# The paradigm of knowledge acquisition and social capital in engineering education: empirical research from Taiwanese universities

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ABSTRACT: In this article, the authors discuss the impact of the social capital of engineering education in Taiwanese universities with regard to external knowledge acquisition. Firstly, the focus is to address related theories and established basic assumptions. Secondly, the research implements an empirical survey on 203 chairpersons of departments of engineering at Taiwanese universities. The results indicate that the structural dimension and the cognitive dimension of social capital in universities and external organisations has an impact on the relational dimension; the structural dimension and cognitive dimension directly influence knowledge acquisition. In addition, the relational dimension also has an indirect effect upon knowledge acquisition.

## INTRODUCTION

### Research Background

The knowledge economy, in recent years, has been inspired by the American experience and has generated great value. Knowledge has now become a useful tool for organisations to expand their horizons and a source for innovation [1]. Knowledge acquisition is either self-developed or acquired externally. External knowledge acquisition fits the principle of specialisation and labour division [2]. It is the focus of this paper to address relevant issues concerning knowledge acquisition.

Tacit knowledge is difficult to acquire through market mechanisms and it is easy to result in insufficient knowledge exchange [3]. The dilemma of knowledge exchange could be solved by utilising elements of social capital, such as network relations, trust and mutual perception [4]. Several studies have also supported the enhancement of social capital to effectively promote knowledge acquisition of organisations [5][6]. Discussions on social capital is the second issue addressed in this research.

Engineering education consists of professional and general courses; it also emphasises the integration of these two courses [7]. The development of engineering education courses also includes social, technology and science (STS) contents. With respect to the social dimension, the key aspects include human interaction, trust and norms; on the other hand, the science and technology dimensions place emphasis on knowledge acquisition and innovation [8]. Thus, education contents and course development should also be considered when addressing social capital and the knowledge acquisition of engineering education at universities, which another issue tackled in this article.

### Research Objectives

This research discusses engineering education, social capital and knowledge acquisition through an empirical survey on Taiwanese universities. The three research objectives are:

- Discussing relevant issues of social capital and knowledge acquisition, and building a research paradigm;
- Addressing the current status of social capital and knowledge acquisition in engineering education at Taiwanese universities, and any correlation;
- Establishing a casual model of social capital to knowledge acquisition in order to realise the impacts between and among each variable.

## LITERATURE REVIEW

The literature review seeks to elaborate on the role of social capital and knowledge acquisition in each dimension.

### The Meaning of Social Capital

The term *social capital* was initially proposed by Lyda J. Hanifan in 1916 in his study on the function of communities; in 1990, its application was extended to the field of public policy study [9]. However, in recent years, social capital has been used with regard to education, enterprises and knowledge management. Relevant paper discussions have grown in both quantity and quality, and become an important research topic [10][11].

The definition of social capital is examined from the viewpoints of technology, behaviour motivation, economic development and ties [12]. Social capital refers to behaviours to maintain interpersonal relationships, relationship structures in groups, and the linkages that exist between these two. It also includes

egocentric variants of such networks, with an emphasis on external relationships and the socio-centric whole-network, with a focus on ties within the group [10].

Social Capital Research Dimensions

Due to multiple dimensional features, the research dimension of social capital varies [6]. For example, Spellerberg put his focus on contact, communication, sharing, cooperation and trust [12]. Beugelsdijk, Noorderhaven, and Koen emphasised the whole network, business position in the network, type of ties, trust, open communication and common solution to solve problems [13]. Westland believed that social capital is composed of networks, norms, values, preferences and other social attributes and characteristics [11].

Nahapiet and Ghoshal, in their study on the creation of social capital and intelligence capital, categorised social capital into three dimensions, namely: structural, relational and cognitive [14]. These provide benefits through resource exchange and combination, the creation of value, and the building of long-lasting competitive advantages. The content of each dimension is illustrated as follows.

- The *structural* dimension involves the social interaction ties of the dealer, the position in the network as an information provider and the ties between the dealer and the information provider for determining the quantity and quality of information used by the dealer [6]. The structural dimension also covers the position to engage the dealer in social interaction, bringing the dealer some advantages. Therefore, the relation between engineering education at universities and external organisations is regarded as the social interaction and ties in this dimension [5]. Universities work with enterprises through this external network of ties.
- The *relational* dimension involves the concept that, through mutual interaction, human relationships have been built, and assets have thus been created and utilised through that relationship [15]. The relational dimension has an impact on qualitative assets, especially trust and trustworthiness [14]. It emphasises respect, trust, trustworthiness and friendship, which are highly valued in human relationships [5]. As a result, the relations between engineering education and external enterprises focus on the dimension of trust and trustworthiness.
- The *cognitive* dimension refers to shared codes, rules, representations, interpretations and systems of meaning [14]. It also includes interdependent norms, values, attitudes and beliefs [16]. Norms constitute an influential type of social capital, and norms and shared vision are both regarded within the scope of the cognitive dimension [6][7]. Based on this, the cognitive dimension of an organisation and its members emphasises norms, shared codes plus shared language codes.

In summary, this research addresses the social capital of engineering education and external enterprises. In terms of the research dimension, the structural dimension concerns social interaction, ties and networked ties of organisations and their members; the relational dimension, on the other hand, places emphasis on trust and trustworthiness. The most important elements of the cognitive dimension are shared norms, shared codes and shared language codes.

Relation of Social Capital with Each Dimension

Shared codes and language are not generated after only one or two contacts; they are built after people identify commonalities through frequent contact. Only with increasing interaction can shared language code, values and norms be understood and accepted [18]. The more interaction between members, the more easily they can create norms that represent their mutual identification to some degree [16][19]. Thus this research proposes the following hypothesis:

- Hypothesis 1: The structural dimension between engineering departments at universities and external organisations has a positive impact upon the cognitive dimension.

Trust in the relational dimension is a feature because close interaction ties enable dealers to understand each other [20]. Ties that have been established by cooperative partners help to build a foundation of trust, and through long-term interaction, their trust becomes more solid and they find each other more trustworthy [12]. When more ties are fostered between universities engaged in engineering education and external organisations, then members of these two stakeholders have a higher degree of trust and will define each other as a trustworthy partner [21]. Thus, the following hypothesis statement is made:

- Hypothesis 2: The structural dimension between engineering departments at universities and external organisations has a positive impact upon the relational dimension.

Shared values and norms help to build trust and a higher degree of trustworthiness [22]. It is likely that different professions, organisations and departments use different terminologies; but through shared codes and language, information exchange is facilitated and mutual understanding and trust is promoted [23]. Consequently, the following hypothesis statement is made:

- Hypothesis 3: The cognitive dimension between engineering departments at universities and external organisations has a positive impact upon the relational dimension.

Knowledge Acquisition

Knowledge includes learning structures incorporating valuable experiences, characterised information, expert opinions and new experiences; knowledge is also involves concepts, beliefs and information used for solving problems. According to its expressive degree, knowledge is categorised into explicit knowledge that is easy to express, and tacit knowledge, which is not easy to express [24]. However, knowledge is a product, technique, market resource, and an important element that helps organisations to acquire advantages [15][25].

In the current era of the knowledge economy, knowledge acquisition cannot be overemphasised, particularly regarding tacit knowledge acquisition [26]. The exploration mechanism of knowledge refers to acquiring knowledge with exploration, innovation and a willingness to take risks. Organisations are able to externally seek knowledge acquisition [27]. Successful social capital is able to enhance the depth, broadness and efficiency of the knowledge acquisition through close social interaction [13]. With the respect to engineering education,

knowledge acquisition helps foster growth, innovation and the cultivation of technical personnel needed by society.

Social Capital and Knowledge Acquisition

New design concepts often come from external networks, and new knowledge can be generated from unique techniques via the use of external social capital [28]. The structural dimension of organisations helps in the acquisition of new technologies and abilities through social interaction; from this, tacit knowledge and innovation, as well as new learning processes, are generated [11][29][30]. Based on the above, this research proposes the next hypothesis as follows:

- Hypothesis 4: The structural dimension between engineering departments at universities and external organisations has a positive impact upon knowledge acquisition.

The enhancement of the relational dimension can reduce the risk of knowledge exchange, cut down on the cost of knowledge transfer, and improve the efficiency of knowledge acquisition [4]. The relational dimension between partners impacts positively on learning processes and, if there is no trust, partners will not be willing to be responsible for the exchange of knowledge [30]. Trust relationships enhance exchange efficiency in knowledge of each dimension: technology, organisation and strategy [13][31]. Thus, the following hypothesis is also proposed:

- Hypothesis 5: The relational dimension between engineering departments at universities and external organisations has a positive impact upon knowledge acquisition.

Shared codes and representations are common in the process of knowledge exchange and this combination helps in acquiring knowledge [30]. Knowledge management is built upon the shared cognitive dimension, shared codes, representations, norms and visions, and only those familiar with the language will be able to acquire related knowledge [32]. This research, therefore, suggests the following hypothesis:

- Hypothesis 6: The cognitive dimension between engineering departments at universities and external organisations has a positive impact upon knowledge acquisition.

METHODOLOGY

Framework

According to the literature review, the researchers built a knowledge acquisition framework for engineering education at universities as shown in Figure 1.

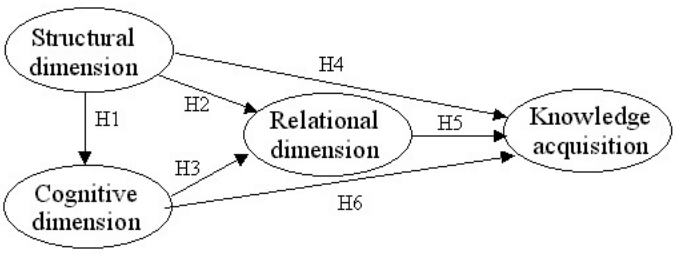



Figure 1: The research framework.

Variables Operational Definition and Measurement

With regard to social capital, this research adopts the viewpoint of Westland, ie social capital is external related to organisations, the network between engineering education in universities and external organisations [11]. Concerning scale development, this research refers to the proposal made by Nahapiet and Ghoshal, including structural, cognitive and relational dimensions [14]. The current research uses 15 questions, five for each dimension, which are measured by a five-point Likert Scale.

Concerning knowledge acquisition, based on the suggestions of Yli-Renko et al, whose research concluded that knowledge acquisition embodies information shared by engineering education at universities and external organisations, such that technology, customers and products include tacit and explicit knowledge [15]. A five-point scale from ref. [25] is thus used for four questions.

Samples

This research surveyed the subjects of 160 Taiwanese universities; the population was divided into public university, public college, private university and private college. Using a stratified sampling method, chairpersons of the engineering departments at 80 universities were sampled. Five questionnaires were sent out to each university, totalling 400; this yielded 203 valid returns, reaching an effective rate of 51%.

Data Analysis

- Reliability and validity: Cronbach's α and principal component method were used to evaluate the reliability and validity for the scale;
- Descriptive statistics and correlation analysis: the mean, standard deviation (SD) and Pearson moment correlation analysis were adopted to evaluate the status of variables and their correlation;
- Linear structural relation analysis (LISREL) was utilised to analyse the fitness of the model, and test independent variables' influence on the dependent variables.

Scale Reliability and Validity

As suggested by Nunnally, factor loading is bigger than 0.50, and each dimension of Cronbach's α is greater than 0.70. The eigene value was larger than 1.00, and used for the criteria of the selection of questions and factors [33]. The average factor loading of 15 questions for the social capital scale was greater than 0.50; the structural, cognitive and relational dimensions' eigene values were 3.278, 3.209, 2.961, respectively; their Cronbach's α values were 0.815, 0.842 and 0.839, respectively. The overall α value of the scale was 0.885 and accumulated an explained variation of 62.98%. The average factor loading of the four questions for the knowledge acquisition scale was greater than 0.50, with a Cronbach's α value of 0.740 and an explained variation of 66.76%. The indices of reliability and validity in these two scales fitted to an ideal standard.

RESULTS ANALYSIS

This section addresses each variable of descriptive statistics, a correlation analysis, overall model fit and fit of the model's internal structure.

Descriptive Statistics and Correlation Analysis

Table 1 shows the mean of each valuable lay between 3.614 and 3.972, indicating that Taiwanese universities display fair performance in social capital and knowledge acquisition, although there is still room for improvement. The correlation coefficient of each variable showed a positive impact and that of the three dimensions of knowledge acquisition and social capital was about 0.50, showing a middle-degree correlation.

Table 1: Descriptive statistics and correlation analysis.

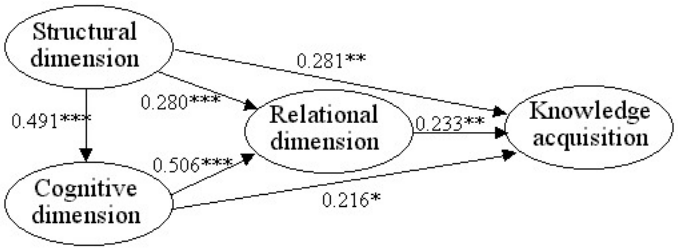
| Variables | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| Structural | 1.000 | | | |
| Cognitive | 0.492*** | 1.000 | | |
| Relational | 0.361*** | 0.551*** | 1.000 | |
| Knowledge acquisition | 0.473*** | 0.554*** | 0.516*** | 1.000 |
| Mean | 3.781 | 3.972 | 3.791 | 3.614 |
| SD | 0.634 | 0.593 | 0.611 | 0.701 |

***p<0.001

LISREL Analysis

This research utilises a goodness of fit index (GFI), adjusted goodness of fit index (AGFI), root mean square residual (RMSR) and normed Chi-square (NCI) as the indices for the measurement. According to Bagozzi and Yi, when GFI and AGFI is greater than 0.90, and RMSR is smaller than 0.05 and the NCI is less than 3, then the overall model and information for observation is regarded as a fit [34]. This research gave the following results: GFI = 0.909, AGFI = 0.901, RMSR = 0.027, and an NCI (521/203 = 2.567) smaller than 3; as such, the researchers conclude it as a fit.

Table 2 shows the fitness of model internal structure (path analysis). It was found that the t-value of each parameter was greater than 1.645. The coefficient of $\gamma$, $\beta$ in the table also indicates that all parameter estimators have positive values and significantly positive impacts between each dimension. The structural dimension on the cognitive dimension has a significantly positive impact ($\gamma_{12}$ = 0.491) and this supports Hypothesis 1. The structural dimension and cognitive dimension also have significantly positive impacts on the relational dimension ($\beta_{13}$ = 0.280, $\beta_{23}$ = 0.506), proving Hypotheses 2 and 3 to be true. The structural dimension, relational dimension and cognitive dimension, respectively, have significantly positive impacts on knowledge acquisition ($\beta_{14}$ = 0.281, $\beta_{34}$ = 0.233, $\beta_{24}$ = 0.216), supporting the proposed Hypotheses 4, 5 and 6. Indices used for the fitness of model internal structure are illustrated in Figure 2.




GFI = 0.909, AGFI = 0.901, RMSR =0.027, NCI=2.567
*p<0.05, **p<0.01, *** p<0.001

Figure 2: Result of the LISREL analysis.

Table 2: The LISREL fitness of model internal structure.

| Parameter | Standardised Parameter Value | t Value |
|---|---|---|
| structural→cognitive($\gamma_{12}$) | 0.491 | 6.482*** |
| structural→relational($\beta_{13}$) | 0.280 | 3.836*** |
| cognitive→relational($\beta_{23}$) | 0.506 | 6.930*** |
| structural→knowledge acquisition($\beta_{14}$) | 0.281 | 3.406*** |
| structural→knowledge acquisition($\beta_{34}$) | 0.233 | 2.727** |
| cognitive→knowledge acquisition($\beta_{24}$) | 0.216 | 2.347* |

*p<0.05, **p<0.01, ***p<0.001

CONCLUSION

Research Findings

From the above empirical survey on social capital and the knowledge acquisition of engineering education at Taiwanese universities and external organisations, the current research has found the following research findings:

- There is a positive relation regarding the structural dimension, the cognitive dimension, the relational dimension and knowledge acquisition;
- The structural dimension has a positive impact upon the cognitive dimension;
- The structural dimension and the cognitive dimension have positive impacts upon the relational dimension;
- Each dimension of social capital has a positive impact upon knowledge acquisition.

Research Conclusions

In theoretical study, the social capital and knowledge acquisition model constructed by this graduate institute has shown a good paradigm with regard to the indices of model fitness and path analysis. At the same time, the research scales built according to a relevant literature review have also demonstrated a good reliability and validity. So, it is possible to conclude that the scales of social capita and knowledge acquisition is an effective research instrument that can be utilised for engineering education at universities.

In terms of empirical applications, engineering education in universities should take the opportunities provided by industrial and academic cooperation or Co-ops to foster good interaction with external organisations and to facilitate further understanding of shared objectives and norms. Through trust, good quality relations will help in the acquisition of external knowledge. Given the three dimensions of social capital, engineering education at universities should first focus on the relational dimension, since the structural and cognitive dimensions directly affect knowledge acquisition and, through the relational dimension, the two dimensions also indirectly impact on knowledge acquisition.

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# *8th Baltic Region Seminar on Engineering Education: Seminar Proceedings*

edited by Zenon J. Pudlowski, Norbert Grünwald & Romanas V. Krivickas

These Proceedings consist of papers presented at the *8th Baltic Region Seminar on Engineering Education*, held at Kaunas University of Technology (KUT), Kaunas, Lithuania, between 2 and 4 September 2004. Eight countries are represented in the 29 papers, which include two informative Opening Addresses and assorted Lead Papers. The presented papers incorporated a diverse scope of important and current issues that currently impact on engineering and technology education at the national, regional and international levels. The level of Lithuanian participation indicates the nation's commitment to advancing engineering education in the higher education sector.

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