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Coopetitive relationships in cross-functional software development teams: How to model and measure?

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ABSTRACT

Understanding simultaneous cooperative and competitive (coopetitive) dynamics in cross-functional software development teams is fundamental to the success of software development process. The recent coopetition research is, however, hampered by a lack of conceptual focus, and the corresponding inconsistent treatment of the constructs associated with cross-functional coopetitive relationships. This study conceptualizes and operationalizes the multi-dimensional construct of cross-functional coopetition, and then presents an instrument for measuring this construct. Cross-functional coopetition is conceptualized with 5 distinct and independent constructs; 3 of them are related to cross-functional cooperation, and 2 are associated with cross-functional competition. The data collected from 115 software development project managers in Australia confirms the applicability of the constructs and their measures. This study contributes to the extant literature by providing a consensus on the conceptualization of cross-functional coopetitive behaviors, particularly in multi-party software development teams. The conceptual basis for cross-functional coopetition and its instrument will aid researchers and project managers interested in understanding coopetition in cross-functional collaborative contexts. Research and practical implications are discussed.

1. Introduction

Cross-functional project teams are composed of individuals drawn from various functional units within their organization who possess specialized knowledge and skills relevant to the completion of the project (Clark and Wheelwright, 1992; Holland et al., 2000; Witt et al., 2001). Prior empirical studies point out the double-edged sword consequences of cross-functional teams (Brown and Eisenhardt, 1995; Chen, 2007). More specifically, while the potential for producing innovative outcomes is high, the potential for conflict and stagnation could be even higher (Levina, 2005; Tortoriello and Krackhardt, 2010). Cross-functional teams are likely to experience tension caused by diverse professional philosophies and competing goals from cross-functional representatives (Witt et al., 2001). As a consequence, tension, conflict, and misunderstanding among functional units may win over cooperation, and threaten commitment of team members (Swamidass and Aldridge, 1996; Keller, 2001; Farris et al., 2003). Therefore, while cross-functional team members must cooperate, and work toward the common interests of organization, they might compete with each other in the pursuit of divergent goals, strategic priorities, and scarce resources (Witt et al., 2001; Lin, 2007).

In the context of software development project teams, shared resource pools, different backgrounds and project roles might make the subgroups of business and IT professionals have different goals of their own, in addition to the project goals (Linberg, 1999; Pee et al., 2010). The positive interdependencies make them cooperate with each other and promote mutual goal attainment; however, if the conflict becomes a dominating concern, they may behave uncooperatively in order to prevent others from achieving their goal, since one's success is at the expense of others (Deutsch, 1949; Johnson and Johnson, 2006). For example, end users desire specific functions to serve individual business needs, programmers focus on overcoming technical constraints and enhancing competency of their careers, and project managers are concerned about influencing common elements of the infrastructure for meeting budget expectations and meeting milestones. Similarly, IT professionals might experience similar challenges within their own teams; for example, designers and coders may disagree on design methodology, programming language, database server and etc. (Walz et al., 1993; Tolfo and Wazlawick, 2008).

Performance evaluation systems can also echo teamwork (Tolfo and Wazlawick, 2008). Individual evaluation systems encourage individual performance search, and this may bring competition

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Table 1
Cross-functional coopetition conceptualizations.

Study	Coopetition conceptualization	Coopetition effect	Confirmed effect
Tsai (2002)	Cross-functional cooperation: social interactions Cross-functional competition: competition for tangible resources and market share Cross-functional coopetition: social interactions and cross-functional competition	Synergic impact of competition and social interactions on knowledge sharing	Synergic impact of competition for market share and social interactions on knowledge sharing.
Luo et al. (2006)	Cross-functional cooperation: cooperative ability and cooperative intensity Cross-functional competition: competition for tangible and intangible resources Cross-functional coopetition: cross-functional cooperation and cross-functional competition	Synergic impact of cooperative ability and competition on market learning Positive impact of cooperative intensity among competing units on market learning	Synergic impact of cooperative ability and competition on market learning Positive impact of cooperative intensity among competing units among market learning
Lin (2007)	Cross-functional cooperation: cross-functional coordination Cross-functional competition: competition for tangible and intangible resources Cross-functional Coopetition: cross-functional cooperation and cross-functional competition	Separate impacts of cooperation and competition on knowledge management processes and NPD performance	Positive impact of cross-functional cooperation on knowledge management processes and NPD performance Positive impact of cross-functional competition on NPD performance

among cross-functional team members. However, team evaluation systems facilitate collective effort and collaborative practices. According to Tolfo and Wazlawick (2008), differently management may also stimulate competition among IT developers, for example through signaling the possibility of obtaining rewards and individual acknowledgement. Personal differences and ego dispute can also lead team members to create a competitive atmosphere. Finally, organizational culture, power dispute and competition among managers of different functional units (who have a representative in cross-functional projects) may have negative repercussions on the collaboration of project members (Linberg, 1999).

Despite the dawning recognition of the importance of simultaneous cooperative and competitive behaviors, to date, there has been a lack of empirical studies that focus on the elements that comprise these behaviors, especially at intra-organizational levels (Walley, 2007). Research in this area is hamstrung by the inconsistent treatment of the related constructs, cross-functional cooperation and competition. Hence, this study attempts to presents a conceptualization for cross-functional coopetitive behaviors in an attempt to provide a consistent way of treating them. Software development is chosen as an excellent context because of its inherent simultaneous cooperative and competitive nature (Nambisan and Wilemon, 2000; Levina, 2005; Avital and Singh, 2007). For example, extreme programming (XP) is deeply focused on human relationships, and this is due to the fact that XP strongly depends on the acceptance, compromise and interactions among various stakeholders with different needs and priorities. Thus, our globally competitive environment requires understanding cooperation and competition dynamics in the success of software development projects.

In this regard, this study targets to answer the following research question: How simultaneous coopetitive behaviors among cross-functional software development team members should be modeled and measured? By cross-functional software development teams, we refer to development teams that have member representatives from different functional units such as organizations/departments/and groups. This definition can cover both traditional and globally distributed software development teams. The contribution of this study in terms of presenting a multi-dimensional conceptualization and instrument helps project managers (either in traditional or global software development teams) to (i) understand, (ii) measure, and (iii) influence and manage different dimensions of inevitable cooperation and competition in multi-party software development teams. The better understanding and management of these dimensions (for each project or across different projects) constitute the key practical implication of this study. The conceptual basis and its instrument will not only be valuable to researchers and practitioners interested in measuring team interactions in multi-party software development projects, but also aid future studies in examining the unique impact of each dimension on project outcomes.

The remainder of this paper is organized as follows. First, we present an overview of the literature on the concept of cross-functional coopetition. Second, based on the reviewed literature, a multi-dimensional conceptualization for cross-functional coopetition is postulated. The process of developing the initial instrument is then outlined. The result section discusses the data collection procedure and the quantitative analysis of the conceptual basis and its instrument. The paper concludes by discussing the theoretical and practical implications of the study.

2. Literature review

We conducted a review of coopetition in 11 major academic databases.[1] Table 1 summarizes the 'methods of conceptualizing cross-functional coopetition' as well as the 'coopetition effect' in the previous studies. The review[2] demonstrates limited but different ways of conceptualizing coopetition across functional units. More specifically, Table 1 implies that there are two major differences in the conceptualization of cross-functional coopetition in the previous studies.

Firstly, while cross-functional coopetition is treated with two separate constructs of cross-functional cooperation and competition, cross-functional cooperation and competition in each study convey different meanings and have different indicators (as shown in Table 1). Furthermore, the potential of statistical bias in terms of misspecifying formative measures was found in Luo et al. (2006)

[1] The databases include: ScienceDirect; Business Source Premier; Inspec; Springer Link; AIS (Association for Information System); Scopus; ProQuest; Science Journals; ISI Web of Science; ACM Digital library; IEEE Explore.

[2] The review included papers in the above databases, which either "coopetition" or "co-opetition" was mentioned in their title, subject, or keywords. Furthermore, the references and citations were checked to ensure not any single paper is missed. 184 papers we found. The results show that the number of publications on coopetition has been dramatically increased from *19* prior to 2000 to *35* in the period 2001–2005, and to *130* in the period 2006–2010. Investigating the unit of analysis in the above studies showed that only a few studies (7 studies) have conceptualized and empirically examined coopetition at intra-organizational levels such as strategic business units (SBUs). Reviewing the findings, *3* papers were found that had focused on coopetition across functional units.

and Lin (2007). The extant literature points out the significant difference between formative and reflective constructs (Petter et al., 2007). Formative measures define, produce, or cause the construct rather than vice versa (Diamantopoulos and Winklhofer, 2001). For example, the two dimensions of competition for tangible and intangible resources form or cause the overall competition, rather than being caused by the overall competition. However, Luo et al. (2006) and Lin (2007) conceptualized competition for tangible and intangible resources as reflective indicators. This implies a statistical bias that refers to misspecifying formative measures as reflective ones, and it is considered as a common source of statistical bias in the interpretation of results (Petter et al., 2007; Cenfetelli and Bassellier, 2009).

Secondly, each study has investigated 'coopetition effect' in different ways. Tsai (2002) and Luo et al. (2006) considered cross-functional competition as having a moderating impact on the relationship between cross-functional cooperation and organizational outcomes, whereas Lin (2007) investigated separate impacts of cross-functional cooperation and competition on organizational outcomes.

In addition, it was found out that there is not sufficient attention in investigating the antecedents or factors that generate cross-functional coopetitive behaviors. This is somehow due to the fact that the concept of cross-functional coopetition is largely unstudied, and thus the main yet limited focus has been on understanding this concept and investigating its impacts of organizational outcomes. For example, the extant literature in software development ascertains the importance of a number of factors such as project complexity, process maturity of the organization (Fuggetta, 2000), and perceived goal and reward interdependencies on cooperative behaviors of team members (Pee et al., 2010). However, the extant literature on cross-functional coopetition has not paid theoretical and empirical attention in investigating and combining these factors in an integrated model.

In this study, we target only the first discussed issue (*inconsistent conceptualization of cross-functional cooperation and competition*) in order to provide a consensus on the conceptualization and measurement of cross-functional coopetitive relationships. This would provide a fertile ground for understanding coopetitive behaviors and examining the antecedents and consequences of these behaviors in cross-functional projects.

3. Conceptualization

The previous section discussed that cross-functional coopetition has been conceptualized with two separate constructs including: cross-functional cooperation and cross-functional competition. This study argues that the separation of these two constructs is an appropriate way of modeling coopetition, and it is also consistent with the previous studies in this area. More specifically, the extant literature shows evidence that emphasize the distinct nature of the two constructs of cross-functional cooperation and competition. For example, Molleman (2009) argues that cross-functional team members might develop simultaneous positive and negative attitudes at their works. As an example, a team member may like to help a heavily loaded colleague, while, at the same time, s/he feels territorial competitive attitudes (Molleman, 2009). Similarly, team work literature suggests that broad organizational perspectives and social identities in cross-functional teams make their climate ripe for arising political behaviors; these behaviors may, in turn, suppress team cohesion and cooperation (Pinto et al., 1993; Pelled et al., 1999; Witt et al., 2001; Parker, 2003; De Clercq et al., 2009; Lau and Cobb, 2010). The next two sections conceptualize the two constructs of cross-functional and competition by undertaking the following steps.

3.1. Cross-functional cooperation

The extant literature points to numerous terms and phrases that have been used analogously with cross-functional cooperation such as: cross-functional integration, cross-functional interaction, cross-functional collaboration, and cross-functional coordination (Pinto et al., 1993; Lin, 2007). Depending on the respective studies, cross-functional cooperation has different meanings and covers different issues. For example, Anderson and Narus (1990) refer to cross-functional cooperation as similar or complementary coordinated actions taken cross-functional representative to achieve mutual or singular outcomes (Anderson and Narus, 1990). Fisher et al. (1997) explains cross-functional cooperation in terms of interaction and communication-related activities (Fisher et al., 1997). Cross-functional cooperation has been also typified with team work, resource-sharing, collective goals and mutual respect (Schrage, 1990). Another study, Lin (2007), examined cross-functional cooperation in terms of communication, knowledge sharing, coordination, and joint involvement in mutual tasks.

After reviewing the existing definitions and measures of the cross-functional cooperation, we categorized the broad range of definitions and meanings in three major categories: (i) cooperative task orientation (e.g., collective tasks, spirit of helping each other), (ii) cooperative communication (e.g., social interactions, knowledge sharing), and (iii) cooperative interpersonal relationships (e.g., mutual respect) (Song et al., 1997; Pinto et al., 1993). This categorization concurs with the conceptual definition of cross-functional cooperation in Song et al. (1997) and Pinto et al. (1993), which is based on the work of Deutsch (1949).

The first category, cooperative task orientation, reflects the attitudes of cross-functional members in accomplishing joint tasks such as the spirit of helping each other. Cooperative communication reflects discussion and communication patterns among cross-functional team members. Cooperative interpersonal relationships such as close ties and gratifying relationships refer to the third category of cross-functional cooperation.

A lack of systematic attention in conceptualizing cross-functional cooperation is noticeable. For example, both Pinto et al. and Song et al. simply combined different indicators that reflect the three categories or dimensions of cooperation as reflective measures, rather than a systematic conceptualization that considers the nature of these indicators and their relation to the construct. Given the theoretical superiority of second-orders in studying different dimensions of a construct, we aggregate the above three dimensions as the forming dimensions of cross-functional cooperation. Since these dimensions exert varying effects on cross-functional cooperation rather than vice versa, cross-functional cooperation is conceptualized to be formed by the three forming constructs of (i) cooperative task orientation, (ii) cooperative communication, and (iii) cooperative interpersonal relationships. This conceptualization is believed to let us avoid the common statistical bias of misspecifying separate formative dimensions as reflective ones (Petter et al., 2007).

In addition, the conceptualization of cross-functional cooperation with the above three dimensions provides a more complete viewpoint toward this concept compared to the previous studies in the coopetition literature (e.g., Tsai, 2002; Luo et al., 2006).

3.2. Cross-functional competition

There are relatively fewer studies on cross-functional competition compared to cross-functional cooperation. For example, Tsai (2002) treats cross-functional competition in terms of competition for internal sources and market share among functional units. More recently, Luo et al. (2006) and Lin (2007) extended the meaning of cross-functional competition, and typify it with the degree to which functional units compete for limited tangible resources (e.g., organizational capital, personnel) and intangible resources (e.g., strategic power, top executives' mental time and attention). As stated in the Literature Review Section, the potential of statistical bias in terms of misspecifying formative measures was found in Luo et al. and Lin. For example, the two dimensions of competition for tangible and intangible resources form or cause the overall competition, rather than being caused by the overall competition. However, Luo et al. (2006) and Lin (2007) conceptualized competition for tangible and intangible resources as reflective indicators.

Similar to the previous discussion on cross-functional cooperation, and given the superiority of second-orders conceptualization, we aggregate the two dimensions of competition for tangible and intangible resources as the forming constructs of cross-functional competition.

4. Research methodology

4.1. Data collection

An empirical investigation of software development project managers in Australia was conducted. Data was collected through an online questionnaire survey. Following the similar key informant research to identify a person who would be highly knowledgeable about team events, project managers were targeted as the key respondent (Sethi et al., 2001).

A comprehensive list of ethical issues was carefully considered before conducting the research. Responses were truly voluntary. Project managers could answer questions anonymously. Project managers did not represent their organizations; rather their team experience was represented. Confidentiality and anonymity were guaranteed to respondents.

The criterion for participation was managing or being highly involved in a multipart software development project within the last two years. The survey questions were represented in a random manner. In order to handle challenges of missing data, the submission of the survey required the valid responses for all of the questions, which resulted in no missing data. The questionnaire was sent through an Email that included the link to the survey to a group of 500 members of five IT associations in Australia. These associations are considered as the professional Australian organizations that help experienced IT professionals develop and broaden their expertise. There are restricted membership criteria and the certified member status within these associations is upon to specified criteria, which have limited the memberships to those who carry a reasonable breadth of responsibilities, seniority, and abilities in IT. In order to increase professionals' motivation in filling out the survey, the survey began by highlighting the practical implications of the study to software development teams. It was guaranteed to send them an executive summary of the study, upon their request.

150 questionnaires were returned (30%); out of these, 35 were not completed, and therefore were excluded from the analysis. Thus, 115 usable responses were obtained from a population of IT professionals in Australia. This response rate is consistent with Baruch and Holtom (2008) stating that those studies that are conducted at the organizational level, and seek responses from organizational representatives or top executives are likely to experience lower response rates, approximately 35–40% (Baruch and Holtom, 2008).

The sample size demonstrated a relatively broad range of projects in terms of project duration, project members, project complexity, etc., which collectively can add up to a wide cross-section. The sample included both in-house (72%) and outsourced (28%) projects. 90% of the projects took less than three years to be completed. The projects were mainly moderate or high in complexity, which explain the reason behind involving cross-functional representatives during the project. In addition, majority of the project managers (67%) had more than five years experience in software development project management. This reinforces that representatives of the sample are mostly professionals whose technical contributions and cross-functional experience are highly valued. In summary, the demographics suggest that the selected projects are representative of a considerable population of software development projects. Detailed demographics of the projects are given in Table 2.

Table 2
Projects characteristics.

Sample characteristics
Project type
In-house: 83, Outsourced: 32
Number of functional units
Between 1 and 5: 84, between 6 and 10: 24, between 11 and 20: 7, more than 20: 4
Number of team members
Between 1 and 5: 41, between 6 and 10: 37, between 11 and 20: 16, more than 20: 21
Project manager experience
Less than 1 year: 12, between 1 and 2 years: 9, between 2 and 3 years: 16, between 3 and 5 years: 19, more than 5 years: 77
Project duration
Less than 1 year: 49, between 1 and 2 years: 35, between 2 and 3 years: 19
Between 3 and 5 years: 6, More than 5 years: 6
Project complexity
Very low: 0, low: 5, slightly low: 14, moderate: 26, slightly high: 26, high: 36, very high: 8

4.2. Instrument development

Each of the constructs of cross-functional cooperation and cross-functional competition in this study has multi-item scales derived from relevant prior studies. Each measure was anchored on a 7-point Likert scale ranging from 'strongly disagree" to "strongly agree" (7). In total, 13 measures were used. For cross-functional cooperation we adapted measures from Pinto et al. (1993) and Song et al. (1997). Items used for cross-functional competition were obtained from Luo et al. (2006) and Lin (2007). Several meetings and interviews with 3 academic colleagues and a professor expert in designing questionnaires were conducted to screen the measures, evaluate face validity, and note ambiguous and redundant measures. As a result, Table 3 evinces the measures for each construct and the question related to each measure.

Prior to the test of the conceptual basis and its instrument in the target sample, we decided to have an initial content validation by checking the model and its instrument in a similar context. For this, 3 experienced engineers holding the position of developers in multi-party software development teams were invited to review the pilot of the questionnaire, and note any measure/question that they perceived as 'not necessary' or 'requires changes' from their software development experience perspective. There was no measure/question that was ranked as "not necessary" by all of the software developers. They noted any item that they perceived as ambiguous or needed more explanation. They advised us to make minor changes in questions and the graphical representation of the questionnaire (e.g., order of the questions, the introduction page of the survey that explains the main objective and practical implications of the study). The results of the analysis on the conceptual basis and its instrument are presented in the next section.

Table 3
Cross-functional cooperation and competition measures.

Construct	Forming constructs and Measures and Questions
Cross-functional (CF) cooperation	**Cooperative Task orientation** *Integrative activities:* CF representatives integrated their activities to ensure better attainment of the project outcomes. *Cohesive activities:* CF representatives accomplished project tasks in a cohesive manner. *Helps in tasks:* CF representatives willingly helped each other in their project activities. *Task commitment:* CF representatives were committed in accomplishing project tasks. **Cooperative Communication** *Regular communication:* CF representatives regularly communicated together. *Regular problem discussion:* CF representatives regularly discussed common problems. **Cooperative interpersonal relationships** *Close ties:* CF representatives had close ties with each other. *Gratifying relationships:* The relationships between CF representatives were mutually gratifying
Cross-functional (CF) competition	**Competition for tangible resources** *Competition for resources:* Overall, CF representatives regularly competed for resources. *Tension on resource distribution:* When CF representatives discussed distribution of resources among their departments, tensions frequently occurred. **Competition for intangible resources** *Competition for strategic attention:* CF representatives tried to gain more strategic power during the project. *Competition for strategic power*: CF representatives regularly competed with each other for more attention from top executives. *Protecting departmental turf:* Protecting one's departmental turf seemed to be a way of life by CF representatives.

5. Data analysis

Structural equation modeling (SEM) was applied to investigate the measurement model, and examine the causal relationships between dependent and independent constructs. We employed PLS-Graph Version 03.00, which uses a principal component-based estimation approach (Cheng, 2001). The choice of PLS rather than covariance-based tools (e.g., Amos, LISREL) was mainly because PLS has the ability of modeling latent constructs under conditions of fewer statistical specifications and constraints on the data (e.g., assumptions of non-normality) than the covariance-based strategies. PLS has also more consistency, flexibility, and robustness in small to moderate sample sizes (Chin, 1998; Chin and Newsted, 1999). Table 4 summarizes the statistics of both measurement items and constructs.

In terms of sample size, we followed the procedure for estimating the power (Chin et al., 2003). This procedure takes into account the fact that both sample size and the number of model's indicators affect the power, and contribute to statistical estimates. In order to control statistical power, a priori power analyses was conducted to determine the desirable sample size before conducting the study (Cohen, 1988). Using G*power3 software (Faul et al., 2007) with the alpha = 0.05, power of 0.8 and the effect size of 0.5 (suggested by the method), the sample size of 102 was recommended as sufficient. This indicated that the sample of 115 responses in this study is adequate.

This study used several techniques to evaluate the reliability and validity of the multi-dimensional conceptualization offered for cross-functional coopetition. Since we built the conceptual basis of this study based on the existing theoretical explanations, we employed PLS to perform a confirmatory factor analysis (CFA). The fit of the pre-specified model was then examined to determine construct validities.

This factorial validity deals with whether the pattern of loadings of the measurement items corresponds to the theoretically anticipated factors (Hulland, 1999). Assessment of the measurement model internal consistency is demonstrated when the reliability of each measure in a scale is above 0.7 (Nunnally, 1978). Each of the 13 items had Cronbach's alpha exceeding the recommended value of 0.70 and with the majority loading of more than 0.85, indicating a robust reliability.

The rigorous procedures used to conceptualize and operationalize the multi-dimensional construct of cross-functional coopetition, and the Interviews with academics and domain practitioners and experts suggest that the conceptual basis possesses good content validity.

We applied multitrait-multimethod techniques to examine convergent validity of the constructs (Churchill, 1979). Convergent validity was examined by generating 500 bootstrapping samples. Composite reliability of constructs and average variance extracted (AVE) were checked (Fornell and Larker, 1981). Convergent validity is adequate if each of the constructs has the minimum average variance expected (AVE) of 0.50 (Fornell and Larker, 1981). Additionally, it is recommended that the factor loadings of all items should be above 0.60 for an adequate convergent validity (Hair et al., 1998). As shown in Table 4, measures of internal consistency and convergent validity of all constructs were greater than 0.7 and 0.5, respectively. This finding ensured that measures of each five constructs (task orientation, communication, interpersonal relationships, tangible resources, and intangible resources), are related to their specified construct as a whole.

Discriminant validity was assessed by testing whether the correlation between pairs of constructs is below the threshold value of 0.90, and whether the square root of AVE is larger than correlation coefficients (Fornell and Larker, 1981; Chin, 1998). Our results as presented in Table 5 show that the square root of the AVE for all first-order constructs was higher than their shared variances, and thus the variance shared between each construct and its indicators are distinct and unidimensional. This confirmed the discriminant validity of the constructs, and thus constructs' measures are not simply a reflection of other constructs of the model.

Fig. 1 illustrates the tested model in PLS, including the loadings of the measures and the paths between the second-order constructs (cross-functional cooperation and cross-functional competition) and their first-order constructs. In order to operationalize the second-order constructs of cross-functional cooperation and competition, a repeated indicators approach (the hierarchical component model) was used (Lohmoller, 1989). As such, cross-functional cooperation and competition were measured by the indicators of their associated forming constructs.

The path coefficients in Fig. 1 show the relationship between the forming components and their associated constructs of cross-functional cooperation and competition. The contribution of each forming construct to its associated construct (as shown in Fig. 1) suggests that no single dimension contributed significantly to cross-functional cooperation and competition. Instead, it was the combination of the forming constructs that explained the

Table 4
Outer model statistics.

	Sample estimate	Mean	Standard error	*t*-Statistic
Interpersonal relationships	*AVE = 0.75*	*Composite reliability = 0.86*		
Close ties	0.84	0.83	0.05	14.72
Mutual gratifying relationships	0.88	0.89	0.02	40.99
Task orientation	*AVE = 0.89*	*Composite reliability = 0.68*		
Integrative activities	0.79	0.79	0.04	16.5
Cohesive activities	0.84	0.84	0.03	26.27
Helping each other	0.83	0.82	0.02	27.88
Project commitment	0.81	0.81	0.03	24.79
Communication	*AVE = 0.79*	*Composite reliability = 0.89*		
Regular communication	0.91	91	0.02	43.38
Problem solving discussion	0.88	0.88	0.03	28.4
Tangible resources	*AVE = 0.79*	*Composite reliability = 0.89*		
Competition for resources	0.91	0.91	0.01	57.94
Competition for resource distribution	0.86	0.86	0.03	23.16
Intangible resources	*AVE = 0.77*	*Composite reliability = 0.91*		
Competition for strategic power	0.88	0.88	0.02	33.89
Competition for strategic attention	0.89	0.89	0.02	37.28
Competition for departmental turf	0.86	0.86	0.03	26.47

Table 5
Correlations of latent constructs.

	1	2	3	4	5
Interpersonal relationships	0.86				
Task orientations	0.76	0.94			
Communication	0.52	0.79	0.88		
Tangible resources	−0.27	−0.20	−0.12	0.87	
Intangible resources	−0.24	−0.24	−0.24	0.68	1

second-order constructs of cross-functional cooperation and competition. For example, the path coefficients between first-order constructs of cross-functional cooperation and cross-functional cooperation were: task orientation: 0.54, communication: 0.29, interpersonal relationships: 0.28. This supports the applicability of multi-dimensional conceptualization, and the importance of each of the five forming constructs in predicting cross-functional cooperation and competition.

6. Discussion

6.1. Research contributions

This study attempted to answer how coopetition in cross-functional project teams should be modeled and measured. Accordingly, we postulated and operationalized a multi-dimensional conceptualization for understanding coopetition in multi-party software development teams. Drawn upon the organizational management literature, we modeled coopetition as being formed by five components including: (i) cooperative task orientation, (ii) cooperative communication, (iii) cooperative interpersonal relationships, (iv) competition for tangible resources, and (v) competition for intangible resources.

Based on the results, we demonstrated that the proposed coopetition instrument is a concise multiple-item scale with adequate reliability and validity. The paragraphs below discuss the fourfold research contributions of this study to both organizational management and software development literature.

Firstly, our literature review uncovered the concept of cross-functional coopetition, and in a rigorous way, investigated how this concept has been treated previously. We argued why the separation of the constructs of cross-functional cooperation and competition is an appropriate way for studying cross-functional coopetition. The focus of the literature review advances the recent emphasis on understanding coopetitive structures, and makes a contribution to making this field more robust by explaining the constructs that form cross-functional coopetition.

Secondly, the presented conceptualization of cross-functional coopetition provides a consensus on the application of this concept and its related components. While constructs of cross-functional cooperation and competition are not new to both IS and a management field, the extant literature has treated these concepts differently in different studies. For example, some researchers explain cross-functional cooperation in terms of cooperative communications, whereas some others typify it with integrated activities. There is a need to have a consensus on cross-functional cooperation and competition, especially when researchers are interested to examine their impacts on project outcomes. For example, some studies might measure competition with indicators related to competition for resources, and empirically show its positive impact on project outcomes. Whereas some others might measure competition with indicators related to competition for strategic power, and empirically show the negative impact of competition and organizational politics on project outcomes. Having a consensus on the conceptualization of cross-functional cooperation and competition helps scholars ensure that by cross-functional cooperation and competition, we mean and target the same things. This study provides this consensus by investigating how these constructs have been previously conceptualized, and proposing a multi-dimensional conceptualization for them.

Thirdly, the unique advantage of the multi-dimensional conceptualization is that it provides the possibility of examining the impact of different forms (or dimensions) of competition (e.g., competition for tangible and intangible resources) and cooperation (e.g., task orientation, interpersonal relationships) on project outcomes. Specifically, different forms of competition or cooperation might engender different and even contradictory organizational outcomes. Their mixture prevents researchers from checking potential contradictory effects (such as positive and negative impacts that can be neutralized by mixing), and thereby question the efficacy and reliability of their results.

Fourthly, we successfully transformed our conceptual basis into a validated instrument for measuring coopetition in multi-party software development teams.

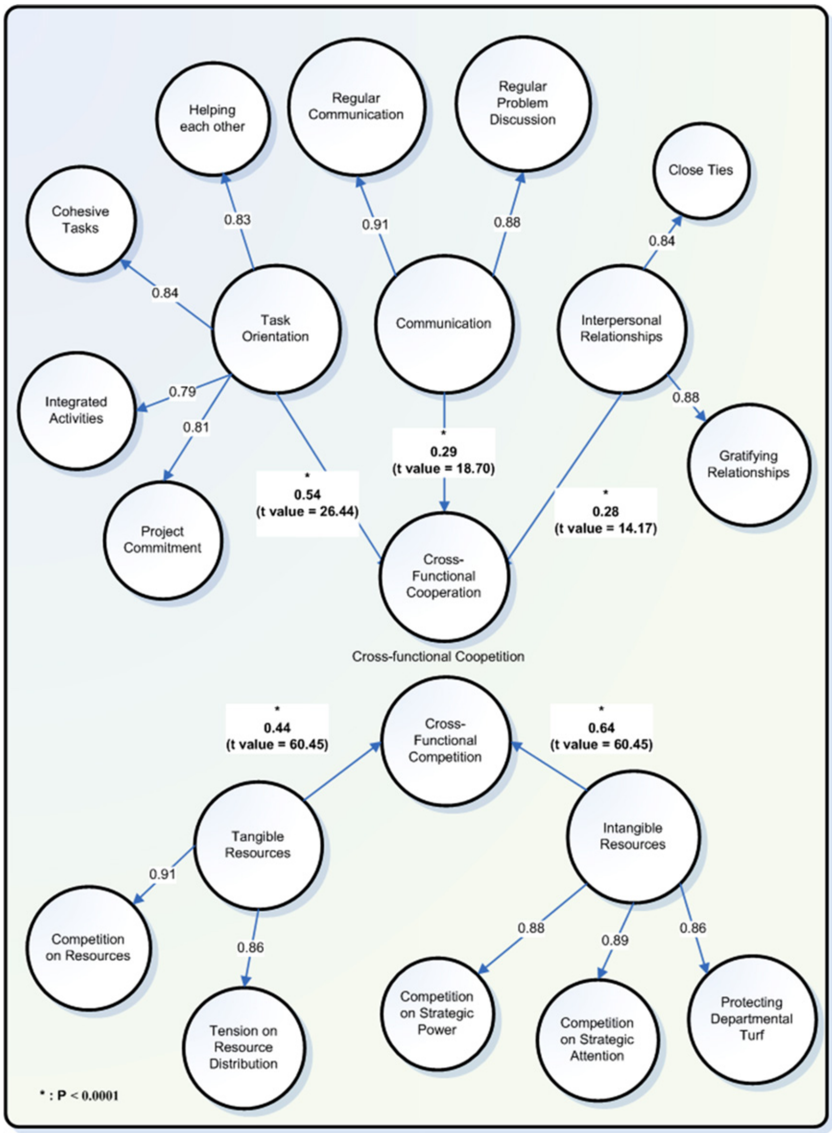

Fig. 1. Tested Model in PLS.

6.2. Practical implications

Organizations are increasingly employing cross-functional project teams for releasing software in less time and with less friction than in previous product releases. IT managers are required to engage in coordinating the efforts among business users, IT developers, and corporate stakeholders. This need is multiplied by the growth of offshoring and outsourcing. The entrance of broad ranges of professionals into the software development process settings adds to the challenges for establishing effective collaboration in these projects (Levina, 2005).

Our research directs managers to understand and measure different dimensions of cooperation and competition in multi-party software development project teams. Having a better understanding of different dimensions of cross-functional cooperation and competition provides the possibility of focusing on the comprising dimensions to emphasize on any of them. For example, managers may nurture the frequency of interactions among functional units as well as close ties and gratifying relationships to promote cooperation among members. This is particularly useful for those projects that consist of cross-functional representatives who used to be competitors. In these situations, project managers require safe and fast ways of switching from competitive structures to cooperative structures or visa versa. Second, managers can use the scores of cross-functional cooperation and competition as an indicator of team interactions quality, because cooperation and competition appear to be highly related to project outcomes.

Third, managers can use this 13-item instrument to determine the relative importance of 5 dimensions (i.e., cooperative task orientation, cooperative communication, cooperative interpersonal relationships, competition for tangible resources, and competition for intangible resources) in order to affect overall coopetitive behaviors. One approach is to regress the overall cross-functional cooperation and competition with each associated dimensions. This is helpful particularly when cross-functional team members have the past experience of being competitors (for example, there are significant organizational politics among the functional units that team members are drown), but they are currently working in a collaborative project for a limited period. In these situations, project managers find cooperation scores low, but they only have a limited time and budget for improvement in team interactions. Managers can prioritize what to do and take appropriate actions and strategies for improving low dimensions of cooperation. The instrument and the related measures can be also used prior to the team formation in order to evaluate the overall cooperative and competitive relationships in the group.

Fourth, the proposed instrument can be used to track the score of cooperation and competition in multi-party project teams by comparing team's or individuals' coopetition scores with organizational norms. This can act as a tool for comparing coopetition scores across different project teams, and associating them to project outcomes such as project success in terms of meeting schedule, budget, etc.

6.3. Limitations

This study offers promise for understanding relationships among team members in multi-party software development teams. However, the study has a number of limitations that must be addressed. Firstly, with regard to the limited literature on coopetition in software development teams, this study is significantly driven by the theories of cooperation and competition in cross-functional contexts. However, we believe the face validities and examination of the conceptual basis by several software development project managers have added to the literature in software development teams. In line with the discussed research and practical implications, this study provides a focus for the future studies investigating the inevitable coopetitive relationships in multi-party software development teams.

The key respondent approach taken in this study is the second limitation that we would like to acknowledge, since it does not provide the inclusion of different opinions and viewpoints that exist within the project team. However, since the major purpose of this study is conceptualization and examining the measurement model, we do not think that this limitation undermines the results of this study.

Thirdly, there are concerns regarding the appropriateness of the retrospective perspectives of project managers in this study. To deal with this issue, participants were asked to answer the survey questions based on the project that they had most recently managed. This strategy has increased the possibility of reflecting the actual practices of software development teams, but this limitation is not fully disappeared.

Finally, we acknowledge a limitation in the data set, since a considerable number of projects were not large (in terms of the project size). However, the conceptual basis in this study did not have a dependant variable, and thus we don't think that this limitation might be a serious challenge for the analysis of our data.

7. Concluding points

We explored the concept of simultaneous cooperative and competitive behaviors in multi-party software development teams in particular, and cross-functional project teams in general. A conceptual basis along with an examined instrument was presented for measuring cross-functional coopetition in these contexts. This study acts as a beginning yet important step in understanding and examining the co-existing cooperation and competition in multi-party software development team.

The study identified a number of gaps in the literature review section. As stated previously, we focused only on the conceptualization and operationalization of cross-functional coopetition. The coopetition effect (the mechanism through which coopetition affect organizational outcomes) is left for investigation in future studies. We need extensive empirical studies that theorize how simultaneous cooperation and competition in cross-functional teams influence project outcomes (e.g., whether there is a synergy between cooperation and competition? Or whether their impacts should be studied separately? Or whether there is any mediating impact in their relationship?).

In addition, future studies should be undertaken to investigate the antecedents or factors that influence the five dimensions of cooperative and competitive behaviors in multi-party software development teams (e.g., process maturity, goal interdependence).

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