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Gender Variations in a Structural Model of the Information Systems Professional

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Abstract

This paper presents a two level factor model describing gender differences in perceptions of the relative contribution and importance of education and skills required of new information systems (IS) professionals. Model development took account of technical skills found in most IS programs, other business oriented academic studies, and soft skills sought by employers in new graduates. The model also includes features of the working environment which influence the career progress of IS graduates. The model suggests the presence of contrasting, gender-based quantitative views of the relative importance of the respective variables to the education and professional development of IS professionals.

Keywords: Information Systems, IS professional, IS graduates, technical skills, soft skills, hard skills, structural model

Introduction

The preparation, quality, and expectations of new information systems (IS) graduates continues to be the focus of many discussions, conferences, workshops, and publications by IS practitioners, employers, students, and academics.

Employers and experienced practitioners are often critical of a lack of practical experience or unrealistic views and expectations perceived to be held by some new graduates. Students and new graduates necessarily lack experience, yet they sometimes seem to expect to begin their professional careers in senior positions. Academics continually revise curricula to accommodate change and growth in the body of knowledge and the skills that they believe are needed by students preparing for entry into professional IS roles.

Previous studies

Numerous studies of the skill requirements of IS graduates, including soft skills, hard skills, and job features that help motivate IS professionals are available. (Van Slyke, Kittner *et al*, 1997; Young (1996).

Some compare various stakeholders such as academics and industry, or focus on student perceptions. In the main, these studies are descriptive in nature covering curriculum emphasis or rating of skills in order of importance. (Williams, 1998; Wong, 1996; Orr, 2000; Lee & Koh, 2002; Goles, 2001; Farwell, Lee *et al*, 1993, 1995).

Interpersonal skills and technical skills are recognised as possessing equal importance for IS professionals. (Young & Keen, 1997) IS students must develop "soft" skills and abilities in various areas including teamwork, creativity, and communication.

Determining those skills employers of new IS graduates seek is important for educators in designing curricula and advising students. Van Slyke (1997) found that specific technical skills were less important than basic technical skills and non-academic skills.

Doke and Williams (1999), in a study across various IS job classifications, found that systems development skills and interpersonal skills were common across classifications but programming skills were more important for entry level IS positions.

Core curriculum requirements have been set in association with professional bodies in Australia (Underwood, 1997) and the USA (Gorgone *et al,* 1997). However, it has been suggested that course requirements surrounding the IS 2002 model curriculum (ACM-AIS, 2002) as it stands probably contains more technical material than can be covered in a single degree program (Beachboard & Parker, 2003).

Yet as Ross & Ruhleder (1993) note, IS education often is seen as concentrating too much on a narrow set of technical skills and suggest that the IS curriculum should concentrate on developing technical and business skills. Others (Ashley & Padgett, 1997; Turner & Lowry, 2001) have shown that despite the call from IS employers for more business-orientated skills in exiting IS students, core business subjects do not rate highly.

Technical skills are not the whole answer when preparing students for entry into professional IS roles (Ross & Ruhleder, 1993). They suggest that programs aimed at developing IS professionals of the future must cover a wide range of skills and assist students in developing and integrating these skills in complex environments. Little, Granger *et al* (1999) suggest that it is not sufficient for CIT graduates to just possess technical capabilities. They must also be aware of the need for professionals to take responsibility for their work and the importance of appropriate ethical behaviour. They further suggest a need to include these aspects in the curriculum of current CIT programmes. Their identification of an "industry-academic gap" that leads to dissatisfaction amongst employer groups with CIT graduates is consistent with findings by Turner and Lowry (1999, 2000).

An early study by Young (Young, 1996) looking at the importance of a range of technical and interpersonal skills to industry when employing new IS personnel was replicated in a study of students from differing backgrounds (Weber *et al*, 2001). They found that there were substantive differences in student perception of industry requirements that was based on background and gender.

Several recent studies have focused on gender issues. (Tapia *et al*, 2004) discuss the issues affecting attraction and retention of IS profession in relation to gender. Gender differences were observed in relation to handling of stress and lower job satisfaction for women in IS, but not in other areas (Gallivan, 2003; Gallivan, 2004). In another study Rowell *et al* (2003) found no gender-based differences in confidence, career understanding, and social bias in computing students. Another survey of IS students (Joshi *et al*, 2003) showed that there were no gender differences in understanding of the nature of IS being part technical, part social, and part managerial. None of these studies reports the relative importance of the various technical and academic skills, soft skills, personal attributes, and job aspects that are factors in the make up of the IS professional. The methodology of the study reported in this paper has been tested in a number of different situations and has been shown to be robust. (Turner, Fisher and Lowry 2004a, 2004b, 2005)

Method

A multipart questionnaire was developed that solicited views on the importance of academic areas that are included in the curriculum of many IS degrees along with a number of others that may be regarded as useful adjunct subjects in an IS degree programme. The instrument developed was based on surveys by others (Cappel 2001/2002; Cheney, 1988; Cheney, *et al* 1980; Farwell, *et al*. 1995; Leitheiser 1992; Leonard 1999; Snoke, *et al* 1998; Tang, *et al*, 2001; Trauth, *et al*, 1993; Van Slyke, *et al*, 1997) and modified by the authors to include some additional items. Questions covered technical topics found in undergraduate IS degree programmes, core non-IS subjects, personal skills/attributes and a number of work features and incentives that are appealing to graduates seeking employment in the field.

On-line surveys were distributed to IS academics, professionals and decision makers and a paper survey to students undertaking subjects in information systems specialisation area at three universities in Victoria. Table 1 shows details of questionnaire distribution and responses.

Table 1: Survey Questionnaire Distribution and Responses

Survey Group	Number of questionnaires sent	Number of questionnaires completed	Group response rate	Percent of total
Students	300	253	84.0 %	35.0
IS Academics	395	195	49.0 %	27.0
IT/IS Professionals	1200	136	11.3 %	18.8
IT/IS Employers	2000	138	6.9 %	19.1
Total	3895	722		100.0

A total of 3,895 survey questionnaires were distributed during 2002-2004. A total of 722 usable responses were received, achieving an overall response rate of 18.5%.

The distribution of responses by group by gender is shown in Table 2.

Table 2: Distribution of Responses by Gender

Group / Gender	Frequency		Percentage	
	Female	Male	Female	Male
Students	112	141	44.3	55.7
Academics	54	141	27.7	72.3
IS Professionals	38	98	27.9	72.1
IS Decision Makers	19	119	13.8	86.2

The majority of responses for all groups except Students were overwhelmingly from male respondents. The more even gender representation of responses from female and male students may reflect success in sustained efforts over the past decade to recruit females into tertiary information systems study. Future studies may reflect a more even gender balance in the discipline.

The data were analysed using SPSS R11 to produce descriptive statistics and factor analysis. The structural models presented below were developed from the SPSS data using AMOS 5.

Results & analysis

Item reliability was tested using Cronbach's α (Cronbach, 1951). Item reliability was good as the overall value for each subscale exceeding the recognised benchmark value of 0.7

Exploratory factor analysis involving students, faculty members, IS practitioners and IS decision makers was performed on the items in the questionnaire using PCA analysis with Varimax rotation. Questions that did not clearly load onto a single factor or which did not have a value of at least 0.5 were removed. The final outcome identified nine separate factors in four separate areas of interest. Two factors (SF1W and SF2W) were identified as soft skills and these were measured by eight questions. Two factors (WF1W and WF2W) concerned work related incentives and were measured by seven questions. Two factors (OAF1W and OAF2W) were identified as non-IS academic subject areas, measured by eight questions. Three factors (F1W, F2W and F3W) were identified as IS academic subjects, measured by eight questions. The interpretation of these factors is shown in Table 3.

Table 3: Factor Interpretations

Factor	Interpretation	Emphasis
F1W	IS academic subjects	High level applications
F2W	IS academic subjects	Design and development
F3W	IS academic subjects	Web related applications
OAF1W	Non-IS academic subjects	Inwardly focussed core non-IS business subjects
OAF2W	Non-IS academic subjects	Outwardly orientated non-IS subjects
SF1W	Soft skill	Get on with people, communicate or stand-out
SF2W	Soft skill	Skills acquisition and able to do job
WF1W	Work related incentive	Environmental and comfort
WF2W	Work related incentive	Reward related (hygiene) factors

Composite variables were determined from the respective questions and factors were identified following the method outlined by Holmes-Smith (Holmes-Smith, *et al*, 1994).

As no single fit measure has been developed for structural equation modelling, a number of fit measures are usually presented. The measures and the values for an acceptable fit are presented in Table 4 below (Hodgson, 1999; Schumacker, *et al*, 1996). Chi square is sensitive to sample size and p values alone should not be relied upon when sample size is larger than about 100 (Hair, *et al*, 1998).

Table 4: Structural model fit indices

Test	Acceptable values
Likelihood ratio χ^2	p>0.05
χ^2/degrees of freedom (normed chi-square, CMIN/DF)	< 3.0
Goodness of fit (GFI)	> 0.9
Adjusted goodness of fit (AGFI)	> 0.9
Root mean square residual (RMR)	Close to zero
Root mean square error of approximation (RMSEA)	< 0.08, and preferably < 0.06
Tucker Lewis Index (TLI)	> 0.9
Normed Fit Index (NFI)	> 0.9
Comparative Fit Index (CFI)	> 0.9

Regression models

The structural model of the IS profession is shown in Figures 1a and 1b. Data from female respondents are fitted to the model in Figure 1a and data from male subjects were fitted to the model in Figure 1b. Note that the structural model fit indices are identical for both versions.

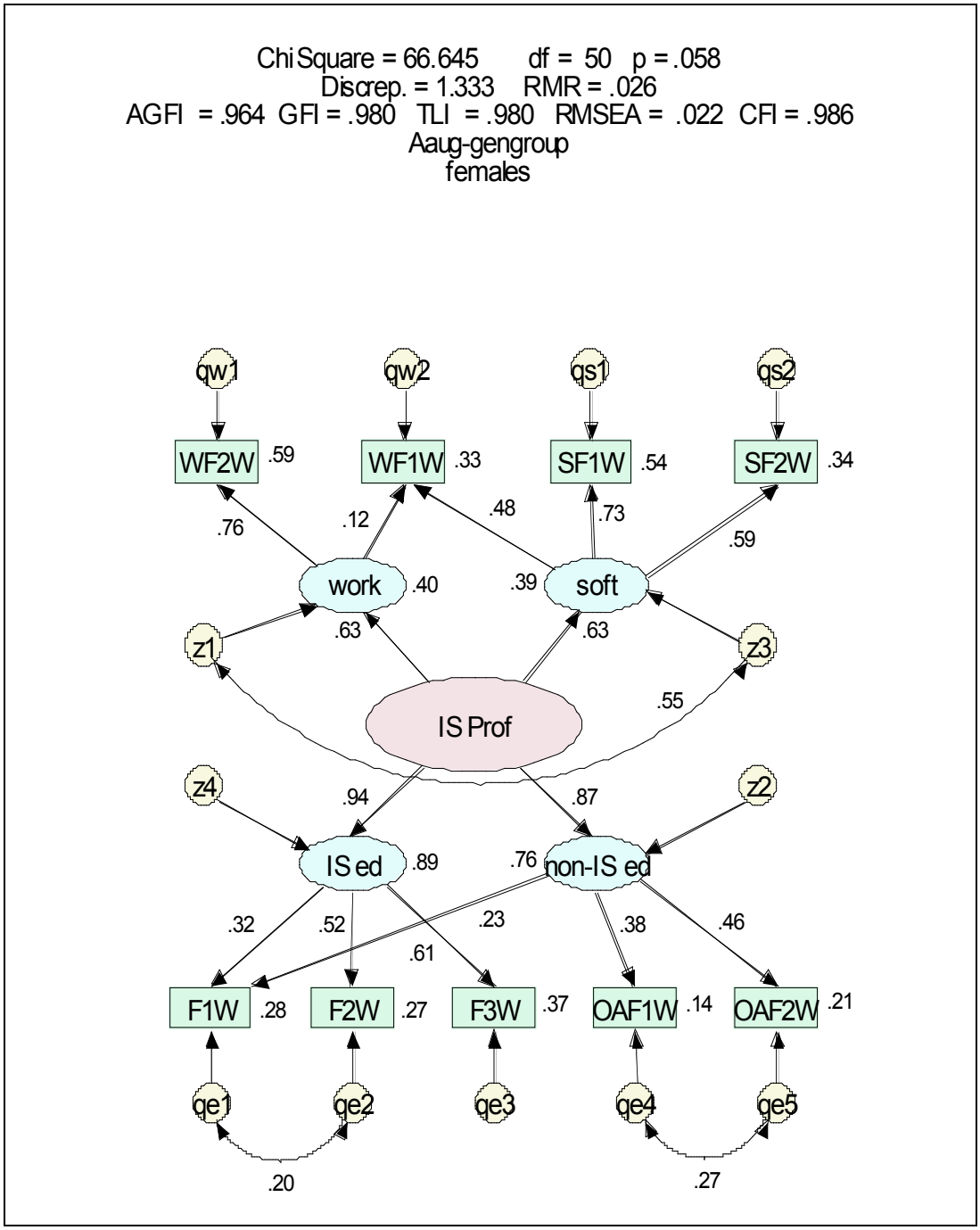

Figure 1a: Structural model (females)

The model shows the relative contributions of the nine factors, expressed as values of r^2, to the four separate areas of interest: Factors WF1W and WF2W accounted for 40% of the variance in the **workplace conditions** area. Factors SF1W and SF2W) accounted for 39% of the **soft skills** area. Factors F1W, F2W, and F3W accounted for 89% of the **IS education** variable, and factors OAF1W and OAF2W accounted for 76% of the **non-IS education** variable.

For males, shown in Figure 1b below, Factors WF1W and WF2W accounted for 52% of the variance in the **workplace conditions** area. Factors SF1W and SF2W) accounted for 58% of the **soft skills** area. Factors F1W, F2W, and F3W accounted for 42% of the **IS education** variable, and factors OAF1W and OAF2W accounted for 88% of the **non-IS education** area.

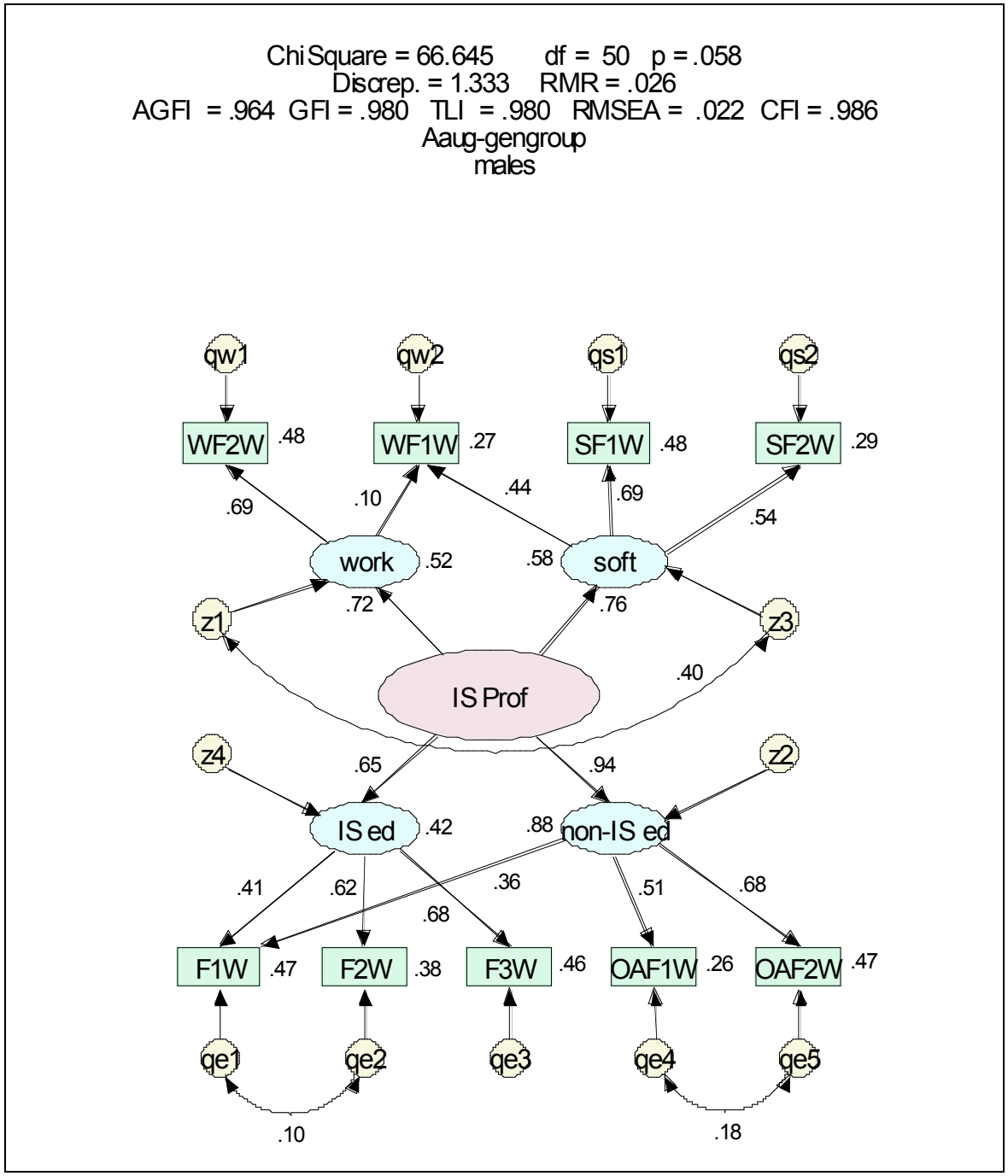

Figure 1b: Structural model (males)

The greatest difference is found in the **IS eduction** area, with r^2 values of .89 for females and 42 for males. The r^2 values for the other areas are closer, with respective values for females and males of .40 and .52 in the **workplace conditions** area, .39 and .58 in the **soft skills** area, and .76 and .88 in the **non-IS education** area.

Table 5 below shows standardised regression weights for female and males participants. Values for regression weight below 0.3 are considered weak. Values between 0.3 and 0.5 are considered mild. Values above 0.5 are considered strong (Holmes-Smith, 2000). From Table 5 it can be seen that most regression weights are sound and have values above 0.3 with the exception of three paths. For females, **WF1W <--- work aspects** and **F1W <--- non-ISed** and for males **WF1W <--- work aspects** are weak.

Table 5: Standardized Regression Weights

			Female	Male
non-IS ed	<---	IS Prof	0.87	0.94
IS ed	<---	IS Prof	0.95	0.65
work aspects	<---	IS Prof	0.63	0.72
soft skills	<---	IS Prof	0.63	0.76
SF2W	<---	soft skills	0.59	0.54
F1W	<---	IS ed	0.32	0.41
F3W	<---	IS ed	0.61	0.68
OAF2W	<---	non-IS ed	0.46	0.68
SF1W	<---	soft skills	0.73	0.69
F2W	<---	IS ed	0.52	0.62
OAF1W	<---	non-IS ed	0.38	0.51
WF1W	<---	work aspects	0.12	0.10
WF2W	<---	work aspects	0.77	0.69
WF1W	<---	soft skills	0.48	0.44
F1W	<---	non-IS ed	0.24	0.36

Squared multiple correlations (r^2 values) presented in Table 6 below the recommended minium value of 0.3 suggesting item reliability is good for most other items (Holmes-Smith 2000). For females OAF1W, F1W, F2W, OAF2W and for males OAF1W, SF2W, WF1W are below this value, suggesting relatively poor reliability. Educational issues rate very strongly for both groups with a stronger emphasis on IS education by females.

Table 6: Squared Multiple Correlations

	females	males
work aspects	0.40	0.53
non-IS ed	0.76	0.88
IS ed	0.89	0.42
soft skills	0.39	0.58
OAF1W	0.14	0.26
F1W	0.28	0.47
F2W	0.27	0.38
F3W	0.38	0.46
OAF2W	0.21	0.47
SF2W	0.35	0.29
SF1W	0.54	0.48
WF1W	0.33	0.27
WF2W	0.59	0.48

The structural component of the model indicates strong contributions from each factor with a slightly lower emphasis on non-IS educational matters by females. Somewhat unexpectedly the variable F3W which relates to web development matters is relatively weak compared with most of the others.

Soft skills are very important in this model and this has been known for some time that employers are seeking a variety of these skills in their employees. This model supports the importance that these qualities have in the overall picture of what constitutes an IS employee and there is little difference in males and females in this respect. More importantly perhaps is the indication that the work situation appears to quite strongly influence these very soft skills.

The model indicates that reward related incentives (WF2W), or the so-called hygiene factors (Hertzberg, 1968) are more important than environmental factors (WF1W). There is a noticeable difference in the importance of soft skills with getting on well with people and communication (SF1W) being much stronger than skills acquisition matters (SF2W).

On education matters, there is a big difference between the traditional business related subjects such as accounting, economics and statistics referred to as inwardly focussed (OAF1W) and the more outwardly oriented subjects such as marketing and management (OAF2W). There is evidence of the importance of high level applications such as client-server application, data mining and ERP (F1W) and database application, OOP and CASE applications (F2W). However the response to web applications ecommerce (F3W) was comparatively weak.

Discussion

Most research published in the area of skills in the IS context is based on one or another view of the IS professional. A number of studies have been published on technical skills required as perceived by the various stakeholders or comparing the perceptions of stakeholders. There is also a body of work illustrating the growing importance of soft skills, again from the perspective of various stakeholders. A number of studies have also been published concerning the effects of the working environment on IS professional perceptions of their work situation. Work has also been presented illustrating the importance placed on business related skills acquired as part of the IS graduate's preparation.

To the authors' knowledge, no research has appeared which links these areas together in a single structural model. The findings reported in this paper suggest that there is a stable and interactive relationship between these four factors. The model shows the relative importance and strength of the factors. Development of a structural model advances our knowledge of the constellation of skills, knowledge, and values held by IS stakeholders beyond conventional factor analysis, an analytical technique which does not allow for comparison of the significance of these factors. Structural equation modelling overcomes this limitation of factor analysis. For the first time it is possible to show the interacting relationships of the four factors along with measures that suggest their relative importance to each of the stakeholder groups.

The model shows a good fit for these data. One of the important requirements for any model is that it is able to fit to independent sets of data, a requirement satisfied in this case.

The results presented here indicate that the perceptions of different groups can be described by a second order, four latent factor model described in terms of hard IS skills, non-IS educational skills, personal attributes and soft skills and workplace conditions.

It should be stressed that the model is not necessarily the only one that can fit the data. It does however show that it is possible to develop a comprehensive model to explain the various attributes of the IS professional. Ultimately it is hoped that such a model can be useful in improving the career prospects of new graduates and as providing indicators of shifting emphasis and value of these factors as individuals change stakeholder groups throughout as their careers develop**.**

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Appendix

Survey questions (abridged)

Technical skills

Analysis & Design of Information Systems
LAN operations & data communications
Web page design & development
Knowledge base or expert systems
Able to apply 3GL programming languages
CASE tool applications
Project management
Client-server applications
ERP implementation & operations
Business application of computers
Database design
E-commerce/E-business development
Knowledge of PC applications
Able to apply object oriented languages
Large computer system experience/knowledge
Use of operating systems
Data mining / Data warehousing

Non-IS academic

Accounting
Business ethics
Business statistics
Knowledge of foreign languages other than English
Communications & report writing
Marketing
Mathematical modelling
International business
Business finance
Business or commercial law
Economics
Psychology
Management
Operations research
Organizational behaviour

Soft skills and personal attributes

Ability to accept direction
Able to independently acquire new skills
Able to meet deadlines
Able to think creatively
Able to work under pressure
Business analysis skills
Information seeking skills
Have leadership potential
Have problem definition skills
Time management skills
Have written communication skills
Able to work with people of different disciplines
Able to quickly apply new skills
Good sense of humour
Able to work as part of a team
Able to work independently
Place organizational objectives first
Able to prepare multimedia presentations
Be client focussed
Have oral presentation skills
Have problem solving skills
Willing to undergo on going professional development
Able to interact with people of different backgrounds
Able to handle concurrent tasks

Job attributes or features

Good promotional prospects within the company
A friendly work environment
Provision for on-going training
Flexible working conditions
Supportive superiors
Fringe benefits (eg company shares, car etc)
Opportunities for travel
Challenging work assignments
An industry competitive salary
Reliable internal communications
Opportunities to expand personal skills