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Factors in team effectiveness: Cognitive and demographic similarities of software development team members

Hye-Ryun Kang, Hee-Dong Yang and Chris Rowley

ABSTRACT

The benefits of teams and teamwork are popular and propounded in management discourse. The use of this lexicon is based on beliefs in the resultant mutual gains for both organizations and individuals. Yet, are all teams, irrespective of the characteristics of membership composition, the same in terms of such beneficial outcomes? This study investigates the importance of team member characteristics, particularly cognitive and demographic, on team effectiveness and which characteristics matter more in team activities, especially where labour turnover is high, such as in software development. The Shared Mental Model is outlined and used as the representative construct for cognitive similarities; while age, tenure and gender are the demographic aspects used. From the relevant literature we develop a hypothesis and subject it to a range of tests based on empirical fieldwork using software development teams in South Korea. Our analysis shows that team effectiveness is more influenced by cognitive than demographic similarities. The implications and limitations of this work are detailed, with its wider relevance to international management, business and practice and other countries, noted.

KEYWORDS

cognitive similarities ▪ demographic similarities ▪ effectiveness ▪ members ▪ Shared Mental Model ▪ teams

Introduction

The call for teams and teamwork in organizations remains one of the more prevalent and perennial ideas for many practitioners and academics, often appearing in management 'best practice' lists (e.g. Pfeffer, 1998) and proposed as a key attribute in employee resourcing decisions. This high profile is partly because teams are seen to bring a variety of benefits for organizations and management as well as employees. These include being an integral part of business success, contributing to competitive advantage, a way of pooling ideas and expanding and improving work processes and job (re)design, direct participation and empowerment leading to better decision-making and more creative solutions and motivation while helping reduce conflicts and miscommunication. Furthermore, especially from the 1980s, teams were seen as a well-developed building block and important competitive ingredient in the then paragons of corporate success, Japanese firms, both domestically and overseas, and more recently as part of the High Performance Work Systems debates. Nevertheless, teamworking remains a contested concept in both meanings and outcomes, which we return to later.

Also, there remain different views on the influential factors in team performance. Some indicate the benefits of diversity (e.g. Jackson et al., 1995) or similarity (e.g. Ancona & Caldwell, 1992) of team members on performance. This debate seems to err on the side of similarity's importance, for example, a meta-analysis of studies over the last 40 years concludes that diversity does not consistently affect team performance (Williams & O'Reilly, 1998). Also, Similarity-Attraction Theory argues people prefer similarities to diversity in interacting with others (Byrne, 1971). Likewise, theories of Selection (Chatman, 1991) and Socialization (Van Maanen & Schein, 1979) share related views, that similarities in values, backgrounds and experiences buttress effective working environments.

While team member traits can be analysed in many different dimensions, Jackson et al. (1995) and Harrison et al. (1998) suggest two: 1) surface-level, that can be observed easily, like demographics (e.g. gender, age, education and tenure); 2) deep-level, like cognitive schemas (e.g. knowledge, skills, capability, experiences and personality). We look at both levels as our objective is to investigate the influence of cognitive and demographic similarities on team effectiveness. To assist in this we adopted the recently popular concept, the Shared Mental Model (SMM), which views cognitive similarities as shaped by sharing knowledge and skills with critical roles in team effectiveness (e.g. Ancona & Caldwell, 1992; Cohen & Bailey, 1997). Team effectiveness is taken as a multi-dimensional construct that consists of both performance effectiveness (i.e. quality and quantity of outputs) and attitudes (i.e. commitment) (Cohen & Bailey, 1997; Kraiger & Wenzel, 1997).

Studies on software (SW) project development teams, the basis of our study, are rare. Such teams consist of knowledge workers who create the value-added to teams by mental activities (Cohen & Bailey, 1997; Davis, 2002). The SW industry is also noteworthy for its high labour turnover ratio [http://discuss.joelonsoftware.com/default.asp?joel.3.319888.16]. We conducted an empirical study of this particular type of team and their member characteristics (cognitive and demographic) and their effectiveness with fieldwork in the information technology (IT) sector in South Korea ('Korea' for shorthand from now on).

In May 2005, the International Institute for Management Development published the 2005 World Competitiveness Yearbook, which ranked Korea first in the area of IT. Thus, the answers to our research questions can provide lessons not only for SW development companies in Korea about team effectiveness, but also for SW development teams in other countries and cultural environments.

Faraj and Sproull (2000) contend that expertise coordination (the management of knowledge- and skill-dependencies) is more important for SW development team effectiveness than administrative coordination. Even though they did not use the term SMM, their finding has importance for effectiveness because a SMM facilitates expertise coordination, especially in sectors such as SW development where labour turnover is quite high compared to other sectors. Through a longitudinal study, Levesque et al. (2001) find an ironic result that time does not guarantee the development of a SMM, rather it only differentiates roles within teams. For the development of a SMM they call attention to interaction within teams. Our study joins this research stream to answer the question: which similarities (cognitive or demographic) are more important for SW development team effectiveness?

This research question is important to SW development organizations because demographic traits have been major concerns in Korean SW development teams. Through our interviews with SW developers we found that workers prefer to work with colleagues with similar demographic traits. It is well known that three major social networks in Korean society are associated with kinship, birthplace and educational backgrounds, all of which are demographic traits. Indeed, this attitude that Korean workers feel comfortable with similarly aged colleagues, and that demographic similarity helps improve psychological stability in the work environment, has been steadily identified in Korean journals (e.g. Kang & Park, 2003; Park & Song, 2005). Considering this, we accepted this attitude and preference for similar demographics in people as very natural at the beginning of our study. Provided that Korean SW development teams are concerned about demographic similarity, we ask: if teams are organized with similar members demographically,

as many people seem to prefer, would it help team performance at all? Are they aware that cognitive similarity could be more important?

This article consists of six sections. After the introduction and discussion of team traits, the theoretical background and major constructs in our study are detailed, along with our hypothesis regarding the relationship between these constructs. The research methodology is then outlined. Attention is paid to how the constructs can be measured at the team level from individual responses. The quality of survey items is also covered in the same section. The next section explains the analysis of the results of our dataset, conducting the hypothesis tests. The discussion and conclusion sections follow.

Theoretical background

Team effectiveness can be influenced by various factors, such as team membership, composition, structure, processes, psychology, tasks and task design, as well as organizational context, resources, structure and environment (Cohen & Bailey, 1997). Among these factors, our study focuses on the composition of team membership in terms of cognitive and demographic factors. However, before we move onto these, we outline the concept of teamworking and some of the relevant debates to our study.

Teamworking

Teamworking remains a contested concept in its meanings and outcomes, with both managerial and critical accounts. A range of older and more contemporary literature indicates this. First, what is teamworking? It can range widely, from individuals in groups sharing skills and knowledge to self-managing work units (Marchington, 2000). This elasticity generates problems of '. . . broad and inconsistent definitions . . .' (Marchington & Wilkinson, 2000: 349). Marchington (2000) suggests greater definitional care, viewing teamworking within dimensions of: scope (technical requirements of work); and degree (extent of influence and control over requirements).

Second, views on teamworking are not universally positive. Thus, whilst some see teamworking '. . . as liberating and generally positive, others would view it as management control at its most subversive and effective because employees take on responsibility for peer surveillance' (Marchington & Wilkinson, 2000: 349). For example, rather than management instructions, teamwork can harness peer pressure for performance and compliance, with burdens, such as stress on team members by horizontal and coercive

surveillance and control (Sewell, 1998). Legge (1998: 19) neatly sums up this area by arguing that the meaning of teamworking in practice depends very much on prevailing organizational culture and market environments and positive experiences may be '. . .juxtaposed against the more critical accounts of writers in the labour process tradition'. These, in place of the 'tripod of success' of 'flexibility, quality and teamwork', identify a 'tripod of subjugation' of 'management by stress, blame and compliance.' In terms of the choice between these 'positive' and 'negative' schools, she concludes: 'You pays your money and takes your pick' (p. 19).

One important implication from this debate is that team success is contingent upon many factors. The problems identified by critical writers, while providing a crucial counterweight to the managerialists, can be moderated by many things, of which intra-team dynamics, cognitive similarities and cultural context, are some.

A team in our study is a project team developing new SW products timely. The SW industry has high labour turnover ratios and requires very innovative skills in individuals. The core task for this kind of team is very creative, complex and sometimes unstructured. Furthermore, team members are responsible for the final outcome of projects. Therefore, coordination, teamwork and shared knowledge of team mates are critical for project success. Product development activity, for example, SW development, is in most cases conducted in teams, which may well have functional diversity in composition for the sake of performance (Ancona & Caldwell, 1992). Thus, teamwork for product development activity cannot be avoided and so management is concerned with influential factors for successful team performance.

Cognitive similarities

The deep level, of less visible or underlying attributes of teams, includes the attitudes, values and beliefs of members. Jackson et al. (1995) extend this range to include knowledge, skills and capability. These attributes can be communicated verbally or non-verbally and shaped similarly among members by personal interactions. Among these attributes, cognitive similarities may be mostly recognized in terms of significance for team effectiveness. Underlying differences in 'schemas' (the conscious and unconscious preconceptions and beliefs that organize people's thinking) can create serious coordination difficulties for teams (Miliken & Martins, 1996). Even delicate differences in perspectives, assumptions and beliefs can cause problems. Therefore, what might be an appropriate construct for deep-level (cognitive) similarities in teams? The SMM can take up this role.

The SMM

Definitions

SMM studies evolved from the individual mental model to discuss the similarities of individual mental models at the team level. The mental model is an information processing mechanism that helps describe, explain and forecast our environments (Rouse & Morris, 1986; Mathieu et al., 2000). The cognitive mechanisms that help understand the surrounding circumstances include 'category' (Rosch, 1978), 'cognitive map' (Neisser, 1976), 'belief structures' (Fiske & Taylor, 1991), 'schema' (Neisser, 1976) and 'script' (Abelson, 1976). All these concepts are associated with knowledge structure and help interpret circumstances by preventing information overload, extreme uncertainty and in choosing relevant and critical information.

A SMM exists at the team level when the mental models of individuals are shared by team members. Various terminologies have been used for the shared cognition of team members, such as 'collective mind' and 'teamwork schema'. It is related to Jehn et al.'s (1999) 'information diversity', the differences in knowledge bases and perspectives that members bring to groups. Among these terms, the SMM is preferred for its use in research.

In our study, a mental model is understood as the knowledge structure that actively involves conducting tasks rather than as the cognitive mechanism of everyday life. Therefore, the SMM is defined as the knowledge structure shared by team members in conducting team tasks.

Typologies

Cannon-Bowers et al. (1993) categorize the SMM into four types based on content. The first type relates to technology/equipment and helps members share its functions, usage, limitations and possible failures. The second type relates to the procedures, general instructions, strategy, constraints and relations of tasks. The third type concerns interactions and helps share roles and responsibilities, information source and flow, interaction pattern, communication channel and mutual dependency of members. The last type is about team mates, and helps share knowledge, skills, attitudes, preferences and tendencies of members.

These four categories can be reduced to two: task-related and team-related (Klimoski & Mohammed, 1994; Mathieu et al., 2000; Cannon-Bowers & Salas, 2001). The first and second types of Cannon-Bowers et al. (1993) relate more to the task-related category, whereas the third and fourth types relate more to the team-related category. The task-related SMM assists

team members in sharing task-specific and task-related knowledge. The team-related SMM relates to transactive memory (Moreland, 2000) about the distribution of team members' expertise.

Measurement

Even under our definition of the SMM there remains the dilemma of whether the SMM is measured by similarity in knowledge 'structure' or knowledge 'content'. Cannon-Bowers and Salas (2001) identify three approaches to measuring knowledge structure. The first concentrates on the 'pathfinder' that calculates the psychological distance between constructs. The second, the 'concept map', depicts the structure of individual beliefs in a particular domain. The third checks the similarities of cards chosen as the 'reflective measure' of psychological similarities or diversity. These all focus on measuring knowledge structure rather than knowledge content contained within it.

This content filling within knowledge structure can be a good alternative measure given the mental model is another kind of knowledge content (Rouse & Morris, 1986). The level of the SMM can be measured by asking members the degree to which they share certain content about tasks and team members (Cannon-Bowers & Salas, 2001). Klimoski and Mohammed (1994) suggest two approaches to the issue of how many similarities are needed to indicate 'sharedness'. The first takes on statistical similarities using actuarial assessment. This approach assumes that team members with a high SMM think in a very similar manner in specific circumstances. However, this perspective still does not resolve the issue of what is the 'proper' level of overlap between the mental models of team members in order for it to be evaluated as being shared.

The second approach is phenomenological because it puts an emphasis on beliefs that members share in the interpretation of occurrences inside the team. The level of the SMM is reflected by the beliefs in the SMM and concordant behaviours of team members. Klimoski and Mohammed (1994: 422) explain the merit of this approach:

> There must be some level of awareness by and among group members regarding how they interpret tasks, situations and events. A statistical similarity is not enough. To be more specific, a model would be shared only if one or more team members believed this were so, and acted on this belief.

Kraiger and Wenzel (1997) also propose measuring the shared expectations about behavioural tendencies as the surrogate measure of a SMM.

Our study takes the latter approach because shared expectations help team members provide necessary information in a timely manner and cooperate to achieve organizational objectives. Cannon-Bowers et al. (1993) also insist that team members actually share expectations, not the real mental model itself. Therefore, the level of a SMM can be measured by team member perceptions about the degree of 'sharedness' of the characteristics of tasks and team members.

The SMM and team effectiveness

The shared interpretation of tasks and members can lead to appropriate expectations of operations and results, which in turn develop into team effectiveness (Cannon-Bowers et al., 1993; Kraiger & Wenzel, 1997). Mathieu et al. (2000) report that both team mate-related and task-related SMMs have positive influences on team performance. Through the SMM, team members develop an exact understanding and proper expectation of tasks and are likely to meet other members' expectations (Cannon-Bowers et al., 1993). Cannon-Bowers and Salas (2001) find that shared cognition among team members enhances accuracy, timeliness and eventually the quality of outcomes, and that a SMM facilitates team communication even in stressful situations, and enhances performance and cooperation. Using the team member 'schema agreement' (rather than the SMM), Rentsch and Klimoski (2001) reveal a positive relationship with team effectiveness. The SMM is also found to contribute to motivational aspects, such as team member cohesiveness, trust, group efficacy, satisfaction (Brannick et al., 1993) and commitment (Kraiger & Wenzel, 1997; Cannon-Bowers & Salas, 2001).

In sum, the SMM of team members promotes common expectations for team tasks and members and facilitates information processing and coordination. The shared cognition helps identify team member needs, forecast task operations and strengthen teamwork, and thus improves team effectiveness, such as efficiency and commitment.

Demographic similarities and team effectiveness

In contrast to the SMM, demographic characteristics are at the surface level, regardless of whether they are related to tasks or relations, and can be broken down into task-related and social categories (Jackson et al., 1995; Jehn et al., 1999). Organizational/team tenure, department/unit membership, education and formal credentials are task-related characteristics. Age, gender, race and ethnicity represent the social category. Tenure similarity has been recognized as the representative task-related demographic for team effectiveness (Ancona & Caldwell, 1992). Educational background is

another strong candidate, but is excluded from our study due to lack of variance because most (97% in our dataset) members' qualifications were higher than bachelor degree level.

As for the social category, age and gender tend to be the primary aspects. In some Asian societies this is due to the deep-rooted inheritance of culture and religion, such as Confucianism in Korea (Rowley & Bae, 2003) and Bhuddism in Thailand. Therefore, among the various demographic variables we selected tenure (task-related), age (social category) and gender (social category).

Demographics, such as tenure, age, and gender, are related to the values and attitudes of organizational members and lead to differences in communication and coordination, eventually influencing intentions to stay or leave (Pfeffer, 1983). Such concerns are not exceptional for team studies. In particular, demographics are often the critical concern in team composition. Such interest has increased because the demographic attributes of team members have become more diverse in many countries and employment sectors.

However, the results of research on demographic similarities on team effectiveness are not consistent (Guzzo & Shea, 1992). Some report a positive influence, whereas others indicate that demographic dissimilarities matter. Through a meta-analysis of the last 40 years of studies, Williams and O'Reilly (1998) find that diversity in features such as age and tenure have a negative effect on social integration and communication. The more similar the age, tenure and gender of team members, the more integrated the social atmosphere and the more likely organizational objectives are achieved. Therefore, we examine the age, tenure and gender of members as influential demographics on team effectiveness.

Age similarities

In Social Identity Theory group members establish positive social identity and confirm affiliation by showing favouritism to members of their own social category (Billing & Tajfel, 1973). Studies of team demographics (e.g. Wagner et al., 1984) argue that those of a similar age accumulate similar social and economic experiences, which influence the shaping of common values and attitudes. Such attitudinal and value similarities facilitate communication and social integration. These, in turn, lead to reduced turnover and increased commitment (Wagner et al., 1984).

Age diversity has been found to act negatively on various dimensions of organizational behaviour. These include turnover ratios (Wagner et al., 1984), organizational attachment (Tsui et al., 1992), social integration (O'Reilly et al., 1989) and resolving relational conflicts (Jehn et al., 1999).

Tenure similarities

Even though tenure may be a task-related characteristic, it would be better regarded as a demographic characteristic. In Jackson et al.'s (1995) comprehensive category of diversity, tenure is taken as a surface-level characteristic. Studies have reported inconsistent results regarding the influence of tenure on team effectiveness. Some indicate a positive influence from tenure diversity on innovativeness and creativeness (e.g. Eisenhardt & Schoonhoven, 1990), whereas others contend that diversity in task-related attributes, such as tenure and job experiences, increase task conflicts (e.g. Pelled et al., 1999).

Among such contradictory arguments, some studies show similarity of tenure has more positive impacts on team effectiveness than do differences in tenure. Team members with similar tenure have similar social and economic experiences, which can lead to similar attitudes and values that in turn reduce the desire to leave. Wagner et al. (1984) report that the degree of tenure diversity helps predict the turnover of top managers. O'Reilly et al. (1989) and Zenger and Lawrence (1989) find tenure similarities have a significant influence on turnover and ROI, and that such effects are mediated by social integration and communication. Relatedly, socialization (such as communication and collaboration) among new employees is noticeable between similarly tenured people.

Gender

Gender diversity has been found to influence teamwork (Gibson & Zellmer-Bruhn, 2001) and team cohesion (Harrison et al., 1998). However, studies have reported conflicting results regarding whether gender similarity or diversity helps team chemistry or supervisor–subordinate relationships. Gibson and Zellmer-Bruhn (2001) controlled the effect of gender in investigating the influence of national/organizational culture on teamwork.

In sum, similarities in demographic attributes, such as age, tenure and gender, among team members decrease conflict, facilitate social integration and eventually contribute to stability and performance of team activities.

Which matters more for SW development team effectiveness?

Based on the analysis above, we can see that both cognitive (SMM) and demographic (age, tenure and gender) similarities are important for team effectiveness. Which one is more important for SW development team effectiveness? Intellectual tasks contain substantial challenges for cognitive load and coordination with team mates, and thus require an individual's

professional capabilities for successful team performance. The relative importance between cognitive and demographic similarity is an important issue because teams are faced more with intellectual tasks, and demographic characteristics are a frequent and critical consideration in team composition in some countries, such as Korea. As such practices remain pervasive in SW development team composition, we need to verify whether this management practice is indeed valid for team composition and management behaviour and actions.

Demographic similarities are related to social intimacy among team members, which could indirectly, but eventually, enhance team effectiveness. Meanwhile, cognitive similarities are directly involved with execution of team tasks and coordination with team mates' capabilities. The more team tasks feature intellectual challenges and creativity, the more likely team members depend on the cognitive capabilities of team members rather than demographic characteristics. Moreover, as many SW development team projects are composed of intellectual tasks run in short and speedy cycles (due to increasing cost competition and client requirements), team members have less time for socialization, and need agile and instant contributions regardless of such short periods of socialization.

Harrison et al. (1998) and Chatman and Flynn (2001) demonstrate that demographic differences are initially more powerful than cognitive differences (when groups first form), but that, over time, the impact of demographic differences dissipates and the impact of cognitive diversity strengthens. Considering that intellectual tasks take up a substantial amount of time, the importance of cognitive similarity increases, especially as projects with intellectual tasks approach due dates, necessitating team performance and effectiveness. Therefore, we generate the following hypothesis regarding the relative importance between cognitive and demographic similarities on SW development team effectiveness:

> *Hypothesis*: Team members' SMM has a more positive influence on SW development team effectiveness than do demographic (age, tenure and gender) similarities.

Research methodology

Samples

Fieldwork for this study was conducted in late 2001. Samples were chosen from the IT industry, more specifically, SW development and IT consulting

where teams develop SW programmes for business applications. Teams are temporarily organized by recruiting appropriate technicians and consultants who return to their original functional teams after projects are finished. Project managers are appointed first and they recruit team members in negotiation with functional managers. Team members are paid only a regular salary. Incentives, if any, are applied company wide. Personnel evaluations are conducted by project managers. To verify that SW development teams did fit our research context we interviewed seven SW developers. We examined their experiences of projects and team members, which confirmed they satisfied our requirements for further data collection through a survey. SW and system development projects are usually conducted in teams and members are required to cooperate in activities and contribute to teamwork based on their expertise.

The core business of the SW industry in Korea (as well as other countries) is to timely develop new products mainly by project teams. It was well supported by Hoegl and Gemuenden (2001) that teamwork is critical to the success of innovative projects. Since members of each project team are experts in various knowledge domains, the success of the project depends more on the degree of understanding, communication and coordination of each member's expertise, so called teamwork, than on the level of expertise itself.

Further data were collected by surveys. An initial list was made of 130 Korean SW development companies reported in the popular media, such as *PC* magazine, and from the Internet. Most IT companies are new ventures and size is not that large, with two-thirds below 100 employees, mainly located in and near Seoul. We contacted all these firms, with positive responses from 42. Each firm was asked for access to SW development teams to survey. Some 320 surveys were distributed to the randomly selected SW developers, with 304 replies (95% return rate). Respondents replied regarding their own teams. Some 277 surveys from 83 teams in 42 companies were eventually used in our analysis (after excluding those with missing answers or biased tendencies). By member numbers these teams were: 8.3 percent: below 5; 38.6 percent: 5–10; 34.3 percent: 11–15; 11.9 percent: 16–20; 6.9 percent: 21–30. Eight was the average of team member size. The demographic profiles were: males 70.8 percent; 25–30 aged group 43.7 percent; and those with more than bachelor degrees 96.8 percent.

Variables

All the survey items (see Appendix A) were scored by a seven-point Likert scale.

The SMM

We adapted the measurement items from Kraiger and Wenzel (1997), Mathieu et al. (2000) and Cannon-Bowers and Salas (2001). We conducted interviews with academic researchers and the same seven SW developers to verify whether our survey items fit the Korean SW industry and for suggestions and improvements. Through three pilot tests and these interviews the initial 25 items were trimmed down to 13. All items were worded with the team as the referent, not the individual, because we planned to measure the perceived degree of 'sharedness' of certain content.

Age and tenure similarities

The coefficient of variation (CV) was the measure we adopted for age and tenure similarities. The CV was calculated by dividing the standard deviation of the sample by the average value. It has been the popular surrogate measure for the diversity of a continuous interval scale, such as age and tenure (O'Reilly et al., 1989; Chatman & Flynn, 2001). Therefore, we put the minus sign before this value to convert its meaning to the degree of similarities (Zenger & Lawrence, 1989).

Gender

A dummy variable was used for gender information and was measured by binary code (0 for male, 1 for female). Gender information was measured by the percentage of females in teams. This scale was more useful than the CV because gender is a nominal scale not an interval or ratio scale. Therefore, the coefficient of team gender to the dependent variable means the different effect of females against males in the team-level dependent variable.

Team effectiveness

Team effectiveness is a multi-dimensional construct that contains both performance (i.e. quality and quantity of team outputs) and attitude (i.e. team commitment) (Cohen & Bailey, 1997; Kraiger & Wenzel, 1997). Therefore, both items were included in our measure of effectiveness. For performance we adopted the measures of Henderson and Lee (1992) for the performance of IT-related teams (see Appendix B). For attitude we adopted the measures of team commitment (see Appendix C) from Bishop and Scott (2000) who defined organizational commitment as the strength of individuals' participation and identification to referent groups.

Control variables

Team size and history were control variables. These are reported to influence team dynamics and performance (Brewer & Kramer, 1986). Size was measured by the number of members and history by period since launched. We also considered educational major and task categories as additional control variables. However, after running regression analyses to test their significance on the SMM, team performance and team commitment, they were identified as insignificant and, therefore, not included.

Reliability and validity of survey items

As our analysis was conducted at the team level (with different numbers of members), we aggregated the individual scores and divided this measure by the number of members (i.e. the average score) to calculate the scores (James, 1982). We refer to the one-way ANOVA and η(eta)^2 value in justification of whether the summation of individual scores can be used for the team score. The justification is secured if the between-group variance (i.e. differences between teams) is greater than the within-group variance (difference within teams) in ANOVA (Katz & Allen, 1985), or if the η^2 value exceeds .20 (Simon & Peterson, 2000). In our dataset, the between-group variance is significant for SMM, team commitment and team performance ($p = .05$), and all the η^2 values exceed .20. Therefore, we conclude that the above procedure for the team scores is acceptable (see Table 1).

We included items for further analysis only if their Cronbach alphas exceeded 0.7 both at the individual and team-level datasheet (see Table 2). We also conducted an exploratory factor analysis to test construct validity (see Table 2). We applied a strict criterion for the appropriate level of factor loading 0.7. The measurement indicators demonstrated high factor loadings on the related latent factors beyond 0.7 (i.e. confirming convergent validity), but did not have high cross-loadings beyond 0.4 on the other latent factors

Table 1 One-way ANOVA, η^2

	Source	*Sum of square*	*d.f.*	*Mean square*	*F*	*p*	η^2
SMM	Between group	68.658	82	.837	1.400	.031	.654
	Within group	115.441	193	.598			
Team commitment	Between group	90.341	82	1.102	2.225	.000	.696
	Within group	96.046	194	.495			
Team performance	Between group	143.350	82	1.748	2.271	.000	.700
	Within group	149.320	194	.770			

Table 2 Factor analysis: Individual level

Variables	*Survey items*	*Common variance*	*Factor loading*			
			factor 1	*factor2*	*factor 3*	*factor 4*
Team effectiveness						
Team commitment	I-3	.730	**.834**	9.450E-02	.159	–3.7E-02
(.794)	I-6	.688	**.801**	.171	.105	8.156E-02
	I-5	.534	**.729**	–6.3E-02	4.344E-02	2.57E6–02
	I-2	.569	**.685**	.167	.233	.134
Team performance	III-4	.760	.102	**.864**	4.186E-02	3.383E-02
(.784)	III-5	.674	4.380E-02	**.807**	–6.7E-02	.146
	III-2	.697	.222	**.774**	.205	7.614E-02
SMM (.759)						
Team-related	II-10	.759	.162	3.334E-02	**.854**	5.90E-02
	II-11	.703	.128	.124	**.808**	.136
	II-7	.584	.162	.600E-02	**.754**	.246
Task-related	II-2	.749	.302	.147	.216	**.824**
	II-1	.683	.116	–4.7E-02	5.834E-02	**.825**
	II-3	.613	.110	.186	.151	**.739**
Eigen value			2.493	2.141	2.084	2.025
Explained variances (%)			19.174	16.473	16.033	15.579
Accumulated explained variance (%)			19.174	35.647	51.680	67.259

Factor analysis: Team level

Variables	*Survey items*	*Common variance*	*Factor loading*			
			factor 1	*factor2*	*factor 3*	*factor 4*
Team effectiveness						
Team commitment	I-3	.894	**.822**	.277	.236	.295
(.940)	I-5	.816	**.759**	.216	.301	.271
	I-2	.867	**.740**	.323	.351	.245
	I-6	.852	**.738**	.288	.299	.305
Team performance	III-4	.900	.226	**.878**	.140	.240
(.900)	III-5	.841	.260	**.833**	.107	.260
	III-2	.810	.315	**.733**	.361	.207
SMM (.908)						
Team-related	II-10	.827	.276	.157	**.826**	.210
	II-11	.839	.256	.210	**.803**	.290
	II-7	.743	.364	.162	**.707**	.290
Task-related	II-2	.876	.233	.294	.306	**.801**
	II-1	.852	.352	.244	.272	**.772**
	II-3	.759	.323	.302	.293	**.691**
Eigen value			3.118	2.686	2.660	2.411
Explained variances (%)			23.983	20.662	20.465	18.545
Accumulated explained variance (%)			23.893	44.645	65.110	83.655

(i.e. confirming discriminant validity). The resultant set of questionnaire items clearly demonstrated convergent and discriminant validity and reliability.

Due to losing a number of original items through the above item purification procedures, we reviewed the remaining items to search for precise labels. For team performance, all the items regarding the quality of team outcomes were deleted, while retaining the items for efficiency. Thus, we judge our measures for team effectiveness are actually for team efficiency and commitment. As for the SMM, six of the initial 13 items survived after the other items did not show high enough loading values on their relevant latent variables. However, we believe that they still reflect well both the task and team member-related aspects of the SMM that was intended from the beginning.

Common method bias

Common method bias occurs when independent and dependent variables are measured by the same method. Podsakoff et al. (2003) recommended three solutions to test and control this bias: separating measurement of independent and dependent variables psychologically, guaranteeing response anonymity and statistical validation process (so-called confirmatory factor analysis for single-common-method-factor approach). We reflected the first two ideas in our questionnaire. We separated the paragraphs on each construct by putting some space and different numbering on the survey and we did not ask respondents to expose their real names. As for the third idea, statistical validation, we believe the above exploratory factor analysis is enough to prove the constructs of SMM and team effectiveness are not correlated due to an artifactual common method because the indicators are loaded onto four relevant latent variables by lopsided factor-loading scores. In Table 2 (individual level), the factor-loading scores on the relevant latent variable exceed 0.7, whereas most scores on the irrelevant latent variable are less than 0.25. If responses to indicators are seriously affected by common method bias they could be loaded on a single factor or demonstrate the similarly distributed factor loadings.

Results and analysis

In testing the hypothesis regarding the influence of team members' cognitive and demographic similarities on team effectiveness, we used structural equation modeling (SEM), multiple regression and ANOVA. PLS was

adopted for SEM due to the small number of data points (83 in our case). PLS is the desirable method in small number of data points (Gefen et al., 2000). The descriptive statistics and correlations are summarized in Table 3.

Our model has two multi-dimensional constructs: the SMM and team effectiveness. Multi-dimensional constructs could be measured by a latent factor or by aggregation of individual dimensions (Law et al., 1998). For the latent factor model, the multi-dimensional construct exists at a deeper level as a higher-order abstraction underlying its dimensions. The latent model is preferred in the following two conditions. First, individual dimensions are the reflective indicators of the multi-dimensional construct (i.e. the multi-dimensional construct leads to the dimensions). In common terms, the dimensions are simply different forms and ways the construct is realized and manifested. Second, individual dimensions have high correlations with each other.

We conclude that the latent model is appropriate for both the SMM and team effectiveness, the second order latent factors in our data. The correlations between individual dimensions in each construct are significantly high: 0.690 ($p < 0.01$) between two latent factors of the SMM, and 0.677 ($p < 0.01$) between two latent factors of team effectiveness.

Figure 1 depicts the result of PLS with a reasonable R^2 for team effectiveness (69.4%). It clearly shows that only the SMM significantly influences team effectiveness, whereas other independent variables and control variables do not.

Table 4 also shows the results of hierarchical regression analysis to address the changes of the relative power of cognitive and demographic similarities. After both the control variables and the SMM were controlled, demographic similarities contribute insignificant variances to team effectiveness ($p > 0.05$). Meanwhile, when the control variables and demographic similarities are both controlled, the SMM adds substantial contributions to team effectiveness ($p < 0.01$).

The relative importance of cognitive similarities, compared to demographic, for team effectiveness is also explicit in the ANOVA. We compare team effectiveness according to four possible combinations between the different levels of the SMM and demographic similarities. The level of similarities (high and low) is the relative position compared to the median value. In those four cells, the case of high cognitive similarities and low demographic similarities records the highest team effectiveness (5.82). Two cases with high cognitive similarities are ranked first (5.82 with low demographic similarities) and second (5.27 with high demographic similarities) in terms of team effectiveness (4.74 for low cognitive similarities and high demographic similarities, 4.5 for low cognitive similarities and low demographic

Table 3 Correlations

Variables	*M*	*SD*	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*
1. Task–SMM	4.781	.763	**.839**								
2. Team–SMM	4.302	.798	.690**	**.893**							
3. Age similarities[a]	−.838	.387	−.018	.081	**1.000**						
4. Tenure similarities[a]	−10.687	7.219	.128	.079	.035	**1.000**					
5. Team commitment	5.352	.927	.735**	.727**	.155	.128	**.925**				
6. Team performance	4.511	.925	.658**	.538**	.129	.108	.677**	**.922**			
7. Team size	8.707	3.658	.128	.162	−.049	.021	.010	.045	**1.000**		
8. Team history	13.072	6.260	−.049	−.067	.047	.156	−.172	.034	.305**	**1.000**	
9. Gender[b]	.297	.274	−.030	.012	.043	.101	−.020	.024	−.175	−.015	**1.000**

Diagonal: (average variance extracted from the observed variables by the latent variables)$^{1/2}$ = $(\Sigma\lambda^2/q)^{1/2}$.
Off-diagonals: correlation between latent variables = (shared variance)$^{1/2}$.
Team size: Number of team members.
Team history: Months.
* $p < .05$, ** $p < .01$.
[a] CV (Coefficient of Variation).
[b] Categorical variable: Each individual was coded as 0 for Male or 1 for Female. As a team, the percentrage of female team mates over total team mates is counted for this variable.

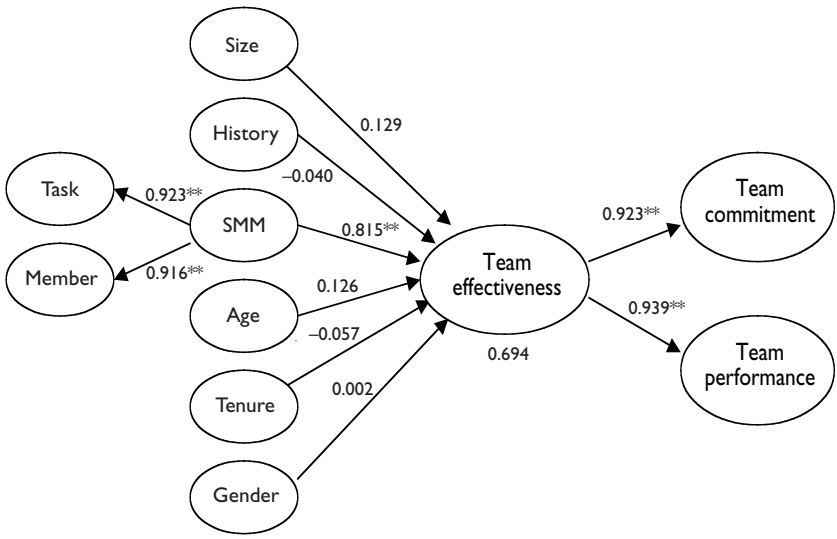

Figure 1 PLS (Partial Least Squares)
** $p < 0.01$

similarities). The Scheffe analysis shows the SMM makes a difference, whereas demographic similarities do not. This additional analysis adds support to our arguments that the SMM is more important than demographic similarities for team effectiveness. Therefore, we conclude that our hypothesis is supported.

Discussion

Except for situations where creativity and innovativeness are stressed, team member similarity, rather than diversity are often reportedly more critical for team effectiveness. As Nonaka and Takeuchi (1995) argue regarding the conditions for knowledge-creating companies, severe diversity among group members may not be desirable. Rather, similarities in perspectives among members are necessary for laying common ground that will eventually facilitate team effectiveness. We investigated the influences of some member traits on team effectiveness and tested which type of member similarities (cognitive versus demographic) mattered more. The SMM was introduced as a critical aspect of cognitive similarities in the team context. We concluded that cognitive similarities were important for both team performance and commitment, whereas demographic similarities were not. Of course, this

Table 4 Hierarchical regression analysis

Variables	*Team efficiency*					
	Step 1	*Step 2*	*Step 3*	*Step 1*	*Step 2*	*Step 3*
Control variables:						
Team size	.015	–.101	–.109	.015	.027	–.109
Team history	.051	.123	.110	.051	.017	.110
Cognitive similarities:						
SMM		.565**	.548**			.548**
Demographic similarities:						
Age similarities			.093		.127	.093
Tenure similarities			.080		.158	.080
Gender			–.091			–.091
R^2	.003	.310	.331	.003	.045	.331
F	.133	11.812**	6.267**	.133	.912	6.267**
ΔR^2	.003	.306	.021	.003	.041	.286
ΔF	.133	35.055**	1.021	.133	1.688	32.381**

* $p < .05$, ** $p < .01$.
All the numbers for the variables in the table are the standard regression coefficients.

outcome, in Korean SW development teams, may be different in other sectors and contexts, such as Korean businesses operating internationally or non-indigenous firms in Korea, as well as other international businesses.

Nevertheless, our findings have implications for not only local firms in Korea, but also for international management and business. This can be seen in two ways, both specifically and directly, such as for businesses with similar characteristics (knowledge-based, small size, high labour turnover in Hofstedian 'high power distance' cultures) and generally and indirectly, such as for those with different organizational attributes and locations. First, for businesses with similar dimensions. Possible management apprehension concerning demographic diversity in team construction can be misplaced since it is less important than the SMM, which can override such diversity. Therefore, rather than worrying about what might be 'appropriate' levels of demographic similarities in team composition, especially in an era of more common workforce heterogenity, managers could help develop and enhance SMMs and team management skills. Thus, SW development teams in the IT industry may be less tightly monitored by managers compared to general work teams since they are knowledge workers and prefer autonomous and flexible working environments. Many are paid partly according to team

performance. Thus, it is critical for success to have knowledge shared and a supporting, trust-based system without tight supervision. These attributes, and commensurate management styles, can have relevance for other sectors, especially those with knowledge-based professions.

Labour tenure and turnover are also important. The effectiveness of project teams in the Korean IT industry was examined by integrating the SMM (measured with a more elaborate and direct measurement technique, Pathfinder Network) with other variables: team tenure as a demographic factor, team rewards as an organizational factor, and collective efficacy as a motivational factor (Kim, 2005). The SMM had a strong impact on team performance through collective efficacy. Team tenure had a direct impact on the SMM. Team rewards had a direct impact on team performance but not on the SMM. It is expected that team tenure facilitates the shared cognition of team mates. However, it is not simple to achieve this since most people in the Korean IT industry work in small to medium-sized venture businesses with relatively high labour turnover. This means IT experts are recruited mainly by their relevant or superior skills and knowledge in specific domains. Such experts, however, may not be properly integrated into new teams due to some lack of sharing team contexts. In other words, criteria for recruitment can be different from criteria for team performance. Thus, for management, it is important to compose and train team members so as to build up the SMM. In addition to such official methods for sharing team contexts, managers can also take advantage of diverse unofficial methods to increase the 'sharedness' of team contexts. Socializing could be a strong candidate for such approaches. Team maintenance is more important and challenging than team-building and composition for the sake of team performance in high turnover sectors, such as SW development.

Second, more generally, for business operating across countries (with different national cultures) or in one country with multinational teams of members from mixed national cultures, such as more individualist (i.e. western) and more collecivist (i.e. Asian). Managing such inter- and intra-team diversity is an important business issue.

Of course, some prudence is needed in generalizing our findings. First, the importance of high cognitive similarities, a SMM, does not necessarily mean teams should consist of members with identical backgrounds, skills or knowledge. The level of the SMM is not exclusive to the diversity of team members and we do not totally disregard the importance of member diversity. Actually, in our data the case with high cognitive and low demographic similarities recorded higher team effectiveness than the case with high cognitive and demographic similarities, even though their differences were insignificant. No matter how diverse team members are,

they should be aware of each other's expertise, can locate appropriate people and have common expectations regarding tasks and systems in teams. There is a distinction between the SMM and the uniformity of team members. Member 'sharedness' should be understood as being 'similar' not 'identical', that is, team members possess some amount of shared knowledge rather than knowledge content being identical. These results support Similarity-Attraction Theory with its emphasis on the importance of team member similarities for effectiveness. Our result that demographics did not influence team effectiveness may seem a little strong, but it may make more sense in Korean culture where demographic diversity is not as large as in western countries. Koreans go to college and take jobs at similar ages. Those with similar education have similar job preferences. In such cultural contexts demographic diversity is small and cognitive similarity is welcome in social relationships. Therefore, instead of insisting that demographics do not matter at all, we cautiously assume their importance could be more explicit in western cultures where more demographic diversity exists.

Therefore, we need to be careful not to underestimate the importance of demographic similarities. The main purpose of our study was to compare the relative impact of cognitive versus demographic factors on team effectiveness. Age, tenure and gender were used as they were more the general type of demographic variables than were racial or ethnic factors in organizational studies. Racial or ethnic issues are less provocative in Korea (with its ethnically homogenous population and labour force), and our study did not include them, so our results may be somewhat 'distinctive'.

Second, more examination is needed regarding the different roles of demographic similarities. Demographic variables could moderate the SMM's effect on team effectiveness. The possibility is plausible for tenure similarities because tenure is highly job-related, whereas age is more moot (Pelled et al., 1999). It was found that age similarities are unlikely to have much direct bearing on technical work, while it may produce similarities in general attitudes to work (Pelled et al., 1999). However, other studies regard age as a career-related attribute and employees tend to measure their own career progress by comparing themselves with co-workers in their age cohort. When age similarities increase in a group, and a team, these career comparisons, which can prompt jealous rivalries, often increase as well (Lawrence, 1988). Also, personality could be a candidate as an additional demographic characteristic in future studies.

Third, our measurement could be improved. Through a series of measurement item purifications some constructs lost their originally intended dimensions. In our study, team effectiveness consists of efficiency and

commitment, losing the measurement items for the quality of outputs and we shed items of the SMM. More comprehensive measures could be developed in future studies. Also, self-reporting about the level of the SMM and team effectiveness is not without problems. We are aware that this evaluation is subjective, so that the SMM and team effectiveness could have been exaggerated.

Fourth, the results of our study could be strongly related to particular types of team (i.e. SW development) and/or national cultures (i.e. Korean). Among various social demographic variables, only age and gender were considered. This was because they are quite influential in Korean culture compared to others, such as ethnicity and race. Educational background was excluded as well because most (97%) team members had more than a bachelor degree. In other national cultures different demographic variables may be considered when being compared to the SMM's impacts on team effectiveness. For instance, Gibson and Zellmer-Bruhn (2001) contend that the teamwork concept differs according to national culture. They found that countries with 'high power distance' (acceptance of unequal and hierarchical control) remind teams of tight relationships like the military or family. So, team members in such cultures, like Korea, expect clear roles in teams and appreciate high levels of 'sharedness' of team mental models. In our sample, members may feel comfortable where teams appeal to their expectations and images of teams. When teams run with clear roles and a SMM, our samples could work better or concentrate more on teamwork. In national cultures of 'low power distance' it is possible that other issues could surface that are more important than 'sharedness' of team mental models. In western cultures, where ethnic and gender issues may also be more significant, team composition or processes must consider diverse demographic issues that can influence team effectiveness, such as communication, commitment, satisfaction and performance.

Some characteristics of our sample, SW development teams, could influence our results. The IT industry, including SW development, has high labour turnover so that sharing a team's SMM can be critical and indispensable for at least maintaining some status quo in teams and teamwork. For Ancona and Caldwell (1992), in product development teams the most important diversity is the functional mix rather than demographic dimensions. Our finding advances this argument and implies that if such teams can share expectations with each other by enhancing a SMM, the merits of functional diversity can be further enhanced. Again, such positive effects of the SMM on product development teams are more explicit in national cultures of 'high power distance', like Korea.

Conclusion

Teams and teamworking remain popular but contested and debated concepts. For some, teamworking is key to many businesses as they grapple with global competition and the search for distinctive competitive capabilities. On the one hand, management could leave teams to 'self-form', but in reality they may often need encouragement or even to be forged. However, putting teams together and running them is rife with uncertainty – are teams better if membership composition characteristics are more similar or diverse? Of course, in some respects this may not be a real choice given the more heterogeneous nature of many workforces.

Our empirical study of SW development teams has shown that team member cognitive similarities (a SMM) are more important than team member demographic similarities (age, tenure and gender) for SW development team effectiveness. Indeed, such SMMs can over-ride the possible load of demographic similarities and remove managerial fears of this issue in composing teams for maximum effectiveness in an era of less homogeneous labour markets. For management this is a useful and practical finding when approaching the often thorny issue of team construction and also when teams are in high labour turnover sectors.

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Appendix A: Questionnaire

Items rated on a seven-point scale ranging from 1 (*strongly disagree*) to 7 (*strongly agree*).

The Shared Mental Model (SMM)

1. Members of the team have similar sources for problem solving in regard to technologies, equipment, and tasks.
2. Members of the team have similar standards in evaluating the importance of equipment required for tasks.
3. Members of the team have similar procedural knowledge about how the task is conducted.
4. Members of the team have similar understandings on the relationships between tasks.
5. Members of the team have similar senses of difficulty and challenge about the team project.
6. Predictions on task-related outcomes are similar among team members.
7. Team members have similar expectations on the penalties and tolerance of task-related errors and mistakes.

8. Team members have similar criteria on the judgement of task-related errors and mistakes.
9. Perceptions on the task progress are similar among team members.
10. The evaluative standards about teammates' strengths and weaknesses are similar among team members.
11. Team members in need of information retrieve information from similar sources.

Team commitment (TC)

1. I'm confident that I am loyal to my roles in our team.
2. I would accept any jobs in order to keep working in our team.
3. I am proud to say that I belong to our team.
4. I sincerely desire to see more progress of our team.
5. I think our team is the best to work with.

Team performance (TP)

1. Our team has efficient operations.
2. Our team adheres to work schedules.
3. Our team produces decent amount of output.
4. Our team rarely misses the project due date.
5. This team adheres to the project budgets.

Appendix B

Henderson and Lee's (1992) measure of team performance:

The following questions ask you to compare the XXX project team to other teams. In relations to other comparable project teams, you have served on or observed, how does the XXX project team rate on each of the following?

- The efficiency of team operations
- The amount of work the team produces
- The team's adherence to schedules
- The team's adherence to budgets
- The quality of work the team produces
- Effectiveness of the team's interactions with people outside of the team
- The team's ability to meet the goals of the project
- The team could have done its work faster with the same level of quality
- The team met the goals as quickly as possible.

Appendix C

Bishop and Scott's (2000) measure of team commitment:

- I talk up (brag about) this team to my friends as a great team to work on.
- I would accept almost any job in order to keep working with this team.
- I find that my values and the team's values are very similar.
- I am pround to tell others that I am part of this team.
- This team really inspires the very best in me in the way of job performance.
- I am extremely glad that I chose this team to work with over other teams.
- I really care about the fate of this team.
- For me, this is the best of all possible teams with which to work.

Hye-Ryun Kang is Professor of Management in the College of Business, Ewha Womans University. She holds a PhD in industrial and organizational psychology from Iowa State University. Her research interests include team effectiveness, shared mental models of knowledge workers, comparative human resource management, and women in management. She has published over 30 articles and authored several books. She serves as the university's Dean for Planning & Coordination and as a Vice-President of the Korean Academy of Management.
[E-mail: hrk@ewha.ac.kr]

Hee-Dong Yang is an Associate Professor in the College of Management at Ewha Womans University in Korea. He has a PhD from Case Western Reserve University in Management of Information Systems. He previously was an Assistant Professor at the University of Massachusetts, Boston. His research interests include mobile business, adoption of information technology, organizational impact of information technology, team mental model, and strategic use of information systems. His papers have appeared in the *Decision Support Systems*, *Journal of Strategic Information Systems*, *International Journal of Human-Computer Studies*, *International Journal of Electronic Commerce*, *Journal of Information Technology Management* and have been presented at many leading international conferences (ICIS, AMCIS, HICSS, Academy of Management, ASAC).
[E-mail: hdyang@ewha.ac.kr]

Chris Rowley, BA, MA (Warwick), DPhil (Nuffield College, Oxford) is Subject Group leader and the inaugural Professor of Human Resource Management at Cass Business School, City University. He is the founding Director of the new, multi-disciplinary and internationally networked Centre for Research on Asian Management, Editor of *Asia Pacific Business Review* [www.tandf.co.uk/journals/titles/13602381.asp] and founding Series Editor of 'Studies in Asia Pacific Business' and 'Asian Studies: Contemporary Issues and Trends'. Professor Rowley researches in a range of areas, including international and comparative human resource management and Asia Pacific management and business. He has published in *California Management Review, Journal of World Business, International Journal of HRM*, amongst many others, with over 100 articles, 80 book chapters and other contributions and 20 edited and sole authored books [www.cass.city.ac.uk/research/faculty.nsf/c.rowley]. He recently co-edited *Globalization and labour in the Asia Pacific* (2001), *Managing Korean business* (2002), *Management of human resources in the Asia Pacific region* (2003), *Globalization and competition: Big business in Asia* (2005), *Business and management in South East Asia* (2006) and *The changing face of Management in South East Asia* (2006), amongst others. He also authored *The management of people: HRM in context* (2003) and is writing *The practice of HRM in Asia*, *The changing face of management in Korea*, *The changing face of Asian women in management*, *Asian industrial relations: An enterprise case book*, *Trends in mobile technology & business in Asia* and *HRM: The key concepts* (all forthcoming in 2007). He wrote regularly for the *Financial Times*' series 'Mastering Management Online'.
[E-mail: c.rowley@city.ac.uk]