The impact of socio-cultural differences on the management of technical error: Are engineering graduates aware of this?

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***Abstract**: A great deal of literature exists related to what an individual should do if they make technical errors at work, but what should they do if their supervisor or manager is the person making the mistake? This paper investigates the socio-cultural influences on the way engineers respond to the above scenario. Whilst research has been undertaken on leadership, manager-employee and supervisor-supervisee relationships in a variety of sectors including education, health care and hospitality, no such studies have been carried out in the engineering sector. Engineers, in general, are not aware on the importance of social and cultural dimensions of their work because they are not seen as a 'technical problem'. Engineering education is largely restricted to technical analysis and students learn very little on how engineering work is practiced. However, engineering education and engineering practice are very much interrelated. It is hoped that by better understanding of the work of engineers, further steps can be taken to improve the quality of engineering education, bringing it closer to engineering practice. Activities such as role-play could be used to engage students and better prepare them for the "real" world. Qualitative research methods used in this study are based on data from interviews and field observations with engineers in Brunei and Western Australia. This paper will discuss preliminary analysis of this data.*

Introduction

The Supreme Court of New South Wales handed down a decision on March 8, 2010, which is significant to engineers, particularly structural engineers. The collapse of the first floor ceiling, which resulted in injuries to people, was caused by "inadequately sized and poorly fixed screws" used to install the ceiling. However, it could have been prevented if the pre-incident written report instruction was clearer and more specific (*Al Mousawy v Howitt-Stevens Constructions Pty Limited & Ors, NSWSC 122*, March 8, 2010). Practising engineers, regardless of discipline, need to be aware that they could make similar mistakes in their engineering work. A graduate or even a senior engineer could generate this mistake.

There is evidence in the literature on what an individual should do if they make mistake(s) at work (A. Edmondson, 1999; A. C. Edmondson, 2004), but not relating to the field of engineering. While there have been some very interesting and thorough accounts of engineering practice, for example, see the

work of (Barley, 2005; Kilduff, Funk, & Mehra, 1997; Lam, 1996; Lee, 1994; Trevelyan, 2007, 2008), no evidence can be found in the literature relating to engineering practice on what an individual should do if their supervisor or manager were to make the technical error.

The authors did not intentionally set up to collect data to determine what engineers do when their supervisors make mistakes. However, these phenomena arose in the course of the study on engineering practice in Brunei in which qualitative ethnography, semi-structured interviews and field observations were carried out. Participants were interviewed on their engineering studies experiences, continuing education or training and to elaborate in detail on their existing and past work experiences. The participants represent a range of engineering disciplines, industries, ages and years of professional experience. This research is part of a wider on-going study of engineering learning and practice, conducted in School of Mechanical Engineering at the University of Western Australia.

This study is especially important for policy makers dealing with engineering education, practising engineers and particularly engineering academics. By having a clearer picture, engineering academics and policy makers can adopt suitable pedagogy to better prepare the students for the real engineering work. This will, to some extent, narrow the gap between engineering education and engineering practice.

The following section presents the methods section, which explores the research setting and participants. This is followed by explanation on the data collection and how analysis of data is done. The result and discussion section presents participants experiences when dealing with mistake(s) made either by themselves or by their supervisor or manager. Finally, the conclusion section explained why this study is important and how it is related to engineering education.

Research Methods and Participants

A qualitative study design was selected because it is suitable for the exploration of the complex role of social phenomenon (Moffatt, White, Mackintosh, & Howel, 2006). A flexible data collection using semi-structured open-ended interviews was selected to allow the participants to speak freely, permitting emerging issues to be further explored. The participants were interviewed on their engineering studies experiences, continuing education or training, how they deal with mistakes made by their supervisor or manager or by themselves, and to elaborate in detail on their existing and previous work experiences. Beside interviews, field observations were also carried out to monitor social patterns, communication, behaviour and interactions. Some engineers were observed to triangulate the interview data and to develop a deeper understanding into their work. The sample of engineers (n=34) consists of male and female practising engineers from Brunei and Australia working in various disciplines: Telecommunication, Military, Electrical, Mechanical & Electrical (M&E), Sales/Manager, Oil & Gas, and Radio & Television (Broadcasting). Out of the thirty-four engineers interviewed, only three were female engineers from Brunei. Brunei Darussalam is a multiethnic society, comprises of a mixture of foreign and local workforce. The participants in our study included Brunei and Malaysia Malays, Brunei, Malaysia and Singapore Chinese, Australians, and an engineer from India. Brunei, Malaysia and Singapore share some cultural similarities. The population of Brunei is estimated at 401,000 (2009 IMF data). About 66 per cent are Malay while a further 11 per cent are Chinese.

Data Analysis

All data from interviews and field observations were digitally recorded. The duration of interviews ranged between 1-1.5 hours and a total of ten engineers were observed for approximately three days each over a period of two months. The digital audio files were transcribed verbatim into text. A software program frequently used in qualitative research, ATLAS.ti version 5.5, was used to analyse the interview transcripts and notes from field observation, followed by labelling of descriptors, coding to reveal coding descriptors and grouping them into categories. A system of constant comparison was used, making comparisons and connections until no further codes can be identified and the data was considered to be saturated.

Result and Discussion

Hughes (1951, p. 320) outlined that work carried out by humans are subject to mistakes and failures, regardless of how competent the individual is. Although this study focuses on the behaviour of engineers when the supervisor or manager makes mistakes, it is equally interesting to understand their course of action when they themselves make the mistakes. Senior engineers or those in managerial position are not exempted from making mistakes but it is more likely for junior engineers to make the mistakes due to their lack of experience. Before evaluating the interview outcomes of the participants on how they deal with mistakes made by their supervisor or manager, it is worthwhile to evaluate how they deal with the technical mistakes they made themselves. Some of the participants would consider the seriousness of their mistakes before deciding on whether to inform their supervisor or manager or not. Most would report serious mistakes while less serious mistakes tend to be ignored or dealt with discreetly. However if safety is compromised, all participants said they would inform their supervisor or manager.

> *Safety cannot be compromised in any scenario. If it is serious, it must be communicated to your* supervisor or manager *at once, he/she may be grateful for you being able to identify the fault. .*

Some participant would inform their supervisors or managers of the mistakes in private, whereas others might take a direct approach.

1. *I would inform him privately about the mistake and work with him to come up with the best solution.*
2. *...just bluntly tell him [supervisor or manager] as I have the knowledge and expertise on this matter*

The latter approach may result in the supervisor or manager being defensive, especially if mentioned in front of others. Those (especially middle or senior level engineers) who choose this approach say they are comfortable with this approach because they have a good relationship with their supervisor or manager and understand what their supervisor or manager are comfortable or uncomfortable with. This is somehow contrast to when junior engineer tries to inform their supervisor or manager.

> *I had an experience where I was asked to remove critical safety equipment to save costs. I approached him [*supervisor or manager*] and asked directly if it was a mistake... I disagreed... [might] cause a major hazard to the people staying in the vicinity. In the end... I was eventually fired from the company.*

Some Southeast Asia cultures emphasis on relationships, on personal ties, as the basis of working together for a common end however it is uncommon to share with others one's failures (Young, 2002). Hofstede (1983, 1993) label this as national cultures with a high power distance. Hofstede is well known for his research done in fifty countries and three regions and his five dimensions. There were initial concerns by some of the participants as to the revelation of their identities if they were discussing the errors or co-workers. Once reassured that the anonymity of the participants is paramount, the participants were willing to share their experiences. Two types of engineers were identified: those who are willing to announce, correct and improve and those who keep quiet and hope that the problem will 'go away' and the blame shifted to others. One junior engineer participant in the latter category quoted,

> *I recently realised I had made a mistake in a previous project which was not spotted by anybody. I had forgotten to put switches for a few overhead projectors. As the project was already completed, I did not raise it as an issue. Also, the contractor had made some changes to the design which the client approved but was not reviewed or rectified by my company at the time so it was 'hidden' so to speak. The outcome was that the projectors would tend to overheat but everybody thinks it's the contractors fault, I hope!*

From the study, most participants appear to fall in the first category. They are keen to admit their mistakes and would rectify them without fearing their supervisors or managers; possibly some were trained to do so while others learned from experience.

> *If I have made a mistake, I would admit/address it and rectify it so as to avoid any damage or further consequences.*

The nature of the organisation may influence which category the participants fall into. Where work is related to health and safety, there is likely to have a mandate to inform the supervisor, manager or higher authority when there is a compromise on either health or safety.

Most of the participants did not feel that race, religion, age, and gender have much influence over their decision whether or not to tell their supervisor or manager of the latter's technical mistake. However, in Chinese culture, there is the concept of '*Mianzhi'* which means 'giving face' when interacting with someone of a higher rank (Buttery & Leung, 1998). Junior employees would not contemplate drawing attention to their supervisor's or manager's mistakes due to this reason. This concept is almost similar to the Malay culture, which is common in Malaysia and Brunei. Respect for the elders or those in higher rankings take precedence in any process (Abdullah, 1992). Hence, it was anticipated that many engineers in Brunei might not be willing to share 'sensitive' information due to the nature of their culture, relative to their more out-spoken Western counterparts. Not surprisingly out of the thirty-four participants, only nine participants from Brunei were willing to share 'sensitive' information.

Some participants commented that they would contradict the supervisors' or managers' only if deemed necessary, avoid offending everyone not just the supervisors or managers and informing them in an appropriate manner. Could good communication skills assist in this problem of how to deal with errors in the work of others? Bowden (2004) argues that only when related to subject matter are communication skills relevant. If this is the case then it suggested that it is crucial to be competent in both technical and non-technical skills. In fact, Trevelyan (2007) suggests that this is a false dichotomy and that being a competent practising engineering involves 'technical coordination' – a practice where communication skills are inextricably linked to and entirely necessary for successful engineering practice. Non-technical skills such as communication may become a challenge once the junior engineer starts working with 'people', instead of 'nuts and bolts because these skills may not have been taught in the engineering curriculum (Tang & Trevelyan, 2009). Many participants found attending relevant courses helped them to cope with these challenges. Participants claimed that effective communication, motivation, appropriate people skill, teamwork and refreshing one's mindset might be achieved through various workshops.

- *...[I]n the University, we were not taught how to manage and give orders to other people or how to work with subordinates and superiors - supervising and negotiating skills.*
- *I went to the workshop called 'Recognising Your Inner Self'. After that I realised the importance of teamwork and that being egoistic will not solve any problem...*

Many participants felt that it was easier for one to accept criticism from a colleague with similar or more experience than from a junior engineer. Their years of engineering experience also determine if they are likely to speak out should their supervisor or manager make a technical mistake.

One of the participants, a junior engineer, commented that the superiors/managers might not be appreciated the new creative ideas by, especially if it is from a junior engineer.

> *...I reckon that younger engineers are more willing to try out new techniques or be creative. But as time goes by, it is not rewarding to be creative. As one of my seniors put it, it's better to stick to the same things so that you will not make mistakes! I was designing a lighting layout for a relatively high profile public building. I wanted to put in some interesting ideas I had studied in university but was told the above. Bear in mind that budget was adequate. The senior engineer basically wanted to go with the very tried and tested fluorescent tubes where as I wanted to go with down lights.*

A number of participants felt disappointed that some Bruneian has more confidence in the foreign engineers working in Brunei rather than Bruneian engineers. According to one participant:

> *...[T]he local senior management in the government and private sector always believe that the local Brunei engineers are incompetent and inexperienced. They often ask whether you are from Singapore or Malaysia, instead of believing the local Brunei engineers.*

Conclusion

To summarise, no participants in our study followed any set rules or procedures when dealing with supervisor or manager who has made a technical error. It really depends on the seriousness of the error, the risks involved, if the errors were notified and the relationship between supervisor-supervisee or employer-employee.

This study is an attempt to understand what engineers actually do, based on accounts given by practising engineers. Managing errors is a learning process regardless of whether you are a Supervisor, Manager or Graduate Engineer. With more exposures and experiences, one will be better equipped in dealing with similar scenarios in the future. It is hoped that by better understanding of the work of engineers, further steps can be taken to improve the quality of engineering education, bringing it closer to engineering practice.

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