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Quantitative versus Qualitative Approaches to Tacit Knowledge Testing

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ABSTRACT

Research in knowledge management covering tacit knowledge tends to be descriptive and often makes little use of empiricism. Psychology as another discipline is very empirical and tends to use statistics to process quantitative data. There are alternative approaches to interpreting data that do not rely on reductionist approaches along numerical lines. We do not negate statistics; rather we provide an alternative to statistical processing of empirical tacit knowledge data. Using empirical data, we show how graphical, qualitative data analysis was used to interpret lower level patterns in the data on tacit knowledge enabling more meaningful quantitative data analysis

INTRODUCTION

Tacit knowledge is a form of knowledge that is typically not written or taught directly. It is possible to split this knowledge into two types being that of articulable and inarticulable tacit knowledge. The former are the street smarts, shop skills or trade secrets, which can be passed on. Strictly speaking this is not really tacit knowledge. The latter is a truly tacit form of knowledge that requires deeply embedded personal use of sense and meaning for us as individuals to understand and make use of the knowledge. In this paper we limit ourselves to talking about the former type. What is presented here is not simply a presentation of tacit knowledge, but rather a discussion of the means of testing and more importantly analysing such knowledge. The work offered here is based on sample data acquired by questionnaire through three Information Technology (IT) firms.

The goal of the paper is to show an alternative to the use of descriptive statistics for data analysis. In our study we had small sample sizes that were not appropriate for the kind of quantitative analysis needing large sample sizes. We have thus used a qualitative and graphical approach to analyse the data, known as formal concept analysis (FCA) (Ganter and Wille 1999). Specifically we were interested in identifying individuals who responded similarly to peer-identified experts so that the organisation would be alerted to the potential value of these "quiet achievers".

THE TACIT KNOWLEDGE INVENTORY

There have been a number of approaches to measuring tacit knowledge. The most validated approach is the use of workplace scenarios and answer options along the lines of a Sternberg *et al.* (2001) psychological testing instrument. While most of the work of Sternberg and his associates has been in the psychology and management areas, we were interested in the IT domain. Our work, thus, is applying and testing the approach to a new domain and has resulted in the development of an IT tacit knowledge inventory. Another differentiating feature is that we do not have: a) random respondents, b) large sample populations or c) captive participants. Thus for data modelling we chose to use Formal Concept Analysis with its lattice-based means of representing data. In addition to measuring tacit knowledge, we mapped knowledge flows between the individuals using social network analysis (SNA) (Scott 1991), though this is not discussed in this paper.

In order to obtain a sample data set, empirical research was conducted in three IT organisations. In each organisation, we measured the extent to which a person could be said to possess tacit knowledge using our own inventory of IT workplace scenarios and answer options along the lines of an instrument. We stress the makeup of the organisations are not the central theme here, rather the possibilities for data processing of tacit knowledge, beyond the use of just statistics. For readers interested in further details of the case studies, our research goals, methodology and findings are provided in Busch and Richards (2003). Very *briefly*, the tacit knowledge inventory was composed of 16 IT workplace scenarios with relevant answer options for each given scenario. In total there were 126 answer items for all 16 scenarios together. The number of answer items varied from as few as 6 answers (Scenarios 5, 9, 13) up to 12 answers (Scenario 3). Figure 1 shows the text for scenario 10 with answer option 2. Respondents used a 7-point Likert scale to select an ethical (*what should you*) and a realistic (*what would you do*) answer for each answer option, for each randomly assigned scenario. Behind each of the Likert Scales were numerical values, where Extremely Bad was represented with a numerical value of 1, through to Extremely Good with a value of 7. In addition to this, respondents were asked to identify peers they felt were 'proficient' in their work related tasks. The proficient personnel became the 'expert' sample whose results would be compared to the results of others.

QUANTITATIVE DATA ANALYSIS

As Likert scale data is ordinal, descriptive statistics were able to provide an indication of: (1) whether experts in general were answering the tacit

Figure 1: Illustrating sample scenario 10, answer option 2 and 7-point Likert scale used in the online tacit knowledge inventory.

Scenario 10

There are a number of ways of looking at system success.

One view is that the system is unsuccessful from an implementation point of view, in other words the system specifications are drawn up, software is then compiled, technical documents are created, but everything ends up 'sitting on the shelf'. Such a system may nevertheless prove successful from a financial point of view insofar as a profit was made by your contracting firm to supply the software, manuals and so forth to a client firm.

Another 'view' of success is a system that runs well but ended up being overbudget.

Yet another way of looking at system success is a system that *does* actually get implemented and was also financially profitable for your business to implement. In other words it was successful as far as you and your firm were concerned as well as being successful as far as the client firm was concerned.

Rate each of the following responses in relation to the given scenario. It is advisable to read all of the responses before replying.

2. As long as the clients (and particularly their end users) are happy with what your group delivered, regardless of what you think of the system, the client's happiness is basically all that really counts

ETHICAL	Choose one	☐	☐	☐	☐	☐	☐	☐
		Extremely Bad		Neither Good nor Bad		Extremely Good		
REALISTIC	Choose one	☐	☐	☐	☐	☐	☐	☐
		Extremely Bad		Neither Good nor Bad		Extremely Good		

knowledge inventories differently from novices; (2) which particular scenarios and answer options were being answered differently by experts; (3) which scenarios and answer options showing the greatest degree of variation between how experts differed in terms of their ethical and realistic answers as compared to novices; and (4) which individuals who were not actually identified by their peers as being experts, ended up having answers (ethically and realistically) close to that of experts. The descriptive statistics produced for all questionnaire results included: Mean, Median, Standard Deviation, Minimum and Maximum values (1 to 7 in the case of the Likert scale), Count (of the number of respondents who had answered the scenario/answer combination) and Confidence Level (95%). This process was repeated for each Organisation’s data. Tables 1a and 1b show the results for scenario 10, answer option 2.

The descriptive statistics shown in table(s) 1 illustrate several things. Firstly the control (or novice) group’s statistics are provided on the left hand side, with the expert’s statistics are on the right. Starting with the count given towards the bottom of each table, we see that 15 novices answered this question dealing with this scenario, whereas 9 experts did so. These figures represent those from one of the three organisations who answered this section of the inventory. We see that the Means were 5.7 (ethical) and 5.2 (realistic) for novices, but 3.7 (ethical) and 4.6 (realistic) for the experts. In other words the experts were inclined to be more negative ethically and more noncommittal realistically when dealing with this answer, than the novices who considered the option to be good on the whole. Examining the median values we also note that the experts tended to be negative (3.0 or Bad) ethically but positive (5.0 or Good) realistically. The novices did not vary so much in their ethical or realistic responses which were 6.0 (Very Good) and 5.0 (Good), respectively. This sample shows a clear difference between the two groups. This is not the case for all scenarios and answer options. Also, the trends in this scenario could have been completely different for alternative options and scenario combinations. In general, the experts were more reserved in their responses. More substantial statistical testing took place in the form of a Wilcoxon test.

THE WILCOXON MATCHED PAIRS SIGNED RANK TEST

The statistics that had been completed up until now were simplistic and descriptive, and furthermore were conducted on small a small sample

Table 1: A sample of descriptive statistics from Scenario 10, answer 2 (Tables 1a and 1b) and Wilcoxon test results where the expert sample has been compared with the control population

Scenario 10 - 2nd Question			Scenario 10 - 2nd Question		
	Ethical	Realistic		Ethical	Realistic
Mean	5.7	5.2	Mean	3.7	4.6
Standard Error	0.3	0.3	Standard Error	0.7	0.7
Median	6.0	5.0	Median	3.0	5.0
Standard Deviation	1.2	1.3	Standard Deviation	2.2	2.1
Minimum	3.0	2.0	Minimum	1.0	1.0
Maximum	7.0	7.0	Maximum	7.0	7.0
Count	15.0	15.0	Count	9.0	9.0
Largest(7)	6.0	6.0	Largest(7)	2.0	3.0
Smallest(1)	3.0	2.0	Smallest(1)	1.0	1.0
Confidence Level (95.0%)	0.7	0.7	Confidence Level (95.0%)	1.7	1.6

Table 1a: Novices

Table 1b: Experts

All three organisations combined.
Null hypothesis: declares there is no difference in the scores (Likert scale 1-7) between experts and novices.
Statistical significance: z = -1.1
Answer: We cannot reject the null hypothesis
Just organisation X (the largest of our organisations)
Null hypothesis: declares there is no difference in the scores (Likert scale 1-7) between experts and others.
Statistical significance: z = 1.4.
Answer: We cannot reject the null hypothesis.

1c: Wilcoxon test results

size. The Wilcoxon nonparametric statistical test (Siegel 1956) permits a one tailed test of statistical significance on data to determine whether in fact statistically, experts and novices were answering the scenario questions in different ways. At the same time the intention of this research was also to identify other individuals who attained results similar to that of experts but were not necessarily recognised by their peers as such. This group we label ‘expert non-experts’. Alternatively the term acronym ENE will be utilised from time to time. For the readers information we may like to think of these expert non-experts as expert-novices. That is to say people not formally identified by their peers as experts, nevertheless their test results indicate they were similar in their answers to that of experts.

With regard to undertaking a test between experts (as the respondents were so identified as part of the questionnaire process) and novices, the following results were achieved (using the medians). A number of tests were conducted. First for all the organisational data combined (as this was recommended by the Statistics Department at our University, given that the tacit knowledge inventory was the same for all three IT organisations, and that combining the results would increase the sample size). Second a test just for the largest of our organisations (Organisation X), which of any of the organisations would have had the largest statistically significant data set. And third (and the main purpose of the test), to see if there was any difference between the scores of experts and novices. We see the results of this in table 1c. Note that were unable to find a statistically significant difference, insofar as the null hypothesis has been rejected. We will reconsider these results again later.

THE USE OF FORMAL CONCEPT ANALYSIS

The adoption of Formal Concept Analysis has occurred for a number of key reasons. First of all there was a desire to model the tacit knowledge inventory results (elicited by way of a questionnaire) in a visual environment, which would permit finer interpretive granularity. Second it was expected that the sample sizes would be too small to permit effective quantitative interpretation of the datasets along traditional Sternberg/psychology lines. Third the graphical Formal Concept Analysis (lattice theory) based approach has allowed us to uncover a group of individuals who behaved similarly to their peer-identified experts thus becoming known in this research as ‘expert non-experts’ (previously mentioned). Through a worked example, let us now examine this alternative or rather complementary means of interpreting the questionnaire data.

The main research instrument involved acquiring responses to workplace scenarios via an online survey questionnaire using a 7-point Likert scales as shown in Figure 1. Apart from a slightly similar method by Kollwe (1989), no evidence has been found for the use of FCA in processing survey questionnaire data. If we convert the Likert scale into a crosstable (figure 2a), similar to the approach used by Spangenberg and Wolff (1988), we see how the data presented in the rows represents the Likert value given in the diagram above. For example we note ([A24]=”1”) corresponds to a Structured Query Language (SQL) statement whereby A24 represents the column in the database table, and 1 equates to the value ‘Extremely Bad’ (remembering 1 referred to Extremely Bad through to 7 relating to Extremely Good). In creating and examining each formal concept lattice for each answer option for each scenario, we are slowly able to build up a picture for how novices have answered relative to that of experts. Figure 2b shows the data that has been taken from the crosstable (table 2a) and converted into a lattice. When the data from the questionnaire database is introduced into the lattice we begin to see how respondents have answered a single question and answer in the questionnaire.

The data visualisation can become even more sophisticated when using FCA. For example, in figure 3 we have used nested lattices to visualise both the ethical (outer ellipse) and realistic (inner ellipse) responses. The swing from bad to good noted in tables 1a and 1b can be seen here in greater number of experts on the negative side for the outer lattice and a greater number of experts on the positive (right hand) side in the inner lattices, as identified by the solid black dots. While the lattice does

the expert sample. In doing so we provide an example to organisations where they may wish to identify, in this case tacit knowledge savvy individuals, who may not have been so identified by their peers.

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