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Mixing rich and asynchronous communication for new service development performance

Chris Storey, Helen Perks

Publication date

01-03-2015

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Citation for this work (American Psychological Association 7th edition)

Storey, C., & Perks, H. (2015). *Mixing rich and asynchronous communication for new service development performance* (Version 1). University of Sussex. <https://hdl.handle.net/10779/uos.23423000.v1>

Published in

R&D Management

Link to external publisher version

<https://doi.org/10.1111/radm.12055>

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Article (Unspecified)

Storey, Chris and Perks, Helen (2015) Mixing rich and asynchronous communication for new service development performance. R&D Management, 45 (2). pp. 107-125. ISSN 0033-6807

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MIXING RICH and ASYNCHRONOUS COMMUNICATION FOR NEW SERVICE DEVELOPMENT PERFORMANCE

Dr. Chris Storey

Cass Business School, City University London

106 Bunhill Row, London, United Kingdom EC1Y 8TZ

Tel. +44 (0)20 70408728 (c.d.storey@city.ac.uk)

Prof. Helen Perks

Nottingham University Business School, University of Nottingham,

Jubilee Campus, Wollaton Road, Nottingham, United Kingdom NG8 1BB

Tel: +44 (0)115 8466659 (helen.perks@nottingham.ac.uk)

This is the pre-publication version of: Storey C, and Perks H (2015), "Mixing Communication Modes for Learning and Proficiency During New Service Development", R&D Management, 45(2): 107-125.

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ABSTRACT

This article explores the nature of relationships between internal communication modes, new service development (NSD) competencies (specifically learning and development competencies) and NSD performance. To do so, it draws on and advances communication theory by comparing and contrasting the contingent approach, favored by media richness theory and media synchronicity theory, with the multiplicative manner of dual coding theory. Antecedent roles of rich and asynchronous communication modes for two NSD competencies are investigated and their function as critical contingency variables affecting the competencies-performance link is unravelled. An empirical quantitative study of senior managers of leading service firms was conducted, with a survey-based methodology. Results show that a learning competency drives development competency which in turn drives NSD performance. Asynchronous communication is essential for learning competency but not for development competency. In contrast, rich communication underpins development but has no direct effect on learning competency. Rich communication is essential for NSD performance when a firm has a low development competency. The interaction between asynchronous and rich communication is shown to be positive for learning whereas surprisingly it is negative for development competency.

Keywords: communication, new service development, competency, learning

INTRODUCTION

Service innovation is vital to developed economies (Ettlie and Rosenthal, 2011; Song *et al.*, 2009). Even established manufacturing and technology companies are seeking to develop service-based revenue streams (Kowalkowski *et al.*, 2012). Researchers have highlighted differences between the new product and the new service development (NSD) process (e.g. Cooper *et al.*, 1994; Ettlie and Rosenthal, 2011). NSD is less formal, less structured and more iterative than product development (Voss, 1994; Menor *et al.*, 2002). Often competitors can copy new services quickly, easily and cheaply (Cooper *et al.*, 1994; de Brentani, 2001) and as a consequence firms must have the means and processes in place to develop new services repeatedly (den Hertog *et al.*, 2010; Storey and Kahn, 2010). This article explores the nature of relationships between internal communication modes, NSD competencies and NSD performance. Internal competencies are critical components of a firm's ability to achieve its long-term NSD goals (Blazevic and Lievens, 2004; Song *et al.*, 2009; Storey and Kahn, 2010). They are internal information processing activities and as such require internal communication as a key antecedent for their execution.

Internal communication can support effective transformation of inputs into outputs within the NSD process (Blazevic and Lievens, 2004; Montoya *et al.*, 2009). The relationship between the quality and quantity of internal communication and success is firmly established in the new product development (NPD) and NSD literatures (e.g., Pinto *et al.*, 1993; Song *et al.*, 1997). There is evidence that internal communication is more important for innovation than external communication (Kivimäki *et al.*, 2000). Yet internal communication is a costly endeavour. Face-to-face communication has long been considered an expensive indulgence for organizations. Even asynchronous modes of communication incur time costs associated with encoding and decoding communication. Incorrect communication creates redundancy which can decrease communication efficiency, increase information-processing costs (Hsia,

1977; Gibson and Mendleson, 1984) and cause wasted organizational effort and resources (Watson-Manheim and Bélanger, 2007). However little is known about the types of communication modes that should be employed in NSD (Montoya-Weiss *et al.*, 2009, Song *et al.*, 2007) and existing research shows contradictory results. Kahn (1996), for example, finds that informal interpersonal communication leads to greater development success, whereas Montoya-Weiss *et al.*, (2009) fail to find a relationship. Moenaert and Souder (1996) find documentary modes of communication to be more credible and useful. Very few studies systematically compare the relative effects of *different* communication modes (Song *et al.*, 2007) on the nature and performance of the innovation process.

Communication theory can help make sense of the contradictions in previous research. The underlying premise of media richness theory (MRT) and media synchronicity theory (MST) is a contingent view of communication. It is argued that the performance of a communication mode, and therefore its usage, will be moderated by the information transmission and processing needs of the communication task (Dennis *et al.*, 2008). Hence, communication modes differ in the way they affect the effectiveness of different NSD competencies.

Dual coding theory (DCT) shows that people process information differently when it arrives in more than one form (Thatcher and Brown, 2010). This signifies that the effectiveness of one communication mode on NSD competencies may be affected by another and a simple contingent approach is insufficient. This article expands on such communication theories by delineating the role of asynchronous and rich communication as critical contingency variables affecting the NSD competencies-performance link (Montoya *et al.* 2009). By comparing and contrasting the contingent approach favored by MRT and MST with the multiplicative manner of DCT, this research shows how these theories work together. It

helps explain the contradictions in previous research and provides insight to guide more effective organizational use of internal communications.

Central to this research is the notion of competencies. Competencies are defined as a skill at performing a particular task (Danneels, 2008). NSD competencies reflect an organization's proficiency in deploying resources and routines to deliver a stream of new services that meet the requirements of the marketplace (Froehle and Roth, 2007; Menor and Roth, 2007). This research explores the relationship between communication modes and two specific internal NSD competencies: a NSD development competency and a NSD learning competency. A development competency is a firm's skills and ability to proficiently execute the NSD process itself (Henard and Szymanski, 2001; Montoya–Weiss and Calantone, 1994). Learning competency is characterized as an ability to learn from on-going and completed NSD projects (De Luca and Atuahene-Gima, 2007; Ordanini and Parasuraman, 2011). For both competencies internal communication is central to their conduct, but the effectiveness of communication modes may differ across each competency. This research limits itself to internally focused NSD competencies. Externally focused NSD competencies, such as market acuity (Menor and Roth, 2007) and engagement with customers (Hull *et al.*, 2006) are also important to a firm's NSD effort and such competencies require effective communication. However the way a firm communicates internally is likely to be very different from the way it communicates externally. Previous research has shown that internal and external communications operate independently and their impact on innovation performance is different (Kelly, 2001). The effectiveness of modes of external communication is beyond the scope of the current research.

To frame the research, a conceptual model is developed that links modes of communication, NSD competencies and NSD performance. Specifically the research examines the antecedent role of different communication modes (asynchronous and rich

communication) on NSD competencies, and the moderating role these modes have on the NSD competencies-NSD performance link. The extent to which rich and asynchronous communication interact and strengthen each other is also investigated. The level of analysis is the NSD programme. It is generally accepted that it is the stream of new products and services, developed over time, that affect organizational performance rather than individual project success or failure (Alam, 2006; Storey and Kahn, 2010). Hypotheses are developed around these relationships.

COMMUNICATION MODES

MRT differentiates between those communication modes that allow the use of social cues during communication and those that transmit explicit information (Sproull and Kiesler, 1986). Interpersonal face-to-face communication is considered to be the richest form of communication. Interpersonal communication can be either one-to-one or many-to-many and can occur via formal meetings or through informal exchange, such as hallway interactions and after-work socialization. Such interaction allows verbal, par verbal (tone, inflection, volume), and non-verbal (facial clues, body language) information to be shared (Daft and Lengel, 1986).

MST, on the other hand, differentiates between synchronous communication modes that allow for the possibility of immediate feedback, and those that allow the production and consumption of the communication to be separated. Asynchronous communication is characteristic of a more formal, mechanistic approach to sharing information (Daft and Lengel, 1986). It is a lean form of communication with few restrictions on time or place and typically captures one-way rather than two-way flows of information. Asynchronous communication is typified by the use of the written word in the form of documents, reports

and memos. Asynchronous communication modes have the advantage of enabling the same information to be shared by many people speeding the diffusion of knowledge.

Both MRT and MST take a contingent view of communication. As prescriptive theories, both theories argue that the proper alignment of communication modes to activities will enhance communication effectiveness (Daft, and Lengel, 1986; Montoya *et al.*, 2009). The matching of the information transmission and processing needs of the communication activities, with the capabilities of the mode, will influence communication performance (Dennis *et al.*, 2008). This suggests that different communication modes may be better suited for the execution of different NSD competencies.

This implies that either rich communication or asynchronous communication is appropriate for a given situation. However there is contradictory evidence that this is not the case. Research has not consistently shown that different communication modes yield different levels of performance when applied to the same task (Burke and Chidambaram, 1999; Dennis and Kinney, 1998; Dennis *et al.*, 2008). For NPD there is evidence that rich communication leads to greater new product success (Kahn, 1996) but this is not supported by Montoya-Weiss *et al* (2009), and alternative research shows that documentary communication has more utility during NPD (Moenaert and Souder, 1996). Similarly contradictory evidence has found that teams utilizing more asynchronous communication modes outperform face-to-face teams (Burke and Chidambaram, 1999; Dennis and Kinney, 1998) or do worse (Kerr and Murthy, 2009) or performance is about the same (Pazos and Beruvides, 2011).

This may in part be explained by DCT, which posits that individuals learn and retain information in a multitude of ways (Thatcher and Brown, 2010). This implies that using more than one mode of communication has advantages. The use of multiple modes allows us to process different facets of information in a variety of ways. This also creates information

redundancy. Information redundancy is the intentional overlapping of information over and above the minimal amount required by each person to do the job (Hargadon, 1998; Madhavan and Grover 1998). Having an additional communication mode enables information to travel more quickly among people thereby enhancing learning about and the adoption of new ideas (Akgün *et al.*, 2012). This allows for the serendipitous interaction of ideas, enhancing creativity (Madhavan and Grover, 1998; Thatcher and Brown, 2010).

These theories (MRT, MST and DCT) suggest that the optimal deployment of communication modes for NSD is complex.

NSD COMPETENCIES

This article explores the interaction of communication modes with two NSD competencies: A NSD learning competency and a NSD development competency. A key competency in NSD concerns the ability to learn from on-going or completed NSD projects. *Learning competency* reflects the formal processes and structures that facilitate the capture, analysis, and integration of various types of NSD knowledge and information (De Luca and Atuahene-Gima, 2007). However many organizations lack procedures and systems to record and recall their learning (Von Zedtwitz, 2002); post project reviews occur infrequently and are often relatively shallow in practice (Blazevic and Lievens, 2004; Busby, 1999). Activities such as formal project review processes, audits, and presentations provide the mechanism for teams to engage in reflective practices which can enhance learning (Newell and Edelman, 2008). This contributes to the effective retention and replication of knowledge developed during NSD (Marsh and Stock, 2003) and stops mistakes being repeated (Storey and Hughes, 2013).

Development competency is a firm's skill and ability to proficiently carry out the tasks inherent in the NSD process (Millson and Wilemon, 2002). Previous research has shown that

the process of conceptualizing the NSD project is often distinguished from the process of realizing the project (Menor *et al.*, 2002). Conceptualization refers to proficiency of tasks associated with the front end of NSD. Realization concerns proficiency of tasks associated with the back end of NSD. Successful NSD must reflect competency in both these processes (Millson and Wilemon, 2002), namely a generic development competency.

CONCEPTUAL MODEL

*** Insert figure 1 here ***

Figure 1 depicts the conceptual model of the research. It shows linkages between modes of internal communication, NSD competencies and NSD performance. It is argued that the nature of communication modes will influence both the appropriation of the mode, and ultimately the successful execution of NSD competencies (Dennis *et al.*, 2008). Learning competency reflects the codification of tacit knowledge from past projects into explicit knowledge suggesting the importance of asynchronous communication. Development competency involves highly conflictual decision-making suggesting the importance of rich communication. Contingency theory proposes that performance is attributable to a match between activities and the task requirements (Venkatraman, 1989; De Luca and Atuahene-Gima, 2007). This suggests that the two communication modes will differently moderate the effect of learning competency on development competency; and of development competency on NSD performance. However DCT suggests rich and asynchronous will interact and strengthen each other. Rich communication will not benefit learning competency without asynchronous communication; and asynchronous communication without rich communication will not enhance development competency.

NSD performance is recognized to be multi-dimensional (Montoya-Weiss and Calantone, 1994). Two common measures employed are *NSD innovativeness* and *NSD market*

performance. The innovativeness of a firm's new services is often seen as a driver of long-term competitive advantage (Akgün *et al.*, 2012; Storey and Kahn, 2010). Firms are not necessarily aiming to develop innovative services per se but rather new services that achieve more immediate sales, profit and other objectives in the marketplace (de Brentani, 2001; Storey and Easingwood, 1999). Together the two dimensions represent the success of the firm's NSD programme.

NSD COMPETENCIES and PERFORMANCE

Those organizations that formally externalize learning are more likely to experience process improvements and higher levels of organizational effectiveness (Gopesh *et al.*, 2010; Salo and Kakola, 2005). A learning competency reflects the continuous monitoring and adaptation of existing practices aimed at both incremental improvement and competence change (Schreyögg and Kliesch-Eberl, 2007). Project post-mortems are effective at stimulating the codification of learning embedded in NSD personnel and disseminating knowledge about good practices (Busby, 1999; Goffin and Koners, 2011). Formalized review procedures are effective in countering hindsight biases and the over simplification of explanations for complex situations (Lilly and Porter, 2003). The lessons learned from the post-project review process provide a consolidated body of data and information that can serve as the baseline for future projects resulting in a spiral of improvement of project planning, implementation, and management (Anbari *et al.*, 2008). Hence:

H1: A learning competency is positively related to development competency.

Development competency is the firm's proficiency at new service conceptualization and realization. Firms that are proficient in NSD conceptualization are better at initiating new service ideas and service concepts (Millson and Wilemon, 2002). Effective conceptualization results in new services that are more responsive to pioneering market opportunities

(Kleinschmidt *et al.*, 2007). Closer to the realization of the project, at the back-end stage, the features of the service are specified. Activities typically consist of definable actions for transforming a rough service concept into a viable service offering (Madhavan and Grover, 1998). During realization, delivery processes are formulated and potential operational issues identified. Proficient market testing may identify service improvements as well as difficulties in communicating new service benefits, before commercialization (Harmaciglou *et al.*, 2009). Hence:

H2: A development competency is positively related to NSD performance.

ASYNCHRONOUS COMMUNICATION AND LEARNING COMPETENCY

Organizations gain knowledge and consequently learn as organizational members exchange information (e.g., Kim, 1993; Lei *et al.*, 1999). MST theory suggests that asynchronous communication is the key to learning competency as it is an explicit approach to sharing information (Daft and Lengel, 1986). Zollo and Winter (2002) argue that the higher the degree of causal ambiguity between actions and performance outcomes (such as those inherent in NSD), the higher the likelihood that explicit articulation and codification mechanisms will exhibit stronger effectiveness in developing organizational learning as compared with the tacit accumulation of past experiences.

The reflection inherent in codifying knowledge leads to meta-learning (McKee, 1992). Hence communication modes based around making knowledge explicit are more likely to be effective in generating learning than exchanges of tacit knowledge. Asynchronicity implies that individuals can take more time between exchanges, allowing time to analyze the content of a message or to develop meaning across pieces of information (Robert and Dennis, 2005). It has been found that mere articulation, via interpersonal communication, during project post mortems is insufficient to create learning (Newell and Edelman, 2008). The activity of

creating a document to capture learning may enhance perspective-making within the project team. Hence:

H3: The use of asynchronous communication modes is positively related to learning competency.

Learning by itself is of little value. Learning is only effective when it is acted upon. Whilst individual learning can be acted upon without further communication, organizational learning will be more effective when further communication takes place. Communication across the organization extends the impact of a learning competency as it enhances the knowledge that is available to service developers.

Asynchronous communication enables learning to be shared by more people and at different times. Organizations have long used documentary communication mechanisms to store and share learning in formats such as formal project handbooks, best practice documents, manuals, and blueprints. (Marsh and Stock, 2003; Meyers and Wilemon, 1989; Subranamin and Youndt, 2005). Effective NSD learning requires that this knowledge is usable by any member of the development team (Hansen *et al.*, 1999). Asynchronous communication enables the same information to be shared by many people, speeding the diffusion of learning. Hence it is hypothesized:

H4: The use of asynchronous communication strengthens the relationship between learning competency and development competency.

RICH COMMUNICATION AND DEVELOPMENT COMPETENCY

Development competency is characterized by decision-making behaviors that involve NSD personnel from across the organization. Since decision-making requires the development of shared meanings and agreement, MRT suggests that rich communication modes may be

more effective than asynchronous modes; they are relatively higher in terms of interactivity and social presence (Montoya *et al.*, 2009). Services are intangible and therefore subjective. This makes the negotiation and judgmental tasks in NSD highly conflictual in nature. Hence rich communication is essential for development tasks. Subtle cues like body language may affect the degree of closeness others feel in sharing provisional ideas (Massey and Montoya-Weiss, 2006; Szulanski, 1996). In addition rich communication provides immediate feedback which aids mutual understanding. Through rich communication NSD personnel can build common mental models and unify cross-functional understanding, in new and different ways to give shared meaning which supports effective execution of development tasks (Nonaka, 1994). Communication modes with less human involvement may prove less effective (Montoya-Weiss *et al.*, 2001). Asynchronous communication's capacity to support information exchange under ambiguity is weak (Song *et al.*, 2007). Therefore it is postulated that:

H5: The use of rich communication modes is positively related to development competency.

For service development success there needs to be a feedback loop between customer service staff and development functions (Antioco *et al.*, 2008). Customer contact staff has in-depth knowledge of customer requirements, opportunities, and competitive offerings (Storey and Easingwood, 1998). Much of this working knowledge will be of a tacit nature suggesting the need for rich communication modes. De Luca and Atuahene-Gima (2007) propose that the communication of tacit market knowledge generates new perspectives which enhance performance of the firms' innovation activities. Furthermore the implementation of new services is often people-based. As such, service innovations will succeed only insofar as the customer contact staff embrace, execute, and promote them (Cadwallader *et al.*, 2010). Those engaged in service delivery need to know and understand what to do and be motivated to do

it. Rich communication has been shown to be better at doing this by building trust and motivation more than asynchronous communication (Bracken *et al.*, 2004). Previous research has indicated that communication has an important leveraging effect on the quality and outcome of the development process (Lievens *et al.*, 1999) therefore:

H6: The use of rich communication modes strengthens the relationship between development competency and NSD performance.

INTERACTION BETWEEN COMMUNICATION MODES

The previous discussion argues that different modes of communication separately affect development and learning competencies. However it is suggested that, under conditions of complex coordination typically found during the execution of an NSD project, a repertoire of different modes should be employed (Watson-Manheim and Bélanger, 2007). DCT suggests that rich and asynchronous modes interact and strengthen each other. Personal discussions can correct misunderstandings in written documents. Minutes of team meetings allow people, who could not be present, to be kept informed. Using multiple methods creates information with higher credibility, validity, and comprehensibility (Moenaert and Souder, 1996). This increases the likelihood of the information being acted upon and hence improves the development process.

As NSD is a process of constant problem solving, rich and asynchronous communication will interact for the development competency. Supporting this, Maznevski and Chudoba (2000) found successful development teams communicate via a rhythm of face-to-face communication interspersed with asynchronous modes. For learning, Newell and Edelman (2008) argue that project teams should be encouraged to give examples and tell stories about their project experiences. Such narrative framing is likely to provide the contextual information that will allow others to interpret the experiences with reference to

their own situation. Koners and Goffin (2007) found that metaphors and stories are used to share tacit knowledge about NSD. In addition rich communication helps create trust which encourages more information sharing and the use of that information (Robert *et al.*, 2008). This may encourage NSD learning especially from failed projects which the project team may be reluctant to discuss.

Therefore, it can be posited that there may be additional benefits of employing multiple communication modes:

H7a: The use of rich communication modes strengthens the relationship between the use of asynchronous communication modes and learning competency.

H7b: The use of asynchronous communication modes strengthens the relationship between the use of rich communication modes and development competency.

METHODOLOGY

Research Instrument

To test the conceptual model a questionnaire survey was carried out. Scales developed specifically for this article are based on the literature, as outlined in the conceptual model, and on interviews from a group of senior managers with leading UK service firms. The questionnaire was pretested with 12 senior managers who were responsible for NSD in their respective firms to ensure understanding and determine if respondents possess sufficient knowledge to answer. All scale items are assessed on 7-point Likert scales. See the appendix for a complete list of measures.

In order to avoid the omission of sensitive data an indirect approach was utilized in assessing the performance of the firm's NSD programme. Indirect measures of performance

are used extensively in NPD/NSD research (e.g., De Luca and Atuahene-Gima, 2007; Montoya-Weiss and Calantone, 1994). *NSD performance* was formed as a reflective latent second order factor comprising of market performance and innovativeness. In measuring market performance respondents were asked to evaluate the overall success of their firm's NSD programme (during the past three years) in meeting its performance objectives, relative to its main competitors, in meeting its profit objectives, and in meeting its sale objectives (de Brentani, 2001; Storey and Easingwood, 1999). The innovativeness of a firm's NSD programme is measured by its innovativeness *per se* relative to its competitors, the generation of innovative new service ideas, and the creation of an innovative perception of the business (Akgün *et al.*, 2012; Narver *et al.*, 2004; Storey and Easingwood, 1999).

The study measures the extent to which rich and asynchronous modes of communication are used during NSD. *Rich communication* (5 items) is an interpersonal form of communication and consists of face-to-face meetings, "water-cooler" encounters, formal team meetings, telephone conversations and teleconferencing (Antioco *et al.*, 2008) whereas *asynchronous communication* (4 items) is centred on exchanging explicit knowledge and is a document-led form of communication made up of memos, NSD manuals and written reports (Kahn, 1996; Madhavan and Grover, 1998; Maltz, 2000).

Development competency was modelled as a reflective second order latent variable comprising conceptualization and realization proficiency, reflecting the tasks associated with the front-end and the back-end of the NSD cycle respectively. Conceptualization proficiency was assessed by how proficient the firm is at carrying out idea generation, concept development and business analysis. Realization proficiency covered the subsequent stages - development, market testing, commercialization and implementation (Avlonitis *et al.*, 2001; John and Storey, 1998; Menor *et al.*, 2002).

Learning competency reflects the firm's processes and structures to capture, interpret, and integrate knowledge and information about service innovation from existing and completed NSD projects (De Luca and Atuahene-Gima, 2007; Ordanini and Parasuraman, 2011). Based on measures used in previous studies learning competency was measured by the proficiency of post-launch project reviews, whether lessons learned from completed NSD projects are formally collected and the likelihood that mistakes on one project will be repeated on subsequent projects (De Luca and Atuahene-Gima, 2007; Gopesh *et al.*, 2010; Marsh and Stock, 2006).

Controls

A number of controls were included. A third communication mode - Computer Mediated Communication (CMC) - was measured. CMC (4 items) comprises IT based systems that can share information in multiple forms such as groupware, expert systems, document management systems and e-mail (Akgün *et al.*, 2008). This sits interstitially between the two other modes and may be central to supporting both rich and asynchronous communication (Song *et al.*, 2007)¹. Respondents were asked to identify their innovation strategy in terms of the four Miles and Snow (1978) categorization. A self-typing approach used in previous studies was adopted (McKee *et al.*, 1989; Wang, 2008). Dummy variables for Prospector, Analyser and Defender firms were included in the analysis to control for the firm's strategy.

Turbulence, both market and technical, was included as a control variable and was measured on one four-item scale as per similar innovation studies (e.g. Atuahene-Gima, 2005; De Luca and Atuahene-Gima, 2007). Using data collected on industry sector, firms were

¹ To test the influence of CMC the model was analysed with and without CMC. The effects of rich and asynchronous modes were only marginally affected by the exclusion of CMC.

grouped according to whether the sector was predominantly technology-based versus being more people-based services as in previous services research (e.g., Storey and Kahn, 2010; Walsh *et al.*, 2012). The former group comprised banking, insurance, telecommunications, utilities firms; the latter group comprised professional services, travel, retailing and IT consultancy firms. This allowed for consideration of the nature of the service sector in analysis. In addition firm size was measured on a five-point scale based on turnover.

Sample and Procedure

A key informant approach was employed due to the precedent of its use in this type of research (cf. Moorman and Miner, 1997). The senior executive having directorial responsibility for NSD was identified, for each firm, as the key informant due to their organizational knowledge and access to relevant information. Literature suggests such people are suitable respondents (Bello *et al.*, 2010). The majority of respondents were marketing directors (57%). The lack of specific innovation directors in most organizations suggests a continuing lack of sophistication of NSD in service companies.

The survey sample comprised the leading 385 service businesses, based on number of employees, identified from the Times Top 1000 UK-based firms. The sample was restricted to larger firms as they tend to have more systematic NSD procedures compared to small firms with more idiosyncratic practices (Alam, 2002). The sample consisted of: Banking (17%), Insurance (15%), Telecommunications (15%), Travel and Transport (15%), IT consultancy (15%), Professional services (14%), Retailing (6%) and Utilities (4%). Following two survey mailing waves, a total of 121 completed questionnaires were returned, equating to a 31% response rate.

To ensure the validity of the sample, the data was explored for sector, respondent position and firm size differences between respondents and non-respondents (Bello *et al.*,

2010). Early and late respondents were tested for differences in their responses. No systematic differences were identified suggesting non-response bias is not a significant issue (Armstrong and Overton, 1977). An exploratory factor analysis was conducted. After removing two items with low loadings, a 7 factor solution revealed that all remaining items load cleanly on their intended constructs with low cross-loadings. The first factor accounted for 27% of the total variance (65%). As no one factor accounted for the majority of the variance, common method bias does not appear to be a significant problem (Podsakoff and Organ, 1986).

ANALYSIS AND RESULTS

Partial Least Squares

SmartPLS v2.0 (Ringle *et al.*, 2005) was used to obtain partial least squares (PLS) estimates for both the measurement and the structural model. PLS path modeling was employed as it can accommodate relatively small samples and is more suitable for complex models with second order latent variables (Chin, 1998; Fornell and Bookstein, 1982; Wetzels *et al.*, 2009). Furthermore, Chin *et al.* (2003) find that PLS path modeling is a suitable alternative to regression analysis and covariance-based methods for testing moderating hypotheses. To test the stability and statistical significance of the parameters estimates (t-values) in the structural model, a bootstrapping procedure with 500 re-samples was used (Chin, 1998).

Analysis suggests the latent variables are reliable and valid. For the reflective performance measures coefficient α , composite reliability (CR) and average variance extracted (AVE) were calculated (see appendix). The values suggest high reliability and validity (Chin, 1998; Hair *et al.*, 2007). Discriminant validity was assessed by examining whether each construct shared more variance with its measures than with other constructs in the model (Chin, 1998). The AVE for the constructs are all higher than their highest shared

variance (HSV) supporting validity of the model (Fornell and Larcker, 1981). The second order latent variables were modelled by repeated use of the first order manifest variables (Wetzels *et al.*, 2009). Table 1 shows the latent variable correlations.

**** Table 1. About here ****

Structural Model

The result of the PLS path model is shown in Table 2. The R^2 values of the endogenous variables are investigated to assess the quality of the model (Cohen, 1988; Tenenhaus *et al.*, 2005). A goodness-of-fit measure ($\sqrt{\text{average } R^2 * \text{average AVE}}$) is calculated for the model. This is 0.50. Assuming a large average effect size for R^2 (0.26) and a cut-off value of VE of 0.70, a comparison value of 0.43 is obtained, acknowledging this model to be of good fit (Tenenhaus *et al.*, 2005). In addition Q^2 was calculated for the outcome variables to assess predictive validity (Tenenhaus *et al.*, 2005; Wetzels *et al.*, 2009). This was 0.14 for learning competency, 0.19 for development competency and 0.29 for NSD performance suggesting the direct effects model has predictive relevance.

*** Table 2. About here ***

Direct Effects

Learning competency drives development competency ($\beta = .35$, $p < 0.01$) and development competency has a direct effect on NSD performance ($\beta = .33$, $p < 0.01$) providing strong evidence to support H1 and H2.²

² It may be argued that learning competency has a direct impact on NSD performance (Ordanini and Parasuraman, 2011). Therefore an alternate model was tested with a direct path from learning competency and NSD performance. The path was non-significant at the 5% level and did not affect the other relationships in the model. This suggests the hypothesized mediated model is appropriate.

Asynchronous communication has a strong impact on learning competency ($\beta = .35$, $p < 0.01$) but not development competency ($\beta = -.02$, n.s.). In contrast rich communications has a large impact on development competency ($\beta = .28$, $p < 0.01$) but not learning competency ($\beta = .08$, n.s.). This supports H3 and H5. In addition it was found that CMC was significantly associated with both learning ($\beta = .26$, $p < 0.01$) and development ($\beta = .19$, $p < 0.05$) supporting the positioning of CMC in-between the two other communication modes.

The conceptual model did not posit relationships between the communication modes and NSD performance. However a significant relationship was found between rich communication and NSD performance ($\beta = 0.20$, $p < 0.05$).

Interaction Effects

In order to test for the interaction effects in the model interaction terms were developed using an orthogonalizing residual product indicator approach (Henseler and Chin, 2010). Product terms were created between all indicators of the two variables. In the case of learning competency the second order latent variable indicators were used. The product terms were then regressed on all the indicators and the residuals used as indicators of the interaction term. This limits multicollinearity amongst the interaction terms. Subsequent checks revealed that the variance inflation factors of all terms in the final model to be less than 3. The results of the full model with the interactions are shown in Table 2.

Comparing a model with the interaction terms to the direct model, excluding the interaction terms, learning competency R^2 increases from 0.26 to 0.30 ($\Delta R^2 = 0.04$, $p < 0.01$). The effect size (f^2) of the interaction term is 0.06 suggesting a weak effect size (Chin *et al.*, 2003; Cohen 1988). Similarly the increases in R^2 for development competency ($\Delta R^2 = 0.16$, $p < 0.01$; $f^2 = 0.33$) and for NSD performance ($\Delta R^2 = 0.05$, $p < 0.01$; $f^2 = .13$) are both significant with large and moderate effects respectively. These provide strong support for

including the two-way interactions in the model. To help understand the interaction effects the relationships were graphed (Figures 2 and 3).

*** Figures 2 and 3 about here ***

Asynchronous communication positively moderates the relationship between learning competency and development competency ($\beta = .17, p < 0.05$). Figure 2a shows that at higher levels of asynchronous communication the effect of learning on development competency is greater providing support for H4. For NSD performance the interaction between development competency and rich interpersonal communication is significant ($\beta = -.23, p < 0.05$). Surprisingly this is negative failing to support H6. Development competency has a stronger effect on NSD performance under conditions of low rich communication (Fig. 2b). The results also show that rich communication positively moderates the relationship between learning competency and development competency ($\beta = .20, p < 0.05$). At higher levels of rich communication, as well as asynchronous communication, the effect of learning on development competency is greater (Fig. 2c).

The interaction of asynchronous communication with rich communication ($\beta = .21, p < 0.01$; H7a) for learning competency show the enhanced benefit of having multiple communication modes (Fig. 3a). However the negative interaction of asynchronous and rich communication on development competency ($\beta = -.31, P < 0.01$; H7b; Fig. 3b) indicate in certain situations these are substitutes.

Post-hoc analysis

The conceptual model hypothesized that asynchronous and rich communications interact to affect the execution of NSD competencies. This logic can be extended to the possible interaction effects on the learning-development and the development-performance

relationships. A further PLS model was constructed with two 3-way interaction terms: Learning competency x asynchronous communication x rich communication as an antecedent of development competency; development competency x asynchronous communication x rich communication on NSD performance. Table 3 shows the results of the model with all 2- and 3-way interactions (for the sake of brevity the direct effects are not shown in table 3 but were included in the model).

*** Table 3 about here ***

Comparing the 3-way model with the 2-way interaction effects model (Table 2) it can be seen that for development competency R^2 increases from 0.51 to 0.57 ($\Delta R^2 = 0.06$, $p < 0.01$). The effect size (f^2) of the interaction term is 0.14 suggesting a medium effect (Chin *et al.*, 2003; Cohen 1988). Similarly the increases in R^2 for NSD performance ($\Delta R^2 = 0.04$, $p < 0.01$; $f^2 = 0.11$) is significant with a small to medium effect. To help understand the interaction effects they were graphed (Figure 4).

*** Figure 4 about here ***

Figure 4a shows that, without communication, learning competency can have a detrimental effect on development competency. Both modes of communication, separately, can overcome this. However the use of asynchronous communication can limit the benefits of using rich communication. Figure 4b shows that under conditions of low rich and low asynchronous communication development competency has a very strong influence on NSD performance. This effect is diminished with the addition of communication, especially rich communication.

DISCUSSION

Our results unpick the complexity of relationships between internal communication modes, NSD competencies (specifically learning and development competencies) and NSD performance. Findings demonstrate that both rich and asynchronous communication modes are important for NSD competencies, and hence NSD performance, but in very different ways.

Asynchronous communication is essential for learning competency but not for development competency. In contrast, rich communication drives development competency but has no direct effect on learning. The conceptual model argued that communication modes would be multiplicative rather than purely additive. For learning this was found to be the case (see Fig 3a). Having both types of communication is shown to be beneficial. This can be linked to the assertion of Nonaka (1994) that the interaction of tacit and explicit knowledge is important in creating a higher and richer level of knowledge. Rich communication is most effective when it is used to augment rather than supplant asynchronous communication. For example, personal discussions can correct misunderstandings in written documents.

Contrasting this is the negative interaction between asynchronous and rich communication for development competency (Fig 3b). Previous research has shown that when one type of communication channel is already present, the benefits of adding another type of communication channel is smaller than if the first was absent (Song *et al.*, 2007). For firms that employ rich communication adding asynchronous communication can actually harm their development competency. These results may be an indication of the negative efficiency effects of too much communication. Information overload becomes a problem, as managers are receiving more information than they can possibly process effectively. They tend to process information superficially or only in part (Maltz, 2000), increasing communication errors and equivocation and thereby reducing communication efficiency and dependability (Hsia, 1977). Similarly it has been found that too much coordination, based on

excessive communication, can dilute development proficiency (Millson and Wilemon, 2002). There may be an inverted 'U' shaped relationship between communication and development competency but this would need to be determined by further research.

Both asynchronous and rich communication is essential for learning competency, increasing its effectiveness (Fig 2a and 2c). Furthermore without rich or asynchronous communication, learning competency can have a detrimental effect on development competency (see Figure 4a). A learning competency by itself is of little value. Communication is needed to induce people to accept new ways of working. Without communication learning may be ineffectively applied. Communication has a vital role in explaining and interpreting prior learning, increasing its effect on the proficiency of development activities. Research has revealed that NSD learning is frequently not absorbed by people uninvolved in the process (Lilly and Porter, 2003).

Unexpectedly the results show that rich communication decreases the impact of development competency on NSD performance (Fig. 2b). Firms that have an existing NSD competency may undertake multiple time-consuming inter-personal coordination activities, such as team meetings, reducing the efficiency of their development processes. The detrimental effects of communication may be partly offset by favoring asynchronous over rich modes (Fig. 4b). It seems that asynchronous communication has a role to play in alleviating the ambiguity and intangibility of the NSD process. It can focus attention to the tasks at hand rather than dealing with potential conflict and divergent perspectives which may come to the surface when interpersonal communication is predominant. This builds upon the work of Song and Song (2010) who found that more asynchronous communication can help reduce the negative effects of disagreements during development.

An alternative way of looking at this is to turn the logic around. Inexperienced firms, with low development competency, need communication, in particular rich communication, to succeed. Under conditions of high development competency, and where people have experience of working together, people know task and activity requirements, so there is less need for communication within the team.

Contrary to expectations, rich communication had a positive direct effect on NSD performance. Customer contact staff are crucial for the successful implementation of new services because of their intimate knowledge of customer requirements (Johne and Storey, 1998; Ordanini and Parasuraman, 2011). Also, new services are often customized and augmented during delivery, based on real-time feedback from customers, requiring ongoing communication across the organization (Storey and Kahn, 2010). Much of the information shared is tacit in nature and helps explain the direct link between rich communication and NSD performance.

In all, this article makes three substantive contributions to theory. First, it extends understanding of the linkage between communication modes, competencies and innovation performance to the services arena. Prior research has primarily focused on the role of different modes of communication in product innovation. This is one of very few studies to attempt to assess the relative importance of different modes of communication within the context of NSD. However services are intangible and hence are more tacit knowledge-based. Such knowledge is more difficult to codify and embed in new offerings compared to new products (Zippel-Schultz and Schultz, 2011). This, and the relatively unstructured and iterative nature of NSD (Voss, 1994; Menor *et al.*, 2002), draws attention to the importance of communication for NSD competencies and NSD performance. This article thus closes a gap in the literature by incorporating NSD development competency, NSD learning competency

and communication modes in a complex, interdependent model to explain NSD performance (Froehle and Roth, 2007).

Second, the study expands media richness and synchronicity communication theory by delineating the role of communication modes as critical contingency variables affecting the competencies-performance link. Past research has not specified the nature of the relationships among these contingency variables. By comparing and contrasting the contingent approach favored by MRT and MST with the multiplicative manner of dual coding, this article shows how these theories work together and helps explain the contradictions in previous research.

Third, this article demonstrates how rich and asynchronous communication modes have, separately and together, diverse effects on NSD performance through the way they affect two NSD competencies (learning competency and development competency). Prior research focuses on the use of a single communication mode and this fails to capture the complexities of combining modes (Watson-Manheim and Bélanger, 2007). Therefore the article addresses recent calls to explore the interactions between communication modes and their impact on organizational outcomes (Thatcher and Brown, 2010).

CONCLUSION AND MANAGERIAL IMPLICATIONS

The study findings suggest that different communication modes need to be managed as an integrated system. This allows firms to deal with the heterogeneous nature of knowledge flows both during the development process and between projects. Understanding the specific impact of disparate communication modes has implications for management action for enhancing both learning and development competency.

In terms of learning competency:

- Asynchronous communication is critical. Project teams should be encouraged to articulate and codify their knowledge and experience in reports, papers and presentations. By doing this further perspective-making within the team will take place.
- The benefit of codifying knowledge can be enhanced by rich communication. Managers should encourage people to tell stories. This can help provide the contextual information that help people understand when and how to apply learning. However just relying on this storytelling (rich communication) will not result in learning.
- Learning without communication is at best useless, at worst detrimental. Blindly following NSD playbooks, developing new services as per the manual is unlikely to be effective.
- To make the most of learning, managers should employ rich communication, such as workshops and debrief sessions. Personnel from successful projects, and even unsuccessful ones, should act as advisers to ongoing projects. It is this communication that can activate NSD learning increasing its effectiveness.
- If people cannot be brought together (although videoconferencing can also be used here) managers should substitute inter-personal communication with asynchronous forms to share learning. This could include building a database of learning, such as case studies; whitepapers and innovation newsletters.

In term of development competency:

- For the construction of a development competency rich communication is the key. NSD is a fuzzy process and is difficult to articulate in a manual. Decision-making needs to be based around discussion and consensus for more creative outputs.

- Care must be taken when using asynchronous communication as it can negate the positive impact of rich communication. A culture of memos and emails can quickly drive out interpersonal interactions to the detriment of the firm's development competency.
- Firms need to balance the need for asynchronous communication to promote learning without stifling rich communication and hence curtailing its development competency. It may be a case that a climate of rich communication punctuated by episodic asynchronous communication, to help codify the knowledge developed by rich communication, may be optimal. Communication is especially important for firms inexperienced at NSD. It is important to involve people as widely as possible to ensure everybody understands their role in development.
- For experienced firms too much communication can hinder NSD. Once a firm has built a NSD competence it is important to reduce communication. Managers should reduce the number of meetings and let people get on with their jobs. They should move from a tight control to a loose control culture.

This article is not without its limitations. The research takes the well-used approach of a single key informant providing subjective cross sectional data. Longitudinal methodologies would be a welcome extension of this research. Internal communication is a dynamic process and further research could investigate how firms adapt their communication portfolios over time as their competencies develop. This article took a programme level perspective and future research could attempt to link this research to objective corporate performance measures.

In addition further research could extend into the inter-organizational dimension. For NSD the involvement of both customers and suppliers has been found to be important for

success (Hull *et al.*, 2006). However the way a firm communicates internally is likely to be very different from the way it communicates externally and the relative importance of asynchronous and rich communication may differ between upstream and downstream linkages. Further research is needed to understand how ongoing communication with customers during the implementation of new services affects new service success. This is particularly important as firms move towards more open innovation approaches.

This research investigates the role of communication modes for NSD competencies and performance. However it does not take into account the type of NSD that a firm pursues. Highly complex situations, such as in radical innovation projects, may benefit from the employment of richer communication modes. Alternatively the effectiveness of asynchronous communication may be greater in relatively stable contexts where NSD projects are similar to previous ones. This is an area for further research. Similarly the research context could be extended to different sectors. Compared to NPD the NSD model is less formal and structured (Menor *et al.*, 2002; Song *et al.*, 2009) suggesting that the relative importance of communication modes may be different in a product-manufacturing context.

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APPENDIX. ITEMS FOR MEASURING CONSTRUCTS IN THE MODEL

NSD Performance ($\alpha = 0.76$, CR = 0.89, VE = 0.80, HSV = 0.33) ¹	
<u>Market Performance</u> ($\alpha = 0.88$, CR = 0.92, VE = 0.75)	0.93 ³
To what extent has the business' NSD programme been successful ² :	
• In meeting its performance objectives,	0.77
• Relative to its main competitors,	0.92
• In meeting its profit objectives.	0.86
• In meeting its sales objectives	0.90
<u>Innovativeness</u> ($\alpha = 0.77$, CR = 0.87, VE = 0.68)	0.86
Relative to the competition...	
• This business's NSD programme is highly innovative	0.84
• This business is successful at generating innovative new service ideas	0.83
• This business is perceived by its customer to be innovative	0.81
Development Competency ($\alpha = 0.75$, CR = 0.89, VE = 0.80, HSV = 0.33)	
<u>Conceptualization Proficiency</u> ($\alpha = 0.81$, CR = 0.89, VE = 0.73)	0.89
The business is proficient at executing the following NSD tasks:	
• Idea generation	0.83
• Concept development and evaluation	0.93
• Business analysis	0.80
<u>Realization Proficiency</u> ($\alpha = 0.79$, CR = 0.87, VE = 0.63)	0.91
The business is proficient at executing the following NSD tasks:	
• Development	0.78
• Market testing	0.72
• Implementation	0.86
• Commercialization	0.80
Learning Competency ($\alpha = 0.67$, CR = 0.81, VE = 0.60, HSV = 0.21)	
• It is likely that mistakes on one project will be repeated on subsequent projects. ⁴	0.64
• The business is proficient at conducting post-launch project reviews	0.84
• The business formally collects the lessons learned from completed NSD projects	0.82
Rich Communication ($\alpha = 0.75$, CR = 0.84, VE = 0.51, HSV = 0.21)	
During NSD the following methods for sharing knowledge are used extensively:	
• Formal team/group meetings.	0.63
• Scheduled one-to-one meetings	0.81
• Impromptu 'water-cooler' meetings.	0.84
• Telephone conversations	0.72
• Teleconferencing	0.52
Asynchronous Communication ($\alpha = 0.69$, CR = 0.81, VE = 0.60, HSV = 0.18)	
During NSD the following methods for sharing knowledge are used extensively:	
• Manuals and handbooks	0.80
• Memos	0.67
• Documents and reports	0.84
• <i>Libraries and document repositories</i> ⁵	

APPENDIX. Cont.

Computer Mediated Communication ($\alpha = 0.76$, CR = 0.86, VE = 0.68, HSV = 0.15)	
During NSD the following methods for sharing knowledge are used extensively:	
• Intranets	0.77
• Groupware	0.85
• Expert, knowledge based systems	0.85
• <i>Emails</i> ⁵	
Turbulence ($\alpha = 0.72$, CR = 0.82, VE = 0.54, HSV = 0.12)	
In the markets in which this business operates:	
• Customer's service preferences change rapidly over time	0.75
• Customers look for new services all the time	0.69
• It is very difficult to forecast where the technology will be in the next 5 years	0.79
• A large number of new service ideas have been made possible through technological breakthrough	0.71
1. α = Scale reliability coefficient; CR = composite reliability, VE = variance extracted, HSV = Highest shared variance	
2. Scale (1) very unsuccessful (7) very successful. All other items measured on 7-point Likert scale – (1) strongly disagree, (7) strongly agree.	
3. Standardized loadings. For the second order factors	
4. Reverse scored	
5. Scale item dropped during analysis	

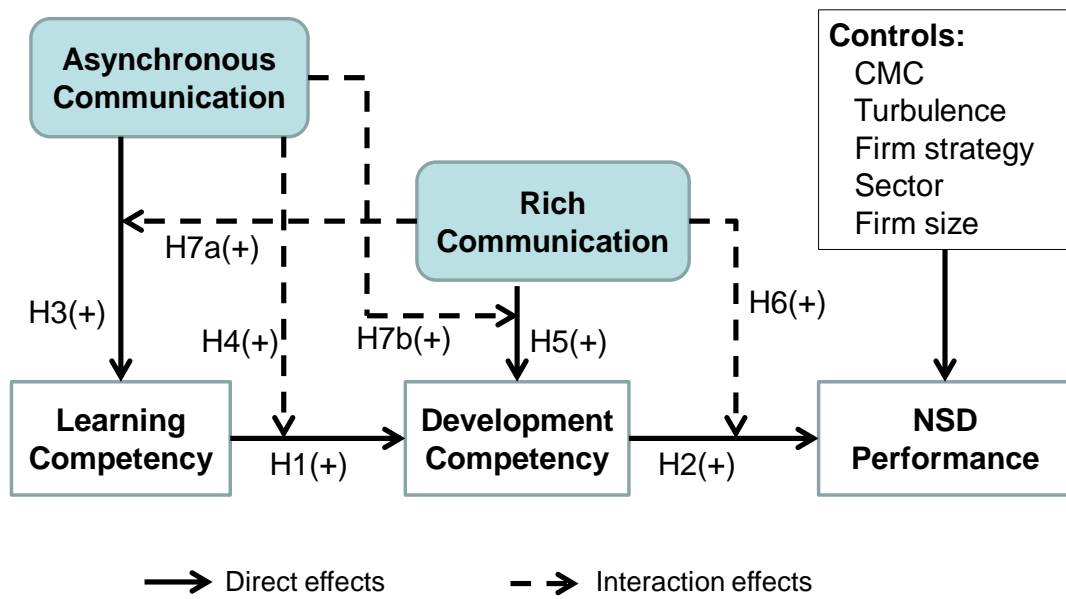


Figure 1. Conceptual Model

Table 1. Latent Variable Correlations

	A. NSD Performance	B	C	D	E	F	G	H	I	J	K
B. Development Competency	0.57**	-									
C. Learning Competency	0.36**	0.48**	-								
D. Rich Communication	0.45**	0.41**	0.24**	-							
E. Asynchronous Comm.	0.20*	0.25*	0.43**	0.28**	-						
F. CMC	0.38**	0.39**	0.37**	0.27**	0.24*	-					
G. Sector	0.01	-0.13	0.02	-0.02	0.00	-0.02	-				
H. Firm Size	-0.04	-0.04	0.01	-0.03	0.03	-0.03	-0.17+	-			
I. Strategy(Prospector)	0.41**	0.16+	0.05	0.11	0.01	0.18*	-0.02	0.02	-		
J. Strategy(Analyzer)	0.05	0.19*	0.09	0.08	0.06	0.12	-0.03	-0.02	-0.57**		
K. Strategy(Defender)	-0.24*	-0.18	-0.03	-0.14	-0.09	-0.12	0.05	-0.01	-0.30**	-0.39**	
L. Turbulence	0.32**	0.19*	0.06	0.29**	0.08	0.31	-0.14	0.13	0.00	-0.06	-0.23*

+ - significant at 10% level; * - significant at 5% level; ** - significant at 1% level.

Table 2. Summary of Effects

Path	Direct Effects Model Path coef (t-stat)²	Interaction Effects Model Path coef (t-stat)	Hypothesis Supported?
Learning Competency → Development Competency	0.35 (2.26)*	0.41 (5.50)**	H1 – Yes
Development Competency → NSD Performance	0.33 (3.87)**	0.36 (4.52)**	H2 – Yes
Rich Communication → Learning Competency	0.08 (1.12)	0.08 (1.33)	
Asynchronous Comm. → Learning Competency	0.35 (4.39)**	0.35 (4.40)**	H3 – Yes
CMC → Learning Competency	0.26 (3.11)**	0.24 (2.99)**	
Rich Communication → Development Competency	0.28 (3.82)**	0.26 (3.82)**	H5 – Yes
Asynchronous Comm. → Development Competency	-0.02 (0.37)	-0.03 (0.67)	
CMC → Development Competency	0.19 (2.34)*	0.10 (1.49)	
Rich Communication → NSD Performance	0.20 (2.36)*	0.20 (2.32)*	
Asynchronous Comm. → NSD Performance	0.04 (0.99)	0.02 (0.45)	
CMC → NSD Performance	0.02 (0.55)	0.03 (0.59)	
Strategy(Prospector) → NSD Performance	0.56 (5.53)**	0.50 (4.70)**	-
Strategy(Analyzer) → NSD Performance	0.37 (3.19)**	0.28 (2.46)*	-
Strategy(Defender) → NSD Performance	0.19 (2.28)*	0.13 (1.64)	-
Turbulence → NSD Performance	0.12 (1.67)	0.09 (1.53)	-
Technology-enabled service sector → NSD Performance	0.08 (1.42)	0.07 (1.30)	-
Firm size → NSD Performance	-0.03 (0.64)	0.00 (0.09)	-
Learning Competency x Asynchronous Comm. → Development Comp.		0.17 (2.17)*	H4 – Yes
Learning Competency x Rich Comm. → Development Competency		0.20 (2.40)*	
Development Competency x Rich Comm. → NSD Performance		-0.20 (2.37)*	H6 – No
Development Comp. x Asynchronous Comm. → NSD Performance		-0.09 (1.29)	
Asynchronous x Rich Comm. → Learning Competency		0.21 (2.73)*	H7a – Yes
Asynchronous x Rich Comm. → Development Competency		-0.31 (3.36)**	H7b – No
Asynchronous x Rich Comm. → NSD Performance		-0.03 (0.37)	
<u>Variance Explained</u>	<u>R²</u>	<u>R² (F change)</u>	
Learning Competency	0.26	0.30 (6.63**)	
Development Competency	0.35	0.51 (12.30**)	
NSD Performance	0.54	0.59 (3.05**)	

* - significant at 5% level; ** - significant at 1% level.

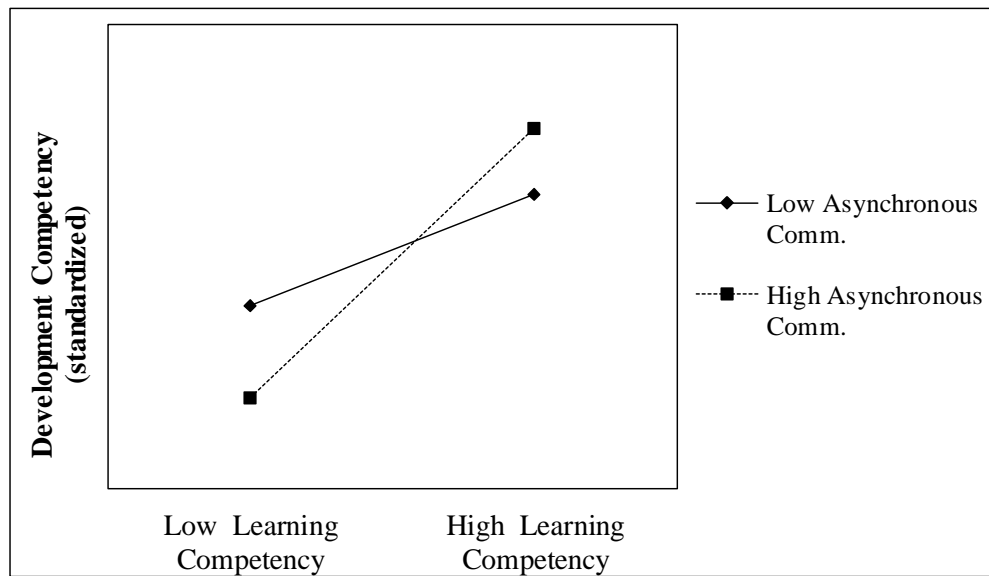
Table 3. Post-hoc Analysis (3-way Interactions)

Path¹	Post-hoc Model Path coef (t-stat)
Learning Competency x Asynchronous Comm. → Development Comp.	0.17 (2.36)*
Learning Competency x Rich Comm. → Development Competency	0.20 (2.42)*
Development Competency x Rich Comm. → NSD Performance	-0.20 (2.40)*
Development Competency x Asynchronous Comm. → NSD Performance	-0.09 (1.22)
Asynchronous x Rich Comm. → Learning Competency	0.21 (2.81)**
Asynchronous x Rich Comm. → Development Competency	-0.31 (3.56)**
Asynchronous x Rich Comm. → NSD Performance	-0.03 (0.43)
Asynchronous x Rich Comm. x Learning Comp. → Development Comp.	-0.26 (3.55)**
Asynchronous x Rich Comm. x Development Comp. → NSD Performance	0.21 (2.78)**
<u>Variance Explained</u>	<u>R² (F change)²</u>
Learning Competency	-
Development Competency	0.57 (15.63**)
NSD Performance	0.63 (11.46**)

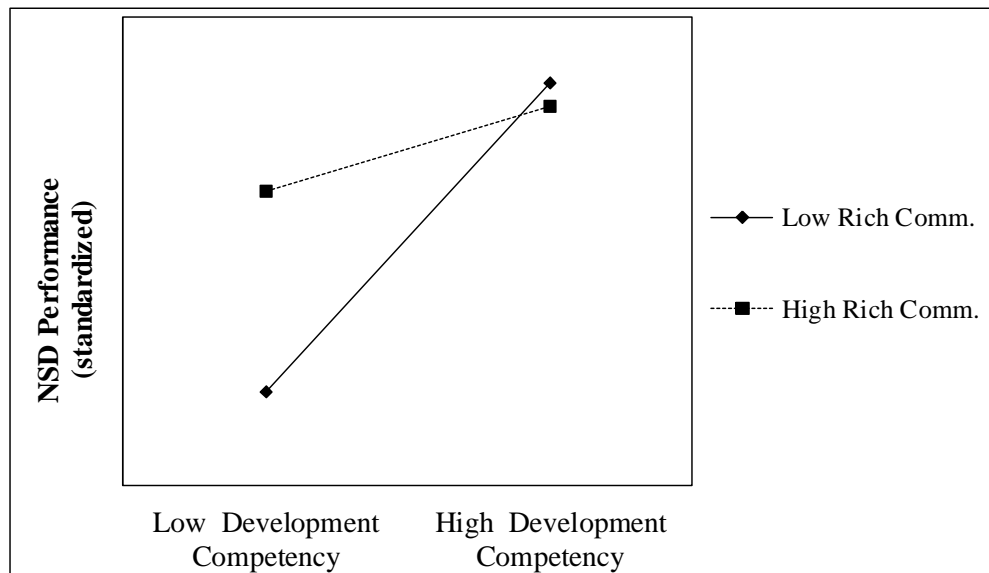
1. Only the interaction terms are shown (direct effects were included in the model)

2. F change compared to the interaction effects model (Table 2.)

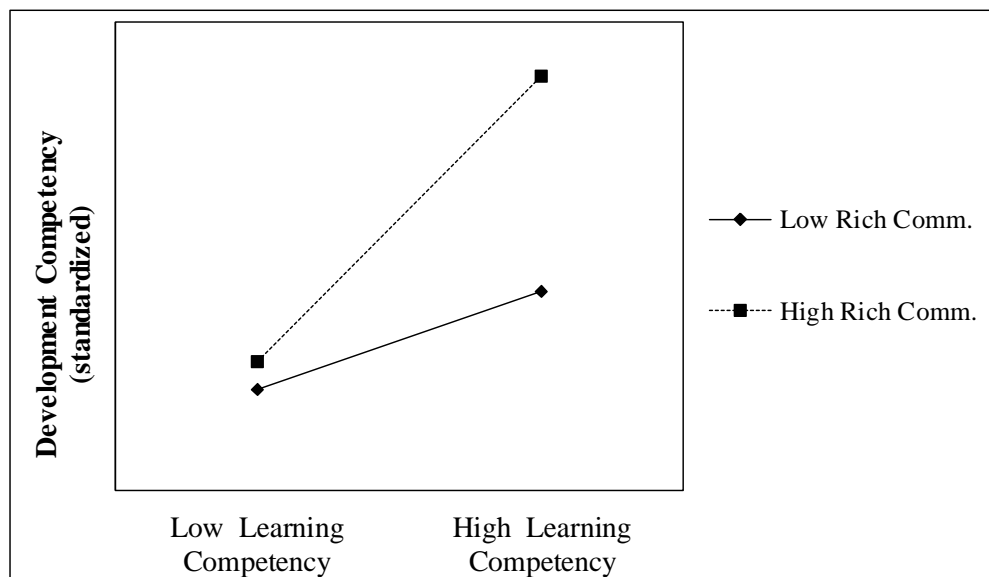
* - significant at 5% level; ** - significant at 1% level.



2a

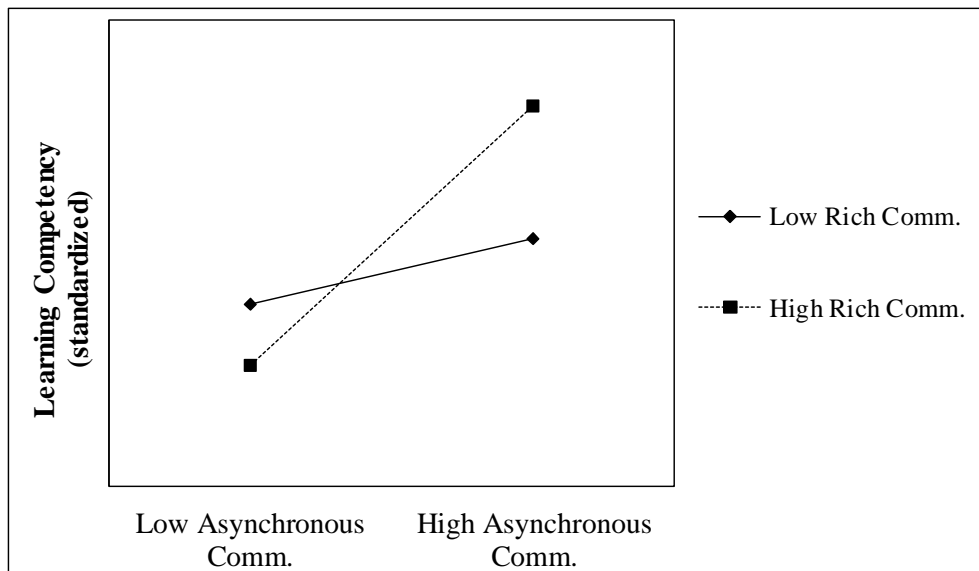


2b

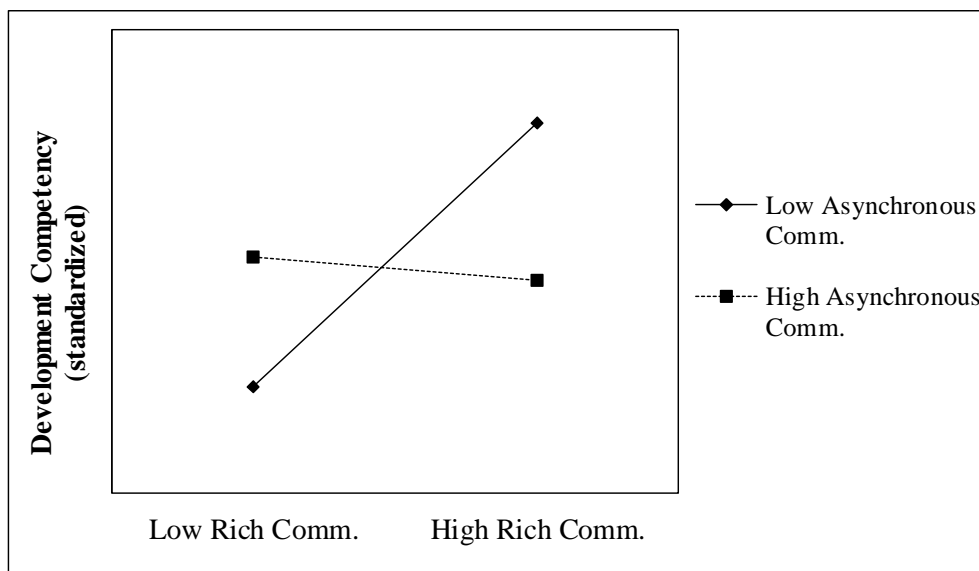


2c

Figure 2. Significant Moderating Roles of Communication Modes

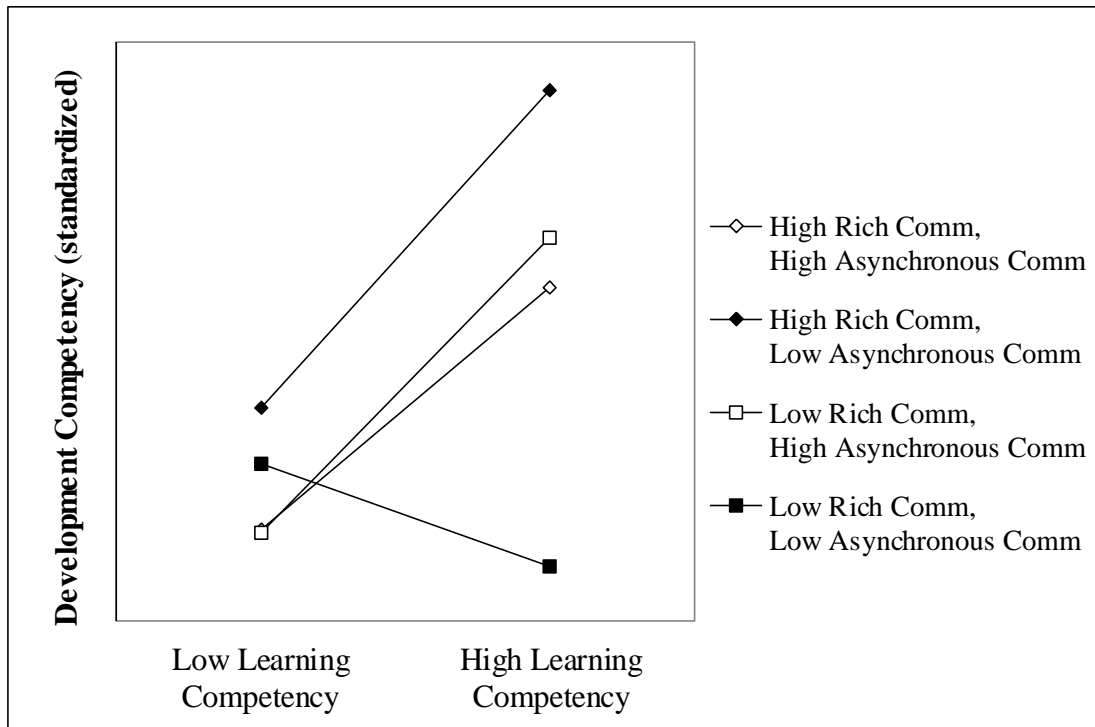


3a

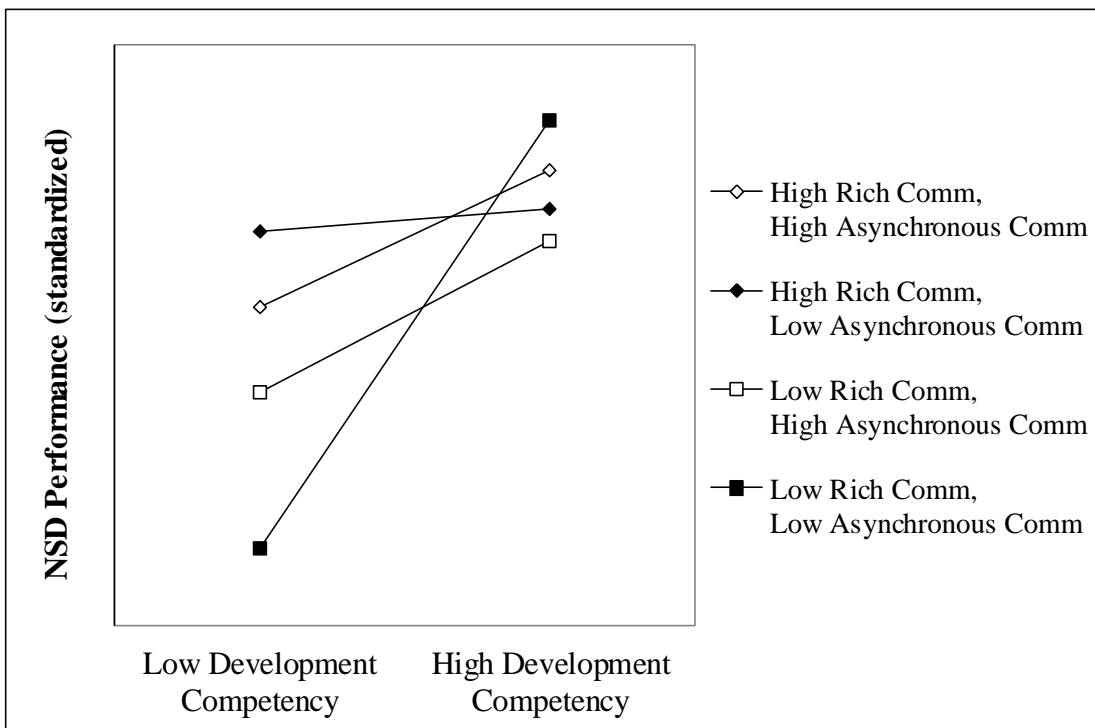


3b

Figure 3. Significant Interaction Effects of Communication Modes



4a



4b

Figure 4. 3-Way Interactions