
10. Paneda, X.G., Garcia, R., Melendi, D., Vilas, M.: Popularity Analysis of a Video-on-demand Service in a Digital Newspaper: Influence of the Subject, Video Characteristics and New Content Publication Policy. *Int. J. Adv. Media. Comm.* 1(4), 369–385 (2007)
11. Qiu, F., Cui, Y.: An Analysis of User Behavior in Online Video Streaming. In: *The International Workshop on Very-large scale Multimedia Corpus, Mining and Retrieval*, pp. 49–54. ACM Press, New York (2010)
12. Rau, P.L.P., Choong, Y.Y., Salvendy, G.: A Cross Cultural Study on Knowledge Representation and Structure in Human Computer Interfaces. *Int. J. Ind. Ergonom.* 34(2), 117–129 (2004)
13. Vilas, M., Pañeda, X.G., García, R., Melendi, D., García, V.G.: User Behavior Analysis of a Video-on-demand Service with a Wide Variety of Subjects and Lengths. In: *31st Euro-micro Conference on Software Engineering and Advanced Applications*, pp. 330–337. IEEE Conference Publications (2005)
14. Xie, A., Rau, P.L.P., Tseng, Y., Su, H., Zhao, C.: Cross-cultural Influence on Communication Effectiveness and User Interface Design. *Int. J. Intercul. Rel.* 33(1), 11–20 (2009)
15. Yu, H., Zheng, D., Zhao, B.Y., Zheng, W.: Understanding User Behavior in Large-scale Video-on-demand Systems. In: *1st ACM SIGOPS/EuroSys European Conference on Computer System*, pp. 333–344. ACM Press, New York (2006)

A Comparison of Eye Movements When Searching Web Pages between Americans and Koreans

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Abstract. The purpose of this research was to identify the differences and similarities in eye movements between American and Korean participants when searching Web pages of different levels of complexity. Several eye-movement metrics were employed using eye-tracking systems. The results revealed that there was no significant difference between Americans and Koreans in terms of attention to visual elements and areas of the Web pages.

Keywords: cultural differences, eye movement, Web design.

1 Introduction

Due to the large portion of international users of in the Internet, the fields of Web design and development have addressed the cultural issues in Web design. Many previous design guidelines and much of the empirical research addressed various cultural aspects in Web design by comparing users' preferences and behaviors.

However, little research on the cultural differences in users' preferences regarding Web-site design and performance has been conducted from the point of view of cognitive differences. For an insightful understanding of the cultural aspects of interface design, the cognitive aspects of human-computer interaction should be studied along with user behavioral characteristics. Therefore, it is important for a user-interface designer to understand and consider whether each culture has its own cognitive style when it comes to viewing Web pages.

In this study, eye-tracking methodology was used to examine patterns of eye movement when searching information on Web pages among members of two different cultures, Americans and Koreans. The research question for this study is to identify what, when, and where people pay attention to on a Web page and what visual elements attract a visitor's attention.

2 Research Background

2.1 Cognition and Culture

The cultural differences in cognition between Easterners (especially, East Asian) and Westerners have been shown in many experiments, specifically those conducted by

Nisbett et al. [1] Nisbett and Masuda [2] argued that “East Asians and Westerners perceive the world and think about it in very different ways” (p. 11163). This difference extends to attention and perception. According to Nisbett et al. [1], Westerners, in particular North Americans, attend more to focal objects, whereas East Asians attend more to contextual information. Chua, Boland, and Nisbett [3] tried to understand these differences in cognitive processing by examining users from members of different cultures (American and Chinese), recording patterns when they viewed naturalistic scene photographs that have a focal object on a complex background. The results showed that “Americans fixed more on focal objects than did the Chinese, and Americans tend to move their attention to the focal object quickly. In addition, the Chinese made more saccades to the background than did Americans” (p. 12629).

3 Methodology




In this study, the usability method was adopted only to collect eye movement data during the procedure of the usability test. The Web pages used for this study were not evaluated by the usability test.

3.1 Apparatus and Stimuli

Apparatus. The Tobii 1750 eye-tracking system was used. All of the hardware for the eye tracker were integrated into a slim metal casing of a 17” thin-film transistor (TFT) display at a resolution of 1024 x 768 and 32-bit color quality so that no camera or other hardware were visible to the user. This system was set up to sample the user’s eye position every 20msec with an accuracy of 0.5-degree gaze estimation.

Stimuli. To select Web pages that had different levels of Web complexity, a two-step procedure was used. In the first step, 89 undergraduate or graduate students looked at 30 Web pages selected from global websites that had multiple language versions one by one on a projection screen for 10 seconds. After they looked at each Web page, they were asked about the complexity of the Web pages and their familiarity and experience with the Web pages. Web-page complexity was evaluated on a 10-point scale (1: least complex, 10: most complex). Once the data were collected, they were statistically analyzed, and twenty Web pages used in the first step were categorized into three categories: simple, moderately complex, and complex. If there were more than two Web pages in a category, the Web pages were compared based on the metrics and researcher’s intuition for Web-page complexity. Then finally one Web page for each level of complexity was selected. Selected Web pages (see Table 1.) for both countries have almost identical Web-page layout and content. Each pair was modified to have the identical layout and content.

Table 1. Screenshots of Web Pages and Complexity

Complexity	Simple	Moderate	Complex
Screen Shots			

3.2 Measurement of Eye Movement

The following six eye movements and one performance variable were measured: (1) fixation count on each area of interest (AOI)—number of fixations on each AOI; (2) total gaze time in each AOI—total fixation duration in each AOI, (3) time to first fixation and first fixation area, (4) fixation order (order in which each AOI was fixed), (5) fixation transition (transition of fixations going from each AOI to all other AOIs), and (6) task completion time.

In this study, a fixation is defined as a series of samples within a 30-pixel radius for at least 100 msec.

3.3 Participants

Nineteen American graduate and undergraduate students (13 males, 6 females) and 19 international Korean graduate students (11 males, 8 females) participated. All participants had earned their high school diplomas in their native countries. The American participants primarily came from the field of information technology or information studies, while the Korean participants came from various fields of study such as social science, math, psychology, law, and information studies. About 78 percent of the American participants and 68 percent of the Korean participant regularly used the Internet more than two hours a day to access a Web page. There was no compensation given for participation.

3.4 Procedure

In this experiment, the participants were asked to find a link based on the instructions. The instructions were shown on the computer monitor in English or Korean in PDF format. Some key words for the searching tasks were written in Korean for the Korean participants. Once the participants said they were ready, the Web page for the task was loaded. And participants were then asked to look at it approximately two seconds and close the browser if they thought they had found the correct link, because

there were no clickable links on the pages. To avoid order effects, the order of task presentation and level of Web-page complexity were counterbalanced across participants.

4 Data Collection and Analysis

4.1 Data Collection

In this study, the Tobii 1750 eye tracker collected the sample of the user's eye positions every 20msec. ClearView 2.7.1. software, provided with the eye tracker, was used to analyze the data. To obtain accurate data, validity code and eye filters were used. When reviewing the validity code, if a participant had many bad and missing sequences of gaze coordinates, the data from the participant were excluded. Data obtained from the participants whose searching time was more than two standard deviations above the mean for individual participants were also excluded.

4.2 Data Analysis

Descriptive and statistical analyses were conducted by using SPSS (Version 13). The gaze and fixation data were also visualized using gaze plots and hotspots to provide an overview of the eye movements of individuals, multiple participants, or groups. A tool called Hotspot visualizes gaze positions from multiple participants and creates hotspot maps based on various statistical eye-movement data such as gaze time and fixation count on the Web page. In addition, patterns in eye-movement sequences from one AOI to another were analyzed by the fixation transition metrics (probability of fixation transition). In this study, the discussion analysis tool (DAT) developed by Jeong [4] was used to compute transitional probabilities of fixation transition among AOIs. A z-score of ± 1.28 at .10 alpha level was used to identify whether transitional probabilities were significantly higher or lower than were expected probabilities.

5 Results

5.1 Searching Task on the Simple Web Page

For the searching task on the simple Web page, the Dell home page was used. The simple Web page was divided into 10 different AOIs (see Fig. 1).

In this task, participants were asked to assume that they had ordered a laptop from the Web site and wanted to know the order status. Then, the participant was asked to find the link for checking the order status. The answer for the question was located on the top right corner (topmenu). About half of the participants in both groups finished their searching task in seven seconds.

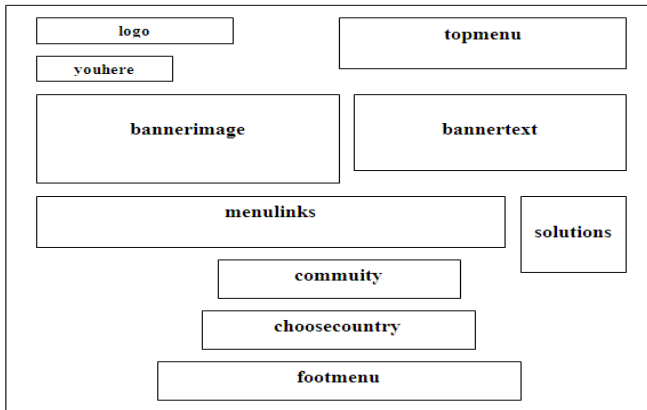


Fig. 1. AOIs of the Dell homepage

Fixation and Gaze on the AOIs. The average fixation count on each of the AOIs for both groups was very similar. As a percentage of subjects viewing AOIs, the Korean participants fixated a little more all over the AOIs on the Web page than did the American participants. Specifically, the Korean participants fixated about two times longer on the menulinks area than did the American participants. Both groups of participants fixated longer on the banner text area than on the banner image area, although the big banner image occupied almost one-sixth of the screen. It is interesting to note that the participants fixated more often on text content than on images. It seemed that the Korean participants spent more time on the menulink than the American participants. However, no significant differences were found between the two groups in the aggregate gaze time and the mean gaze time on each of the AOIs.

Fixation Transition and Gaze Plots. About 72 percent of the American participants reached the top menu area (target area) within 1000 msec, and about 80 percent of the Korean participants looked at the top menu area within 1000 msec. The majority of the American participants reached the top menu area within 20 fixations, while the Korean participants needed more fixations to reach the topmenu area. Participants who completed the task quickly fixated on a couple of AOIs and reached the top menu area, while participants who took a longer time for task completion visited more AOIs. The target AOI (top menu) received the most frequent transition from the banner text between the two groups. The Korean participants seemed to have more diverse fixation transitions among the AOIs than did the American participants. However, there were no significant differences in overall fixation transitions among the AOIs ($c_2(6, N = 130) = 3.80, p > 0.05$).

5.2 Searching Task on the Moderately Complex Web Page

The Bayer homepage (see Table 1) was used for the searching task on the moderately complex Web page. The Web page was divided into 12 AOIs in terms of location and content of the Web page (see Fig. 2).

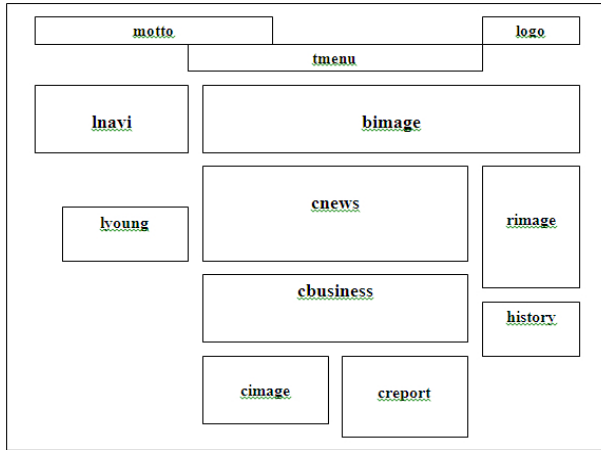


Fig. 2. AOIs of the Bayer homepage

Participants were asked to find the link for Bayer's history. The correct link was located in the history AOI. The longest searching time of the American participants and the Korean participants was 45.82 seconds and 37.76 seconds, respectively. The average searching time of American and Korean participants was 17.7 seconds ($SD = 7.37$) and 14.7 seconds ($SD = 6.26$), respectively. However, there were no significant differences in the searching time between the American and Korean participants ($U = 113, p > 0.05$).

Fixation and Gaze on the AOIs. The left navigation area (lnavi) had the most fixation counts followed by the history area. Both groups fixated more on the text area than on the salient areas with images. That is, participants in both groups selectively looked at the text links and headings of the short passages rather than on the images because the participants anticipated the correct link in the navigation areas or texts areas that had links. Both groups spent the most time on the left navigation area (AME: 19 percent, KORE: 24 percent) followed by the top menu (tmenu) or the right images area (rimages) except on the history area, in which the correct link was located. During the debriefing phase, several participants mentioned they thought the correct answer for the task was in the company link on the top menu. Overall, there seemed no big differences in terms of the fixation counts in each of the AOIs.

Fixation Transition and Gaze Plots. About 70 percent of the American participants started their search on the banner image. They then moved to the top areas of the Web page such as the logo, the motto, or the top menu area. About half of the Korean participants initially looked at the banner image; they moved to the top area of the Web page as well. Both groups of participants then moved to the left navigation area followed by the center news area (cnews) and images in the right column (rimages). In general, participants who found the correct followed an S shape of the gaze plot starting in the banner image (bimage) or top menu (tmenu). However, there were no

significant differences between the two groups in fixation transitions among the AOIs ($\chi^2(10, N = 383) = 14.42, p > .05$).

5.3 Searching Task on the Complex Web Page

For the searching task on the complex web page, the Oracle homepage (see Table 1) was used. The homepage was divided into 12 AOIs (see Fig. 3).

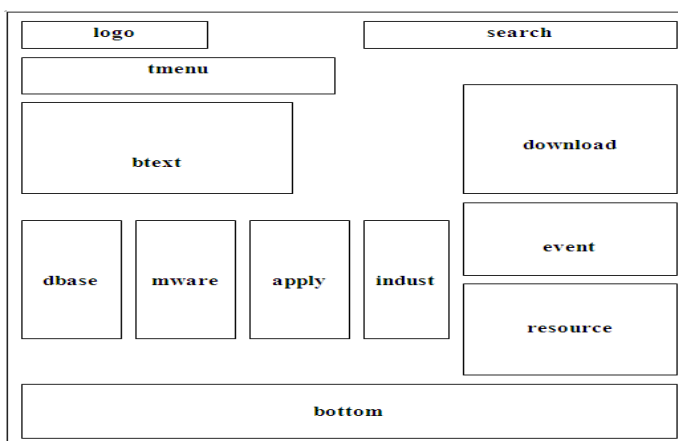


Fig. 3. AOIs of the Oracle homepage

In this task, participants were asked to find the link for information about what and why Oracle products are used in the health care industry. The correct link was located in the indust AOI. One outlier in data collected from the Korean participants was excluded.

Fixation and Gaze on the AOIs. The top menu area (tmenu) received the second highest number of fixations for both groups. The Korean participants looked at the right navigation area (download, event, and resource) about twice as much as American participants did. Other than that, participants for both groups paid similar attention to the other AOIs. Both groups spent more time in the AOIs (dbase, mware, apply, and indust) composed of high-dense English text. In particular, the Korean participants' average fixation duration on those AOIs was higher than that of the American participants.

Fixation Transition and Gaze Plots. Participants for both groups fixated first on the upper areas of the Web page such as the banner, search, logo, or download areas. Sixty-six percent of the American participants and 77 percent of the Korean participants fixated first on the banner area (btext) and then quickly moved to the top menu area (tmenu).

It is interesting that the first fixation time to the AOI, where the correct link was located, for the Korean participants ($M = 6.6\text{sec}$) was faster than it was for American participants ($M = 9.3\text{ sec}$). However, the Koreans' task completion time was slower than that of the American participants. Reviewing the gaze plot and transition matrix revealed that although many Korean participants glanced through the industries area earlier than did the American participants, the Koreans missed the correct link and moved to the other AOIs.

Two common viewing patterns were determined for the participants who found the correct link in the average time by analyzing individual gaze plots and transitional probability matrices: (1) the participants for both groups fixated first on the banner text followed by the top menu and then moved vertically onto the database link area (dbase). Then the participants scanned horizontally until they reached the industry links area (C shape), or (2) the participants first gazed at the banner text followed by the top menu and followed in a clockwise direction (converse C shape). No significant difference was found between the groups in terms of fixation transitions ($\chi^2(9, N = 342) = 8.86, p > 0.05$).

6 Discussion

6.1 Attention

The level of Web page complexity in searching task did not much affect the allocation of attention for either group. The participants of both groups tended to allocate a large amount of their fixation and gaze time in the navigation area and scan through the navigation area regardless of the level of Web-page complexity. In regard to clusters of fixations, the levels of complexity of Web pages did not seem to have much influence on the density of fixation clusters. It is interesting that icons and images, which are regarded as salient elements in Web-page design, did not receive fixations first when they were displayed alongside text descriptions. By analyzing hotspots more closely, both groups of participants tended to give more attention to text information than to images.

Familiarity with the Web page, or previous Web searching experience might influence searching time and viewing patterns on the Web page. The participants might guess the location of the link on the Web page from their previous Web searching activities as they read the instructions. This suggests that in the searching tasks, participants might expect the target link in text format rather than in image format. Therefore, users intentionally tended to try to find the target link in the text format link on the navigation area, menu area, or content area first.

Overall, there were no significant differences between the two groups regarding visual attention and the eye-movement patterns in all different levels of Web-page complexity.

6.2 Cross-Cultural Web Design Practice

American participants tended to give more attention and spend more time on the banner image than did the Korean participants. Korean participants tended to allocate

their attention and spend more time on viewing navigation areas; Korean participants might want to know the whole structure of a Web site to which the Web page belongs. Nevertheless, given that no significant findings were observed, it may be too strong to state that Korean participants had a more holistic viewpoint when they looked at a Web page. However, it is worth considering that a navigation area needs to represent the whole structure or context of a Web site in greater detail when designing a Web page for Korean users.

In general, participants for both groups reached about five AOIs (banner image, banner text, logo, top menu, and right top area) in three seconds in searching tasks regardless of the level of complexity. With respect to fixation transitions, the participants for both groups tended to make direct transitions to the menu or navigation areas. In addition, Korean participants seemed to require more cognitive effort when they viewed the dense text areas such as navigation areas or main contents areas than did the American participants. Specifically, Korean participants' mean fixation durations were longer when they read English than the American participants were. Therefore, these differences in eye movements when viewing a Web page between two groups should be taken into consideration depending on the purpose of a Web page and the visual complexity of a Web page.

6.3 Limitation of the Study

Although eye-movement data obtained from the experiment were reliable, the findings of this study cannot be generalized because of the limitations of the methodology. First, the Web pages used in this study were not actual Web pages. They looked like active Web pages, but, in fact, they were image files (jpg). Nothing was activated on the Web page. Moving graphics such as flash banner images or active icons could be an important factor that could influence eye movement. Second, participants for both groups were not a perfect match. All the American participants were majoring in information science or information technology, while only about half of the Korean participants were majoring in information science. All the Web pages used in this study except one Web page were information- or computer systems-related Web pages. Familiarity with the Web pages used in this study and the participants' majors might have affected their eye movement behavior.

Overall, eye movement characteristics revealed in this study may not generally apply to all types of Web pages. The pattern of eye movements can vary depending on other factors such as the domain of the Web page, task difficulty, individual experience, familiarity with a Web page, or the visual elements of a Web page.

7 Conclusion

The research examines whether differences in eye movement exist between groups from two cultures (United States and Korea) when viewing a Web page, and if so, whether their eye movements are affected by the types of activities and the levels of Web-page complexity. Although this study showed similarities and differences in eye

movement behaviors when searching information on a Web page, this study did not show significant differences between American participants and Korean participants in terms of initial attention to visual elements and areas on the Web pages. With respect to viewing patterns, similar patterns were found between the groups. The findings and observations obtained in this exploratory eye-movement experiment could suggest guidelines for Web page design from the cognitive viewpoint for different cultures and provide a methodological example for future cross-cultural usability tests.

References

1. Nisbett, R.E., Peng, K., Choi, I., Norenzayan, A.: Culture and Systems of Thought: Historic vs. Analytic Cognition. *Psychological Review* 108, 291–310 (2001)
2. Nisbett, R.E., Masuda, T.: Culture and Point of View. *PNAS* 100(19), 1163–1170 (2003)
3. Chua, H.F., Boland, J.E., Nisbett, R.E.: Cultural Variation in Eye Movements during Scene Perception. *PNAS* 102(35), 12629–12633 (2005)
4. Jeong, A.: Discussion Analysis Tool, <http://myweb.fsu.edu/ajeong/dat/>

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