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Team delivery capability and agility: complementary effects on information systems development project outcomes

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Abstract:
Contemporary Information systems development (ISD) involves not only implementing a predefined set of requirements but also managing changes that emerge during the development process due to unanticipated business and technical needs. ISD project requirements increasingly become both planned and emergent. ISD teams need delivery capabilities to routinely execute what has been planned, and agile capabilities to sense and respond to changes that emerge during the development project. In other words, ISD teams must effectively manage their abilities to not only routinely deliver software applications that meet defined requirements but also sense and respond to changes emerging during the project. The extant literature has not studied the distinction and relationship between ISD team delivery capability and agility. This study empirically examines the differential effects of ISD team delivery capability and agility on ISD project outcomes. Survey data collected from professionals working on 160 software development projects were used to test the research model and hypotheses. The results suggest that ISD delivery capability positively affects agility, agility positively impacts change-response outcome, and agility mediates the relationship between delivery capability and change-response outcome.

Keywords:
information systems development; team delivery capability; team agility; project outcomes; PLS.

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1. Introduction

Information systems development (ISD) is a complex process involving many resources, collaboration among diverse stakeholders, and multiple project outcomes [1, 2]. The nature of ISD has evolved in recent years to include not only implementing a predefined set of requirements but also managing changes that emerge during the development process [1, 3]. Many changes can emerge during the ISD project, primarily due to unanticipated business and technical changes. Traditional plan-driven software development approaches provide delivery capabilities focusing on routine predictability, stability, and assurance [4]. These approaches follow a disciplined and planned process to manage the ISD team's ability to deliver software applications that meet the business requirements. Such approaches are appropriate where requirements are predefined and stable, but not adequate where requirements are frequently changing [5]. In contrast, agile approaches provide flexibility for sensing and responding to emerging changes during an ISD project [6, 7]. Agile methods are recommended when frequent changes are expected, and requirements are emergent in ISD projects [8, 9]. Many organizations have recently adopted agile methods [10, 11]. Agile methods focus more on rapid business value and response to change [4]. These methods recommend agile practices for developing the capabilities that ISD teams need to effectively anticipate and execute ongoing changes in project requirements.

ISD teams need delivery capabilities to routinely execute what has been planned, and agile capabilities to sense and respond to changes that emerge during the development project. However, in practice, ISD teams often struggle to maintain a balance between their disciplined delivery capability and agility during the project [4, 12]. Understanding the distinction, relationship, and impacts of ISD team delivery capability and agility is critical for organizations to plan and manage appropriate capabilities based on the project context. As both business and technology environments become uncertain and fast changing, practitioners need to understand and appropriately plan and manage the relationships between ISD team delivery capabilities and agility, and their impacts on project outcomes. However, the distinctions and relationship between ISD team delivery capability and agility, as well as their impacts on ISD project outcomes, have not been studied in the literature.

This study addresses the practical need and research gap by empirically examining the differential effects of ISD team delivery capability and agility on project outcomes. The objective of this study is to answer this research question: "What is the relationship between team delivery capabilities and agility, and their impacts on project outcomes?". The main contributions of this study include building a theoretical rationale for the use of agile methods, distinguishing between ISD team delivery capability and agility, conceptualizing ISD team agility as a multi-dimensional variable, and providing rich insights about the differential effects of ISD team delivery capability and agility on project outcomes.

The following sections draw on the organizational and agile literature to define ISD team delivery capability and agility. We propose a set of hypotheses regarding the relationships between ISD delivery capability, agility, and their differential effects on two types of ISD project outcomes: change-response outcomes and project satisfaction. We then present the measures, data collection methods, and data analysis results. We conclude the paper by discussing the theoretical contributions and practical implications of our study findings, as well as the limitations of our study and future research directions.

2. Theoretical background

In this study, capability refers to the ability of an organization or a team to perform a task or activity in at least a minimally satisfactory manner [13, 14]. The literature has commonly conceptualized two types of capabilities: routine and dynamic capability [15-19]. Routine capability is also referred to as a basic operational, ordinary, or delivery capability. Routine capability is the ability to deliver or perform defined, repetitive, and planned activities based on the knowledge of basic operational and daily tasks [19, 20]. Dynamic capability is the ability to integrate and reconfigure internal and external resources and competencies to address rapidly changing environments [18, 19, 21, 22]. Dynamic capability can be viewed as a higher-order organizational ability and improvisation of routine capability [19]. Agility is a dynamic capability defined as an organization's ability to sense environmental changes and respond efficiently and effectively [23, 24]. It is an organization's ability to deal with constantly changing market conditions and to thrive by

exploiting unpredictable and emerging business opportunities [25, 26]. Organizations conduct their business in a dynamic business environment due to intense competition, market unpredictability, and the need to continuously innovate [27]. Organizations must balance their routine and dynamic capabilities for survival and competitive advantage. While organizations need the dynamic capability to adapt to unanticipated changes due to rapidly changing environments, they also need the routine capability to manage their standards and processes to achieve operational efficiency [28, 29]. Based on the organizational literature, in the following section, we conceptualize ISD team delivery (routine) capability and agility (dynamic capability) in the ISD context.

The ISD process is complex and knowledge-intensive, involving business and technology issues and changes [30-32]. ISD teams must deal with not only implementing predefined business requirements and technical specifications but also sensing and responding to unanticipated business and technology changes [33, 34]. In this research, we define ISD team delivery capability as the team's routine and essential ability to perform basic operational activities, such as delivering a solution as planned to a given set of requirements by efficiently applying their resources (e.g., time and money) and skills (e.g., technical, business, interpersonal, and problem-solving) in the ISD project. Whether or not the target amount of work is completed by the end of each iteration is an indicator of the delivery capability of the ISD team [35]. ISD team delivery capability is the result of the team's following standard processes and knowledge base to perform project activities to deliver information systems that meet the requirements. Such standard and routine-based approaches bring discipline to the project and emphasize assurance and predictability in project outputs [4].

ISD team agility is a multidimensional construct [5, 36-38]. It is often not a prior characteristic but an emergent capability of the team due to the use of agile methods in ISD projects [39, 40]. ISD team agility concerns "the continual readiness of an ISD method to rapidly or inherently create change, proactively or reactively embrace change, and learn from change while contributing to perceived customer value (economy, quality, and simplicity), through its collective components and relationships with its environment" [36] (p. 340). In this study, we conceptualize ISD team agility as the ability to sense changes, respond to changes, and learn from the changes that occur during the project, in addition to the given requirements or known conditions. ISD team agility is presented as a dynamic capability based on the organizational literature. It is a critical success factor when an ISD project has a high level of uncertainty or experiences frequent unanticipated changes during the project [41-43].

As both business and technology environments become increasingly dynamic and fast-evolving, an ISD project must deal with frequent business and technical requirement changes that were not anticipated and planned before project inception [36, 44]. For example, ISD projects may experience hardware and software resource changes [5, 36], human resource changes [5, 45], and budget and schedule changes [36, 40]. The requirement changes in the project are the most common among all other changes. Requirements can change because of changes in stakeholder preferences, competition threats, and changes in technology [46, 47]. ISD teams need to develop agility to deal with project changes and enhance project performance, especially when the changes are large. Agility allows teams to integrate, build, and reconfigure resources and competencies for effective sensing, responding, and learning from changes [48, 49]. ISD team agility is critical for project success [48].

The dynamic capabilities of an organization allow it to sense and respond to opportunities and threats by reconfiguring its assets for competitive advantage [50, 51]. Organizations need dynamic capabilities to handle unpredictable changes and turbulent market dynamics, which require a novel reconfiguration of delivery capabilities [15, 16]. Organizations struggle to balance between dynamic and routine capabilities [14]. While organizations need to be strategically flexible to adapt to unanticipated changes, they also need to optimize their routine processes to achieve operational efficiency for planned tasks. Similarly, in ISD projects, a successful project in a changing environment requires a disciplined balance between delivery capability and agility [52, 53]. The balance between these capabilities becomes more critical when the project environment evolves rapidly. While the ISD team needs discipline for stability, it needs agility for sensing, responding to, and learning from changes, yet these two capabilities are often conflicting in nature [12]. ISD teams must reconcile the conflicting demands for project success. The delivery capability provides discipline and structure to the project, and agility provides flexibility and adaptability. Developing and sustaining these capabilities requires effective and efficient use of team members' collective skills and coordination. A team's collective skills and coordination are important for developing the capabilities of the software development team for project success [54].

ISD teams need both the delivery capability to execute the predefined activities as per the plans and the agility to deal with changes that can occur during the development process. The ISD team members use different methods to develop their capabilities. The use of agile methods is particularly important in helping ISD teams balance delivery capabilities and agility. Agile methods (e.g., Scrum, Kanban) are a set of software development methods that exhibit the ability to respond to changes in turbulent business environments [12, 55]. These methods are based on the view that organizations are complex adaptive systems in which requirements are emergent rather than predefined [4]. These methods emphasize people and their skills in developing the capabilities required to deal with emergent changes. The social and technical practices of agile methods help achieve agility in ISD projects [56]. Agile practices recommended by various agile methods help capitalize on ISD team members' capabilities to achieve project success [57].

Short delivery cycles, frequent customer feedback, minimum documentation, prioritizing requirements, and accepting changes based on priority are some of the key characteristics of agile methods [8, 9]. In contemporary ISD contexts, the practices recommended by various agile methods enable ISD teams to develop and balance delivery capabilities and agility. For example, the Scrum method recommends working on prioritized requirements in short iterations of two to eight weeks [58]. Within each iteration, IT and Business teams have the stability to utilize their delivery capability to execute planned tasks. However, at the end of each iteration, these teams can consider new requirements and prioritize again to decide on the set of delivery tasks that they need to do in the next iteration. These agile practices enable ISD teams to develop and sustain delivery capabilities and agility.

3. Research model and hypothesis development

The research model of this study, as shown in Figure 1, illustrates the relationships between team delivery capability, team agility, project satisfaction, and project change response outcome.

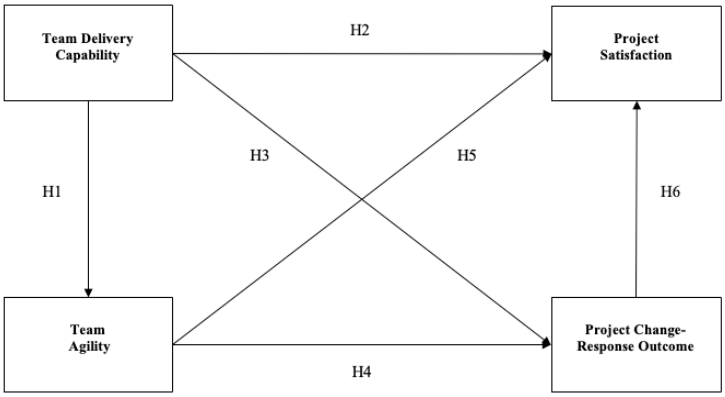

Figure 1: Research Model

ISD team delivery capability represents the basic ability of a team to effectively use its skills to routinely accomplish a planned task. As defined above, ISD team agility refers to the team's ability to sense, respond to, and learn from changes that were not part of the initial project scope and plan. Although ISD team agility is important for sensing changes, ISD team delivery capability is required to respond effectively. Agility or dynamic capability relies on delivery or routine capability [18, 21, 59]. Agility is achieved by improving delivery capabilities [19]. An ISD team cannot effectively and efficiently deal with the changes that emerge during an ISD project if the team does not possess the necessary delivery capability [60]. An ISD team is more likely to have a higher level of agility if it has a higher delivery capability. Therefore, we hypothesize as follows:

H1: ISD team delivery capability positively correlates with the ISD team's agility.

ISD team capabilities impact project outcomes [33]. The definition and measurement of IS project success can vary depending on the stakeholders' perspective [61]. The Project Management Institute (PMI) has defined project success in four dimensions: scope, schedule, cost, and quality. Previous ISD studies used various project outcome measures to assess project success, such as software quality [32, 62, 63], business value [1, 63], software functionality [1, 33], on-time completion [33, 64], on-budget completion [33, 64], process effectiveness [65], and customer satisfaction [1, 63].

In this study, to capture both traditional project outcomes and emergent change-related outcomes, we define two categories of project outcomes: project satisfaction and change-response outcome. Project satisfaction refers to client satisfaction regarding project time and budget, functionalities of the developed system, quality of the system, and business value of the system [63, 66]. Project satisfaction indicates the extent to which the ISD team can achieve its intended goals and deliver the system according to the expectations of the clients [67]. Agile methods specifically emphasize customer satisfaction through continuous software delivery [54]. One of the agile principles states that "our highest priority is to satisfy the customer through early and continuous delivery of valuable software." Therefore, measuring how customers feel about the delivered system is critical for understanding project outcomes.

ISD teams with higher delivery capability are more likely to accomplish the given project tasks as per the project plan, directly affecting project satisfaction outcomes [17]. For example, when an ISD team delivers the prioritized requirements as per the plan at the end of an iteration, the customer can see the business value of the delivered product. This enhances the customer satisfaction level with the system being developed. The delivery capability of an ISD team indicates that the team can optimize its process and resources to deliver working software products over time as per the plan [68]. Such a team is more likely to reconfigure its processes and resources to handle the changes that can occur during the ISD project. A team with a higher delivery capability can deal with various changes in a project more effectively and efficiently, which directly impacts the change-response outcome. Therefore, we hypothesize as follows:

H2: ISD team delivery capability positively correlates with project satisfaction.

H3: ISD team delivery capability positively correlates with project change-response outcome.

An ISD project environment that is often unstable owing to changes serves as a critical risk factor for ISD project success [34, 69]. ISD teams should be able to sense changes, develop expertise, coordinate with each other, and take collective actions to respond to and learn from changes [34]. These teams must possess the necessary skills and resources to deal with such changes. ISD team agility is an indicator that a team can effectively deal with changes in requirements during a project. Requirement changes affect project outcomes [70]. Managing requirement changes is one of the main activities in ISD projects, because it significantly impacts project outcomes [71]. The key focus of agile methods is to deliver rapid business value to customers by responding quickly to changes in requirements [4]. Ongoing changes will be incorporated into the development process when the ISD team can sense, respond to, and learn from changes effectively and efficiently, which results in better change-response outcomes [72]. A team with high agility is more likely to deal with changes more effectively and efficiently than a team with low agility. Project satisfaction is also higher when the change-response outcome is better. Therefore, we hypothesize as follows:

H4: ISD team agility positively correlates with project change-response outcome.

H5: ISD team agility positively correlates with project satisfaction.

ISD teams need agility for sensing, responding to, and learning from the requirement changes caused by evolving market conditions, emerging system requirements, and changes in technology [73]. Agile values and principles recommend embracing and responding to changes in ISD. Agile methods are recommended for projects where frequent requirement changes are expected, as the project scope is not well-defined at the beginning of the project [8, 9]. How effectively the changes are handled in the project is an important indicator of the project outcomes [32]. Therefore, we include change-response outcomes as an important aspect of ISD project outcomes. The change-response outcome refers to how satisfied the clients are with the way various changes (business and technical requirement changes, human resources, schedule changes, etc.) are handled by the ISD team during the project [5]. Clients will be more satisfied with project outcomes when the change-response outcome is better. Therefore, we hypothesize as follows:

H6: ISD project change-response outcome positively correlates with project satisfaction.

4. Research method

A quantitative research approach was used to conduct this study [74]. Survey data were collected and analyzed using the partial least squares structural equation modelling (PLS-SEM) method to test the hypotheses. The measures for the study variables were adapted from relevant literature sources. The variables can be measured using reflective or formative indicators, depending on the researcher's theoretical expectations [75]. These indicators represent the defining characteristics of the latent variables in this study [76]. All variables were measured using formative indicators. The ISD team delivery capability was measured using four items adapted from the literature [35, 59, 77]. These items assessed the extent to which the ISD team could deliver system solutions that met (1) business requirements, (2) technical requirements, (3) functional requirements, and (4) non-functional requirements. The ISD project satisfaction was measured using five items adapted from the literature [1, 63, 66]. These items assessed the extent to which the customer was satisfied with the new system delivered in terms of (1) functionalities, (2) quality, (3) delivery time, (4) project cost, and (5) benefits/value from the system. The ISD project change-response outcome was measured using four items adapted from the literature [1, 5, 63, 66]. These items assessed the extent to which the customer was satisfied with how the changes were managed by the ISD team in terms of changes in (1) business requirements, (2) technical requirements, (3) human resources, and (4) schedules.

ISD team agility was conceptualized as a second-order construct consisting of three dimensions: sense, respond, and learn. The ISD team sense capability was assessed using four items adapted from the literature [36, 44, 78, 79]. These items assessed the extent to which the ISD team could sense changes in (1) business requirements, (2) technical requirements, (3) human resources, and (4) project schedules. The ISD team response capability was assessed using four items adapted from the literature [33, 36, 78, 80]. These items assessed the extent to which the ISD team could respond to changes in (1) business requirements, (2) technical requirements, (3) human resources, and (4) project schedules. The ISD team learning capability was assessed using four items adapted from the literature [36, 78, 79]. These items assessed the extent to which the ISD team was able to learn and enhance its ability to sense and respond to changes in (1) business requirements, (2) technical requirements, (3) human resources, and (4) project schedules. A Q-sorting procedure was conducted with five ISD experts to ensure the content validity of the measures [75, 81]. After completing the Q-sorting procedure, a pilot test was conducted with 18 ISD practitioners to refine the survey items. We used a seven-point Likert-type scale to measure the variables in this study. In addition to the items used to assess the studied variables, information about the survey respondents, such as their project type, industry type, and agile experience, was also collected. Table A1 in the Appendix shows the final survey items and references.

4.1 Data collection

Data for this study were collected using an online survey. Online surveys are efficient at quickly distributing and helping to get relevant data [82]. ISD team members (software developers, business analysts, and project managers) working on agile software development projects were the survey respondents. The respondents were contacted by approaching IT companies using snowball sampling and posting the survey on professional communities on Facebook and LinkedIn. Table 1 shows the study sample characteristics, including the respondents' countries, roles in the agile project, the agile methods used in the project, and industry types. The total number of final usable survey responses was one hundred and ninety-four. To define the minimum sample size required for our data analysis, we used the guideline recommended by [83]; the minimum sample size should be at least ten times the number of indicators used to assess the formative construct with the highest number of indicators.

In this study, the project satisfaction variable had the maximum number of indicators (five). The survey responses were checked for incompleteness and inconsistencies to enhance data quality before data analysis [84]. Thirty-four responses with more than 15% missing values were removed from the initial sample [85]. One hundred and sixty responses were used for the final data analysis, which is more than the minimum sample size required. The PLS-SEM statistical technique was used for data analysis using SmartPLS3 software. It is a non-parametric technique to estimate coefficients and maximize the variance (R^2 value) explained by endogenous variables [85]. The PLS-SEM technique was used because this study's research model consisted of formative variables. PLS-SEM is best suited for data analysis

when formative variables are in the research model and are more appropriate when the study sample is not very large [81, 86-89].

Table 1: Survey sample characteristics (n=160)

Respondent Role		**Industry Type**	
Software Developer	51 (31.9%)	Financial Services	51 (31.9%)
Project Manager	17 (10.6%)	Telecom	13 (8.1%)
Senior Management	15 (9.4%)	Education, Research	4 (2.5%)
Business Analyst	5 (3.1%)	Healthcare, Medical	15 (9.4%)
Scrum Master	26 (16.3%)	Transportation	14 (8.8%)
Product Owner	9 (5.6%)	Manufacturing	11 (6.9%)
Tester	30 (%)	Media and Entertainment	8 (5.0%)
Others	7 (4.4%)	Other	44 (27.5%)
Agile Method		**Country/Region**	
Scrum	84 (52.5%)	India	73 (45.6%)
Extreme Programming	3 (1.9%)	US/Canada	55 (34.4%)
Modified Agile Method	32 (20.0%)	Europe	24 (15.0%)
Hybrid	24 (15.0%)	Others (China, Latin America)	8 (5.0%)
Others	17 11.6)		

Harmon's single-factor test was conducted to check for common method bias [90, 91]. All constructs were analyzed by performing an unrotated principal component analysis using SPSS software. The analysis identified more than one factor with an eigenvalue greater than one. These results indicate that not one factor is responsible for explaining the majority of the variance, which suggests that a common method bias is not an issue for this study [90, 91]. Table A2 in the Appendix shows the factors with eigenvalues greater than one and the variances explained.

4.2 Measurement validation

The measures were validated before the structural model assessment based on the guidelines suggested in the literature [75, 85, 92, 93]. The variance inflation factor (VIF), the significance of outer weights, and outer loadings are estimated and checked to validate the formative constructs used in the study. Each indicator of a formative construct represents a different aspect of that construct; therefore, a high correlation is not required between formative indications [92]. A high correlation between indicators leads to multicollinearity issues [75]. Variance inflation factor (VIF) values were used to identify multicollinearity problems in formative indicators [92, 94]. If the VIF value is less than five, multicollinearity is not a problem for that formative indicator [85]. Some researchers suggest a more conservative VIF value of 3.3 or less to ensure that multicollinearity is not a problem [92, 95]. VIF values, outer weights, their significance, and outer loadings for the second-order formative indicators are presented in Table 2.

Table 2: VIF, outer weights, and outer loadings (second order)

Indicators	**VIF**	**Outer Loadings**	**Outer Weights**	**P-Values (Outer Weights)**
CNGOTM1	1.749	0.794	0.276	0.044
CNGOTM2	1.586	0.725	0.221	0.266
CNGOTM3	1.558	0.742	0.264	0.019
CNGOTM4	1.567	0.865	0.491	0.001
DLVCAP1	1.961	0.820	0.340	0.010
DLVCAP2	1.596	0.754	0.250	0.046
DLVCAP3	2.184	0.850	0.301	0.040
DLVCAP4	1.458	0.768	0.361	0.005
DLVSTF1	1.850	0.571	0.134	0.511
DLVSTF2	1.708	0.314	-0.387	0.113
DLVSTF3	1.652	0.806	0.562	0.001
DLVSTF4	1.666	0.759	0.422	0.006
DLVSTF5	1.352	0.709	0.384	0.084
LEARN	1.544	0.756	0.317	0.016
RESPOND	1.474	0.906	0.618	0.000
SENSE	1.640	0.760	0.264	0.042

The formative indicators used in this study did not have multicollinearity issues because all indicators had VIF values less than 3.3. Table A3 in the Appendix shows the detailed results for first-order formative indicators. The outer weights of the formative indicators represent their relative importance, whereas the outer loadings represent their absolute importance in defining a construct. Indicators with significant weights were also included in the analysis. Formative indicators with insignificant outer weights (p-value <0.05) and outer loadings greater than 0.5 can also be included in the data analysis [85]. One of the indicators (DLVSTF2) did not have significant outer weights or loadings of >0.5. This was not removed from the analysis because it is important for the content validity of the delivery satisfaction variable [85]. All the formative indicators shown in Table 2 were used in the data analysis because they had significant outer weights or outer loadings greater than 0.5 or were critical for the content validity of the construct [85].

4.3 Hypothesis testing

A structural model assessment was conducted after the measurement model of the variables was validated. The analysis of the structural model consisted of calculating the path coefficients and their significance, variance explained (R^2 value), and effect size (F^2 value) [85]. The PLS algorithm using the factor-weighing scheme was used to test the relationships between variables in this study. As discussed in the previous section, ISD agility was conceptualized as a second-order formative hierarchical construct with sense, respond, and learn as its first-order formative variables. Since ISD team agility is a second-order formative variable, a two-stage approach for estimating the latent hierarchal variables was used. This approach is recommended for estimating research models that consist of higher-order formative variables [87, 96]. In this approach, the latent scores of lower-order variables are used as indicators for higher-order variables. The latent scores of ISD team sense, response, and learning capabilities were used as formative indicators of ISD team agility.

Path coefficients were estimated to indicate the strengths of the relationships among the various variables using the PLS algorithm. Figure 2 shows the path coefficients among the variables and their significance (p-values in brackets). The bootstrapping procedure was used with five thousand samples to calculate the significance levels of the path coefficients [85, 97, 98].

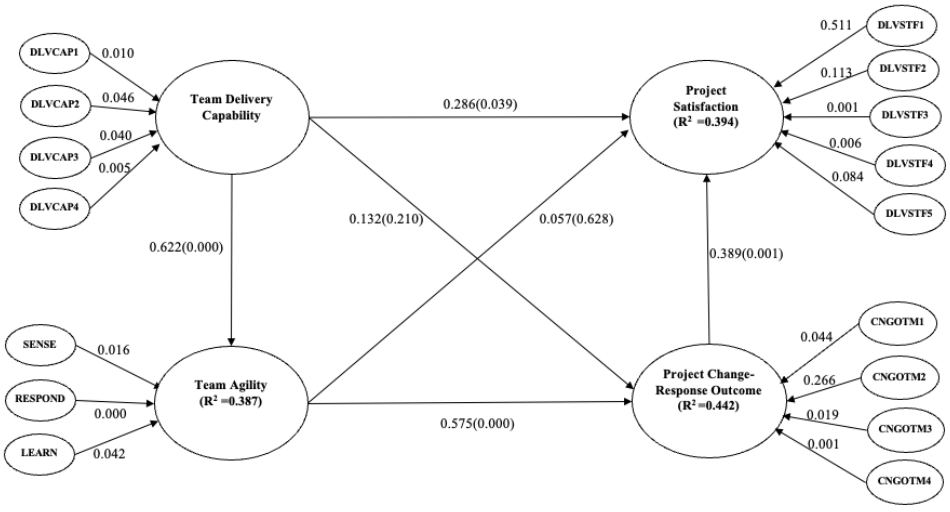

Figure 2: Results of structural model testing

Table 3 shows the path coefficients of the original sample, means of the bootstrap samples, standard deviations, and their p-values. These results suggest that ISD team delivery capability had significant and positive effects on ISD team agility (β=0.622, p <0.01) and project satisfaction (β=0.286, p <0.05), supporting hypotheses 1 and 2, respectively. However, ISD team delivery capability had an insignificant effect on project change-response outcomes; as such, hypothesis 3 was not supported. ISD team agility had a significant and positive effect on project change-response

outcomes (β=0.575, p <0.01), supporting hypothesis 4. However, ISD team agility had an insignificant effect on project satisfaction; as such, hypothesis 5 was not supported. Project change-response outcomes had a significant and positive effect on project satisfaction (β=0.389, p <0.01), supporting hypothesis 6. The coefficient of determination (R^2) was calculated to determine the predictive power of the model. It represents the amount of variance in the endogenous variables explained by the exogenous variables. It is a "squared correlation between a specific endogenous construct's actual and predicted values" [85] p198).

Table 3: Path coefficients and their significance

Relationship Paths	Original Sample (O)	Sample Mean (M)	Std Dev (STDEV)	T Statistics (|O/STDEV|)	p Values
Agility -> Change-response Outcome	0.575	0.556	0.092	6.230	0.000
Agility -> Delivery Satisfaction	0.057	0.106	0.117	0.485	0.628
Change-response Outcome -> Delivery Satisfaction	0.389	0.399	0.113	3.442	0.001
Delivery Capability -> Agility	0.622	0.634	0.052	12.055	0.000
Delivery Capability -> Change-response Outcome	0.132	0.176	0.105	1.254	0.210
Delivery Capability -> Delivery Satisfaction	0.286	0.254	0.139	2.062	0.039

Table 4 presents the adjusted R^2 and R^2 values. R^2 adjusted values are better indicators of the parsimony of the model [85, 99]. These values were calculated by adjusting R^2 based on the sample size and number of exogenous variables [85].

Table 4: Coefficient of determination (R^2)

Endogenous Constructs	R^2	R^2 Adjusted
Agility	0.387	0.383
Change-response outcome	0.442	0.435
Project satisfaction	0.394	0.382

The effect size (F^2) value was calculated for the research model, which indicates the impact of removing an exogenous construct on the R^2 value of an endogenous variable [85]. For example, the variance in project change-response outcomes was mainly explained by ISD team agility but not by ISD team delivery capability. Table 5 shows the F^2 values. The exogenous variable does not affect the endogenous variable when the F^2 values are less than 0.02 [100].

Table 5: Effect size (F^2)

Exogenous > Endogenous Constructs	F^2
Agility -> Change-response outcome	0.363
Agility -> Project satisfaction	0.002
Change-response Outcome -> Project satisfaction	0.139
Delivery Capability -> Agility	0.632
Delivery Capability -> Change-response Outcome	0.019
Delivery Capability -> Project satisfaction	0.081

4.4 Testing mediating effects

We further tested the indirect effects of ISD team delivery capability on project satisfaction and project change-response outcomes, as well as the indirect effect of ISD team agility on project satisfaction. There are mediation effects of variables if the indirect effects are significant [85, 101]. For example, as shown in the first row of Table 6, the total indirect effect of ISD team agility on project satisfaction, which was mediated by the change-response outcome, was significant (β=0.223, p=0.007).

Table 6: Total indirect effects

Relationship Path	Original Sample	P Values
Agility -> Delivery Satisfaction	0.223	0.008
Delivery Capability -> Change-response Outcome	0.358	0.000
Delivery Capability -> Delivery Satisfaction	0.225	0.005

Specific indirect effects were examined to assess the mediating effects of each path separately. For example, as shown in Table 7, the relationship between ISD team delivery capability and project satisfaction had three paths; only one of the three paths was significant (β=0.139, p=0.009). The total indirect effects indicate the combined mediating effects of all the mediating paths. By contrast, specific indirect effects indicate the individual contribution of each mediator in defining the strength of the mediating relationship between the dependent and independent variables.

Table 7: Specific indirect effects

Relationship Path	Original Sample	P Values
Delivery Capability -> Agility -> Change-response Outcome	0.358	0.000
Delivery Capability -> Agility -> Delivery Satisfaction	0.035	0.637
Agility -> Change-response Outcome -> Delivery Satisfaction	0.223	0.008
Delivery Capability -> Agility -> Change-response Outcome -> Delivery Satisfaction	0.139	0.010
Delivery Capability -> Change-response Outcome -> Delivery Satisfaction	0.051	0.231

5. Discussion

The use of agile methods has increased in recent years. Most of the studies related to agile methods and ISD are qualitative in nature [102-104]. Very little theoretically grounded empirical research affirms the relationships between, and benefits of, different agile project team capabilities [105]. In this study, we answer the research question: What is the relationship between team delivery capabilities and agility, and their impacts on project outcomes? The empirical results of this study presented an interesting set of relationships between ISD team capabilities and project outcomes. The results suggest that ISD team delivery capability is a significant determinant of ISD agility and project satisfaction but not a direct determinant of project change-response outcomes. This indicates that ISD teams with a high level of delivery capability are more likely to develop high levels of team agility and project satisfaction. The result is consistent with the organizational agility literature in that routine delivery capability impacts operational performance [68]. The relationship between ISD delivery capability and ISD project change-response outcomes is mediated by ISD team agility. ISD team agility is a significant determinant of project change-response outcomes, but not a significant determinant of project satisfaction. In addition, project change-response outcomes mediate the relationship between ISD team agility and project satisfaction. These results have important implications for the ISD/agile literature and ISD/agile practitioners.

5.1 Implications

This study contributes to both the theoretical development and practical management of ISD and agile practices. First, it contributes to the ISD/agile literature by taking a step forward in building a theoretical understanding of the use of agile methods, distinguishing between ISD team delivery capability and agility, conceptualizing ISD team agility as a multi-dimensional variable, and providing rich insights about the differential effects of ISD team delivery capability and agility on project outcomes. This study contributes to the literature by responding to calls for research to build a theoretical rationale for the use of agile practices [36], and to focus on theoretical development in agile literature [12]. Drawing on the organizational routine and dynamic capabilities literature and the ISD/agile literature, we conceptualize two distinct and complementary, and yet often conflicting, ISD team capabilities: delivery capability and agility. While the ISD/agile literature has recognized that ISD/agile teams must deal with not only implementing predefined business requirements and technical specifications but also sensing and responding to unanticipated business and technology changes [33, 34], no empirical studies have made a clear distinction between ISD team delivery capability and agility. Our study will serve as a first stepstone for developing a theoretical foundation that helps explain the different ISD team capabilities required for executing routine tasks versus for sensing, responding to, and learning from emergent changes.

Second, the extent literature often uses agility as an adjective for agile methods and practices without a theoretical basis [36, 106]. Our research conceptualize ISD agility as a second-order variable with three dimensions (sense, respond, and learn). Previous studies have called for the empirical validation of the multifaceted concept of agility in the software development context [36, 56]. Agility is a nebulous concept, and its dimensions are still not clearly understood [107].

Studies in the literature have measured agility using a particular aspect of agility, for example, the response dimension [33]. This study helps to develop a deeper understanding of agility by studying all three dimensions of ISD team agility. The results show that an ISD team possessing a high level of agility in terms of sensing, responding to, and learning from changes would produce better change-response outcomes, which in turn would lead to better project satisfaction. This study contributes to the ISD/agile literature by conducting a rigorous quantitative study on two related ISD team capabilities that have not been adequately examined in the ISD/agile literature [103]. ISD practitioners can use the results of this study to understand the multidimensional nature of ISD agility and how ISD team delivery capability is necessary for ISD team agility.

Third, in addition to distinguishing the two types of ISD team capabilities, our study shed light on their relationship. While these two ISD capabilities have been discussed individually in the literature [4, 35, 48, 108, 109], they have not been conceptualized and examined together. Our study suggests that ISD team delivery capability enables ISD team agility, which is required to address the changes that occur during an ongoing project. The risk of software project failure is reduced when prioritized changes are incrementally delivered within punctuated time-boxes [110]. This understanding of the relationships is important for developing a theoretical understanding of agile methods. It also helps to understand the assumptions underlying agile practices. Such understanding is critical for the effective application of agile practices in a particular project context [111]. Agile practices need to be tailored based on project and organizational contexts [112, 113]. The results of this study will help ISD practitioners understand the nature and relationship between these capabilities. It can serve as a guide to adapt organizations' project practices to appropriately plan and manage the development and balance of these capabilities. Organizations must create a project environment in which they can balance discipline and flexibility for better project performance [12].

Finally, our study provides insights into how the two types of ISD team capabilities jointly affect ISD project outcomes. Team performance is an important research theme in agile software development [114]. This study helps to understand the different roles that the two types of team capabilities play in impacting ISD project outcomes. Our results contribute to the literature by bridging a theoretical gap regarding the lack of understanding of the relationships between ISD team delivery capability and agility, and project outcomes [106]. The change-response outcome variable can be used to assess the performance impact of ISD team agility. Previous studies in the agile literature have used traditional project outcomes, such as project satisfaction, time, cost, scope, and quality, to study the impact of ISD team agility [33, 48, 115]. The empirical results of our study concerning the differential effects of ISD team delivery capability and agility on project change-response outcomes and project satisfaction provide a much richer understanding of the dynamic relationships between ISD team capabilities and project outcomes than what is provided by the existing literature. Understanding such a relationship is critical for ISD practitioners as it will help them build a balance between these two capabilities.

5.2 Limitations and future research

The results of this study should be interpreted with caution because of its limitations. First, the data for this study were collected only from agile ISD projects. The results of this study are related to the agility and delivery capabilities of teams using agile methods in their projects. These results may not be readily generalizable to ISD projects that use a traditional waterfall model-based software development approach. Future studies may collect data from projects using agile and traditional approaches and compare the results based on the different development approaches used.

Second, this study used data collected primarily from an ISD team's perspective. Perceptions of project outcomes, such as delivery satisfaction, can differ between IT and business teams. Future research may collect data from both the IT and the business team's perspectives to better estimate project outcomes, such as customer satisfaction.

Lastly, this study focused on the relationships between ISD team delivery capability and agility, and their differential effects on ISD project change-response outcomes and project satisfaction. We did not include variables that may affect the ISD team’s delivery capability and agility. Many factors can affect ISD team capabilities. Agility can be influenced by external and internal factors such as team size, project type, team autonomy, and market conditions, which require further investigation [106]. Future studies may include factors such as team competence, team culture, team

collaboration, team communication, and iterative development to investigate how these variables affect ISD team delivery capability and agility.

6. Conclusion

As both business and technology become increasingly dynamic and uncertain, ISD teams are facing difficulties in appropriately managing the constant conflict between executing planned tasks and dealing with unexpected changes. In this study, we provide a theoretical perspective to understand and explain this challenge by distinguishing two ISD team capabilities, delivery capability and agility, and empirically examining their relationship and joint effects of project outcomes. The PLS-SEM analysis results of the survey data suggest that ISD team delivery capability significantly impacts ISD agility and project satisfaction but not project change-response outcomes. These results show that ISD teams with a high level of delivery capability are more likely to develop high levels of team agility and project satisfaction. This study contributes to the literature by initiating a new research stream that will enable researchers to build a theoretical rationale for the use of agile methods and provide further insights about the differential effects of ISD team delivery capability and agility on project outcomes. This study will help ISD practitioners to understand the multi-dimensional nature of agility and the dynamic relationships between ISD team capabilities and project outcomes.

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Appendix A

Table A1: Survey measurements

Variables	Measures	Key References
Project Satisfaction	The customer is satisfied with the functionalities of the new system (DLVSTF1) The customer is satisfied with the quality of the new system (DLVSTF2) The customer is satisfied with the delivery time of the system (DLVSTF3) The customer is satisfied with the cost of the new system (DLVSTF4) The customer is satisfied with the benefits/value from the new system (DLVSTF5)	[63], [1], [66]
Change-Response Outcome	The customer is satisfied with the way changes in business requirements were managed in the project (CNGOTM1) The customer is satisfied with the way changes in technical requirements were managed in the project (CNGOTM2) The customer is satisfied with the way changes in human resource requirements were managed in the project (CNGOTM3) The customer is satisfied with the way changes in schedule was managed in the project (CNGOTM4)	[63], [1], [66], [5]
Delivery Capability	Project team was able to deliver solutions that met business requirements (DVLCAP1) Project team was able to deliver solutions that met technical requirements (DVLCAP2) Project team was able to deliver solutions that met functional requirements (DVLCAP3) Project team was able to deliver solutions that met non-functional requirements (DVLCAP4)	[35], [59], [77]
Agility-Sense	During the project, project team was able to sense changes in business requirements. (Sense1) During the project, project team was able to sense changes in technical requirements. (Sense2)	[78], [36],

Variables	Measures	Key References
Agility-Respond	During the project, project team was able to sense changes in human resource requirements. (Sense3) During the project, project team was able to sense changes in schedule. (Sense4) During the project, project team was able to respond to changes in business requirements. (Respond1) During the project, project team was able to respond to changes in technical requirements. (Respond2) During the project, project team was able to respond to changes in human resource requirements. (Respond3) During the project, project team was able to respond to changes in schedule. (Respond4)	[79], [44], [116] [80], [78], [36], [33], [116]
Agility-Learn	As the project progressed, project team member(s) were able to learn and enhance their ability to sense and respond to changes in business requirements. (Learn1) As the project progressed, project team member(s) were able to learn and enhance their ability to sense and respond to changes in technical requirements. (Learn2) As the project progressed, project team member(s) were able to learn and enhance their ability to sense and respond to changes in human resource requirements. (Learn3) As the project progressed, project team member(s) were able to learn and enhance their ability to sense and respond to changes in schedule (Learn4)	[78], [36], [79], [116]

Table A2: Harman's single factor test: total variance explained

	Initial Eigenvalues			Extraction Sums of Squared Loadings		
Component	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	8.461	33.845	33.845	8.461	33.845	33.845
2	2.381	9.523	43.368	2.381	9.523	43.368
3	1.774	7.095	50.464	1.774	7.095	50.464
4	1.509	6.036	56.500	1.509	6.036	56.500
5	1.247	4.989	61.489	1.247	4.989	61.489
6	1.210	4.838	66.327	1.210	4.838	66.327
7	1.089	4.355	70.681	1.089	4.355	70.681
8	.919	3.676	74.358			
9	.732	2.926	77.284			
10	.677	2.707	79.991			
11	.603	2.412	82.402			
12	.523	2.094	84.496			
13	.467	1.866	86.362			
14	.452	1.808	88.171			
15	.417	1.669	89.840			
16	.387	1.546	91.386			
17	.333	1.333	92.718			
18	.305	1.219	93.938			
19	.280	1.119	95.057			
20	.256	1.024	96.080			
21	.237	.948	97.028			
22	.229	.917	97.946			
23	.203	.811	98.757			
24	.173	.694	99.451			
25	.137	.549	100.000			

Extraction Method: Principal Component Analysis.

Table A3: VIF, outer weights, and outer loadings (first order)

Indicators	VIF	Outer Loadings	Outer Weights	P Values(Outer Weights)
CNGOTM1	1.749	0.789	0.262	0.084
CNGOTM2	1.586	0.742	0.250	0.195
CNGOTM3	1.558	0.752	0.278	0.124
CNGOTM4	1.567	0.853	0.467	0.013
DLVCAP1	1.961	0.806	0.298	0.027
DLVCAP2	1.596	0.739	0.223	0.141
DLVCAP3	2.184	0.872	0.366	0.015
DLVCAP4	1.458	0.771	0.359	0.031

Indicators	VIF	Outer Loadings	Outer Weights	P Values(Outer Weights)
DLVSTF1	1.850	0.576	0.182	0.480
DLVSTF2	1.708	0.279	-0.438	0.090
DLVSTF3	1.652	0.773	0.515	0.010
DLVSTF4	1.666	0.746	0.409	0.028
DLVSTF5	1.352	0.730	0.430	0.046
LEARN1	1.368	0.705	0.339	0.183
LEARN2	1.607	0.740	0.229	0.304
LEARN3	1.532	0.670	0.151	0.477
LEARN4	1.694	0.881	0.556	0.004
RESPOND1	2.113	0.828	0.308	0.108
RESPOND2	2.141	0.824	0.282	0.106
RESPOND3	1.810	0.789	0.265	0.128
RESPOND4	1.924	0.844	0.360	0.019
SENSE1	1.470	0.854	0.655	0.000
SENSE2	1.726	0.608	-0.037	0.848
SENSE3	1.499	0.613	0.138	0.511
SENSE4	1.346	0.753	0.502	0.004

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