Usable Trust Management for Mobile Applications

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Outline

- Mobile application market
- Research caused by practical issues
- Notions of trust and trust management
- A methodology of user driven trust modeling and management
- Usable trust management for mobile applications
- Conclusion and future work

Mobile Application Market

- A mobile device
  - An open computing platform
  - Execute various mobile applications
- Future mobile application market
  - Very competitive: multiple choices for users
  - User needs to make a decision on, e.g., purchase, safe to use
  - Crucial issue: which mobile application is more trustworthy

Trust management for mobile applications

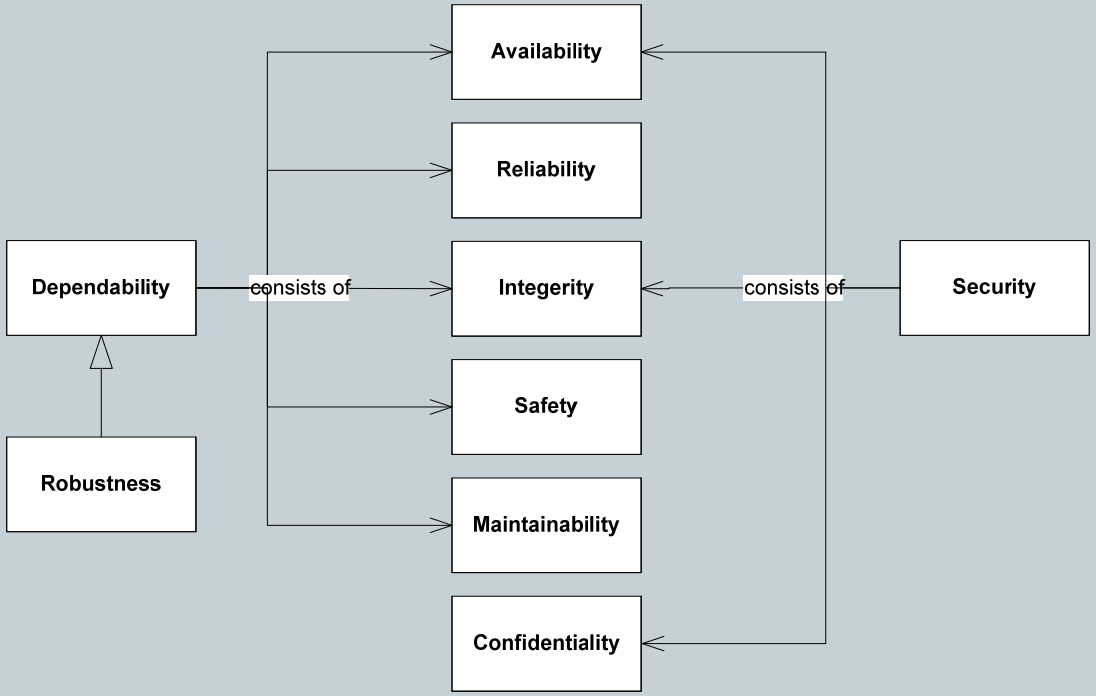
- Evaluate a mobile application's trust/reputation
  - Traditional certificate based validation and access control -> security support
  - Rating based evaluation: credible? Usable?
  - Evaluation: number of downloading (top 10)
    - More downloading more trust?
    - Is it precise?
    - How to calculate the number of 'stars' in a trustworthy and usable way?
    - How to select one from multiple similar applications?

Research Caused by Practical Issues: towards usable trust management

- Human-Machine Interaction for trust management
  - Subjective concept -> Concern trustor (user)'s criteria
- Usability issue
  - User-device interaction for trust related decisions
  - User lacks information and knowledge for decisions
  - Autonomic trust management
    - Auto-data collection for trust evaluation
    - Auto-trust management based on the trust evaluation result
    - Based on high-level trust polices
- Usable trust management requires a friendly user interface
  - Collect useful information -> trust evaluation and management;
  - Present the evaluation results in a comprehensive manner;
  - Disseminate individual experiences to other devices.

Notion of Trust

- A multidimensional, multidisciplinary and multifaceted concept
- Definition: confidence, belief, and expectation on the goodness, reliability, ability, or character, etc. of a person or thing
- A relationship between a trustor and a trustee
- Characteristics: subjective & dynamic, context-aware
- Trust & Security



Factors of Software trust (Avizienis, Laprie, Randell & Landwehr, 2004, IEEE Transactions on Dependable and Secure Computing)

Trust Management

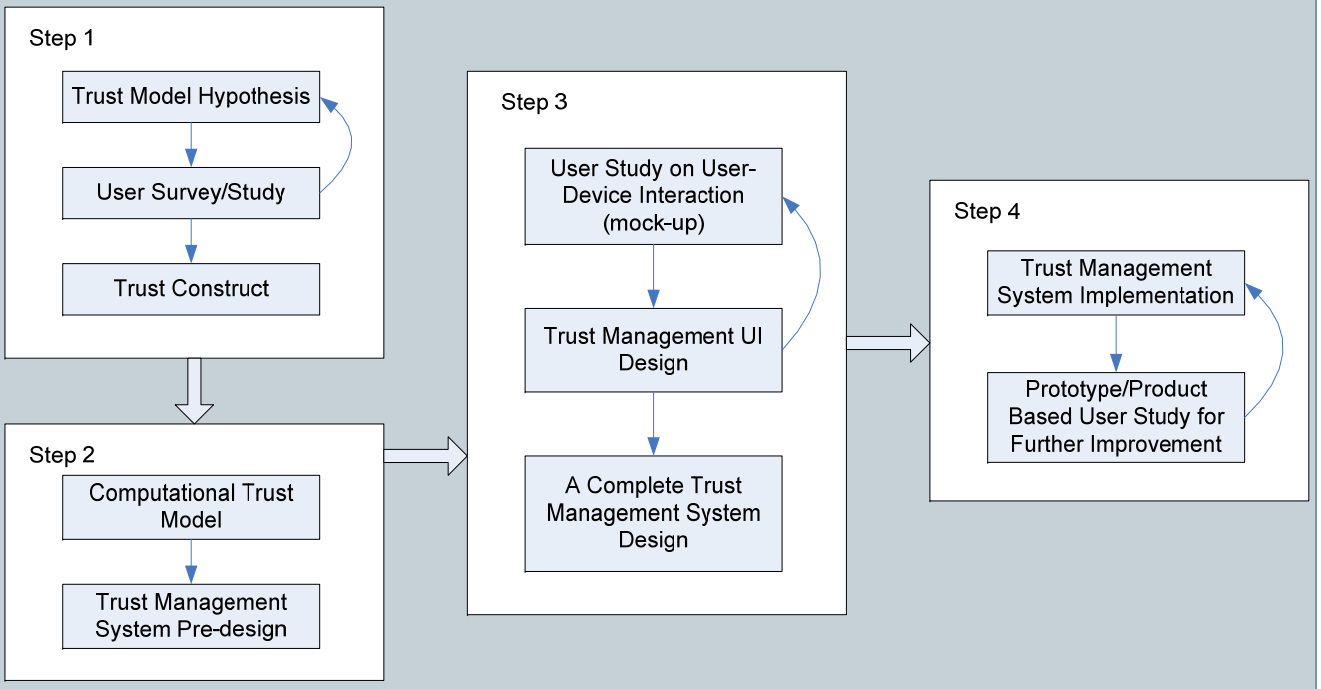
- Definition: evaluating, establishing, controlling, enhancing and ensuring trust -> automating the process
- Trust evaluation
  - Collecting the information required to make a trust relationship decision
  - Trust model: calculate a trust value by considering factors influencing trust
    - Trust modeling: a technical approach used to represent trust for the purpose of digital processing
    - Graphic, linguistic and mathematic
- Reputation system (help in decision making)
  - Public opinion of trust
  - Many proposals for on-line transactions and distributed systems
- 'Soft' and 'hard' solutions
  - Soft: evaluation based trust management -> lack root trust support
  - Hard: security enhanced trust management (trusted computing technology) -> lack intelligence
  - Integrated: Z. Yan, Security via trusted communications, book chapter in Handbook on Communications and Information Security, Springer, 2009.

A Methodology of User Driven Trust Modeling and Management

- Purpose:
  - Design and develop a usable trust management system that can be easily accepted by the users towards practical deployment
- User Driven
  - User study is applied in every step
  - A user-driven computational trust model play as the core of the trust management system
  - Additional user experimental studies will be further conducted in order to design a trustworthy human-device interaction required in the trust management system
- Reference:
  - Z. Yan, V. Niemi, A Methodology towards Usable Trust Management, ATC09, LNCS, Australia, 2009.

A Methodology of User Driven Trust Modeling and Management

- **Step 1:** figure out a trust construct for computational trust modeling.
- **Step 2:** work out a user driven trust model and the pre-design of trust management system.
- **Step 3:** conducts relevant user study about the pre-designed trust management system
- **Step 4:** conduct a prototype or a trial product implementation and do system improvement based on additional user feedback

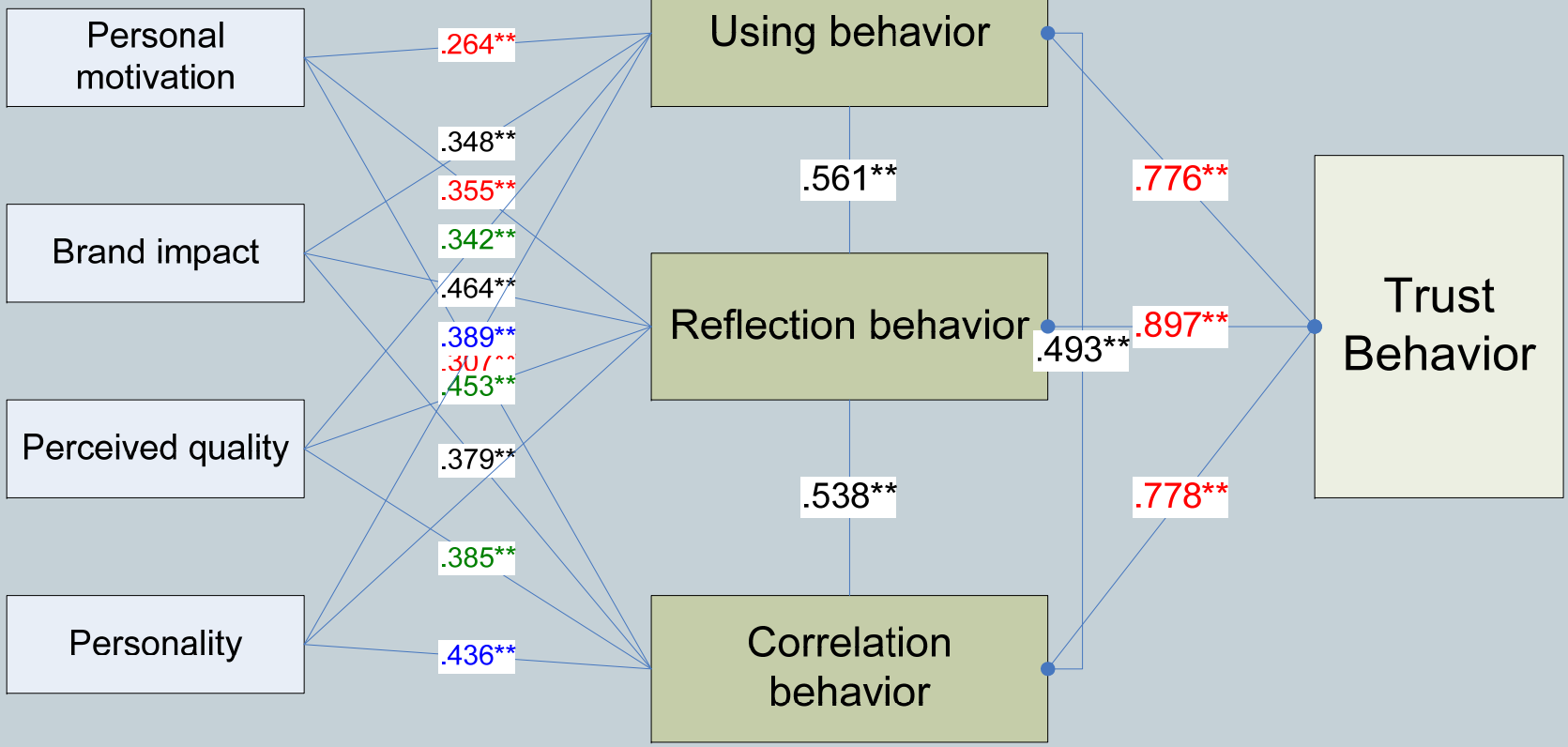


Step 1: trust behavior construct study

- Target: design and develop a common and usable reputation system for various mobile applications that could help the mobile users' purchase and usage -> a service
- Step 1: Trust construct analysis
  - Hypothesis: a user's trust in a mobile application can be reflected through his/her usage behaviour (theoretical support)
    - Support sound usability and autonomic trust evaluation
  - Design a questionnaire with seven-point Likert measurement scale to analyse the detailed construct of trust behaviors regarding mobile application usage
  - Two experiments conducted in China
    - Pre-experiment (N=318) -> Principal Component Analysis -> optimize the measure
    - Formal experiment (N=1120) -> Principal Component Analysis, Confirmatory Factor Analysis, Reliability Analysis and Correlation Analysis -> Trust behavior construct of mobile application usage
- Reference:

  - Z. Yan, V. Niemi, Y. Dong, & G.L. Yu. (2008). A user behavior based trust model for mobile applications. *Proceedings of Autonomic and Trusted Computing ATC08*, LNCS.
  - Z. Yan, Y. Dong, V. Niemi, G.L. Yu. Exploring Trust of Mobile Applications Based on User Behaviors: An Empirical Study, 2010 (submitted).

Trust behavior construct of mobile application usage



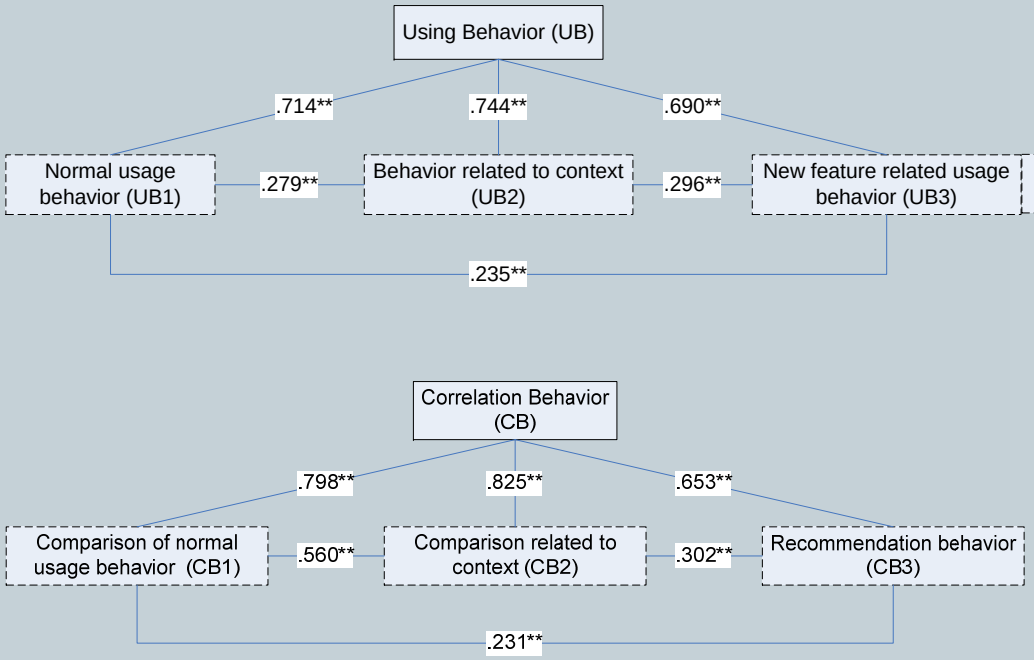
** Correlation is significant at the 0.01 level (2-tailed);

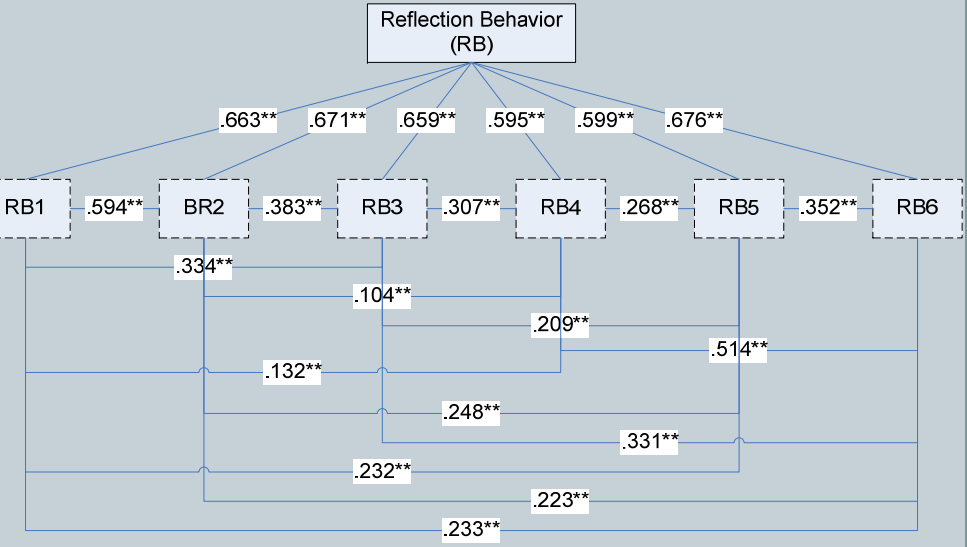
* Correlation is significant at the 0.05 level (2-tailed).

Reliability: Using behavior: alpha =0.71; Reflection behavior: alpha =0.85;

Correlation behavior: alpha=0.79; overall trust behavior: alpha=0.90

Internal relationships of three factors of trust behavior





** Correlation is significant at the 0.01 level (2-tailed);

* Correlation is significant at the 0.05 level (2-tailed).

RB1: bad performance reflection behavior;

RB2: bad performance reflection behavior related to context;

RB3: good performance reflection behavior;

RB4: good performance reflection behavior related to context;

RB5: bad experience reflection to context;

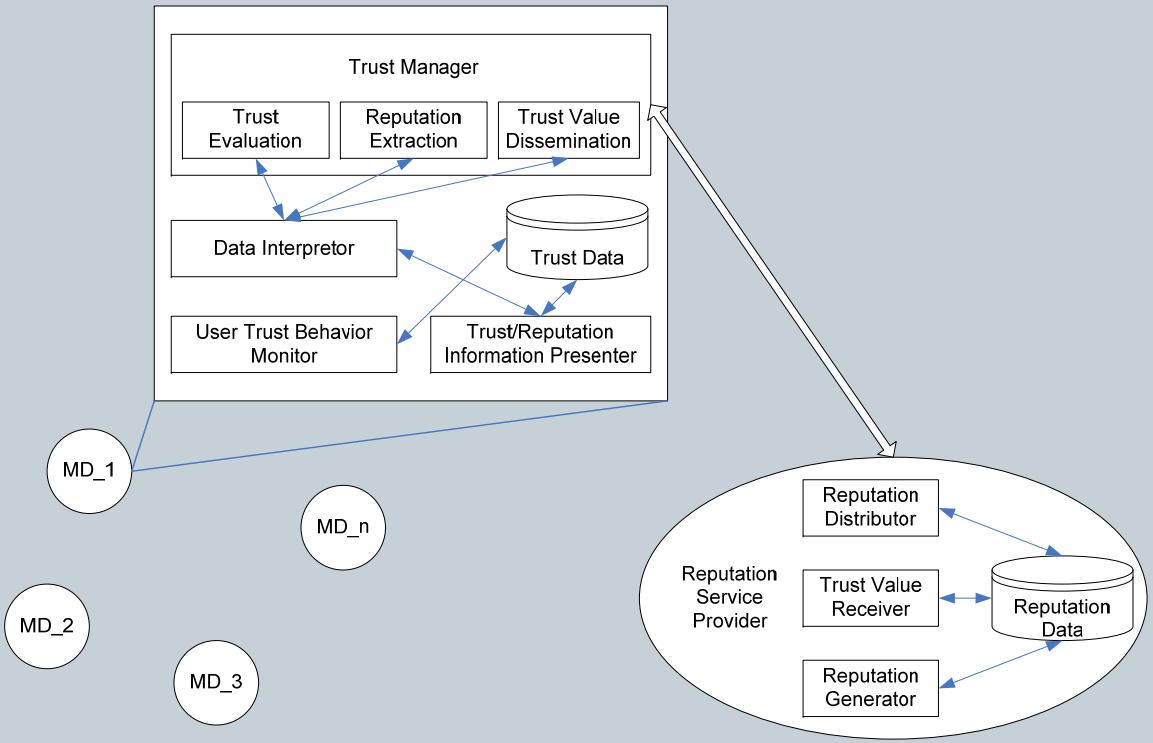
RB6: good experience reflection to context.

Step 2: Computational Trust Model and Trust Management Pre-Design

- Formalizing trust based on the achieved trust behavior construct
  - Reflect the principal factors related to trust behaviors and their causal relationships with a mathematical measure
  - Conduct laboratory simulations to optimize and improve the computational model

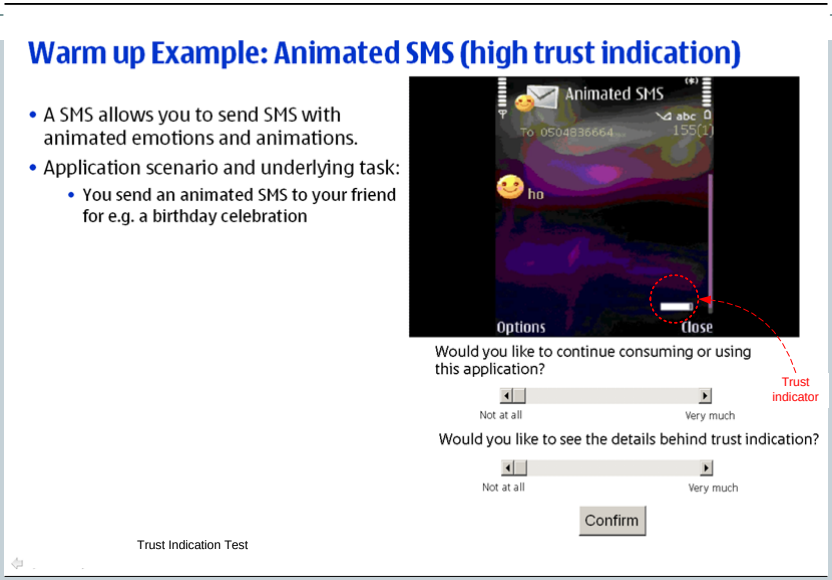
$$T(i) = T(i)_o + \alpha T(i)_{UB} + \beta T(i)_{RB} + \gamma T(i)_{CB}$$

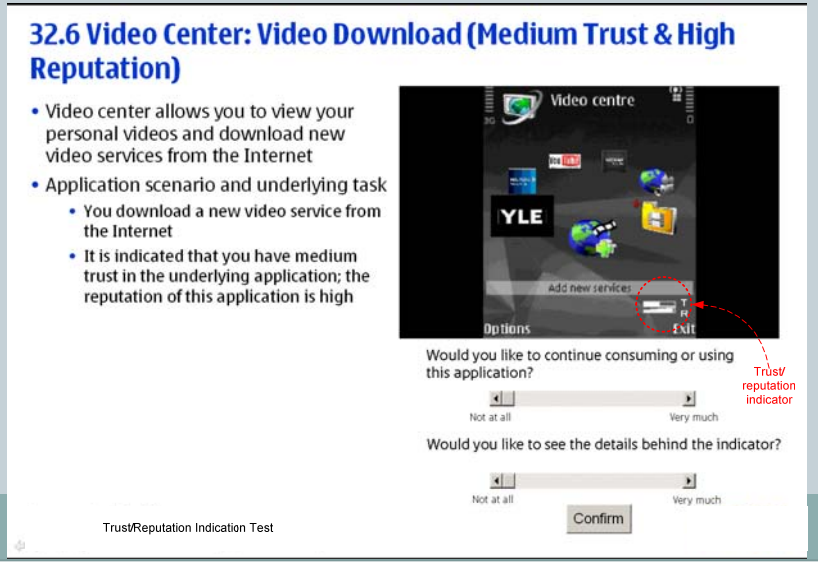
- Pre-design a reputation system for mobile applications
- Reference
  - Z. Yan, R. Yan, Formalizing Trust Based on Usage Behaviors for Mobile Applications, ATC09, LNCS, Australia, 2009.



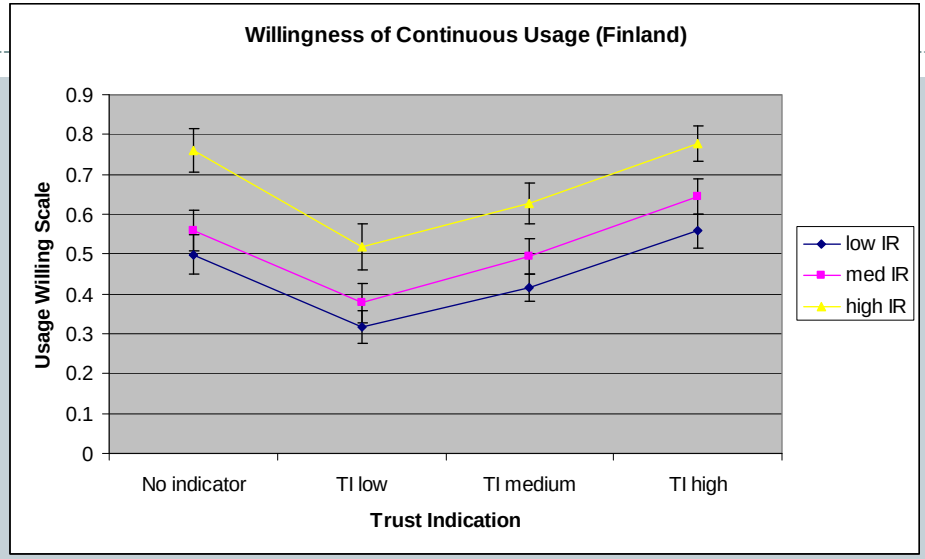
Step 3: User study on pre-designed trust management system

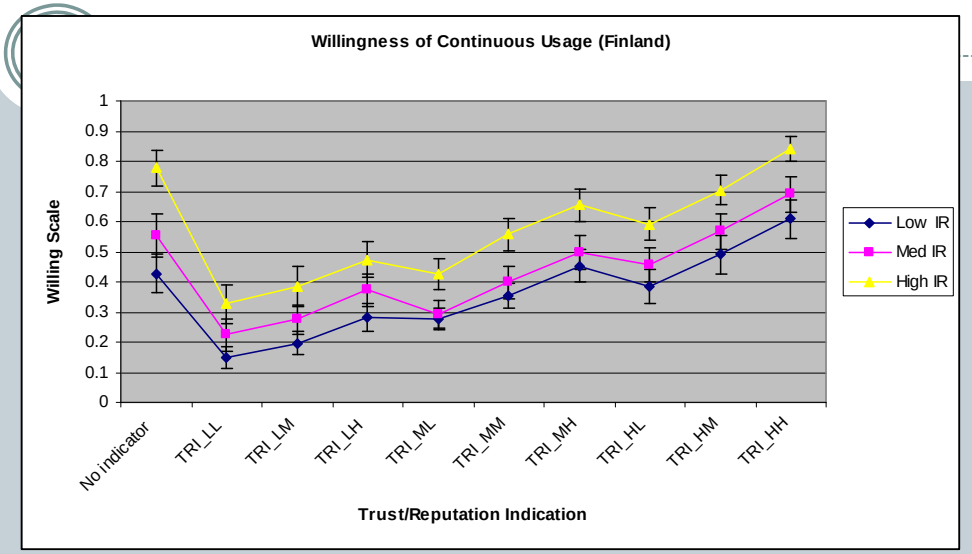
- User study for user-device interaction in the pre-designed system
  - Study why, how, what and when to show the trust/reputation information
  - Finish user-device interaction design and a complete system design
- Experiments in both China and Finland
  - Effects of displaying trust information on mobile application usage
  - Mockup based user study + interview
  - About 180 participants
  - Results (based on paired samples t tests and analysis of variance)
    - **Statistical significance to indicate the trust value or the trust/reputation values** of a mobile application during its usage in both countries.
- Reference
  - Z. Yan, C. Liu, V. Niemi, G.L. Yu, Effects of Displaying Trust Information on Mobile Application Usage, ATC'10, 2010.

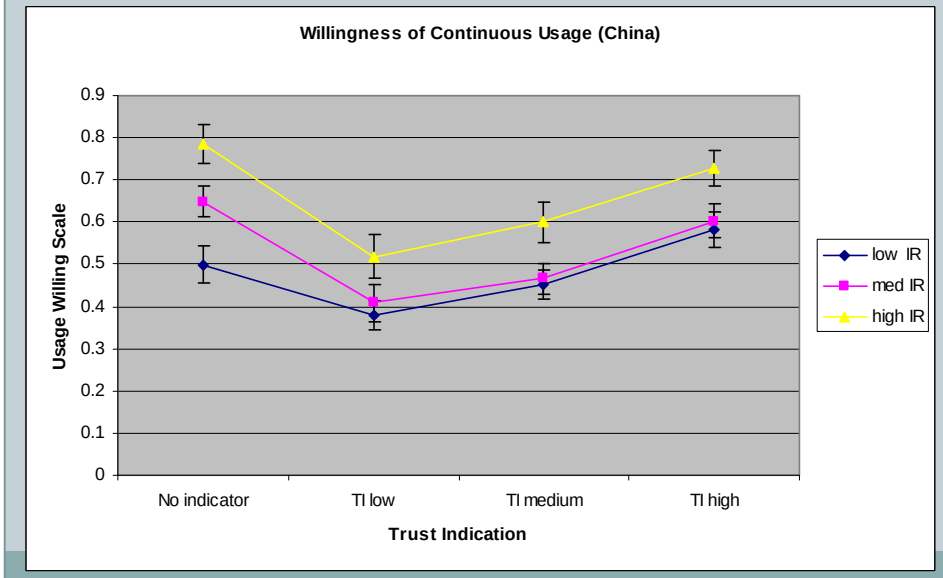


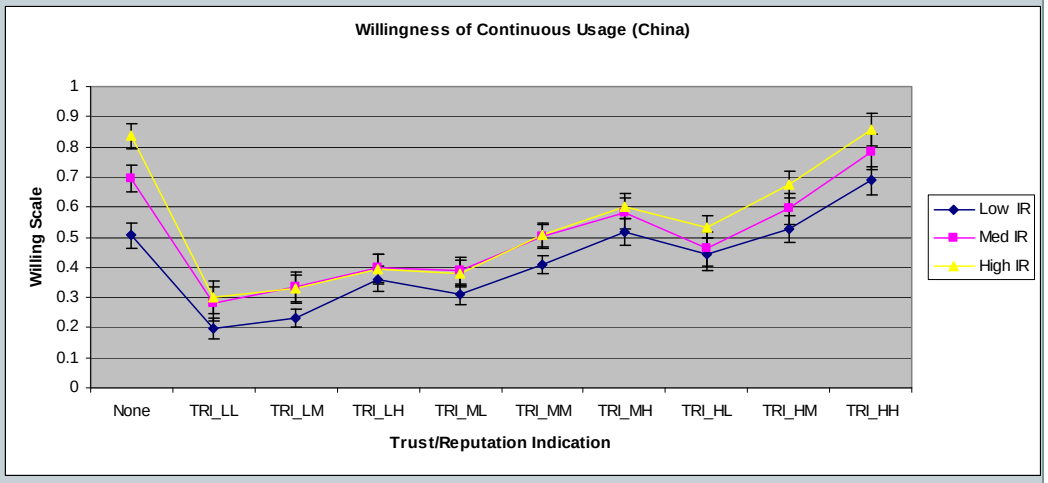


Usage willingness with/without trust information









Step 4: Prototype based user study for further improvement

- Design guidelines
  - Personalized trust information notification
    - Control when and how to display the indicator.
    - Applying transparent indicator to improve the application's usability.
  - Essential technologies
    - People welcome displaying trust/reputation information about mobile applications (based on personal usage information and public usage information)
    - Privacy concern: anonymous and flexible control of usage information sharing
  - UI design of the trust indicator and the trust/reputation indicator
    - Suggestions on detailed trust information access and display.
  - Business model: encourage usage information sharing
- System implementation
- Trail based user study for further improvement

Conclusion and Future Work

- Conclusions
  - Motivated the crucial needs for developing a usable trust management solution for mobile applications
  - Proposed a cross-disciplinary methodology called user driven trust modeling and management to design and development a usable trust management system
  - Applied it into the design and development of a reputation system for mobile applications
- Future work
  - A recommender system based on trust behavior model
  - Additional user study based on real usage experiences
- Current focus: unwanted traffic control via trust management

Thank You!

QUESTIONS AND COMMENTS