Exploring National Culture in Software Development Practices

Aileen Cater-Steel and Mark Toleman

Abstract

The software development industry has become globalised. Trends which have contributed to globalisation include the maturation of software industries in developing countries, collaborative teams covering extended geographic areas, and migration of computing professionals. This paper analyses the Australian computer professional workforce and determines that 40 percent of computing professionals were not born in Australia. Results from surveys about adoption of software development best practice conducted in 16 countries are then summarised and analysed using Hofstede's cultural dimensions. The discussion considers the efficacy of the concept 'national culture' in light of the analysis and concludes that information systems researchers need to reconsider what national culture is, and how it can best be measured.

Keywords

National Culture, Globalisation, software development best practice

1 Introduction

Software development has become a global activity and it is recognised that the business environment and culture varies from one location to another (Shore and Venkatachalam 1995). Dramatic improvements in software development tools and methods have also allowed geographically and culturally diverse developers to collaborate in global software development teams (Karolak 1998). Added to this, recent migration trends have resulted in a multicultural information communication and technology (ICT) workforce in Australia, and in other countries such as the USA, Great Britain and Ireland. The concept of *national culture* as defined by Hofstede refers to the collective mental programming shared by people which distinguishes the members of one nation from that of other nations (1980). To date, there has been limited research into the role of national culture in software development, and doubts raised about whether national culture, as defined by Hofstede, ever actually existed (Myers and Tan 2002). For example, cultural factors were identified by Paulish and Carleton (1994) as evidenced by differences in adoption of software process methods in Siemens sites in Germany and USA. In commenting on the fact that the capability maturity model integration (CMMI) and ISO 15504 have two dimensions, the process dimension and capability dimension, Biro, Messnarz and Davison (2002) call for a third dimension to CMMI and ISO 15504—the cultural dimension—because 'the national cultural position of the company may determine a different meaning and suitable improvement actions' (p. 36).

This paper explores the relevance of national culture solely in relation to the software development team. Other SE research has considered the role of national culture in relation to developing systems for a culturally diverse range of users, and the deployment, use and management of international information systems. Essentially, the study attempts to validate Hofstede's national culture dimensions for the case of software developers.

In the next section (§2), the emergence of a multicultural software development industry is discussed and the Australian computing professional workforce is analysed to determine the extent to which recent immigration trends have impacted. In §3, the results from a software development best practice survey carried out by the European Software Institute (ESI), and replicated in Queensland are used to highlight variations in the adoption of software practices across 16 countries. Following the approach of Biro, Messnarz and Davison (2002), Hofstede's (1980) five generic factors which characterise value systems in different national culture dimensions are described in §4 and used to explore the relationship between the ESI survey results and the cultural dimensions. The discussion (in §5) focuses on the outcomes of the immigration analysis and survey analysis, in particular highlighting limitations in the concept of national culture and its shortcomings in explaining issues in software development. The conclusion (§6) suggests directions for future research.

2 Multinational Software Development

Three recent trends have necessitated the consideration of the effect of national culture: the globalisation of the software industry; geographically dispersed collaborative software development teams; and migration of software developers.

2.1 Globalisation of Software Industry

Over the last decade, global development efforts have become the industry norm rather than the exception (MacGregor et al. 2005). Previously, systems were either developed locally, or software development was carried out in countries with relatively mature software industries. With the recent liberalisation of markets and economic progress in many developing nations, emerging countries such as India are increasing in software development capability, and gaining a greater share of the international market (Costlow 2003).

In order to maintain a role in the domestic and international market, software firms are under pressure to comply with recognised software process improvement programs such as the CMMI, which was developed by the Software Engineering Institute (SEI) at Carnegie Mellon University in Pittsburgh. CMMI has gained international acceptance in the software development community: of the 87 CMMI appraisals performed up to mid 2003, only 39 were carried out in the USA (Phillips 2003). Third party assessments of software development processes provide evidence to investors and customers of the firm's commitment to software quality (Saran 2001). Increasingly, large Australian software purchasers, such as the Defence Materiel Organisation (DMO), Telstra and ANZ Bank, are recognising CMMI benchmark results when selecting their suppliers (Howarth 2004).

Countries such as Australia and India are adopting standards such as the US-based CMMI in order to be competitive. Consequently, local development firms 'must struggle with systems development methods created in other countries' (Shore and Venkatachalam 1995, p.5). As well as taking into account the variation in national cultures, Krutchen (2004) believes 'everyone knows the difficulty of adapting technology and methods to other cultures' so the variation in adoption of specific software development practices across different countries should come as no surprise. The cost and complexity of the CMMI sets a high hurdle for domestic firms to overcome: 'the Standard CMMI Appraisal Method for Process Improvement (SCAMPI) audit process is rigorous and intense. Accenture, for one, reported spending 8045 hours—six months' solid work for a team of eight—implementing the CMMI Product Suite … IBM's CMMI Level 5 certification required a review of 1100 developers in four cities, testing compliance with 425 distinct CMMI practices; its SCAMPI audit required five weeks' work from a team of nine auditors' (Braue 2004).

Large multinational corporations need to balance their systems to accommodate the local needs of host organisations, as well as the centralised needs of headquarters (Cheung and Burn 1994). It has been determined that critical success factors for IT vary, depending on geographic region, therefore, it is important for multinational corporations to understand the different sets of issues so that management can take appropriate actions to achieve success (Khandelwal and Ferguson 1999).

2.2 Collaborative Teams

It has been claimed that the use of widely dispersed collaborative teams is prompting a radical change in the way software is developed (Karolak 1998). Promoted as a just-in-time approach, organisations such as Bangalore-based Infosys provide low-cost, world-wide application developers and use Internet-based, open-source tools to create application development teams in collaboration with their clients' IT staff (McCarthy 2003). Such teams are able to respond quickly when new applications are required urgently, in contrast to in-house development projects which are often delayed due to the organisation's systems development backlog.

2.3 Australian Multicultural IT Industry

In response to a skills shortage, Australia's immigration policies were changed in 2001 to encourage overseas ICT professionals. This policy change was reversed in 2003 as it became apparent that the skills shortfall had been grossly overestimated and migrants were competing with unemployed locals for a shrinking number of IT positions (AAP 2003).

As a result of the approval of permanent and temporary visas, the Australian IT industry now has many computer professionals from a wide range of birthplaces. An analysis of the 2001 ABS Census revealed that 40 percent of computing professionals, 35 percent of IT Managers and 32 percent of Computing Support Technicians were not born in Australia. (ABS 2005)

The majority of permanent and temporary migrant computing professionals recorded their birthplace as Asia (41%) or Europe (35%). Considering the relative populations of areas, the proportion of migrants from New Zealand (6%) is very high, probably due to its close proximity, common language and similar culture to Australia. Of the remainder, the breakdown was Africa (6%), America (5%) and other (7%).

The proportion of migrant IT workers has increased since the 2001 census. In the two years from July 2003 to June 2005, 18,000 Computing Professionals were granted skill stream visas (Vanstone 2005), and in the last financial year, a further 3,379 temporary skilled visas were awarded to IT workers (Bajkowski 2005). Consequently, the multicultural diversity of software development teams in Australia has increased substantially.

Although organisations have been undertaking software development activities for many years, the lack of implementation of local or international standards and curriculum has resulted in a wide variation of practices in use. This variety in software development practice has implications for organisations purchasing software, off-shore outsourcing, and collaborative teams with diversity in terms of geographic location or multicultural members. The next section reports on the results of surveys used to determine the variation in adoption of best practice in software development.

3 ESI Best Practice Survey

Although many authors refer to software developers using dominant, prevalent, or common practices, there has been little research to date to document actual current use. The most widely reported survey of best practice in Europe was that conducted by the ESI (Dutta et al. 1998b; ESI 1996). In 1995, the European Commission launched the European Systems and Software Initiative (ESSI) program with the aim of motivating organisations to test and deploy software best practices. The ESSI program was administered by the ESI as part of the European Commission's Information Technologies program (Dutta et al. 1999). Organisations were encouraged to apply for funding to enable them to adopt a specific software process improvement (SPI) project in a real-life commercial environment. The ESSI program included a longitudinal study of European software practices to assess and monitor the level to which European software developers were adopting best practices.

The ESI developed the Software Best Practices Questionnaire (SBPQ) to collect data for the ESSI program. Previous research in software process improvement and popular models such as the CMM, Bootstrap and ISO 15504 influenced the development of the questionnaire. On three occasions (between 1995 and 1997), the questionnaire was distributed by the ESI as part of the call for proposals for ESSI funding. Respondents were explicitly informed that the questionnaire was independent of the funding proposal review process (Dutta et al. 1999).

A best practice is defined as 'a management practice that is widely recognised as excellent and is recommended by most practitioners and experts in the field' (ESI 1997). The SBPQ represents the 'subjective consensual views of multiple experts' (Dutta and Van Wassenhove 1997), and comprises a subset of core software development practices including organisational issues, standards and processes, metrics, control of the development process, and tools and technology.

The content of the questionnaire has been criticised on two counts by Dutta and Van Wassenhove (1997): firstly, it overlooks important issues related to organisational and acquisition management; and, secondly, it does not include practices associated with high maturity organisations (for example, CMM level four and five practices).

However, despite its shortcomings, the ESI study yielded valuable findings from the analysis of the 1,279 responses received over three years. There were 463 responses to the first survey in March 1995 from 17 countries (ESI 1996). The second survey was conducted in mid 1996 and received 488 responses from 17 countries (ESI 1996). The third and final survey in 1997 generated 397 responses (ESI 1997) and showed 'wide variation in both awareness and application of process improvement techniques' (Dutta et al. 1999). On average, the respondents had adopted 51 percent of all practices. The difference in the average adoption varied markedly, as detailed in table 1: firms from the United Kingdom and France showed the highest overall adoption rates, while Sweden and Spain had adopted the lowest proportion of practices.

For specific practices, adoption varied greatly from one country to another. For example, while 83 percent of Norwegian firms establish a change control function for each project, only 20 percent of Belgian organisations have adopted this practice. Both Belgium and Denmark scored an average of 53 percent for maintaining awareness of CASE or other new software development technologies compared to only 8 percent of Irish firms. While Spain scored poorly on most practices, it was the

leader for controlling estimates, schedules and changes, and also obtaining signoff from all parties before changing plans (Dutta et al. 1999).

Table 1. Best Practice average adoption for each country– overall and for each group of processes. Source: (ESI 1997).

Country (N)	Org. Issues	Standards & Processes	Metrics	Control	Tools	Overall Average Adoption
Queensland Australia (205)	48	54	35	49	47	48%
Austria (16)	66	50	42	60	46	53%
Belgium (15)	52	41	40	46	40	43%
Denmark (17)	64	53	46	63	53	55%
Finland (4)	63	56	50	54	50	55%
France (18)	72	62	61	76	58	65%
Germany (62)	55	48	43	52	47	49%
Greece (18)	63	57	49	65	50	57%
Ireland (12)	51	43	36	51	45	45%
Israel (11)	57	47	38	55	34	46%
Italy (77)	57	52	50	61	40	52%
Netherlands (30)	57	49	41	51	48	49%
Norway (6)	60	53	44	61	48	53%
Spain (34)	53	44	36	57	35	44%
Sweden (13)	38	36	25	33	26	32%
U.K. (52)	66	63	52	67	50	60%

(Note ESI results are from 1997 survey. Countries with less than 4 responses were omitted.)

The ESI survey was replicated as a mail survey in Queensland in 1998. The intention was to conduct the survey initially in Queensland, then later in other Australian states. The survey returned 205 responses from organisations which develop software for sale or for internal use. As shown in table 1, the average adoption of 48 percent by Queensland firms is lower than that reported by 10 of the listed countries in the final ESI survey, but higher than Belgium, Ireland, Israel, Spain and Sweden. Queensland organisations showed strength in the use of standards and processes (54% adoption), but were very weak in the application of metrics (35% adoption).

As world class standards are dynamic, the set of practices considered to be the *best* changes over time, especially in software development which has frequently adapted to changes brought about by evolution of technology (Finkelstein and Kramer 2000). With the passing of time, best practice becomes standard practice as other superior practices emerge (Cragg 2002). Recently, agile software development methods have been promoted as best practice. Proponents of agile methods would compile a different set of best practice techniques, focussing on customer satisfaction and early incremental delivery of software; small highly motivated project teams; informal methods; minimal software development work products; overall development simplicity stressing delivery over analysis and design; and active and continuous communication between developers and customers (Pressman 2003).

The best practice questionnaire heavily emphasises project management, but has no practices relating to risk management, measurement, validation, joint review or audit. The questionnaire does not include Beta test management, an important process for firms developing packaged software. Jones (2003) notes that Beta testing has been used since the 1960s, and Cusumano et al. (2003) reported its widespread use at 73 percent. Therefore, it is recognised that the items from the ESI questionnaire may not provide an entirely valid measurement of best practice across the industry. This point is acknowledged by the ESI: 'progress in software engineering may not be visible along dimensions measured in the survey' (ESI 1998, p. 29).

Another issue to consider is that software practices may have changed significantly in the six years between the design of the ESI questionnaire and its use in the Queensland survey. For example,

reuse is now recognised as one of the most valuable software development practices (Mili et al. 1995) but is not included in the ESI questionnaire. So while longitudinal studies such as that undertaken by the ESI are valuable in mapping the take-up rate of recommended techniques and practices, the data collection tools need to be kept up-to-date while still providing comparative data.

The results of the ESI survey highlight disparities across a range of 16 countries in terms of their adoption rates of software development best practice. The next section explores the potential role of national culture in explaining such differences.

4 Analysis of Adoption by Country

The difference in the ESI best practice adoption levels across Europe raises the question of national cultural issues, which has been briefly explored by Dutta, Lee and Van Wassenhove (1998a) who used Ronen and Shenkar's (1985) national culture clusters to compare adoption of clustered countries. Dutta, Lee and Van Wassenhove (1998a) observed that Germany and Austria behaved similarly; however, with respect to Scandinavian countries, they found considerable variance warranting further research. The clusters derived by Ronen and Shenkar measure work goals, values, needs, and job attitudes and are named Anglo, Germanic, Nordic, Latin European, Latin American, with Australia classed in the Anglo cluster along with United Kingdom, Ireland, USA, Canada, New Zealand and South Africa (Mahoney et al. 2001).

Hofstede's initial research was based on the analysis of 116,000 IBM employees from more than 50 countries surveyed over 6 years from 1967. His results have been applied by researchers and verified by many replications (Hofstede and Hofstede 2005). In defending the strength of the underlying theory of static national culture in the face of global use of email and other technology, Hofstede and Hofstede believe 'the software of the machines may be globalised, but the software of the minds that use them is not' (2005, p.330). A dimension is defined as 'an aspect of culture which can be measured relative to other cultures' (Hofstede and Hofstede 2005, p.23) and the five dimensions are explained in table 2.

Table 2. Hofstede's dimensions (Mahoney et al. 2001)

Dimension	Low Score Value	High Score Value
Power distance	society de-emphasizes the differences between citizen's power and wealth	inequalities of power and wealth within society
Individualism vs collectivism	collectivist nature with close ties between individuals	individualism and individual rights are paramount
Uncertainty avoidance	tolerance for variety of opinions, less concern about ambiguity, uncertainty	low tolerance for uncertainty and ambiguity
Masculinity vs femininity	value social relevance, quality of life, welfare of others	aggressive goal behaviour, high gender differentiation, males dominate
Long term vs short-term orientation	place less emphasis on hard work, perseverance	embraces long-term devotion to traditional, forward thinking values

The scores for each of Hofstede's five dimensions for the countries where the ESI best practice survey was conducted are listed in Table 3.

In relating Hofstede's dimensions to the adoption of best practice techniques, it could be expected that higher adoption may be associated with low uncertainty avoidance (willingness to adopt new techniques), and low individualism (conformance to group working practices). Hofstede's scores indicate that Australians, as shown in Table 3, compared to others, have low uncertainty avoidance (would be quick to adopt innovations) but high individualism (resistant to standard work practices) (Mahoney et al. 2001). To investigate if an association exists between the dimensions and the adoption of best practice, Pearson's correlation tests were performed, based on the data in tables 1 and 3.

Table 3. List of relevant Hofstede Dimension Scores for each dimension by country (Hofstede and Hofstede 2005)

Country	Power Distance	Individualism	Uncertainty Avoidance	Masculinity	Long term orientation
Australia	36	90	51	61	31
Austria	11	55	70	79	31
Belgium	65	75	94	54	38
Denmark	18	74	23	16	46
Finland	33	63	59	26	41
France	68	71	86	43	39
Germany FR	35	67	65	66	31
Great Britain	35	89	35	66	25
Greece	60	35	112	57	Not available
Ireland	28	70	35	68	43
Israel	13	54	81	47	Not available
Italy	50	76	75	70	34
Netherlands	38	80	53	14	44
Norway	31	69	50	8	44
Spain	57	51	86	42	19
Sweden	31	71	29	5	33

Before discussing the analysis, it is important to recognise some differences which exist between Hofstede's populations and those involved in the ESI surveys. Firstly, Hofstede's score for Great Britain was used in the analysis with the United Kingdom ESI survey data, although it was not reported if any Northern Ireland firms responded to the ESI survey. Secondly, Hofstede's score for Germany relates to the time period when Germany was divided and represents the west area (FR) whereas the ESI data was collected from a united Germany. Finally, Hofstede's score for Australia was used in the analysis with the survey data collected from Queensland as it was considered that the Queensland responses were representative of the Australian software development population.

As shown in table 4, no significant correlations were identified of best practice adoption with any of Hofstede's dimensions. Therefore, Hofstede's theory is not validated for the case of software development organisations across 16 countries. The next section discusses reasons for the lack of correlations, the sample upon which Hofstede based his theory, and also the notion of national culture.

Table 4. Pearson Correlation test results Hofstede's dimensions and Best Practice adoption.

Hofstede's Dimensions		Org. Issues	Standards & Processes	Metrics	Control	Tools	Overall
Power Distance	Pearson Correlation	.058	.141	.349	.216	.126	.172
N=16	*p* (2-tailed)	.831	.604	.185	.421	.643	.524
Individualism	Pearson Correlation	-.170	.120	-.001	-.154	.154	-.001
N=16	*p* (2-tailed)	.530	.658	.997	.569	.569	.997
Uncertainty Avoidance	Pearson Correlation	.247	.092	.295	.289	-.005	.187
N=16	*p* (2-tailed)	.357	.735	.267	.278	.985	.488
Masculinity	Pearson Correlation	.169	.170	.190	.244	.108	.211
N=16	*p* (2-tailed)	.531	.530	.480	.362	.691	.433
Long Term Orientation	Pearson Correlation	.171	.043	.177	.019	.417	.158
N=14	*p* (2-tailed)	.558	.885	.544	.949	.138	.590

(Note: Long term orientation dimension scores were not available for Greece and Israel)

5 Discussion

This study raises doubts about whether it is reasonable to expect that software development best practice adoption would be related to Hofstede's national culture dimensions. Other researchers have successfully applied Hofstede's scores in IT related research, for example, Frank et al. (2001) found evidence that innovativeness correlates with low uncertainty avoidance in a study of the adoption of mobile technology across Finland, Germany and Greece; and more recently, Borchers (2003) applied Hofstede's theory to understand project problems experienced by project teams of Indian, Japanese and American software developers.

In recent years, Hofstede's analysis and model have drawn criticism (McSweeney 2002). One of the issues raised by Myers and Tan (2002) and other researchers concerns the ability to generalise Hofstede's scores, considering the limited demographic variation in the population surveyed: the survey data was mainly from male employees of one multinational organisation (IBM) and severely limited in terms of the range of ages of respondents. Although the proportion of female computing professionals in Australia is low at 22 percent (ABS 2005), Hofstede's sample did not accurately represent female workers. Another related issue, also explored by Myers and Tan, is whether national culture remains static—as claimed by Hofstede—or contested, temporal and emergent as claimed by Kahn (1989)

The diversity of birthplaces in the Australian workforce of computing professionals (presented in §2) provides support for the temporal and emerging nature of national culture, influenced by changes in the ethnic and racial mix of the population. It is suggested, therefore, that Hofstede's sample of Australian IBM male employees from 1967 to 1973 may not represent the diverse workforce which exists in Australia today, and which is gradually changing as more migrants are employed in ICT positions.

Hofstede maintains that although people may have similar occupational and organisational culture, as evidenced through similar practices, national culture is about deeply held values and is part of the mental software acquired from family and school during the first ten years of life (Hofstede and Hofstede 2005). This issue has been explored by Shore and Venkatachalam (1995) who recognise that organisational culture may play an intervening role in the influence of national culture on organisational behaviour. Therefore, the disparate rates of adoption by country found in analysing the ESI survey results (in §3) may be caused by factors other than the deeply held cultural values. For example, the practices used by firms may originate from the methods and techniques taught in the curriculum of local colleges and universities, or individual government purchasing policies promoting various methodologies such as CMM. Factors such as these may foster standardisation within the local industry, but may be the source of variations when comparing diverse geographical groups of software development firms. The ESI best practice survey, although providing a valuable snapshot of the state of practice in many countries, was designed to measure behaviour, not culture. Culture is very difficult to measure and it has been recommended that in-depth case studies, discourse analysis and ethnographies are required rather than surveys (Myers and Tan 2002; Sharp et al. 2000).

6 Conclusion

The software development industry has become globalised due to trends such as the maturation of software industries in developing countries, collaborative teams covering extended geographic areas, and migration of computing professionals. Multinational corporations, software purchasers, firms undertaking off-shore outsourcing, and firms with teams of local or distributed developers all need to be aware that practices used by software developers vary according to geographic location, in the same way senior managers need to be aware of local business practices in negotiating contracts with international business partners.

The migration analysis provided a profile of the multinational nature of the Australian computing workforce. This workforce analysis provided evidence for the argument to view national culture as temporal and emergent, rather than the notion that national culture is static. Furthermore, the correlation analysis failed to prove a link between any of Hofstede's cultural dimensions and practices

surveyed in the ESI best practice survey representing 16 countries. Consequently, researchers are advised against the use of simplistic frameworks such as that espoused by Hofstede, and are encouraged to explore the concept of national culture with appropriate research methodologies.

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