University–industry linkage evolution: an empirical investigation of relational success factors

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University–industry linkages (UILs) offer an array of benefits for the parties involved and the economy at large; however, research provides limited theoretical development and practical advice on successfully managing UILs from initial negotiations to project completion and beyond. This paper, thus, empirically investigates the impact of relational success factors (communication, trust, understanding, individuals) on UIL performance across three phases of evolution, accounting for the changing manifestations of these factors over time. Communication emerged as a consistent predictor of success, with positive interrelationships between individuals advancing all relational success factors across all phases. A positive effect of trust and understanding, however, only emerged for some relationship phases. Results provide managers with insight into forms relational drivers take throughout long-lasting successful UILs.

1. Introduction

Numerous sources of innovation exist, with universities providing one avenue for organizations to access specialized knowledge (Stanko and Calantone, 2011). While certainly not new (Dill, 1990), there is a renewed interest in innovation-oriented, university–industry linkages (UILs) from academics, practitioners and governments alike (Gulbrandsen et al., 2011; Perkmann et al., 2011). Potential benefits from UILs, defined here as two-way linkages between university and industry/government entities established to enable the diffusion of creativity, ideas, skills and people with the aim of creating mutual value over time, are many for the parties involved (Lee, 2011) and for the regions’ broader innovation and economic success (van Looy et al., 2003). Realization of these benefits, however, depends on the partners’ ability to overcome numerous barriers (Bruneel et al., 2010),
commonly attributed to differing institutional backgrounds, purposes, cultures and norms (Lopez-Martinez et al., 1994; Plewa, 2009).

While the UIL literature in the areas of innovation management, technology transfer and commercialization provides insight into various organizational, contextual and relational success factors, gaps remain. For example, despite the importance of long-term collaborative success, we still lack an understanding and comparison of relational success factors throughout phases of UIL evolution. Existing research has been limited to a broad analysis ofUILs, lacking evaluations of partnerships at different stages of development. This is despite the development of stages and states theories in related disciplines, such as relationship marketing and network theories, illuminating the dynamic nature of relationships (Lambe et al., 2011), as well as recent calls for research on improving our understanding on the management of projects with innovation partners (Hsuan and Mahnke, 2011; Stanko and Calantone, 2011), and on investigating UILs as they evolve over time (Bruneel et al., 2010). This paper closes this gap by comparing relational success factors across three phases of UIL development.

A range of stakeholders are likely to benefit from a greater understanding of the dynamics of UILs. While university administration and their technology transfer offices will be able to more effectively facilitate long-term UILs, knowledge of the evolution of UILs helps governments to more closely align policies with specific goals, such as the development of long-term strategic university–industry partnerships. Finally, businesses gain insight into how to build lasting relationships with universities in order to optimize their innovation strategy.

This research examines the role of dynamic relationship factors for success across three phases of UIL development. While relational factors alone are insufficient to achieve relationship success, with complementary resources and alliance competence augmenting their influence (Wittmann et al., 2009), their proven criticality in a UIL context (Mora-Valentin et al., 2004; Rampersad et al., 2010) warrants in-depth analysis across phases. Consensus is developing within the strategic alliances, marketing and innovation literatures regarding drivers of successful business relationships, such as trust, commitment, cooperation and communication (Anderson and Narus, 1990; Morgan and Hunt, 1994; Mohr et al., 1996). These relational success factors have also been noted to shape the evolution of exchange relationships; yet causal relationships between them remain uncertain (Snellman, 2001).

Although extant research has identified relational drivers of UIL success, those papers that consider relationship evolution estimate factors to either remain static, or increase or decrease over time (i.e. Ford, 1982). No one has studied the changes of relational factors across the UIL evolutionary phases, despite indications that the nature of such factors, that is communication, differ between various phases of relationship development (Larson, 1992). This research engages theories of interaction, as well as stages and states theories, to conceptualize and test the impact of relational success factors (trust, communication and understanding) on UIL success, extending current literature by accounting for the differences between these factors across evolutionary phases.

This study further adds to the literature on UIL evolution by utilizing outcome measures specific to each phase rather than general measures of overall success (Sivadas and Dwyer, 2000; Wittmann et al., 2009). Furthermore, given the role of individuals in driving relational exchange (Santoro and Chakrabarti, 2002), interpersonal relationships between key UIL actors at an individual level are taken into account. The interrelationship of individuals refers to the interplay between individuals involved in collaborative research. Such interplay is crucial for the establishment and evolution of relational success factors (Walter et al., 2011).

In summary, this paper extends the literature on university–industry collaboration by investigating relational success factors of UILs across different stages of relationship development. Moreover, it examines the different forms success factors may take in each phase. Drawing on stages and states theories, interaction theories as well as an exploratory qualitative pre-study, this paper examines inter-relationships of individuals, communication, trust and understanding, as well as their influence on the relevant measures of success throughout the phases of UIL evolution. A review of the extant literature that sheds light on the evolution of UILs in Australia, and the subsequent development of hypotheses, then leads into an outline of the quantitative research design. A discussion of the results and managerial implications follows. The paper concludes with limitations and future research directions.

### 2. UILs in the context of Australia

Since the 1980s, universities and businesses in Australia have aimed at uniting their previously independent research efforts, albeit to a limited extent (Harman, 2001). Traditionally, spin-off companies...
have been a particular target, despite the Australian Research Council’s (ARC thereafter) (2001) concern that this strategy does not assist Australia’s global success. The financial and distributional abilities of medium to large business entities, or the development of networks or value chains on a global basis, are believed to offer a greater opportunity of innovation reaching a global level (ARC, 2001).

During 2010–2011, 5.4% of innovation-active Australian businesses collaborated with universities or other higher education institutions either in Australia or overseas [Australian Bureau of Statistics (ABS), 2012a]. This signals a trend towards UILs, with a significant increase on the mere 3.6% of companies collaborating with universities in 2008–2009 (ABS, 2010) and 1.9% in 2006–2007 (ABS, 2008). Particularly noteworthy is the increase in collaborations involving small- and medium-sized enterprises. Nevertheless, significant opportunities exist for additional business R&D expenditure to be allocated towards university–industry engagement. Such expenditure has continued its rapid growth in recent years, except for a small decrease during 2009 and 2010 (ABS, 2012b).

Australia depends particularly strongly on the diffusion of knowledge and technology to stimulate the nation’s global involvement and competitiveness, given its small economy in comparison to major players in the global environment and the need to foster national productivity growth. The Australian government has, thus, significantly increased its efforts to stimulate university–industry collaboration, stating in its 2009 report (Commonwealth of Australia, 2009) that ‘it is especially important that we increase the level of collaboration between public researchers and private industry – we rank last in the OECD on this measure’ (p. 8). Hence, insight into UILs in the Australian context is critical not only to the involved players but also to the economy at large.

3. Hypotheses development

UILs demand interaction between involved partners, which in turn implies dynamism, attributable not only to differing characteristics, goals and actions of partners but also to continuous changes in the environment in which the UIL transpires. Ongoing involvement is, thus, expected to change the nature of interactions between partners. Interestingly, while authors have called for research on UIL evolution (Santoro and Gopalakrishnan, 2000; Bruneel et al., 2010), current literature provides little theoretical development or practical advice on how to successfully manage UILs from the initial inception to project completion and beyond.

We apply a theoretical framework drawn from stages and states theories, founded in social exchange theory (Thibaut and Kelly, 1959; Blau, 1968) with the basic premise that the perceived economic and social outcomes of earlier engagement are used to determine any future interactions. These future interactions, in turn, enable the development of relational success factors, such as trust (Lambe et al., 2011). While united in the premise that change processes occur in the development of inter-firm partnerships, stages and states theories differ in the linearity and flexibility of relationship evolution. Stages models describe a sequential and irreversible approach (Dwyer et al., 1987), explaining relationship evolution by means of a life cycle analogy or as growth-stage models (Batonda and Perry, 2003). States models, on the other hand, reflect complexity and dynamism (Tikkanen and Tuominen, 2000), arguing that relationships evolve in qualitatively different phases (Grayson and Ambler, 1999). For example, partners may re-evaluate a UIL and its future at any time, meaning that dissolution or divergence may occur, for example due to a lack of immediate projects.

In line with existing literature (e.g. Ford et al., 2003), we investigate success factors across three relationship phases, clarified through a qualitative pre-study (Plewa et al., 2013), namely the initiation phase, and thus the time of initial discussions between parties relating to a potential project; the engagement phase, during which the first project is conducted; and the continuing engagement phase, when parties engage in ongoing collaboration. In each phase, different outcomes reflect success. The initiation phase is expected to lead to an agreement, as well as a clear definition of deliverables, project goals and priorities, timelines, milestones, and responsibilities (Ayers et al., 1997). Given the project focus of the engagement phase, satisfactory project results are an obvious outcome measure (Bansal et al., 2004), while delivery of value beyond the project and word of mouth (WOM) are reaped from continuing engagement (Fink et al., 2008).

We also draw on interaction theories to further frame our hypotheses. The interaction approach upon which current network theory is anchored argues that no transactions occur independently and should be studied as integrative parts of relationships between various parties (Wilkinson and Young, 2002). Moreover, interaction theories elucidate relationship evolution dynamics by investigating the processes and drivers internal to relationships. In line with these theories (e.g. Van de Ven and Walker, 1984;
Heide and Miner, (1992), interaction and relational factors, such as communication, understanding and trust, are proposed here to foster relationship success and development (Geisler, 1995).

While this study focuses on relational drivers following the theories of interaction and evolution, it should be noted that the literature has provided a substantial report of research on other drivers of UILs, such as organizational factors (e.g. structures and cultures) (Santoro and Gopalakrishnan, 2000), as well as contextual factors, including previous links, partners’ reputation, definition of objectives, institutionalization of the relationship and geographical proximity (Mora-Valentin et al., 2004). Joia and Lemos (2010) more recently added other drivers, such as individual management of time, common language, relationship network, hierarchy, reward, type of training, knowledge transference and storage, power, and internal level of questioning. As these authors offer comprehensive accounts of potential UIL drivers, this research specifically focuses on relational success factors to allow for an in-depth comparison across multiple evolutionary phases.

Authors often identify the critical role of individuals for innovation management, technology transfer and UIL success (Howell et al., 2005; Hoye and Pries, 2009), as UILs commonly develop around tacit rather than implicit knowledge, which can only be translated and utilized with the involvement of key individuals (Shane, 2004). Recent research has, thus, stated the importance of personal interaction, personal networks and social engagement (Gertner et al., 2011; Walter et al., 2011). Positive interrelationships between individuals united in a UIL are expected to increase the extent and quality of communication between the partners, and foster understanding of the other throughout relationship evolution. Moreover, close interaction is likely to facilitate the development of trust by allowing individuals to develop confidence in, and reliance on, the partner, its intentions and actions. Hence:

H1a: Interrelationships between individuals is positively associated with communication in the initiation phase (H1a1), the engagement phase (H1a2) and the continuing engagement phase (H1a3).

H1b: Interrelationships between individuals is positively associated with understanding in the initiation phase (H1b1), the engagement phase (H1b2) and the continuing engagement phase (H1b3).

H1c: Interrelationships between individuals is positively associated with trust in the initiation phase (H1c1), the engagement phase (H1c2) and the continuing engagement phase (H1c3).

Consensus exists regarding the close association between trust and communication (Morgan and Hunt, 1994), although causality remains unproven. While bilateral communication can be argued to establish a trusting bond between parties (Grönroos, 2000), with communication fostering the development of trust (Wittmann et al., 2009), trust may also be a prerequisite for communication, given the potential for misuse of information provided to another party (Jordan, 2004). UILs not only commonly require the exchange of sensitive information (Harman and Sherwell, 2002); the differing and often unfamiliar culture united in these arrangements implies high levels of uncertainty (Plewa, 2009). In line with previous literature on UILs, we propose that trust leads to information and knowledge exchange (Bruneel et al., 2010). In turn, communication is expected to further the partners’ understanding of each other (Irwin et al., 1998; Conway and Swift, 2000) as it enables the development of a common knowledge platform. Therefore:

H2: Trust is positively associated with communication in the initiation phase (H2.1), the engagement phase (H2.2) and the continuing engagement phase (H2.3).

H3: Communication is positively associated with understanding in the initiation phase (H3.1), the engagement phase (H3.2) and the continuing engagement phase (H3.3).

Research-oriented linkages generally aim to integrate and transfer knowledge (Lee, 2000; Schmoch, 2002), explaining the importance of communication for successful UILs (Bonaccorsi and Piccaluga, 1994). Based on the knowledge-based view, successful teams allow people to contribute and assimilate their specialist knowledge and expertise without having to fully immerse themselves in the other’s background (Grant, 1996). Hence, communication creates the foundation for partners to maximize benefits from UILs through the integration of unique sets of knowledge, information and skills (Cummings and Kiesler, 2007). The same applies to the concept of understanding. Only if partners understand each other’s needs, environment and organizational characteristics can relevant knowledge be applied to achieve mutual benefits (Barnes et al., 2002).

Collaborative research is characterized by a high level of risk due to the uncertainty inherent in research and the common need to exchange sensitive information (Harman and Sherwell, 2002). While detailed contracts and governance mechanisms may be employed to minimize risk, rigidity can hamper the research effort. Trust reduces perceived risk,
creates a flexible working environment, and over-comes barriers to UIL function and evolution (Bruneel et al., 2010). In line with the commitment-trust theory of relationship marketing (Morgan and Hunt, 1994), we hypothesize that:

H4a: Communication is positively associated with UIL outcomes in the initiation phase (H4a1), the engagement phase (H4a2) and the continuing engagement phase (H4a3).

H4b: Understanding is positively associated with UIL outcomes in the initiation phase (H4b1), the engagement phase (H4b2) and the continuing engagement phase (H4b3).

H4c: Trust is positively associated with UIL outcomes in the initiation phase (H4c1), the engagement phase (H4c2) and the continuing engagement phase (H4c3).

Corresponding to the previous discussion on the impact of relationship characteristics on UIL success, the ease with which contracts can be agreed upon in the early engagement phase is likely to depend on information exchange. High-quality communication between potential partners is expected to facilitate agreement. A similar positive effect is expected from the desired outcome of phase one (clear definition of project goals, deliverables, timelines, milestones and responsibilities) easing contract negotiations. In line with services marketing literature (Gremler et al., 2001), we expect trust to positively impact WOM in continuing relationships. Only if an individual has confidence in the integrity of the partner and is willing to rely on it will s/he start integrating the partner into his/her network and providing positive referrals (Plewa et al., 2005). Hence:

H5: In the initiation phase, (a) communication and (b) the outcome (clear definition of goals, deliverables, timelines and responsibilities) are positively associated with the ease of reaching an agreement.

H6: In the continuing engagement phase, trust is positively associated with WOM.

The conceptual framework detailing the hypotheses is presented in Figure 1. The framework outlines the interrelationships between individuals as a critical driver of relational characteristics, namely trust, communication and understanding. In turn, these positively influence the outcome in each phase. Furthermore, communication is expected to be influenced by trust, as well as impact the level of understanding and the ease with which agreement is reached (initiation phase). Finally, the outcome of phase three, and thus the delivery of value beyond project terms, is likely to impact WOM.

4. Research design

A quantitative online survey was most suitable to meet the study’s objective to investigate success factors of UILs in various phases of relational development. The process of sample selection, development of measures and data collection follows.

4.1. Sample

Australia puts significant efforts into stimulating university–industry collaboration, for example by investing into initiatives such as the ARC Linkage Grant Scheme. This scheme funds projects between researchers and industry partners, endeavouring to establish long-term strategic alliances between universities and industry partners (ARC, 2012). Publications detailing grants provided under this scheme were, thus, identified as a valuable source of survey respondents. The authors located email addresses for...
researchers mentioned in grants approved between 2002 and 2009, resulting in 714 potential respondents across Australia who are known to have been involved in UILs for at least three years given the grant approval times and length of funding.

To limit sample composition bias that may arise by focusing on a single funding scheme, three universities known to the authors were asked to forward the invitation to 474 researchers known to be involved in UILs, with some overlap between the two sample frames unavoidable. The latter procedure introduced a bias towards South Australian universities, with two out of three universities located in that state. An overall response rate of 217 completed surveys was achieved. While limitations for generalizability of our findings are acknowledged, such response rate reflects the time-poor nature of our respondents and potential confidentiality concerns.

As this study investigates relational success factors across different stages of relational development, only those respondents who had engaged with an industry partner beyond one initial project and were able to complete questions relating to all three relationship phases were included in the analysis (N = 132). The majority of respondents identified themselves as senior researchers (73%), including professors, associate professors and senior lecturers in the Australian university system, with much of the UILs characterized as research-only (54.5%) or entailing both a research and consultancy component (38%). Reported relationship length averaged eight years. Research groups were composed of between one and 35 individuals (mean of 6.65). While a large percentage of respondents (41.5%) were based in South Australia, a broad reach was achieved, including respondents from most Australian states and territories. Primary industrial sectors included health and community services (19.5%), agriculture, forestry and fishing (17.4%), and government administration and defence (14.4%).

4.2. Measurement of constructs

The findings of a qualitative pre-study to this research (in-depth interviews with 15 industry and 15 university key informants in Australia and Germany/the Netherlands; Plewa et al., 2013) suggested three phases of UIL relationship evolution, and supported indications from the literature that communication, trust, understanding and interrelationships between individuals are critical in all phases, yet are manifested differently. These constructs were operationalized based on measurement items established in the literature, tailored specifically to each phase (Appendix A). In line with Larson (1992), the pre-study showed that the nature of communication differs between evolutionary phases. While communication quality, such as perceived credibility and accuracy, is relevant in the initiation phase, bilateral dialogue is necessary to achieve mutually beneficial outcomes in the engagement phase (Dwyer et al., 1987). Finally, communication goes beyond formalized projects, given the ‘value of developing a cooperative pattern of information exchanges that extend beyond the primary economic transaction’ in developed relationships (Larson, 1992, p. 93).

It is well documented that trust develops over time (Walter and Gemünden, 2000). Initially, trust depends on the potential partners’ expertise, with personal reputation providing a ‘foundation for mutual trust’ to develop in later phases (Larson, 1992, p. 84). With increasing experience in dealing with each other, interpersonal trust develops throughout the engagement phase (Doz, 1996), leading to ‘trusted partners’ throughout continuous engagement (Larson, 1992, p. 90). The understanding of the partner also changes throughout relationship evolution. Potential partners seek to understand each other’s expectations initially (Dwyer et al., 1987), yet learn more about the partner and its environment during the engagement phase (Larson, 1992). With increasing operational and strategic ties, phase three extends understanding to an integration that can be described by the statement ‘we are in this together’ (Larson, 1992, p. 91).

Finally, individuals and their interrelationships can take various roles in relationship development (Halinen and Salmin, 2001). The qualitative results indicated that while synergy, often based on similarity and effort, is most relevant in the initiation phase, ongoing interaction leads to the formation of personal relationships during the engagement phase, often progressing to friendships during continuous engagement (reported elsewhere).

4.3. Data collection

An online survey was administered due to its benefits of low costs (Kent and Lee, 1999), minimal resource requirements (Ilieva et al., 2002) and a quick turnaround time (Churchill and Iacobucci, 2005). To detect the dynamic nature of success factors despite the collection of data at a single point in the relationship, respondents were led through three phases and were asked for retrospective evaluation. While retrospective studies allow researchers to identify development periods and cycles (Halinen and Törroos, 1995), some disadvantages exist. For example, respondents may find it challenging to differentiate between current and previous phases, and therefore...
reinterpret occurrences in a similar way (Tikkanen and Tuominen, 2000). We aimed to minimize this limitation by using appropriate tenses and continually repeating the need to focus on the relevant phase.

The prevalent level of analysis is the relationship between the research group and the business unit engaged in the UIL. Hence, respondents were asked to choose one long-term linkage with an industry or government partner and report on their group’s perception of the relationship characteristics and outcomes. Only when considering interrelationships between individuals, respondents were asked to report on their personal connection with the main industry contact person. The survey was pre-tested with a small sample of academic experts and the target audience prior to online data collection during six weeks in July and August 2011. Incentives included a respondent report and the chance to enter into a draw for one of three Apple iPads. An email reminder was sent two weeks later to further increase the response rate.

5. Results

Data analysis employed AMOS 19 (SPSS Inc., Chicago, IL, USA), following structural equation modelling principles (Steenkamp and Baumgartner, 2000). As the data showed moderate non-normality (Lei and Lomax, 2005), analysis entailed the recommended normed fit index and comparative fit index (Lei and Lomax, 2005) and the Bollen-Stine bootstrapping technique (Bollen and Long, 1993). All constructs were shown to be reliable and valid (see Appendix B). Hypotheses were tested separately for each phase. While models relating to the first two phases showed very good model fit, the model relating to phase three did not meet standard requirements. However, modification indices indicated additional paths critical to this phase: a direct link between individuals and the outcome, as well as between understanding and trust. Adding these paths achieved a very good model fit (Table 1).

Results support H1a–c, H3 and H4 for all phases. Interrelationships between individuals (H1a–c) were confirmed as strongly and positively influencing success factors across all phases, yet with rising path coefficients. The added direct path between the individual and outcome in phase three strengthens this finding. Furthermore, results confirmed the impact of communication on understanding and outcome measures for all phases. Communication’s proposed positive effect on the ease of reaching an agreement in the initiation phase was also confirmed (H5a), as was the relevance of the clear definition of deliverables, milestones and responsibilities for reaching the agreement (H5b).

Mixed results emerged in relation to trust and understanding. Trust only significantly affected communication in the engagement phase, providing only support for H2.2. No significant association between trust and outcome variables emerged, disproving H4c. Only trust in the partner strongly and directly impacted WOM in phase three, confirming H6. While understanding only emerged as relevant for success in the engagement phase (H4b2), understanding positively impacted the development of trust, and thus indirectly WOM.

6. Discussion

As exchanging tacit knowledge underpins successful UILs (Shane, 2004), the significance of individuals across all stages is understandable (Gertner et al., 2011). This study extends our current understanding by investigating relevant forms of interpersonal relation across three UIL phases: The more individuals feel they relate to each other (initiation), spend mutual effort into establishing personal relationships (engagement) and develop strong personal ties (continuing engagement), the easier the information exchange required for the successful definition of the terms of the project, project completion and continuing creation of mutual value. Moreover, the results show rising path coefficients, leading to total standardized effects of personal ties on extended value creation in phase three of .73.

Our findings confirm the importance of communication across all stages of relationship development. These results substantiate theories of symbolic interaction, which argue that communication helps individuals form shared meanings and relationships (Singlemann, 1972). UILs are developed to unite the specialist expertise of university scientists and industry staff, demanding communication systems that support knowledge amalgamation without requiring individuals to completely internalize the partners’ knowledge base (Grant, 1996). Hence, throughout evolution, while a general quality of communication promotes a clear definition of project details initially, open professional dialogue during the engagement phase is required for successful project completion. Finally, informal discussions beyond specific project(s) deliver broader value in developed partnerships.

While the limited relevance of trust contradicts current literature (Bruneel et al., 2010), it may be explained by its measurement. Even if a respondent
provided a high trust rating for the university side, dyadic trust might not have been a given, yet may be required for it to influence project outcomes (Plewa, 2009). Furthermore, the affective measure of trust impacted greatly on the outcome measure reflecting a broader relationship, that is WOM intentions, rather than project-specific outcomes. Hence, one should attempt a more comprehensive investigation by integrating project- and relationship-related outcomes, as well as affective and behavioural drivers.

<table>
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<tr>
<td>H2</td>
<td>Trust</td>
<td>Communication</td>
<td>0.06</td>
<td>0.06</td>
<td>0.60</td>
</tr>
<tr>
<td>H3</td>
<td>Communication</td>
<td>Understanding</td>
<td>0.50</td>
<td>0.50</td>
<td>6.03***</td>
</tr>
<tr>
<td>H4a</td>
<td>Communication</td>
<td>Outcome</td>
<td>0.42</td>
<td>0.43</td>
<td>5.20***</td>
</tr>
<tr>
<td>H4b</td>
<td>Understanding</td>
<td>Outcome</td>
<td>0.03</td>
<td>0.03</td>
<td>0.37</td>
</tr>
<tr>
<td>H4c</td>
<td>Trust</td>
<td>Outcome</td>
<td>−0.03</td>
<td>−0.03</td>
<td>−0.42</td>
</tr>
<tr>
<td>H6</td>
<td>Trust</td>
<td>Word of mouth</td>
<td>0.63</td>
<td>0.64</td>
<td>9.29***</td>
</tr>
<tr>
<td>Added</td>
<td>Individuals</td>
<td>Outcome</td>
<td>0.46</td>
<td>0.73</td>
<td>5.99***</td>
</tr>
<tr>
<td>Added</td>
<td>Understanding</td>
<td>Trust</td>
<td>0.40</td>
<td>0.41</td>
<td>4.37***</td>
</tr>
</tbody>
</table>

*P < 0.05.
**P < 0.01.
***P < 0.001.

Results are based on Bootstrap = 500, 95% confidence level.

Model fit:
- **Initiation phase:** χ²: P > 0.05, χ²/df = 0.72, GFI = 0.99, AGFI = 0.96, CFI = 1.0, RMSEA = 0.00, TLI = 1.0, NFI = 0.97.
- **Engagement phase:** χ²: P > 0.05, χ²/df = 1.2, GFI = 0.99, AGFI = 0.95, CFI = 1.0, RMSEA = 0.04, TLI = 0.99, NFI = 0.99.
- **Continuous engagement phase:** χ²: P > 0.05, χ²/df = 1.26, GFI = 0.99, AGFI = 0.94, CFI = 0.99, RMSEA = 0.045, TLI = 0.99, NFI = 0.99.

AGFI, adjusted goodness of fit index; CFI, comparative fit index; df, degree of freedom; GFI, goodness of fit index; NFI, normed fit index; RMSEA, root mean square error of approximation; TLI, Tucker Lewis index.
In line with the trust–outcome paths, hypothesized links between trust and communication only emerged for the engagement phase. Several rationales exist. While communication is consistently reported as influencing trust in UIL, relationship marketing and alliance literatures (Jordan, 2004; Palmatier et al., 2006; Frasquet et al., 2011), none of these investigations differentiated relational phases. Hence, our results might indicate trust to be the most relevant during the time when communication mechanisms between partners are being established. While trust in the initiation phase is determined by perceptions of credibility or expertise, which in itself does not determine communication quality, communication outside project-specific topics in the continuing engagement phase may not demand trust due to experience with the partner.

The relationship marketing literature would support this argument, stating that while communication is required to establish trust when engaging with each other (engagement phase) (Palmatier et al., 2006), the causality may be reversed in later stages of the relationship as the ‘accumulation of trust leads to better communication’ (Anderson and Narus, 1990, p. 45). Furthermore, recent research has suggested that partners may exchange information as part of an assurance process, irrespective of the level of trust as ‘the acquisition of information may be used to partially offset the risks inherent in granting trust or to complement the trust that exists in a relationship’ (Gundlach and Cannon, 2010, p. 411). Hence, in ongoing UILs, communication might be used instead of trust to achieve a higher level of certainty and offset potential risks.

Understanding only significantly impacted success during the engagement phase. Hence, an appreciation of the partner’s capabilities, organizational characteristics, operations and interests promotes successful project completion. Surprisingly, during the early stages of interaction, understanding a potential partner’s needs in the initiation phase only moderately impacts the definition of project goals and deliverables \((P = 0.07)\). That means that a researcher may deem it safer to negotiate project details based on actual communication rather than perceptions of what the partner’s needs are. The lack of association between understanding and delivery of value beyond the project in phase three may be explained by the close integration being project-specific.

### 7. Managerial implications

While successful UILs may vary in their operationalization and characteristics, some general recommendations can be made based on the results. First, to encourage UIL success over time, individuals need to understand the change in relational success factors in line with UIL evolution. In particular, the results show that while individuals must identify whether they can relate to each other’s experience in the early stages of engagement, their focus should shift to attentive, helpful and cooperative behaviour throughout the first project, with continuing focus on maintaining rapport and even developing friendships throughout the linkage (Walter et al., 2011) to enable extended value creation over time. Second, wide-reaching communication mechanisms should be purposefully developed in order to maximize value in ongoing partnerships. As open discussions of emerging issues, questions and achievements relating to the first project may be valuable early in the relationship, frequent scheduled exchanges should be complemented by general accessibility, thus providing structure without limiting spontaneous exchanges. Furthermore, the content of communication should be broadened beyond the project in later stages. The development of trust between partners should also not be overlooked, as it encourages WOM, essential for attracting other potential partners.

Our findings also provide important insights for policy makers. For example, university administration needs to understand the evolving success factors of long-term UILs to establish guidelines for successful partnering. A comprehensive portfolio of incentives and initiatives aimed at fostering UILs across evolutionary stages will help reduce turnover of research and facilitating staff critical to these partnerships, and promote a consistent, positive approach to the university’s dealings with industry. This could include training programmes and the scheduling of opportunities/events for university and industry individuals to familiarize with each other. While this research focused on researchers, it is also relevant for commercialization managers, who facilitate UILs, particularly during the initiation phase. For example, by means of UIL support, they can coach partners, avert a mismatch in partners, encourage face-to-face dialogue and enhance understanding between potential partners.

### 8. Conclusion, limitations and future research directions

This empirical investigation of the dynamic nature of relational success factors across different stages of UIL development contributes to the literature on university–industry collaboration. However, there are limitations to be addressed in future research. This
research provides initial insight into changes of relational success factors over time, but relied on the ability of the respondents to accurately recall their own and their group’s connection to the partner at various points in time. Findings should be confirmed with a larger, more balanced sample. A large number of respondents were located in a narrow region (South Australia), which might have created some bias. Duplication of this study internationally, comparing countries with various levels of development in UILs and longitudinal analysis, as well as a comparison between relationships of various lengths, would also be beneficial.

Causality of the association between trust and communication may also be reversed, requiring future research to further investigate causality. Furthermore, given the ability of individuals to strengthen relationship success factors, future studies should focus specifically on interrelationships between individuals across evolutionary phases. For example, questions remain regarding whether UILs are initiated and developed on an individual or organizational level, how interpersonal relationships influence or are influenced by the broader partnership and even the network in which they operate, and whether the UIL can be personalized or institutionalized depending on how the partnership was initiated.

Acknowledgement

The authors would like to express their sincere gratitude for the support of this research by the Go8 Australia – Germany Joint Research Co-operation Scheme and the Deutscher Akademischer Austausch Dienst (DAAD). They also gratefully acknowledge the very valuable feedback received from the anonymous reviewers and the editor.

References


**Appendix A. Measurement items**

<table>
<thead>
<tr>
<th>Variable</th>
<th>Items used (all measured on 7-point Likert scales)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Initiation phase</strong></td>
<td></td>
</tr>
<tr>
<td>Individual (van Dolen et al., 2002)</td>
<td>The industry contact person could relate to my experiences</td>
</tr>
<tr>
<td></td>
<td>S/he paid special attention to my needs</td>
</tr>
<tr>
<td></td>
<td>S/he went out of his/her way</td>
</tr>
<tr>
<td>Trust (Newell and Goldsmith, 2001)</td>
<td>The partner had extensive experience in their field</td>
</tr>
<tr>
<td></td>
<td>The partner had great expertise</td>
</tr>
<tr>
<td></td>
<td>The partner was skilled in what they do</td>
</tr>
<tr>
<td></td>
<td>The partner did not have much experience (R)</td>
</tr>
<tr>
<td>Understanding (Smith and Barclay, 1997)</td>
<td>We understood the partner’s needs</td>
</tr>
<tr>
<td></td>
<td>We understood the environment in which the partner operates</td>
</tr>
<tr>
<td>Communication (Mohr and Soho, 1995)</td>
<td>Inaccurate/Accurate</td>
</tr>
<tr>
<td></td>
<td>Inadequate/Adequate</td>
</tr>
<tr>
<td></td>
<td>Incomplete/Complete</td>
</tr>
<tr>
<td></td>
<td>Not credible/Credible</td>
</tr>
<tr>
<td>Outcome (Ayers et al., 1997)</td>
<td>Project goals and priorities were clearly defined</td>
</tr>
<tr>
<td></td>
<td>Deliverables were clearly defined</td>
</tr>
<tr>
<td></td>
<td>Timeline and/or milestones were clearly defined</td>
</tr>
<tr>
<td></td>
<td>Responsibilities of all parties involved were clearly defined</td>
</tr>
<tr>
<td>Ease of reaching agreement</td>
<td>Ease of reaching agreement on terms of contract (0 [very difficult] – 100 [very easy])</td>
</tr>
<tr>
<td><strong>Engagement phase</strong></td>
<td></td>
</tr>
<tr>
<td>Individual (Hsieh et al., 2005)</td>
<td>My contact at the partner organisation and I devoted a lot of time and energy to making our relationship work</td>
</tr>
<tr>
<td></td>
<td>S/he kept in touch with me</td>
</tr>
<tr>
<td></td>
<td>S/he sought my opinion</td>
</tr>
<tr>
<td></td>
<td>S/he was willing to react in response to my queries (outside the project)</td>
</tr>
<tr>
<td>Trust (Bansal et al., 2004)</td>
<td>I felt that I can trust our contact person at the partner organisation completely</td>
</tr>
<tr>
<td></td>
<td>S/he was truly sincere in her/his promises</td>
</tr>
<tr>
<td></td>
<td>S/he treated me fairly and justly</td>
</tr>
<tr>
<td></td>
<td>I felt that s/he could be counted on to help me when I need it</td>
</tr>
</tbody>
</table>
Appendix A. (Contd.)

<table>
<thead>
<tr>
<th>Variable</th>
<th>Items used (all measured on 7-point Likert scales)</th>
</tr>
</thead>
</table>
| Understanding (Aaker et al., 2004) | I was familiar with the capabilities of the partner organisation  
I had become very knowledgeable about the partner organisation  
I understood how the partner organisation operates  
I was familiar with the partner organisation’s interests |
| Communication (Fisher et al., 1997) | We had great dialogues  
We had great professional exchange  
There was a lot of two-way communication between the partner and us |
| Outcome (Bansal et al., 2004) | We were satisfied in general with the project  
The project results covered the initial expectations  
The project results provided balanced results for partners |
| Continuing engagement phase | |
| Individual (DeCarlo and Leigh, 1996) | I would describe the contact person at the partner organisation as a friend of mine  
S/he would fit into my circle of friends  
I enjoy having a chat with this person |
| Trust (Ganesan, 1994; Morgan and Hunt, 1994; Doney and Cannon, 1997) | I feel that I can trust this partner completely  
I trust this partner to consider our best interests  
This partner can be counted on to act with integrity |
| Understanding (Song and Parry, 1997) | There is a high degree of integration between us and the industry partner  
The collaboration is stimulated by frequent interactions between us and the industry partner  
The industry partner and us are one team |
| Communication (Li and Dant, 1997) | We often exchange information informally  
We often exchange information beyond what is required by our agreements  
We often just talk without reference to the project |
| Outcome (Fink et al., 2008) | We routinely discuss issues which go beyond the project  
What we offer each other goes beyond our project(s) |
| WOM (Price and Arnould, 1999) | I would propose this industry partner to someone who seeks my advice  
I say positive things about this industry partner to other people  
I would recommend this industry partner to others  
I would encourage colleagues to do business with this industry partner |

R = reverse coded.
Appendix B. Reliability, convergent and discriminant validity scores

<table>
<thead>
<tr>
<th>Construct</th>
<th>No. items</th>
<th>( \alpha )</th>
<th>( p_h )</th>
<th>AVE</th>
<th>Highest ( \lambda^2 )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initiation phase</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Individual</td>
<td>3</td>
<td>0.82</td>
<td>0.83</td>
<td>0.68</td>
<td>0.64</td>
</tr>
<tr>
<td>Trust</td>
<td>4</td>
<td>0.91</td>
<td>0.90</td>
<td>0.69</td>
<td>0.37</td>
</tr>
<tr>
<td>Understanding</td>
<td>3</td>
<td>0.78</td>
<td>0.81</td>
<td>0.63</td>
<td>0.55</td>
</tr>
<tr>
<td>Communication</td>
<td>4</td>
<td>0.89</td>
<td>0.89</td>
<td>0.68</td>
<td>0.62</td>
</tr>
<tr>
<td>Outcome</td>
<td>4</td>
<td>0.91</td>
<td>0.91</td>
<td>0.78</td>
<td>0.45</td>
</tr>
<tr>
<td>Engagement phase</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Individual</td>
<td>4</td>
<td>0.87</td>
<td>0.87</td>
<td>0.63</td>
<td>0.56</td>
</tr>
<tr>
<td>Trust</td>
<td>4</td>
<td>0.93</td>
<td>0.94</td>
<td>0.79</td>
<td>0.66</td>
</tr>
<tr>
<td>Understanding</td>
<td>4</td>
<td>0.89</td>
<td>0.89</td>
<td>0.73</td>
<td>0.35</td>
</tr>
<tr>
<td>Communication</td>
<td>3</td>
<td>0.87</td>
<td>0.87</td>
<td>0.70</td>
<td>0.81</td>
</tr>
<tr>
<td>Outcome</td>
<td>3</td>
<td>0.83</td>
<td>0.82</td>
<td>0.60</td>
<td>0.32</td>
</tr>
<tr>
<td>Continuing engagement phase</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Individual</td>
<td>3</td>
<td>0.88</td>
<td>0.88</td>
<td>0.72</td>
<td>0.68</td>
</tr>
<tr>
<td>Trust</td>
<td>4</td>
<td>0.94</td>
<td>0.94</td>
<td>0.83</td>
<td>0.62</td>
</tr>
<tr>
<td>Understanding</td>
<td>3</td>
<td>0.88</td>
<td>0.88</td>
<td>0.71</td>
<td>0.65</td>
</tr>
<tr>
<td>Communication</td>
<td>3</td>
<td>0.84</td>
<td>0.86</td>
<td>0.68</td>
<td>0.65</td>
</tr>
<tr>
<td>Outcome</td>
<td>2</td>
<td>0.89</td>
<td>0.89</td>
<td>0.80</td>
<td>0.68</td>
</tr>
<tr>
<td>WOM</td>
<td>4</td>
<td>0.94</td>
<td>0.94</td>
<td>0.86</td>
<td>0.42</td>
</tr>
</tbody>
</table>

\( \alpha = \) Cronbach’s alpha (Cronbach, 1951).
\( p_h = \) composite reliability (Diamantopoulos and Siguaw, 2000).
AVE = average variance extracted (Fornell and Larcker, 1981).
Highest \( \lambda^2 = \) highest shared variance (Fornell and Larcker, 1981).

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