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CRITICAL SUCCESS FACTORS (CSFS) IN UNIVERSITY-INDUSTRY COLLABORATION (UIC) PROJECTS IN RESEARCH UNIVERSITIES

Mahanim Hanid[1*], Othman Mohamed[1], Maznah Othman[1], Mohd Suhaimi Mohd Danuri[1]
Kho Mei Ye[1], Mohammed Ali berawi[2]

[1]*Department of Quantity Surveying, Faculty of Built Environment, Universiti Malaya, 50603, Kuala Lumpur, Malaysia*
[2]*Department of Civil Engineering, Faculty of Engineering, Universitas Indonesia, Kampus UI Depok, Depok 16424, Indonesia*

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ABSTRACT

This research study examines the CSFs in UIC to ensure the success of any collaboration. Thirteen success factors were evaluated by respondents from industry and public research universities in order to identify the most critical ones. Adopting a quantitative research strategy, both groups of respondents were selected based on their experience of involvement in UIC projects. Similarities and differences in the two university and industry perspectives were identified. Universities focused more on the quality of the researcher, commitment and financial support as the main factors in ensuring the success of the collaboration. As regards their industrial counterparts, some similar factors to the universities were highlighted. In addition, the industrial partners were concerned with constant communication and strong teamwork as the main ingredients of successful implementation of UIC projects. By understanding the similarities and the differences, a positive environment can be created and thus both parties will prioritize the relevant factors when conducting collaborative activities.

Keywords: Critical success factors; Public research university; University-industry collaboration

1. INTRODUCTION

1.1. Overview of UIC in Malaysia

In today's competitive and globalized business environment, the formation of UIC research is viewed as essential in building and maintaining companies' competitive position. In this regard, the government of Malaysia is promoting a R&D and innovation culture (Yee et al., 2009) among researchers because of the benefits that accompany the implementation of UIC between organizations. With the increasing prevalence of UIC and its importance for the future success of both types of organization involved and for the national economy, it is essential to develop an in-depth understanding of the opportunities and pitfalls involved, and as well as the factors which drive its formation.

In Malaysia, UIC is a new phenomenon among researchers and is another platform for acquiring research grants. In the Ninth Malaysia Plan (9MP), it was acknowledged that there was a need to strengthen the National Innovation System (NIS) by creating and establishing closer links between universities and industry and also to increase the research & development (R&D)

*Corresponding author's email mahanim@um.edu.my, Tel. +603-79676872, Fax. +603-79675713
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funding allocation under both National Plans. Doing this could help public universities to be more actively involved in research. This situation has occurred because of the reduction in national subsidies to universities, combined with the Malaysian government's policy of encouraging self-reliance among universities to generate their own income (MOHE, 2007).

In addition, the Secretary General of the Ministry of Higher Education in Malaysia has emphasized the importance of partnerships between universities and industry as a means of creating alternative funding in light of diminishing national subsidies (MOHE, 2007). The World Bank has also proposed UIC be used as a strategy to improve the relevance of the education system in Malaysia and to offer services to SMEs that do not have a high level of technology adoption and innovation know-how (World Bank, 2006). Moreover, establishing collaborations with universities provides several benefits to business, such as enhanced firm innovations, increased internal resources, and improved processes and product performance. On the other hand, universities also gain benefits in the form of financial support and academicians' improved research results (Ramli & Senin, 2015), additional public and private funding, and increased licensing and patenting income as a result of technology transfer activities (Barnes et al., 2002). Moreover, collaboration provides access to a greater breadth and depth of knowledge and technologies than would normally be possible through internal development.

Although the introduction of UIC is believed in some quarters to have been beneficial, in reality its establishment in Malaysia is still clearly lacking. Moreover, successful collaboration is difficult to determine because of issues that lead to barriers for partners to establish successful collaboration (Dunowski et al., 2010). Previous studies undertaken in overseas contexts, such as in the USA, Germany, Korea, Canada, Mexico, Ireland and the UK, were mainly focused on describing successful models, policies, criteria for benchmarking collaboration, managing UIC projects and challenges or outcomes to successful UIC (Yee et al., 2015) because of the different levels of maturity that they have achieved in such collaboration. Therefore, in this study the focus is on the factors that can lead to successful collaboration between universities and industry and reduce the barriers to such a process.

Correspondingly, the research aims to identify the most critical success factors in UIC projects so that both parties will understand their roles and how to manage future collaborative relationships. This aim is supported by three objectives: to examine the current issues in university-industry collaboration projects in public research universities; to identify the CSFs of UIC projects in social science research at such universities; and to identify the differences and similarities between industry and university approaches to successful collaboration. The scope of the study covers research work in social science at public research universities involved UIC projects. The industrial collaborators were professional experts in various industries. The boundaries of the work were defined to ensure that the data collected were within the constraints of the investigation.

2. EXPERIMENTAL METHODS

2.1. Review of CSFs in UIC Projects

All universities in Malaysia have, in one way or another, participated in UIC, but few studies have considered the critical success factors that contribute to successful projects. Previous studies undertaken in overseas contexts such as the US, Germany, Korea, Canada, Mexico, Ireland and the UK have described successful models, policies, criteria to benchmark collaboration, management of UIC projects and challenges or outcomes to successful of UICs. These show various similarities and differences between countries compared. Almost all countries have similar critical success factors in UIC projects, but different methods and research approaches have been implemented.

Table 1 shows a consolidated list of 28 Critical Success Factors (CSFs) that contribute to successful university - industry collaboration projects in different countries, as identified from various studies.

Table 1 Critical success factors

No	Success Factor	Reference
1	Champion at company	(Wohlin, 2012)
2	Champion's network within the company	(Wohlin, 2012)
3	Buy-in and support from company management	(Wohlin, 2012)
4	Buy-in and support from industry collaborators	(Wohlin, 2012)
5	Short-term results and impact on industry	(Wohlin, 2012)
6	Organizational stability (industry partner)	(Wohlin, 2012)
7	Researcher has a visible presence in industry	(Wohlin, 2012)
8	Regular meetings	(Wohlin, 2012)
9	Relevant expertise of researcher (main person in the collaboration)	(Wohlin, 2012)
10	Attitude and social skills of researcher	(Wohlin, 2012)
11	Researcher's commitment to contributing to industry needs	(Wohlin, 2012)
12	Well-organized collaborative research project	(Wohlin, 2012)
13	Research environment at the university	(Wohlin, 2012)
14	Prior experience of industry-academia collaboration	(Wohlin, 2012)
15	Universal factors such as trust, commitment, and continuity of personnel	(Barnes, 2002)
16	Choice of partner	(Barnes, 2002)
17	Project manager	(Barnes, 2002)
18	Project management	(Barnes, 2002)
19	Ensuring equality	(Barnes, 2002)
20	Environment factors	(Barnes, 2002)
21	Outcome	(Barnes, 2002)
22	Cultural issues	(Barnes, 2002)
23	Flexibility	(Yee et al., 2009)
24	Rewards and benefits	(Yee et al., 2009)
25	Constant communication	(Yee et al., 2009)
26	Commitment and support from management	(Yee et al., 2015)
27	Government support	(Yee et al., 2015)
28	Open and transparent communication	(Yee et al., 2015)

When analysing the CSFs identified from the literature review, some common ones can be identified. However, the selection process to identify the success factors employed as variables in this study is based on evaluation and advice from prominent university experts with experience of UIC projects. Therefore, 13 CSFs (see Table 2) were chosen to suit the purposes of the study and to act as precursors of the research. This led to the development of the provisional CSFs that were revealed through theory.

Table 2 Critical success factors

Success Factor	Description
Trust	Trusted relationship building and sustaining such relationships between all partners
Partner reputation	Academic/industrial partners, when they have been successful, are important catalysts for further collaborations
Strong teamwork	Academic/industrial partners have a good relationship and maintain the relationship from the beginning of the project
Commitment and leadership skill of leader	The leader plays an important role in driving the team to achieve the mission, goals and objectives set. In addition, commitment from industry in collaboration activities.
Researcher's commitment	A high degree of commitment and interdependence among all partners involved in the collaboration
Having the right person	Recruiting or selecting individuals with the appropriate skill set to take the partnership forward.
Constant communication	Effective communication will increase the knowledge and understanding of both collaborating partners and lead to general goals or purposes being developed.
Rewards and benefits	Incentives for researchers to engage in collaborative research (provided by the university/company).
Financial support	Seed and pre-seed funding to motivate researchers to develop new research. The support can be from various sources, including government agencies.
Short-term results and impact on industry and university	Early results from the collaboration - evidence of value for both industry and academia.
Regular meetings	Regular meetings between the parties involved; for example, steering groups for specific collaborative projects.
Research environment at the university	Importance of research excellence in the research environment at the university from which the researcher is from.
Government & management support	Support from institutional and company leaders for the collaborative research initiative. This may include the involvement of high-level individuals within the organization (e.g. rectors or CEOs) in the establishment and negotiation of strategic university-business partnerships.

2.2 Industry and University Roles

Industry partners play an important role in UIC projects. The reasons for universities to seek cooperation with industry appear to be relatively simple. Peters and Fusfeld (1982) identify several reasons for this interaction: (1) industry provides a new source of money for universities; (2) industrial money involves less "red tape" than government money; (3) industry-sponsored research provides students with exposure to real world research problems; (4) such research also provides university researchers with a chance to work on intellectually-challenging research programs; and (5) some government funds are available for applied research, based upon joint efforts between universities and industry. There are five types of industrial partner: multinational corporations (MNCs) (Siwar & Haslina 2009); local Malaysian corporations (MCs); small and medium sized enterprises (SMEs); government-linked organizations (GLCs) (Siwar & Haslina, 2009); and research institutions.

Based on the literature, there is extensive interaction between universities and industry, and various types of collaboration between them. UIC is often related to industrial training for students; scientists' attachment to companies; joint courses; research chairs; consultations;

contract R&D and commercialization activities such as licensing and incubation activities; investment in university start-up companies; knowledge/technology transfers; and the taking of R&D outputs to the market (Yee et al., 2015).

In this research study, six types of collaboration activity were identified, namely consultation projects, prototype/pilot plant development, contract/commissioned research projects, joint applied governmental funds that require industry partners, joint spin-out companies, and research endowment. In addition, there are five types of university- industry collaboration, these being spin-offs, contract research, sponsor research, joint ventures and invention. In terms of seeking funding from industry, collaboration research, contract research and consultation are common activities conducted between universities and industry (Perkmann & Walsh, 2009).

3. METHODOLOGY

The research employs the survey method, as this allows collection of data from a sizeable population in a highly economical way, and is easy to compare and explain. The questionnaire was divided into two sections. Section A consists of the background of the respondents and types of UIC, while Section B covers the critical success factors in university-industry collaboration. The level of importance of each success factor was determined by the university and industry respondents based on a 7 point Likert Scale (Vagias, 2006): (1) not at all important; (2) low importance; (3) slightly important; (4) neutral; (5) moderately important; (6) very important; and (7) extremely important. Based on Sekaran (2003), sampling is the process of selecting a sufficient number of elements from the population, so that a study of the samples and understanding of their properties or characteristics would make it possible to generalize the population elements. 475 academic staff comprised the population from public research universities (RU) in Malaysia, including Universiti Malaya (UM), Universiti Kebangsaan Malaysia (UKM), Universiti Putra Malaysia (UPM), Universiti Teknologi MARA (UiTM) and Universiti Sains Malaysia (USM). They were selected based on their involvement in UIC projects under social science research and involvement with various industries, either local or international. The academic staff data were obtained from the MyGrants system and academic profiles from each university. The sample size was then calculated using Equation 1, as proposed by Krejcie and Morgan (1970), which is intended to identify the sample size of a known population.

$$S = \frac{X^2 NP(1-P)}{D^2(N-1) + X^2 P(1-P)} \quad (1)$$

This survey targeted both academic and industry experts. It was sent to university representatives in five public research universities with a social science background (see Table 3). The universities were selected as a group of respondents in recognition of their involvement in various aspects of quality research, either with local or international agencies. These five research universities are public universities that were selected by the Ministry of Education Malaysia on 11 October 2006 to become leading research and educational hubs.

Table 3 Survey response rate

	Total	University	Industry
Distributed	270	220	50
Returned	47	32	15

The data analysis was conducted using descriptive statistics and reliability analysis and by comparing the score mean of all the success factors. Through the descriptive analysis, the frequency of each distribution of university and industry involvement in UIC projects within

research public universities could be identified. Each success factor as a variable was evaluated by descriptive analysis in order to obtain its ranking. The rankings were then tabulated to observe the similarities and differences between academic and industry perspectives. The data were also compared with secondary documents such as literature reports, proceeding articles, journal articles and policies, which provided supporting information. The final outcome from the study is a set of critical success factors for UIC projects from both industry and university perspectives.

4. ANALYSIS AND FINDINGS

The survey recorded a response rate of only 17%, or equal to 47 respondents, with a range of positions and years of experience in their fields of research. Roscoe (1975) proposes that a rule of thumb in terms of determining an appropriate sample size is that it should be greater than 30 and lower than 500 for most research. Most of the respondents in this research had experience of between 10-20 years; with this background and experience, it was felt that they had the confidence and capability to assess the CSFs. With regard to the industry population, the snowball sampling technique was applied in order to identity the target respondents. The reason for using this technique was because of the difficulty in establishing the right connections with those involved in UIC projects, since they were not listed with any agencies or professional bodies and came from various kinds of sector. The selection was based on the researcher's network, individual contacts in the industry and colleagues introduced by the university respondents as their industrial partners in collaborative projects. Therefore, the number of respondents from industry was only 15, who came from different backgrounds and sectors. The following section presents the detailed background of the respondents from the research universities and industry.

4.1. Research Universities

In total, 32 questionnaires were returned, which included 12 respondents from UM, six from UKM, five from UPM, six from USM and three from UiTM. Among these, 20 were researchers, nine senior researchers and three students. 53% of the respondents had less than 10 years' collaboration experience; 31% had 10 to 20 years of experience; 13% had more than 20 years' collaboration experience; while 3% had never been involved in collaboration. Eight respondents had collaborated with MNCs, two with NCs, five with SMEs, eight with GLCs, eight with RIs and one with another type of organization.

4.2. Industry Respondents

Similar information was derived for the industry participants. Three different types of role in UIC projects were played by the industry respondents, namely industrial sponsor (7%), project owner (40%) and collaborator in industry (53%). The collaborative activities included consultation projects (71%), prototype/pilot plans (14%), contract/commission research projects (5%), jointly-applied government funds (5%) and joint spin-out companies (5%), conducted together with their academic partners in the universities.

4.3. Critical Success Factors

The data on the success factors from the university and industry respondents were analyzed based on their experience in UIC projects. The overall ranking for each success factor from the industry respondents and the range of the mean was 6.3333 to 5.0667 (see Table 4). On the other hand, the overall ranking for each success factor from the university respondents and the range of the mean was 6.5938 to 5.7813 (see Table 4). Comparing the overall results identified, the mean values were practically the same for all the success factors.

Table 4 Descriptive statistics for University and Industry respondents

Critical Success Factor	A	B	A	B	A	B	A	B	A	B
	N		Minimum		Maximum		Mean		Std. Deviation	
Trust	32	15	5.00	4.00	7.00	7.00	6.4375	6.0667	.56440	1.09978
Partner Reputation	32	15	3.00	5.00	7.00	7.00	6.0000	5.8667	.98374	.63994
Strong Teamwork	32	15	5.00	5.00	7.00	7.00	6.5000	6.3333	.56796	.72375
Commitment and Leadership Skills of the Leader	32	15	4.00	4.00	7.00	7.00	6.5000	6.1333	.67202	.91548
Researcher's Commitment	32	15	5.00	4.00	7.00	7.00	6.5938	6.2000	.55992	.86189
Having the Right Person	32	15	5.00	4.00	7.00	7.00	6.2813	6.2000	.68318	.86189
Constant Communication	32	15	4.00	5.00	7.00	7.00	6.3125	6.3333	.82060	.81650
Rewards and Benefits	32	15	3.00	4.00	7.00	7.00	5.7813	5.5333	1.03906	.83381
Financial Support	32	15	4.00	4.00	7.00	7.00	6.4688	6.2000	.80259	.86189
Short Term Results and Impact on Industry and University	32	15	5.00	4.00	7.00	7.00	6.0000	5.5333	.67202	.99043
Regular Meetings	32	15	4.00	4.00	7.00	7.00	5.8125	5.0667	.78030	.96115
Research Environment at the University	32	15	5.00	3.00	7.00	7.00	6.1875	5.2000	.69270	1.37321
Management Support	32	15	5.00	4.00	7.00	7.00	6.4375	6.0000	.61892	.92582
Valid N	32	15								

Note; A is the University Respondents; B is the Industry Respondents

5. DISCUSSION

Among the five research universities taking part in the research study, UM shows the highest involvement in UIC projects of 37.5%, followed by UKM and USM with values of 18.8 % each. This is due to the reputation of UM and its status as a research university, which gives extra benefits in attracting industries to collaborate with them. Strong partnerships with industry will open up opportunities for academia to obtain experience and exposure, relevant to the current needs of the market. It is important to understand the role of academic and industry perspectives and attempt to blend both types of expertise to enhance and encourage more joint venture projects between the two parties for the sake of the nation. It is also considered by the World Bank as a way of improving the relevance of the education system in Malaysia and to serve SMEs that do not have a high level of technology adoption and innovation know-how (World Bank, 2006).

5.1. Critical Success Factors of UIC Projects in Social Science Research

The CSFs identified (Table 5) show that successful collaboration on UIC projects completely depends on the researcher's commitment to lead both parties in order to achieve the vision of the collaboration. Commitment is very important for the success of UIC projects because it helps to drive all the parties involved to achieve the aim of the research by blending both organisations and understanding both environments. This is very important in order for both parties to work together and to put 100% effort into the success of UIC projects and to enhance the collaborative relationship. Strong teamwork between academia and industry, and the leadership skills of the leaders, are important in UIC projects because of the expectation from industry of something that is valued throughout the collaborative project, and definitely something that is tangible. Furthermore, it can also strengthen the individual skills that are related to industry by

disseminating knowledge on the current trends in the actual market in order to ensure that academics does not lose sight of business issues and do not simply focus on theoretical aspects.

Table 5 Overall rankings for universities

Overall Top Rankings	Overall Bottom Rankings
Researcher Commitment	Rewards and Benefits
Strong Teamwork and Commitment and Leadership Skills of Leader	Regular Meetings
Financial Support	Short-term Results and Impact on Industry and University

However, from the perspective of academicians, success is based on the number of journal articles published and improvement in their learning and teaching skills, which also contribute to their promotion or performance appraisal. Therefore, industry plays an important role in ensuring that researchers or academics do not lose sight of the goals of the collaboration.

Table 6 Overall Rankings for Industry

Overall Top Rankings	Overall Bottom Rankings
Strong Teamwork; Constant Communication	Regular Meetings
Having the Right Person and Researcher Commitment	Research Environment
Commitment and Leadership Skills	Rewards and Benefits

Based on the results identified above (Table 6), we can conclude that the opinion of industry is aligned with that of the universities, focusing more on the characteristics of the people involved in UIC projects. Furthermore, they are of the same opinion that strong teamwork and constant communication between both parties are important factors in successful UIC projects. In addition, industry emphasizes researcher commitment and the leadership skills of the researcher; they are attracted to people who are capable of building and managing partnerships because they believe that collaborations only work well when they are managed by people who cross boundaries easily and who have a deep understanding of the two cultures they need to bridge. Industry agreed that it is not important to have regular meetings if both parties are committed and know their responsibilities from the early stages of the collaboration project.

5.2. University and Industry Perspectives of Successful Collaboration in UIC Projects

The university respondents believed that the commitment of researchers to producing quality research work will ensure the success of the UIC project. This is related to positive attitudes toward the collaboration partnerships and understanding by both parties of the meaning of the collaboration, which is believed to create benefits and better quality output from the research. Therefore, the purpose of forming collaborations must be clear from the early stages, and industry and the university must have a clear understanding of the purpose of the collaboration and the functions of the team members from the very start of the collaboration.

In addition, strong teamwork and constant communication are also vital. By understanding the academic and university vision, which sometimes does not align with theirs, industry needs to provide opportunities, trust and space for both parties. Universities and industry agree that strong teamwork and commitment are top priorities to ensure the success of UIC projects. This is in line with Wohlin et al. (2012), who identified that the attitude of researchers is very important because they are key players in building, maintaining and sustaining the relationship with industry. Therefore, this requires a positive and hard work attitude from the researcher, together

with strong social and communication skills. Strong teamwork and the commitment of the leader are ranked second by the university respondents, whereas industry is of the opinion that strong teamwork should combine with constant communication while running the project. Constant communication with industry is vital to ensure that the researcher is on track and following industry needs.

Furthermore, financial support is also seen as an important factor by researchers in the universities because it acts as motivation when conducting university-industry research projects. Extensive funding has been introduced by government institutions and private companies, together with government link organizations such as the CRDF fund under the Malaysian Technologies Development Corporation (MTDC) to encourage such collaborative activities. Funding and communication are closely related to each other, because researchers seek funding to support R&D activities, whilst industry considers the commercial aspects or the value of the research in the market. Without the incentive of research grants, the level of interaction would be much lower (Malairaja & Zawdie, 2008).When both parties understand their role and commitment, the success of the collaborative activities is more likely.

6. CONCLUSION

It should be highlighted that this study only focuses on the non-technology research area, which is something that has previously been missing. Therefore, no physical product that has a commercial value aspect is considered from the academic or industry point of view. Industry and researchers should endeavor to explore the non-technical and social science aspect value, especially from human and environmental aspects. The symbiosis created among the local researchers in Malaysian universities and professional experts from industry can be progressed based on the CSFs identified in this research. Obviously, neither party should concentrate on rewards and benefits, which are based on financial value, but instead consider the positive environment and other human and environmental aspects that can be gained when entering into collaborations.

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