Scoring Technology to Guarantee the Reliability of People in a Connected World

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In recent years, business and lifestyles have been undergoing significant changes with the progress of networks and ICT. Fundraising and information provision, conventionally difficult for individuals, have become easier with the use of affiliate marketing, crowdfunding, websites, social media, and so on. In addition, the emergence of the sharing economy has made various services available at low cost. As this trend becomes more widespread, however, problems between the people involved in transactions and communication on the Internet are emerging. In response to this issue, Fujitsu Laboratories has developed an ICT risk assessment technology for quantifying users' ICT risks based on the psychological and behavioral characteristics observed in people who have experienced harm from cyber attacks, as well as a reliability scoring technology for expanding the scope of application of this assessment technology to various other risks besides ICT risks. These technologies allow for the scoring of a variety of risks, including delays and inadequate service provision even for people with whom transactions are conducted for the first time. The scores obtained in this way can be utilized to develop and implement measures aimed at preventing problems. This paper describes these ICT risk assessment and reliability scoring technologies as well as examples of their application.

1. Introduction

In recent years, advances in networks and ICT have resulted in significant changes making it easier for individuals to conduct business activities and avail themselves of heretofore prohibitively expensive services at low cost. While this facilitates transactions between individuals and between individuals and companies, a hindering factor is the difficulty of judging the reliability of unseen parties. Social psychology experiments have shown that the number of transactions done with parties who cannot be met in person is lower than that with parties who can.[1)] Insufficient information to determine whether the other party can be trusted not only lowers the number of transactions but also introduces the risk of fraud. Thus trust is an important factor for transactions among people.

To promote transactions between individuals and transaction between individuals and enterprises on the Internet, technology that can confirm the reliability of an unspecified large number of partners is required. To solve this problem, Fujitsu Laboratories has developed reliability scoring technology that can be applied to other fields by extending our ICT risk assessment technology. This technology enables one to know in advance the risks associated with parties who cannot be met in person, making possible risk management such as the implementation of precautionary measures to prevent risky transactions and limit unfair or unlawful acts by the other party.

This paper first introduces the ICT risk assessment technology that Fujitsu Laboratories has been doing research on. Next, it introduces the reliability scoring technology that Fujitsu has developed based on that ICT risk assessment technology. Further, as an example of a possible application of this technology, this paper introduces the example of a user arrears risk assessment for personal loans, goods rental services, or the like.

2. Developed technologies

Fujitsu Laboratories conducts research on the quantification of various risks. Among the various technologies that Fujitsu Laboratories is developing, this

section outlines Fujitsu Laboratories' ICT risk assessment technology and the reliability scoring technology that allows the application of the former to other fields.

2.1 ICT risk assessment technology

Figure 1 shows the ICT risk assessment technology framework. This technology quantifies the user's ICT risks and determines whether or not the user should be alerted, based on correlation analysis of psychological and behavioral trends and PC operation logs that are typical of people who are prone to harm from cyber attacks, such as damage from virus infections and email fraud.[2] The two elemental technologies that make up this technology are described below.

The first elemental technology (hereafter, elemental technology 1) generates a body of question topics designed to quantify ICT risks from questionnaires that ask about harm suffered from cyber attacks, their everyday psychology, and how to perceive and act on events. This body of question topics is generated by dividing the questionnaire response data into data from people with little experience in cyber attacks and data from people with extensive experience in cyber attacks, and conducting comparative analysis.

The second elemental technology (hereafter, elemental technology 2) generates formulas for calculating ICT risks by analyzing the correlation between this body of question topics and PC operation logs. This technology makes it possible to determine ICT risks using only PC operation logs.

Advantages of ICT risk assessment technology include the fact that ICT risks are quantified from a psychological point of view, and the fact that through the use of PC operation logs, it is now possible to identify risks that change daily due for example to changes in the workload or physical condition of workers.

Table 1 shows an example of the relationship between ICT risks obtained from ICT risk assessment technology, psychological characteristics, and behavioral characteristics related to PC operation. In this table, users who prioritize benefits over risks tend to exhibit the behavioral characteristic of spending only a short time reading Terms of Use are particularly at risk from virus infections.

2.2 Reliability scoring technology

The disadvantage of ICT risk assessment technology is that it can only be used for ICT risk assessment. Among that technology, however, the algorithms used in elemental technology 1 can be applied also to the quantification of other types of risk. Other applications include reliability scoring technology. Reliability scoring

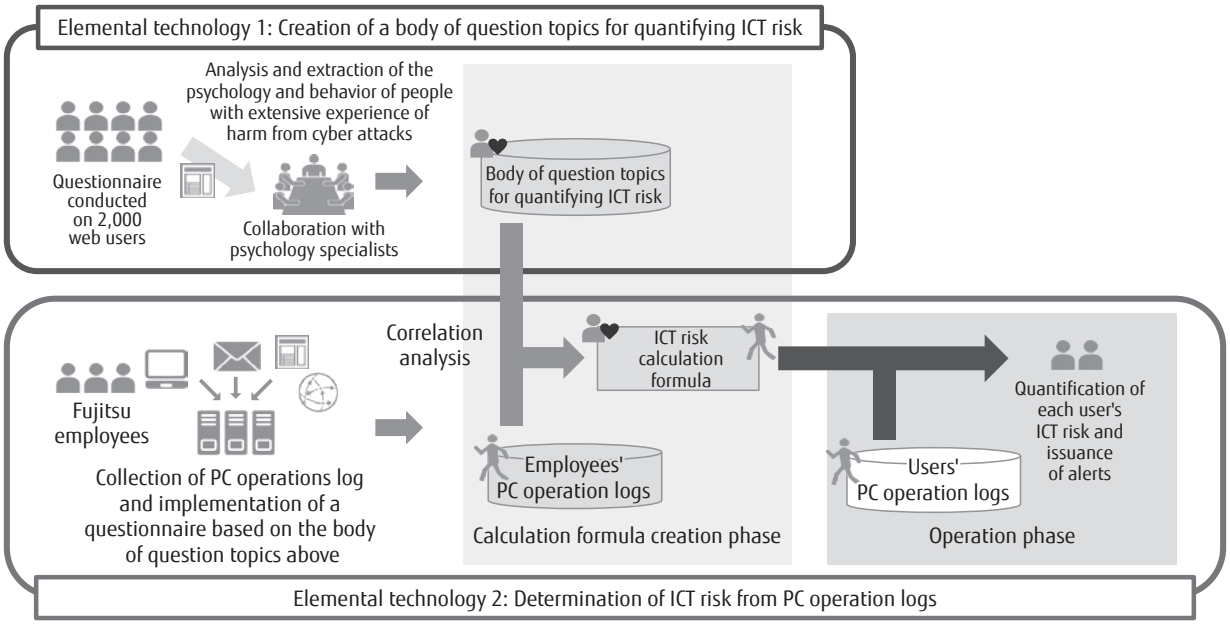

Figure 1
ICT risk assessment technology framework.

Table 1
Examples of relationship between psychological characteristics, behavioral characteristics related to personal computer operation, and ICT risk.

Psychological characteristics of user	Behavioral characteristics related to personal computer operation	ICT risk
Prioritizes benefits over risks.	Spends only a short time reading the Terms of Service for apps and services.	Virus infection
Dislikes changes in status quo.	Spends little time to check whether the address etc. is correct before sending emails.	Information leakage (due to erroneous email addressing or incorrect app authorization settings)
Feels security measures to be a burden.	Often forgets to attach a file or enter something in the Subject field.	Damage from virus infections and information leakage due for example to erroneous email addressing

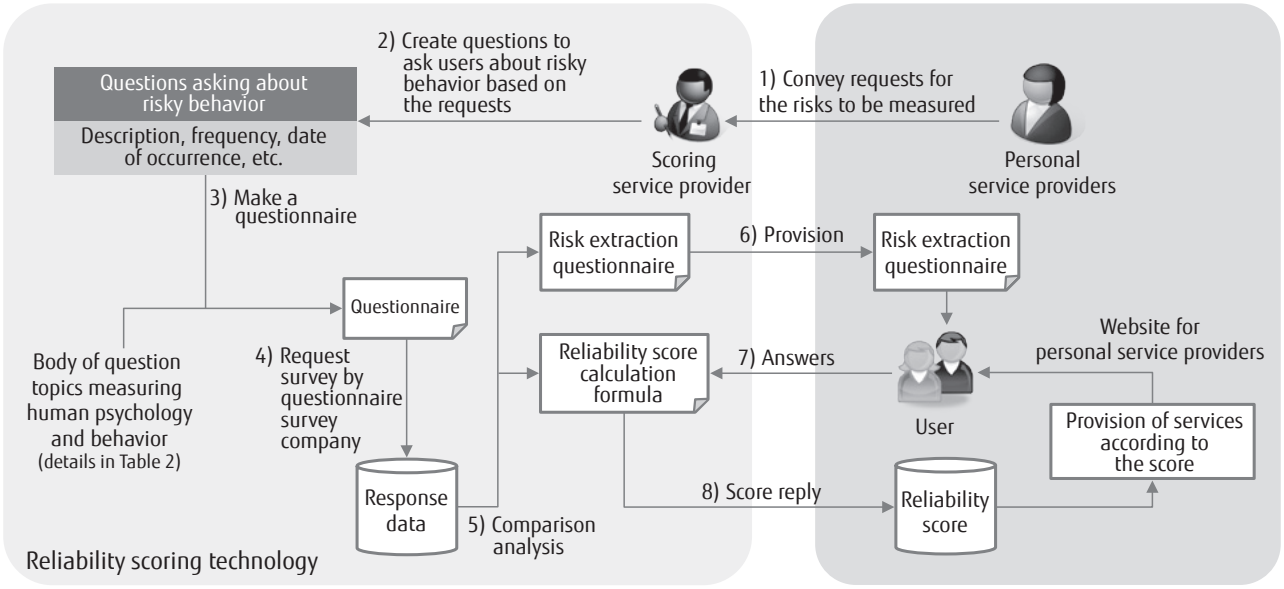

Figure 2
Overview of reliability scoring technology.

technology is technology that uses data on the psychological and behavioral characteristics of users who conduct transactions to determine whether or not they are trustworthy and will engage in wrongful acts such as fraud. The application of the algorithms used in elemental technology 1 to reliability scoring technology makes it possible to handle various kinds of risk.

Figure 2 shows an overview of reliability scoring technology. Users of this technology include personal service providers and scoring service providers. Personal service providers are intermediaries for interpersonal transactions related to specific services such as the rental of goods and equipment and the provision of skills and labor. Scoring service providers offer counter services that involve handling customers through the use of reliability scoring technology.

First, the personal service provider tells the scoring service provider about its specific needs with regard to the risks to be measured, which include non-performance, breach of privacy, damage to other parties' property, etc. The scoring service provider uses the reliability scoring technology to quantify the risk potential of each user registered to use the personal service as a score based on the needs specified by the personal service provider and hands over this score to the personal service provider. Based on the score, the personal service provider is then able to adjust the content of the service to be provided to the user and establish risk-reduction measures.

How to quantify a user's score using the reliability

Table 2
Example of a body of question topics designed to measure human psychology and behavior.

Human psychological and behavioral characteristics	Questions that measure the degree of strength (such as psychometric scales and numerical inputs)
Poor organization skills	Tendency to hoard
Forgetful	Daily deviation scale
Tendency to follow rules	Annoyance recognition scale
Ability to raise questions without hesitation	Assertiveness scale
Ability to overlook foibles in others	Acceptance of others scale
Show-offness	Ratio of debt to income, etc.
⋮	⋮

scoring technology is shown in the left half of Figure 2. First, the scoring service provider formulates questions to find out about the user's experience relating to the risk(s) that the personal service provider is concerned about. These questions are combined with the body of question topics for assessing human psychology and behavior that has been built up through previous surveys to create a questionnaire. An example of a body of question topics is given in **Table 2**. This body of question topics includes question topics designed to quantify the strength of each psychological or behavioral feature. Among these question topics, a psychometric scale consisting of several questions is used as one of the methods for measuring psychological phenomena. The answers to these questions can be selected from multiple options, such as a five-step evaluation. Examples of numerical inputs are the number of traffic violations and the frequency of late arrivals.

Next, the scoring service provider uses a questionnaire survey company to conduct a survey consisting of these question topics. The reason for using a questionnaire survey company here is that even if a user who is currently using or intends to use the service in question is asked to answer questions, he or she is unlikely to give candid answers about past violations with regard to the service in question or other services. Therefore, the survey is conducted on registered monitors of the questionnaire survey company. However, the survey is conducted on monitors who have used services related to the risks that the personal service provider wants to measure.

The response data obtained in this survey is divided into data from the group of users who have engaged in little behavior relating to the risks and the group of users who have extensively engaged in such behavior. By performing statistical comparison analysis of the two sets of data obtained in this way, question topics to ask about psychology and behavior that are characteristic of people likely to engage in risky behavior are selected. As a result, a risk extraction questionnaire consisting only of features highly correlated with risk is created. In addition, a reliability score calculation formula is created by defining a weighting scheme corresponding to the response value of the risk extraction questionnaire for the risk impact for each question topic obtained by the above-mentioned comparative analysis. Based on this calculation formula and the response data to the risk extraction questionnaire, a reliability score representing the possibility of the user performing risky acts is calculated and fed back to the personal service provider. The personal service providers offer services on their websites based on user scores.

This technology makes it possible to evaluate in advance the possibility of future risky acts even for new users who do not have a transaction record for the services offered by the personal service provider. Further, it makes it possible to evaluate the possibility of future risky behavior by existing users, regardless of whether or not they have a history of risky behavior, by making them respond to a questionnaire in the same way as new users.

3. Application example of reliability scoring technology

This section gives an example, assuming the application of our reliability scoring technology, and the scope of application of said technology.

3.1 Assumed application example

Specific application examples of our reliability

scoring technology would be the quantification of the reliability score of users of personal loans or goods rental services.

The personal service provider requests the scoring service provider to evaluate users' arrears/delinquency risk. The scoring service provider prepares questions designed to find out whether users have ever been in arrears/delinquency, how many times, and when. These questions are combined with the body of question topics in Table 2 to produce a questionnaire to be administered by the questionnaire survey company. Furthermore, a risk extraction questionnaire (**Figure 3**) and a reliability score calculation formula are created from the obtained response data.

The created risk extraction questionnaire is provided to the personal service provider, and users are made to take the questionnaire at times such as user registration. From the response data, the arrears/delinquency risk score is calculated. The personal service provider can then use the score to improve service, for example by offering interest rate discounts and higher maximum loan limits.

3.2 Assumed scope of application

The assumed scope of application of the reliability scoring technology is not limited to financing and rental services described in the previous subsection.

Another example is risk assessment of trouble between people. The use of nursing care services and housekeeping services is increasing as society ages and dual-income households become more common. However, troubles can occur between helpers and the users of their services. Examples of troubles that may arise are incorrect change from shopping by helpers, abusive willful ignoring of helpers, and shoddy service on the part of helpers. By using the scores quantified by this technology, proactive actions such as dispatching skilled helpers to new, high-risk users, and communication in advance of preventive measures to the dispatched helpers by management can be taken. For inexperienced helpers, guidance and follow-up can be provided according to their scores.

Similarly, this technology is also applicable to sharing services and crowdfunding. By assessing the risk of unfair transactions involving for example damage to goods or equipment and stealing of money, and restricting transaction content according to the score, legitimate transactions can be encouraged. Furthermore, in recent years, so-called "flaming" has become a major problem due to inappropriate postings on social media. A growing number of companies suffer severe damage from inappropriate postings by part-time workers and employees. Our reliability scoring technology can be used for employee risk assessment and education to prevent postings that start flame wars, thereby avoiding reputational damage to corporations.

4. Conclusion

This paper described the ICT risk assessment technology that Fujitsu Laboratories has been conducting

Risk extraction questionnaire

Question intention *1	Question example *2	Answer choices
Measure the lack of organization	I am unable to get rid of belongings even if I am unlikely to use them	1) Not at all applicable ⋮ 5) Extremely applicable
Measure the degree of forgetfulness	Sometimes I feel as if my personal affairs were those of other people	1) Not at all applicable ⋮ 5) Extremely applicable
Measure the degree of show-offness	Ratio of debt to income	XX (unit: %, enter numerical value)

*1: Not displayed in this questionnaire
*2: Actually ask multiple questions regarding each intention in the left column

Figure 3
Example of arrears/delinquency risk extraction questionnaire.

research on so far, and the reliability scoring technology that allows application of that technology to other fields. Further, reliability assessment of users of personal loans and goods rental services was introduced as an assumed application example.

Going forward, we will identify question topics that have stronger relevance to risk through surveys that expand the scope of the body of question topics. The burden on users will be reduced by decreasing the number of questions in the risk extraction questionnaire. Furthermore, the accuracy of the reliability score will be improved by conducting a follow-up survey of the users whose reliability score was calculated.

Of the above-described research, ICT risk assessment technology is the result of "Research and Development for the Analysis and Detection of Cyber Attacks," a research project commissioned by the Ministry of Internal Affairs and Communications that was conducted from FY 2013 to FY 2015.

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