GUIDELINES FOR ENHANCING DESIGN THINKING ATTRIBUTES AND EMPOWERING THE APPLICATION OF DESIGN THINKING IN SCHOOLS

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Abstract

Design Thinking (DT) is increasingly recognized as a critical capability for leaders in business and other sectors, including education, where schools operate as complex organizations requiring innovation and adaptability similar to businesses. This study positions school administrators as strategic human capital whose DT attributes drive organizational innovation and transformation toward design thinking–oriented schools. Using a mixed-methods design, the study examined DT practices across diverse school contexts and developed implementation guidelines to enhance DT-based leadership. A quantitative survey of 480 administrators was used to assess DT attributes, implementation levels, outcomes, and barriers. This was followed by qualitative interviews and focus groups with administrators and DT experts to explore leadership development pathways, practical DT practices, and context-specific challenges. Results indicated that DT implementation levels were primarily explained by DT attributes—especially acceptance and beliefs—accounting for 44% of the variance, while DT outcomes were influenced by DT attributes and policy implementation within a supportive learning culture, with school context playing a secondary but significant role (44.6%). Qualitative findings highlighted both enablers and barriers, emphasizing the need for context-sensitive strategies. The proposed framework for design-oriented leadership in school leaders, offers actionable guidance for cultivating innovation-oriented, human-centered leadership and aligning educational organizations with design thinking practices commonly applied in progressive business contexts. These findings provide a foundation for context-based strategies to empower the application of DT in schools.

Keywords: design thinking attributes, innovation-oriented leadership, human capital development, organizational transformation, school management

INTRODUCTION

In modern organizations, translating strategic objectives into practice is a complex managerial process that requires effective resource allocation, continuous performance monitoring, and innovation-oriented leadership. Organizations must navigate dynamic environments, foster creativity, and build adaptive teams to sustain a competitive advantage.

Design Thinking (DT), popularized by IDEO and elaborated by Tim Brown (2009), has become widely adopted in the business world as a human-centered framework for addressing complex challenges creatively (Alvarado, 2025; IDEO, 2012; Mueller-Roterberg, 2018). Its five iterative stages of Empathize, Define, Ideate, Prototype, and Test have demonstrated strong potential for enhancing innovation capacity and organizational agility (Kelley & Kelley, 2013).

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While DT is well established in business, its use in education remains in the early stages. Schools in many countries, including Thailand, have begun to adopt DT; however, practical application, organizational readiness, and leadership capability remain limited and underexamined (Fullan, 2016; Gallagher & Thordarson, 2018; Razzouk & Shute, 2012). Differences in school size, resources, administrative structures, and community contexts make one-size-fits-all adoption challenging (Antoniou et al., 2024). Drawing on established DT principles, effective implementation in schools requires leaders with strong human-capital attributes, including creative problem-solving, openness to experimentation, and the ability to mobilize teams.

This study aims to fill the gap in understanding DT attributes and the implementation of DT across diverse school contexts. It investigates how school leaders apply DT, the outcomes that emerge, and the challenges they encounter. Quantitative findings are presented alongside qualitative insights to provide a more integrated understanding. By examining the interactions among DT attributes, contextual factors, and managerial capabilities, this research clarifies how DT can be leveraged in educational leadership.

Grounded in organizational innovation and human-capital perspectives, the study views school administrators as strategic leaders capable of shaping their organizations through Design Thinking principles. The goal is to provide actionable guidelines that help schools build their innovation capacity and progress toward DT-oriented organizations—similar in spirit to how various types of business foster learning, creativity, and innovation for business growth, providing inspiration for educational management which fosters teacher and student growth.

RESEARCH OBJECTIVES

1. To analyze school administrators' DT attributes and the status of DT implementation, including implementation levels, outcomes, and barriers in the school context.

2. To compare DT attributes and DT implementation across different organizational contexts and leadership backgrounds, and to examine contextual and managerial factors influencing DT implementation levels in schools.

3. To identify key DT attributes in need of development in schools and to propose strategic guidelines for strengthening organization-wide DT implementation, based on integrated quantitative and qualitative data.

LITERATURE REVIEW

This section includes a synthesis of the key theoretical perspectives and empirical research relevant to the study. The review covers four major areas: 1) concepts of DT, 2) DT implementation in schools, 3) leadership development for DT implementation, and 4) the conceptual framework of the study. Building on these core insights, the following sections explore how DT operates in school contexts and informs leadership practices.

Concept of DT

Design Thinking (DT) is a human-centered, creative problem-solving approach emphasizing empathy, experimentation, and iterative learning (Brown, 2009; IDEO, 2012). Developed by David Kelley at Stanford's d.school and IDEO, DT fosters openness, resilience, and a proactive orientation toward change (Gallagher & Thordarson, 2018; Liedtka, 2015; Lor, 2017). Skilled design thinkers apply DT principles to practical organizational and business challenges (Schweitzer et al., 2016).

In business contexts, DT integrates desirability, feasibility, and viability through collaborative ideation and rapid prototyping (Brown, 2009). In education, DT drives innovation, strategic leadership, and adaptive management (Gallagher & Thordarson, 2018).

To operationalize DT effectively, leaders must develop a combination of knowledge, attitudes, and applied skills that collectively enable the DT process to generate impactful solutions. These capabilities, referred to as Key DT Components, provide the foundation for strategic problem-solving and organizational innovation. Key DT components include:

1. **DT Knowledge** –Foundational understanding of DT processes and principles through structured conceptual learning, enabling strategic problem-solving and organizational innovation (Koh et al., 2015; Rauth et al., 2010). Brown (2009) and IDEO (2012) have highlighted DT as human-centered innovation using designer tools in a five-stage process.

2. Attitudes and Beliefs –Effective DT implementation requires embracing uncertainty, maintaining empathy, and having confidence in iterative, solution-focused problem-solving. These attitudes collectively strengthen innovation capacity (Clarke & Bell, 2021; Daymond & Knight, 2023; Jaskyte & Liedtka, 2022; Koh et al., 2015; Liedtka, 2015; Schweitzer et al., 2016; Taimur & Onuki, 2022). Positive attitudes enhance organizational and leadership effectiveness (Gallagher & Thordarson, 2018; Lor, 2017).

3. Adoption and Practice – True DT competence involves continuous, reflective practice in complex organizational settings, incorporating frequent application and learning from implementation experiences (IDEO, 2012; Kelly, 2003; Schweitzer et al., 2016).

DT Implementation in Schools

Modern educational leadership increasingly requires a shift from traditional top-down models to agile, collaborative, and innovation-driven management approaches (Gallagher & Thordarson, 2018; Pont, 2014). DT implementation in schools parallels the principles observed in high-performing organizations, where successful outcomes depend on a combination of individual capabilities and systemic conditions.

DT implementation is shaped by both personal and contextual factors, including gender, age, education, experience, self-efficacy, communication, networking skills, and the organizational environment (Bandura, 1997; Hallinger & Heck, 1998; Leithwood et al., 2004; Pont, 2014; Rosenholtz, 1989; Singphen et al., 2019). Organizational conditions—such as leadership capability, strategic vision, and support systems—serve as critical enablers to foster innovation and sustain DT practices (Pegram et al., 2022; Rogers et al., 2019; Wisdom et al., 2014).

Gallagher and Thordarson (2018) identified five design leadership roles that cultivate creativity and user-centered innovation, while persistent barriers—such as insufficient training, unclear budgeting, and limited resources—can impede progress (Muthanna & Sang, 2023). Effective DT implementation requires clarity of purpose, collaborative engagement across stakeholders, and systems thinking, aligning with approaches used in effective organizations (Fullan & Quinn, 2015; Retna, 2019).

Beliefs and mindsets among organizational leadership strongly influence DT adoption, while active DT implementation enhances organizational creativity, critical thinking, and problem-solving capabilities (Koh et al., 2015; Puthaprasert et al., 2023; Rusmann & Ejsing-Duun, 2022). Liedtka (2017) demonstrated that DT integrates creative ideation with analytical rigor, strengthening adaptability and innovation performance.

In Thailand, DT adoption in schools remains limited, though teacher interest is growing, reflecting broader ASEAN trends toward innovation-driven organizations. Kruthangka et al. (2019) found that younger teachers with less than five years of experience were more ready to adopt DT principles. Chatuporn & Wongwanich (2022) noted that, while teachers exhibited strong DT-related attributes, organizational support and leadership guidance are essential in translating DT principles into actionable practice. These findings indicate that building human capital and strategic leadership capability is essential for cultivating schools that operate with agility and the innovation mindset characteristic of high-performing organizations.

Leadership Development for Implementing DT

International research highlights that effective leadership development is critical for translating innovative concepts into practice in both education and organizational contexts (Pont, 2014). Key leadership roles include supporting teacher development, managing resources strategically, and fostering innovation-friendly environments to achieve organizational performance and equity outcomes.

Experienced school leaders continue to grow through ongoing professional development, peer collaboration, and reflective practice, paralleling executive development programs in high-performing organizations (Boyce et al., 2010; Day, 2000). Structured learning experiences—such as on-the-job learning, delegated responsibilities, 360-degree feedback, and coaching—enhance leadership capability and decision-making effectiveness, enabling leaders to drive sustainable innovation and organizational change.

Successful school leaders prioritize instructional and strategic leadership, cultivate positive organizational culture, and use data-informed, evidence-based decision-making to improve student and school outcomes, reflecting principles also observed in effective business leadership (Fullan & Hargreaves, 2016).
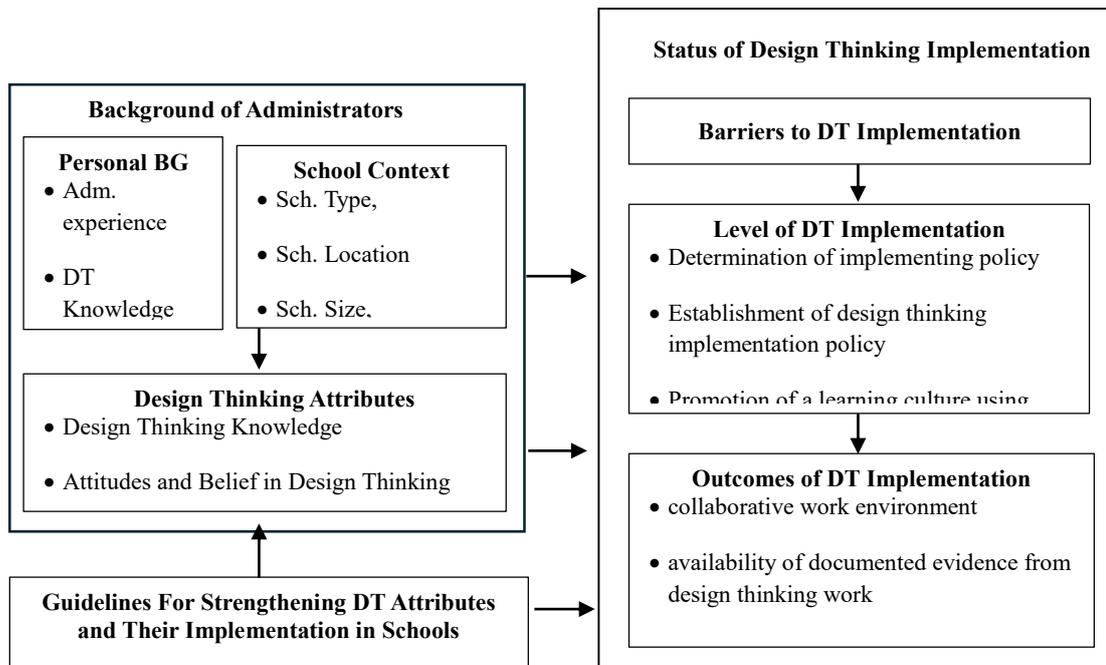
CONCEPTUAL FRAMEWORK

Figure 1 Conceptual Framework

Based on Leithwood et al. (2004), Pont (2014), Rosenholtz (1989), and Singphen et al. (2019), this study considered several factors influencing the implementation of new concepts. Variables such as gender, age, education, experience, self-efficacy, readiness, communication, collaboration, and leadership vision, were reviewed. Some variables were excluded because they overlapped with DT attributes (e.g., networking, collaboration) or were uniformly present among participants (e.g., vision, policy acceptance).

This framework assumes that school leaders function as strategic human capital, whose DT attributes—particularly mastery of the five DT stages (Empathize, Define, Ideate, Prototype, and Test)—determine the extent and effectiveness of DT implementation in schools. Limited attributes result in fragmented application, reducing organizational agility and innovation capacity. Conversely,

strong DT attributes enable systematic, iterative DT implementation, fostering adaptive, innovation-driven school management.

The proposed strategies provide guidance for developing DT attributes as a core leadership capability. They also support aligning organizational processes with human-centered, design thinking practices. Together, these strategies enable schools to operate more like DT–oriented organizations, capable of responding strategically to complex challenges.

RESEARCH METHODOLOGY

This study adopted a Design Thinking (DT) research approach, aligning the research variables and objectives with DT principles. It aimed to develop practical guidelines to empower DT-based leadership and enhance school administrators as strategic human capital. The research process followed the four of the five DT stages—empathizing with school leaders, defining challenges, generating solutions, and prototyping strategies.

A mixed-methods design was used to understand DT implementation in public schools, both primary and secondary, in the Thai context. A quantitative survey was used to assess DT attributes among administrators, followed by qualitative interviews and focus group discussions with school leaders and experts. This approach provided a thorough exploration of the real-world challenges, contextual constraints, and opportunities for innovation-driven leadership, drawing parallels with organizational practices that leverage DT for strategic transformation and human-centered management.

Phase I: Quantitative Study

Design and Sample
This phase employed a descriptive quantitative design to examine school administrators' Design Thinking (DT) attributes, the current state of DT implementation, and the influencing factors in the school context using a structured questionnaire. The sample included 432 administrators from public schools, covering diverse regions and school contexts. The appropriate sample size was calculated using G*Power based on standard parameters to satisfy parametric analysis assumptions (Cohen, 2013).

Definition of Terms
Design thinking attributes: personal qualities enabling effective DT-based leadership, including Knowledge of DT principles, Attitudes and Beliefs, and Acceptance of DT processes.

Level of DT implementation in schools: the extent to which DT is applied to improve school management and problem-solving, including establishing DT policies, translating DT principles into practice, and fostering a culture of creative problem-solving.

Outcomes of DT implementation: results from creative management and leadership, such as enhanced collaboration, development of DT skills among teachers, documented innovative practices, and other outputs.

Barriers to DT implementation: common challenges in schools, including limited resources, time constraints, difficulty shifting stakeholder mindsets, and concerns of negative academic outcomes.

Examination of Measurement Scale Quality
Four research instruments were rigorously evaluated for content validity, internal consistency reliability, and construct validity. Construct validity was particularly assessed for the DT Attributes Scale, as it measures psychological and cognitive dimensions requiring empirical verification to ensure alignment with the theoretical framework.

1) Design Thinking Attributes Scale (15 items)

Content Validity: All items achieved an I-CVI of 1.00, while S-CVI values ranged from 4.83 to 4.90, reflecting strong expert agreement. ***Internal Consistency Reliability:*** The Cronbach's alpha value from the pilot study (n = 50) was .881 overall, with sub-components ranging between .689 to .806. In the main study (n = 480), reliability improved to .926 overall, with sub-component values ranging from .806 to .874, confirming reliability for broader use.

Construct Validity: Using pilot data (n = 191), Exploratory Factor Analysis (EFA) with Principal Axis Factoring and VARIMAX rotation showed high data suitability (KMO = .911; Bartlett's test = 1740.129, p < .001), identifying three major components which together explained 66.54% of variance. Item correlations ranged from .242 to .780. A second-order Confirmatory Factor Analysis (CFA) showed good model fit: χ^2 (df=78) = 96.842, p = .0729; CFI = .989; TLI = .985; $RMSEA$ = .036; $SRMR$ = .035. All factor loadings were significant (p < .05), with item loadings ranging from .516 to .849 and second-order latent factors ranging from .836 to .952. The most influential sub-component was Attitudes and Beliefs (β = .952), followed by Knowledge (β = .911), and Acceptance (β = .836), with R² values ranging from 26.60% to 72.10%.

2) Level of DT Implementation Scale (12 items)

Content Validity: Expert evaluations showed strong content validity, with item-level CVIs ranging from .75 to 1.00 and a scale-level S-CVI of 4.76. All items were refined based on expert feedback to enhance clarity and theoretical alignment. ***Internal Consistency Reliability:*** Cronbach's alpha values were high, with analysis yielding a value of .903 in the pilot study and .944 in the main study, indicating excellent internal consistency.

3) Outcomes of DT Implementation Scale (10 items)

Content Validity: All items demonstrated strong expert agreement, with item-level CVIs ranging from .88 to 1.00 and a scale-level S-CVI of 4.70. ***Internal Consistency Reliability:*** The calculated Cronbach's alpha coefficients were .872 (pilot) and .919 (main study), reflecting high internal consistency.

4) Barriers to DT Implementation Scale (5 items)

Content Validity: Expert reviews produced item-level CVIs ranging from .88 to 1.00 and a scale-level S-CVI of 4.85. However, ***internal consistency reliability*** was not assessed, as the five items represented distinct and non-overlapping issues rather than reflective indicators of a single latent construct.

Data Collection and Analysis

Data were collected via an online survey distributed through Google Forms. The research team coordinated with contact persons to share the survey link with target groups according to predefined criteria, including region, school size, and school type. This targeted approach resulted in responses exceeding the required sample size. After screening, 480 valid responses were retained for analysis. Most respondents were from rural and medium-sized schools. In this study, the proportion of schools under the Educational Innovation Area Policy (hereafter referred to as "pilot schools") was smaller than that of non-pilot schools. SPSS 26 was used to conduct descriptive statistical analyses, ANOVA, crosstabulations, Chi-square tests, and regression analyses, to examine the explanatory variables of DT implementation levels and outcomes, ensuring rigorous quantitative analysis.

Phase II: Qualitative Study

This phase aimed to deepen the findings from Phase I and explore leadership pathways in DT implementation, providing insights for the development and validation of strategic implementation guidelines.

Sample:

Two groups were included: *Group I – Interview Group:* Twelve purposefully selected public school administrators from diverse schools in terms of school type (pilot vs. non-pilot), size (small,

medium, large), level (primary, secondary, combined), and administrative experience. *Group II – Focus Group:* The same twelve administrators plus three experts (DT expert, scholar in educational administration, policymaker) participated in a focus group discussion.

Research Instruments and Analysis:

Interviews explored three areas: 1) professional development pathways in applying DT, 2) policy and school management practices, and 3) administrators' creative approaches to school improvement. Content analysis focused on participants' reflections on the level and practice of DT implementation. Focus group discussions examined strategies for school improvement and provided critical feedback on the feasibility and applicability of the proposed guidelines.

Data Integration and Guideline Development:

Quantitative and qualitative data were combined to identify key DT attributes and implementation factors. The integrated findings were synthesized into practical recommendations for school leaders and stakeholders. Feedback from focus groups ensured that the proposed guidelines were contextually relevant, feasible, and adaptable across diverse school settings.

Research Results

The quantitative data were summarized with minimal emphasis on detailed statistical analyses due to space limitations, focusing instead on insights that support practical implementation. The qualitative findings are discussed in detail to support the development of actionable guidelines for educators and policymakers. These guidelines are specifically tailored to fit diverse school contexts and the unique backgrounds of school administrators, ensuring relevance and effectiveness in varied educational settings. Data presentation includes three parts: Part 1: Results from quantitative data, Part 2: Results from qualitative data, and Part 3: Action-Oriented Guidelines for Enhancing Design Thinking Attributes in Schools

Part 1: Results from Quantitative Data

This section presents the quantitative findings of the study, organized into three main sections. The first section 1.1) focuses on DT attributes and the status of DT implementation, covering the level of DT implementation, implementation outcomes, and barriers. The second section 1.2) compares DT attributes, levels, outcomes, and barriers across school contexts and administrator backgrounds. The third section 1.3) reports the results of multiple regression analysis, exploring the variables that explain the levels and outcomes of DT implementation. Together, these sections provide a comprehensive overview of quantitative evidence that informs the development of practical strategies for enhancing DT implementation in schools.

1.1 DT Attributes and Status of DT Implementation

A survey was conducted to examine DT attributes, levels of DT implementation, outcomes of DT implementation, and barriers to DT implementation among school administrators (Table 1).

DT Attributes. The overall DT attributes of school administrators were found to be high ($M = 4.44$, $SD=0.48$). Among the components, attitudes and beliefs towards DT scored highest ($M = 4.52$, $SD=0.51$), reflecting a very positive mindset and strong confidence in the value of DT. Acceptance of working using DT followed closely ($M = 4.49$, $SD=0.53$), showing readiness to apply DT practices in schools. Knowledge of DT concepts and processes scored a slightly lower value ($M = 4.32$, $SD=0.57$), but remained at a high level, indicating solid understanding with room for further development. Overall, administrators demonstrated strong DT attributes, particularly in terms of mindset and acceptance, while knowledge was slightly less pronounced yet still high (see Table 1).

Level of DT Implementation in Schools. The overall level of DT implementation was high ($M = 4.40$, $SD=0.53$). Component-level results showed that fostering a learning culture to develop DT

creativity scored the highest value *(M* = 4.45*, SD=0.58)*, followed by establishing DT policies (*M* = 4.42*, SD=0.57)*, and translating DT policies into practice (*M* = 4.34*, SD=0.59)*. These findings indicate that schools exhibit substantial commitment to DT, particularly in cultivating a DT-oriented learning culture. While translating policies into operational practice scored slightly lower, it maintains a high rating. Overall, DT implementation demonstrated consistent high-level implementation across policy, practice, and culture (see Table 1).

Outcomes of DT Implementation in Schools. The overall outcomes of DT implementation were moderately high (*M* = 4.02*, SD=0.62*). Among the components, collaborative outcomes for teachers and stakeholders was the most prominent (*M* = 4.29*, SD=0.63*), followed by documented evidence from DT implementation in schools (*M* = 3.96*, SD=0.69*) and creative innovation outcomes in school learning (*M* = 3.84*, SD=0.82*). These results indicate that DT implementation positively affects collaboration and applied practices, while innovation outcomes are at a slightly lower level. Overall, outcomes suggest a moderately high pattern, with collaboration being the strongest component (see Table 1).

Barriers to DT Implementation in Schools. The most notable barrier was found to be insufficient operational resources (*M* = 4.02*, SD* =1.02), including limitations in time, personnel, and budget. Time constraints for team brainstorming (*M* = 3.62*, SD=1.05*), and difficulty shifting stakeholders' mindsets were also high (*M* = 3.62*, SD=0.97*), whereas teachers' concerns about academic achievement impacts (*M* = 3.47*, SD=1.02*) and lack of diverse expert collaboration (M = 3.45*, SD=1.07*) were moderate. These findings highlight that operational and time limitations, as well as mindset-related challenges, are the primary obstacles to DT implementation. Overall, the pattern shows moderate to high levels, with the strongest concern regarding available operational resources (see Table 1).

Table 1 Data Distribution for DT Attributes, Level, and Outcomes of DT Implementation

	Variables	Mean	SD	Sk	Ku
1	**DT Attributes**	**4.44**	**0.48**	**-1.23**	**2.52**
1.1	Knowledge of DT concepts and processes	4.32	0.57	-1.09	2.30
1.2	Attitudes and beliefs towards DT	4.52	0.51	-1.23	1.60
1.3	Acceptance of working using DT	4.49	0.53	-1.12	1.50
2	**Level of DT Implementation in Schools**	**4.40**	**0.53**	**-0.80**	**0.38**
2.1	Establishing DT policies	4.42	0.57	-0.77	0.03
2.2	Translating DT policies in schools into practice	4.34	0.59	-0.73	0.18
2.3	Fostering learning culture to develop DT creativity	4.45	0.58	-0.82	0.28
3	**Outcomes of DT Implementation in Schools**	**4.02**	**0.62**	**-0.53**	**0.73**
3.1	Collaborative outcomes for teachers and stakeholders.	4.29	0.63	-0.83	1.39
3.2	Documented evidence from DT implementation in schools	3.96	0.69	-0.51	0.59
3.3	Creative innovation outcomes in school learning	3.84	0.82	-0.59	0.29
4	**Barriers to DT Implementation in Schools**				
4.1	Insufficient operational resources	4.02	1.02	-0.80	-0.04
4.2	Time constraints for team brainstorming meetings	3.62	1.05	-0.53	-0.14
4.3	Lack of diverse expert collaboration	3.45	1.07	-0.41	-0.33
4.4	Difficulty shifting stakeholders' mindsets	3.62	0.97	-0.44	-0.05
4.5	Teachers' concerns about academic achievement impacts from DT implementation	3.47	1.02	-0.40	-0.19

Note: *n* = 480*, SE. Sk*= .11*, SE. Ku*= .22
Interpretation: 1-1.50= least, 1.51-2.50=low, 2.51-3.50= moderate, 3.51-4.50=high, 4.51-5.00 = highest
The overall mean score of barriers to DT implementation was not analyzed, as nature is independent of one another.

Summary. Overall, school administrators demonstrated strong DT attributes and high levels of DT implementation, particularly in fostering a DT-oriented learning culture and establishing supportive policies. The outcomes of DT implementation are moderately high,

with collaboration emerging as the most prominent component, while innovation outcomes showed slightly lower performance. Barriers to DT implementation ranged from moderate to high, with operational resources representing the greatest challenge. Together, these findings highlight that schools have a substantial commitment to DT, with clear strengths in mindset, culture, and collaborative practices, but face manageable challenges that may influence full implementation.

1.2 Comparisons of DT Attributes, Level, Outcomes, and Barriers of DT Implementation Across Contexts and Backgrounds

Analysis of variance tests (F-tests) were conducted to examine differences in DT attributes, levels, and outcomes, across school contexts and administrator backgrounds, while Chi-square tests were used for perceived barriers. Detailed statistical values are summarized in Tables 2 and 3; only key findings are highlighted here due to space constraints (Table 2).

Table 2 Summary of Mean Differences of DT Variables by School Context and Administrator Background

Contexts	DT Attributes			F-test	Level of DT implementation			F-test	Outcomes of DT implementation			F-test
School Type	n	mean	SD		n	mean	SD		n	mean	SD	
1. Primary	283	4.44	0.49	F=0.079	283	4.38	0.55	F=1.831	283	3.99	0.64	F=3.131
2. Secondary	197	4.45	0.47	p=0.779	197	4.44	0.51	p=0.177	197	4.09	0.59	p=0.077
School Location	n	mean	SD	F-test	n	mean	SD	F-test	n	mean	SD	F-test
1. Urban	120	4.46	0.45	F=0.151	120	4.47	0.50	F=2.678	120	4.15	0.62	F=6.058*
2. Rural	360	4.44	0.49	p <0.698	360	4.38	0.54	p=0.102	360	3.99	0.61	p=0.014 1> 2>
School Size	n	mean	SD	F-test	n	mean	SD	F-test	n	mean	SD	F-test
1. Small	170	4.40	0.50	F=1.143	170	4.30	0.57	F=5.672*	170	3.90	0.63	F=9.598*
2. Medium	227	4.47	0.45	p=0.320	227	4.44	0.52	p=0.004 2 > 1	227	4.04	0.57	p=0.000 3>1
3. Large	83	4.43	0.49		83	4.53	0.47	3 > 1	83	4.26	0.66	3>2
Innovation Pilot School	n	mean	SD	F-test	n	mean	SD	F-test	n	mean	SD	F-test
1. Yes	109	4.46	0.50	F=0.241 p=0.624	109	4.56	0.51	F=11.438 * p<0.001	109	4.22	0.65	F=14.014* p=0.000
2. No	371	4.44	0.47		371	4.36	0.53	1 > 2	371	3.97	0.60	1 > 2
Admin. Exp.	n	mean	SD	F-test	n	mean	SD		n	mean	SD	F-test
1. Low. (<5 yrs.)	170	4.46	0.48	F=0.313 p=0.731	170	4.37	0.56	F=1.039 p=0.355	170	4.03	0.64	F=0.842 p=0.432
2. Med. (5-10 yrs.)	175	4.43	0.51		175	4.39	0.55		175	3.99	0.64	
3. High (10+ yrs.)	135	4.43	0.44		135	4.46	0.47		135	4.08	0.55	
DT knowledge devel. method	n	mean	SD	F-test	n	mean	SD	F-test	n	mean	SD	F-test
1. No dev.	270	4.39	0.50	F=3.701* p=0.025 2 > 1	270	4.31	0.58	F=9.335* p=0.000 2>1	270	3.90	0.64	F=13.819* p=0.000 2>1
2. self learning	111	4.54	0.40		111	4.53	0.44	3>1	111	4.19	0.52	3>1
3. formal training	99	4.46	0.49		99	4.51	0.44		99	4.20	0.59	
Total	480	4.44	0.48		480	4.40	0.53		480	4.02	0.62	

Note: *p <.05. ANOVA and Chi-square Analysis were conducted to examine differences of DT variable across various school contexts and backgrounds. Detailed statistical values are omitted due to space constraints.

Design Thinking Attributes. Overall, DT attributes did not significantly differ across school types, locations, sizes, pilot status, or administrative experience, indicating consistently high attributes among administrators regardless of context. Administrators who engaged in self-directed DT learning demonstrated significantly higher DT attributes compared to those with no formal development, highlighting the value of self-initiated learning for strengthening mindset and acceptance toward DT. Administrators with formal training also showed higher attributes than those without training, although the difference was less pronounced (see Table 2).

Level of Design Thinking Implementation. The level of DT implementation was generally high across all contexts. While school type and location did not significantly influence overall DT implementation, medium and large schools implemented DT at higher levels than small schools. Pilot schools showed the strongest DT implementation, outperforming non-pilot schools. Administrators who received formal DT training and those who engaged in self-directed learning, applied DT more actively than those with no training, with no significant difference observed between self-learners and workshop-trained administrators. Administrative experience did not significantly affect DT implementation (see Table 2).

Outcomes of DT Implementation. Overall, DT outcomes showed moderate to high performance across school contexts. Urban schools tended to achieve slightly better outcomes than rural schools, while medium and large schools outperformed small schools. Pilot schools consistently demonstrated superior outcomes compared to non-pilot schools. Administrators with formal DT training and those who were self-directed learners achieved higher outcomes than those without training. No significant differences were observed by administrative experience. Primary and secondary schools showed similar outcome patterns, with differences being non-significant (see Table 2).

Barriers to DT Implementation. Perceived barriers differed across school contexts and administrator background. Insufficient operational resources was found to be the main obstacle, especially in small schools and among less experienced administrators. Time constraints for team brainstorming were also notable, and slightly higher in rural schools. Other barriers, such as shifting stakeholder mindsets and concerns about academic outcomes, were moderately high. Chi-squared tests showed significant differences for resources and time constraints, highlighting the need to address these challenges (see Table 3).

Table 3 Barriers to DT Implementation by School Context and Administrator Background

Barriers	Least		Low		Medium		High		Highest		Total	
	n	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**
Insufficient operational resources												
School Type												
1. Small	2	1.2%	12	7.1%	26	15.3%	39	22.9%	91	**53.5%**	170	100%
2. Medium	6	2.6%	11	4.8%	49	21.6%	74	**32.6%**	87	**38.3%**	227	100%
3. Large	1	1.2%	4	4.8%	32	**38.6%**	26	**31.3%**	20	**24.1%**	83	100%
Total	9	1.9%	27	5.6%	107	22.3%	139	29.0%	198	41.3%	480	100%
Chi-Square = 31.880*, df = 8. P = .000												
Admin. Exp.												
1. < 5 yrs.	3	1.8%	10	5.9%	31	18.2%	43	25.3%	83	**48.8%**	170	100%
2. 5-10 yrs.	2	1.1%	11	6.3%	34	19.4%	62	**35.4%**	66	**37.7%**	175	100%
3. > 10 yrs.	4	3.0%	6	4.4%	42	**31.1%**	34	25.2%	49	**36.3%**	135	100%
Total	9	1.9%	27	5.6%	107	22.3%	139	29.0%	198	41.3%	480	100%
Chi-Square = 16.142* df = 8. P = .040												
Time constraints for brainstorming												
School Location												
1. Urban	1	0.8%	7	5.8%	45	37.5%	37	30.8%	30	**25.0%**	120	100%
2. Rural	20	5.6%	33	9.2%	101	28.1%	130	**36.1%**	76	21.1%	360	100%
Total	21	4.4%	40	8.3%	146	30.4%	167	34.8%	106	22.1%	480	100%
Chi-Square = 9.763* df = 4. P = .045												

Note: Chi-square tests were performed for all variables across school contexts and backgrounds. The table shows the test results, highlighting the statistically significant ones.

Summary. Overall, DT attributes remained consistently high across all school contexts and administrator backgrounds. The level of DT implementation and outcomes of DT implementation were higher in medium and large schools, pilot schools, and among administrators with formal training or self-directed DT learning. Barriers to DT implementation, especially operational resources and time constraints, were more prominent in small, rural, and non-pilot schools, as well as among administrators without formal or self-directed DT knowledge development, highlighting contexts that require targeted support (see Tables 2–3).

1.3 Multiple Regression Analysis of Variables explaining Level and Outcomes of DT Implementation in Schools

This section presents the results of the multiple regression analyses examining how school context and administrator background explain both the level and outcomes of DT implementation (Table 4).

Explanatory Variables for the Level of DT Implementation in Schools. Nine explanatory variables were tested, including four school context factors (type, location, size, pilot status) and two administrator background factors (experience, DT knowledge development), with the level of DT implementation as the dependent variable. Five variables were found to be statistically significant, collectively explaining 44% of the variance ($R = .664$, $R^2 = .440$) (see Table 4).

- *High influence*: DT acceptance ($\beta = .372$) was the strongest predictor, 1.8 times more influential than DT attitudes and beliefs, and four times stronger than DT knowledge development.
- *Moderate influence*: DT attitudes and beliefs ($\beta = .211$) had a meaningful secondary effect.
- *Low influence:* DT knowledge ($\beta = .117$), pilot school status ($\beta = .112$), and DT knowledge development ($\beta = .097$) were significant but less influential.

Interpretation: The DT attributes of administrators, particularly acceptance and beliefs, played a more critical role than background factors or school contexts in explaining DT implementation levels.

Explanatory Variables for the Outcomes of DT Implementation in Schools. Twelve explanatory variables were examined, covering school context, administrator background, DT attributes, and implementation factors. Five variables were found to contribute significantly, explaining 44.6% of the variance ($R = .667$, $R^2 = .446$) (see Table 4).

- *High influence:* DT policy implementation ($\beta = .452$) was the strongest predictor, over 3.3 times stronger than urban school location.
- *Moderate influence*: Fostering a DT learning culture ($\beta = .134$) and DT knowledge development ($\beta = .121$) contributed moderately, especially in schools with strong professional learning environments.
- *Low influence:* DT acceptance ($\beta = .097$) and urban school location ($\beta = .072$) were statistically significant but had smaller effects.

Interpretation: Achieving meaningful DT outcomes relies more on deliberate policy actions and fostering a supportive learning culture, indicating that careful management and development of DT attributes matter more than school context alone.

Table 4 Regression Coefficients for Factors Explaining Level and Outcomes of DT Implementation

Level of DT Implementation					Outcomes of DT Implementation					
variables	*b*	*SE*	*β*	*t*	*p*	variables	*b*	*SE*	*β*	*t*	*p*
(Constant)	1.183	.175		6.756*	.000	(Constant)	.754	.195		3.859*	.000
DT acceptance	.374	.050	.372	7.534*	.000	DT Policy Implementation	.470	.060	.452	7.781*	.000
DT attitude & Belief	.220	.057	.211	3.874*	.000	DT Knowledge Development	.150	.043	.121	3.470*	.001
Being a Pilot school in innovation area	.142	.045	.112	3.178*	.002	Learning Culture to DT skills dev.	.143	.061	.134	2.352*	.019
DT knowledge development	.105	.038	.097	2.740*	.006	DT Acceptance	.113	.050	.097	2.247*	.025
DT Knowledge	.109	.050	.117	2.185*	.029	Urban Sch./ Location	.102	.049	.072	2.089*	.037

$R = .664$, $R^2 = .440$, *SE* of est. $= .40138$ $R = .667$, $R^2 = .446$, *SE* of est. $= .46193$

*p <.05

Part 2: Results from Qualitative Data

The qualitative phase aimed to deepen the findings from Phase I by uncovering the practical realities behind the quantitative trends. This phase examined how school administrators interpreted and applied innovation-oriented leadership, managed constraints, and developed professional competencies in diverse contexts. In-depth interview analysis revealed decision-making logic, adaptive strategies, and learning processes in school management. Three key analytical areas guided this phase: 1) Professional Development Pathways – how administrators build leadership capability and learn from experience, 2) Innovation-Oriented School Management – how they lead with an innovation focus and foster teacher creativity, and 3) Problem-Solving Approaches – how they address challenges such as limited resources or resistance to change.

The analysis showed that even when surveys reported strong support for a "learning culture," actual practices often depended on mandated structures such as Professional Learning Communities (PLCs) rather than self-initiated DT learning. Case data clarified how contextual factors and personal agency shaped actual implementation and outcomes.

2.1 Professional Development Pathway Analysis

Innovation-oriented administrators possess key skills aligned with design thinking, positioning them as catalysts for educational transformation.

• *Educational Background:* All administrators held bachelor's degrees in education. Most had earned master's degrees in educational administration (9), with one each in Educational Research, Educational Measurement and Evaluation, and Community Development Education. Five held doctorates in Educational Administration.

• *Career Origins:* Most began as elementary school teachers in rural provinces. Administrators with over ten years of experience (5 individuals) were over fifty and had previously served as deputy administrators.

• *Motivations for Leadership*: Administrators were motivated by 1) a desire to improve education systemically, 2) commitment to reducing educational inequality, 3) compassion for students and communities, and 4) goals to enhance learner, community, and societal quality.

• *Innovation as a School Administrator Characteristic*: All twelve interviewees were organizational developers. Six also served as community developers, two were design thinkers demonstrating creative problem-solving, two were technology leaders using digital tools, and two were self-reliant, analytical individuals using resources effectively.

• *Learning Development Methods:* Administrators were found to be using multiple learning

modes: 1) Self-directed learning – reading and researching new ideas, 2) Experiential learning – learning through real work challenges, 3) Network-based learning – engaging with diverse professionals and stakeholders, and 4) Inquiry-based learning – used by eight administrators to experiment with and refine ideas.

These findings confirm that innovation-oriented administrators already have core competencies aligned with design thinking, positioning them to lead DT adoption and inspire educational change.

2.2 Innovation-Oriented School Management

Qualitative evidence revealed how administrators pursued innovation through both policy-level and instructional-level practices. The approaches used reflected strategic intent and contextual constraints, including resources, local culture, and staff capacity. Findings included:

Comparison of School Policies Across Contexts. Three distinctive management patterns emerged (see Table 5):

• *Urban and Suburban Schools* had structured, data-driven management supported by infrastructure and technology integration; emphasis on evidence-based planning, performance tracking, and systematic innovation.

• *Ethnic Minority Schools* demonstrated localized innovation aligned with community culture, moral values, and bilingual learning; creatively adapted goals to limited resources, leveraging family and cultural capital.

• *Remote Schools* focused on flexibility and survival-oriented strategies; relied on community support to sustain education despite scarce infrastructure. Innovation emphasized resilience, life skills, and local wisdom rather than technology.

These variations show that leadership intent interacts with contextual opportunities, making innovation less about formal policy and more about how administrators interpret and mobilize available resources.

Table 5 Comparison of School Policies and Management by Context

Key Aspects	Urban/Suburban	Ethnic Minority	Remote Schools
Main Goals	Holistic student development (academic, social, emotional).	Foster self-worth and cultural identity.	Build practical life and career skills.
Participation	External and community collaboration.	Strong family and community roles.	Community-driven, involving local leaders.
Resources	Sufficient support for tech and innovation.	Limited—depend on external funds.	Limited—require outside support and resource improvisation.
Management Plan	Data-based, tech-enhanced strategies.	Flexible to local language and culture.	Adapted to family and livelihood context.

Note: Based on qualitative data from twelve school administrators across three distinct school contexts

School Management and Instructional Innovations. Across contexts, innovation in management and teaching was shaped by school size, resource availability, and leadership adaptability (see Table 6).

• *Urban schools* prioritized academic excellence, 21st-century competencies, and moral education, also promoting technology integration and parental engagement as part of continuous improvement.

• *Suburban schools* pursued similar goals but faced teacher shortages and limited budgets. They strengthened PLCs, shared teaching resources, and partnered with local

communities to compensate.

• *Ethnic minority schools* focused on character formation, language development, and life skills. This relied on family participation and mobile classrooms with cross-cultural and language-responsive pedagogy.

• *Remote schools* emphasized a focus on life, vocational, and moral development. These schools also leveraged partnerships with universities and NGOs to fill resource gaps and integrate real-world projects tied to rural livelihoods.

Table 6 Summary of School Management and Instructional Innovations by Context

Context	Policy Focus	Management Innovations	Instructional Innovations
Group 1.1 Urban Schools	- Academic excellence - 21st-century skills - Moral development	- Integration of digital technologies - Promoted parental involvement	- Tech integrated, project based, interdisciplinary learning
Group 1.2 Suburban Schools	- Academic & moral development - 21st-century skills	- Teacher shortages addressed via external support - Built PLCs, strengthened community collaboration	- Used technology despite limitations - Integrated subject content
Group 2 Ethnic Minority Schools	- Character & moral education - Thai language skills - Life & vocational skills	- Mobile classrooms - Family & community collaboration - Additional funding	- Cross cultural pedagogy - Instructional media adapted to local language and culture
Group 3 Remote Schools	- Moral values - Practical life & vocational skills	- Strengthened PLCs - Universities partnerships - External funding	- Real world, integrated, project-based learning linked to rural context

Summary. Innovation-oriented management was strongly context-dependent but leadership-driven. Urban schools leveraged structure and technology; ethnic and remote schools relied on cultural grounding, community collaboration, and adaptability. Across all contexts, collaborative leadership and a supportive learning culture were the main drivers of innovation, setting the stage for insights into administrators' approaches to solving complex problems (discussed in the next section).

2.3 Problem-Solving Approaches

In-depth interviews explored: 1) Barriers and Innovative Approaches to DT Implementation, and 2) Challenges in Design Thinking-Based School Management.

Barriers and Innovative Approaches to DT Implementation. Common barriers across school contexts included limited resources, lack of training, and resistance to change. Some administrators addressed these creatively by restructuring leadership teams for collaboration, embedding DT into daily routines rather than separate programs, and partnering with communities to offset resource gaps. These context-sensitive strategies demonstrate adaptive leadership and highlight the importance of localizing DT practices.

Barriers VS Innovative Approaches	
Barriers	**Innovative Approaches**
▪ Limited resources	▪ Restructuring leadership teams
▪ Lack of training	▪ Embedding DT in dairy practices

Challenges in Design Thinking-Based School Management. Even when administrators intend to innovate, obstacles appear at each stage of the DT process, limiting full implementation and consistent outcomes.

Empathize. Administrators mainly collected basic student information, such as bio-data, academic results, and family background. Few actively explored students' perspectives or needs in depth. This limited view may have constrained their understanding of the full range of stakeholders' challenges.

Define. When defining problems, administrators often relied on their prior experience or existing policy structures, such as PLC requirements, rather than systematically analyzing evidence from students or teachers. Consequently, problem definitions tended to be broad and sometimes lacked focus for targeted solutions.

Ideate. Idea generation primarily came from administrators themselves, with limited input from teachers, community members, or external experts. In remote or resource-limited schools, this narrowed the diversity and variety of proposed approaches.

Prototype. Administrators encouraged teachers to experiment with new methods, but constraints such as rigid curricula, limited resources, and minimal guidance often restricted the scope of experimentation. Prototypes were usually partial and sometimes misaligned with actual student needs.

Test & Reflect. Testing and reflection occurred inconsistently. While some outcomes were noted, for example through PLC discussions, reflective practices were often brief and not systematic. Opportunities to iterate or refine approaches based on feedback were limited.

Leaders want to innovate, but DT clarity & confidence are limited		
Empathize	⟶	Lack of tools for deep insight
Define	⟶	Weak data analysis
Ideate	⟶	Limited to internal staff
Prototype	⟶	Rigid curriculum, no feedback
Test	⟶	Superficial reflection

Summary. The qualitative findings showed a clear pattern across the three analytical areas. Innovation-oriented administrators already possess key skills and learning habits aligned with design thinking (section 2.1), which helps them to lead schools toward innovation. However, how they manage innovation varies with context (section 2.2): urban schools leverage structure and technology, while ethnic and remote schools rely on culture, community, and adaptability. Despite their intentions, administrators face challenges at every step of the DT process (section 2.3). Limited understanding of students' actual needs, insufficient contextual data, internally-focused idea generation, and weak feedback and reflection loops, hinder deep, consistent implementation.

Together, the qualitative findings complement the survey results by providing deeper insight into administrators' practices, contextual challenges, and adaptive strategies. They show that while administrators often follow DT-like steps, gaps in knowledge, practice, and structured support limit their effectiveness. Recognizing these gaps provides a foundation for the action-oriented guidelines presented in Part 3.

Part 3: Action-Oriented Guidelines for Enhancing DT Attributes in Schools

Building upon the qualitative results described in Section 2.3, these guidelines translate key findings into actionable leadership practices for enhancing DT in schools. This section presents the proposed guidelines for promoting Design Thinking (DT) attributes and implementing DT practices in schools. The recommendations integrate both the quantitative and qualitative findings and are organized according to the first four stages of the DT process: Empathize, Define, Ideate, and Prototype. The Testing stage—implementing and evaluating the guidelines in real schools—was beyond the scope of this study. Instead, the guidelines were reviewed and validated by experts to ensure clarity, relevance, and practical usefulness. Future research should pilot these guidelines to assess their impact and strengthen evidence for DT in school leadership.

The presentation focuses on two aspects: (1) guidelines for developing DT attributes, and (2) guidelines for empowering DT implementation. Focus group discussions refined the recommendations for practical application in schools.

3.1 Guidelines for Developing DT Attributes

This section integrates the quantitative and qualitative findings to provide actionable steps for cultivating DT attributes among school leaders at each stage (Figure 2).

1) Empathize. School leaders generally have positive attitudes toward DT but limited conceptual understanding. Awareness alone does not ensure effective implementation. Empathy requires understanding actual needs and organizational challenges.

2) Define. Interest in DT does not automatically create practical skills. DT requires hands-on engagement and iterative problem definition. Leaders in smaller or remote schools may face challenges due to limited access to expertise or collaborative networks.

3) Ideate. Knowledge of DT structure alone is insufficient. Leaders must engage in ideation exercises that foster creativity, collaboration, and innovation. Four leadership characteristics—Natural Design Leaders, Experiential Learning, Network-Based Innovation, and Resourcefulness—inform actionable practices to enhance idea generation.

4) Prototype. To translate DT attributes into practice, five actionable guidelines are recommended:

1. Deepen Understanding of DT Concepts. Strengthen leaders' grasp of DT principles, fostering innovation, customer-centered problem-solving, and strategic thinking.

2. Promote Multiple Learning Pathways. Encourage diverse channels, including self-directed learning, peer collaboration, and professional networks. Peer exchange often benefits experienced leaders more than traditional workshops.

3. Clarify DT Principles for Beginners. Provide context-specific explanations to ensure foundational understanding before hands-on application.

4. Provide Hands-On Practice and Follow-Up Coaching. Offer practical workshops with tailored coaching and iterative feedback aligned with organizational contexts.

5. Align Capacity-Building with Supportive Policies and Resources. Integrate skill development with supportive policies, accessible resources, and practical tools for measurable and sustainable outcomes.

Figure 2 Guidelines for Developing Design Thinking Attributes among School Administrators

Integrated Insights from Quantitative and Qualitative Findings across DT Stages

Empathize

- Leaders have positive attitudes toward DT and are open to using it.
- But conceptual understanding is limited; most only "heard of" DT.

Define

POV:
School administrators interested in DT need practical skills and deeper understanding, especially in remote schools with limited support.

HMW:
How might we support school leaders in building practical DT skills and deeper understanding, particularly in remote contexts?

Challenge:
- Theory-heavy exposure
- Lack of experiential learning
- Resource constraints

Insights from Field Experiences:
- Focus first on clarifying DT concepts and linking them to real context.

Implication:
- Provide context-sensitive skill development and support systems

Note: The proposed guidelines have not yet undergone empirical testing and should be validated in future studies.

Ideate

Insights from Field Experiences:
- Natural Design Leaders → have innate creativity
- Experiential Learning → learning-by-doing aligns with DT
- Network-Based Innovation → collaboration drives new ideas
- Resourcefulness → innovation under constraints

Implication:
- Use these strengths to craft practical development guidelines in the next stage.

Prototype – Proposed Guidelines for Developing DT Attributes:

1. **Deepen Understanding of Design Thinking Concepts**
   Clarify DT concepts, build positive mindsets.
2. **Promote Multiple Learning Pathways**
   Self-directed learning, peer learning, professional networks.
3. **Clarify DT Principles for Beginners**
   Tailored sessions for leaders unfamiliar with DT.
4. **Provide Hands-On Practice and Follow-Up Coaching**
   Practice-focused, follow-up support, contextualized.
5. **Align Capacity-Building with Supportive Policies and Resources**
   Integrate with policy support, provide tools and materials.

3.2 Guidelines for Empowering the Implementation of DT in Schools

Implementing DT in school leadership goes beyond developing individual attributes. It requires translating understanding into practical actions supported by effective learning methods, policy backing, and contextualized training. The proposed guidelines help school administrators not only grasp DT concepts but also apply them as actionable strategies that drive systemic change, foster innovation, and embed a culture of continuous learning tailored to their school environments.

Interviews with twelve administrators revealed that school context strongly shapes DT implementation. Disadvantaged or resource-limited schools (e.g., S5 and S6 in rural areas) face structural barriers that restrict meaningful DT application. While government policies can address systemic issues, administrators must manage these constraints locally, often limiting their time, resources, and capacity for creative DT-based instructional and organizational innovation.

In many schools (e.g., S5, S6, and S11), PLCs were the main driver of innovation, while DT remains less visible due to unclear introduction or support. One administrator from S11 stated, *"I don't really know what Design Thinking is; I just set a PLC schedule every Monday so teachers can meet and share ideas."* Another from S12 noted, *"my teachers think innovation must be something technological that requires high-level skills, so they feel afraid to try."*

These examples reveal a common pattern: leaders can support collaboration, but often do not fully understand DT as a structured problem-solving process, so DT is not embedded in daily school practices. Closing this gap requires targeted strategies that build DT competencies and integrate DT systematically alongside PLC.

After focus group discussions, the strategies were refined based on participants' feedback. The final version includes seven practical strategies aimed at helping school leaders apply DT alongside PLC. Each strategy reflects real experiences and is designed to support leadership and learning in schools through context-based and sustainable approaches (see Table 7).

Table 7 Action-Focused Strategies for Promoting DT in Schools

Strategy	Evidence / Problem	Focus	DT Stage	How to Promote / Action Steps
1. Strengthening mindset & intrinsic motivation	Leaders and teachers are unfamiliar with DT and often confuse it with PLC.	Develop DT attributes among staff	Empathize	• Conduct workshops to show PLC as a collaboration base and DT's role in enhancing creativity • Peer discussions and reading/practice exercises • Network learning to integrate human-centered problem-solving into PLC
2. Developing leadership & capacity	Young or inexperienced leaders in remote schools have limited data use and limited problem-solving experience.	Develop DT attributes	Empathize	• Coaching on DT for data-informed problem-solving • Peer learning in context-based leader grps. • Reflect on small-scale projects to improve decisions
3. Creating participatory systems	Stakeholder engagement is limited; PLC remains internal-only, particularly in remote or under-resourced schools.	Promote DT implementation	Define	• Engage stakeholders to analyze the data-based needs of learners, teachers, and families • Use PLCs to co-define core problems grounded in evidence from learner–teacher–family data
4. Managing schools according to local needs	Leaders lack structured methods to analyze the local context; policy and resource constraints slow implementation.	Promote DT implementation	Ideate	• Bring in experts or external networks to co-create solutions that fit local needs • Align proposed ideas with available teacher capacity and school resources/budget • Collaborative planning to adapt solutions locally
5. Designing innovative solutions	Success depends on policy support and stakeholder readiness; PLC plays a critical role in idea testing.	Promote DT implementation	Ideate/ Prototype	• Facilitate structured ideation with experts to generate context-fit options • Prototype small-scale solutions that match teacher capacity and available resources • Provide a safe space for experimentation without fear of failure
6. Providing tools, resources, and technology	Remote schools face resource scarcity and teacher turnover, while urban schools are more ready.	Promote DT implementation	Implement /Test	• Provide practical tools and digital platforms • Train staff and allocate resources effectively for implementation • Monitor progress with simple data tracking
7. Building long-term systems	PLCs often focus on information exchange rather than improvement; reflection systems are weak and inconsistent.	Promote DT implementation	Sustain	• Establish regular reflection routines • Schedule "show & share" sessions • Use data systems for follow-up, monitoring, feedback, and continuous improvement

CONCLUSION AND DISCUSSION

This chapter discusses findings in three key areas: 1) DT attributes as the core driver of implementation, 2) Contextual and managerial factors influencing DT implementation, 3) Context-based challenges and opportunities for DT implementation, and 4) Strategic guidelines for enhancing DT attributes and organizational implementation.

1. DT Attributes as the Core Driver of Implementation

The findings revealed that school administrators demonstrated high levels of DT attributes overall (M = 4.44), particularly in attitudes and beliefs (M = 4.52), followed by acceptance (M = 4.49), and knowledge (M = 4.32). These results align with Rogers' (2003) innovation diffusion theory and Brown's (2009) design thinking principles, emphasizing that an open mindset and positive beliefs are prerequisites for innovation adoption. Administrators' readiness to adopt DT mirrors the entrepreneurial mindset found in business leaders who foster adaptive, user-centered innovation (Brown, 2009; Liedtka, 2015; Martin, 2009).

However, the slightly lower mean in DT knowledge suggests a gap between belief and systematic understanding, echoing Vonder Haar (2020), who highlighted that effective innovation requires a balance of mindset and conceptual depth. While attitudes reflect emotional readiness, implementation demands procedural literacy. From a business lens, this gap resembles firms where enthusiasm for innovation is high but strategic DT literacy is low, leading to inconsistent outcomes (Daymond & Knight, 2023).

Therefore, capacity-building programs for educational leaders should emphasize strategic design literacy, enabling administrators to apply DT frameworks (Empathize–Define–Ideate–Prototype–Test) in complex educational contexts (Blundell, 2022). Moreover, qualitative data indicated that administrators often practiced DT intuitively but lacked structured reflection, particularly in the Reflect stage—similar to business organizations where post-project learning is weak, limiting scalability of innovation (Kolko, 2015; Liedtka & Ogilvie, 2011).

2. Contextual and Managerial Factors Influencing DT Implementation

Regression analysis identified key factors influencing DT implementation, DT attitudes and beliefs, DT acceptance, and DT knowledge development, held significant explanatory power regarding the level of DT implementation (R^2 = .44, p < .001), while policy implementation, DT learning culture, and knowledge development, were strong explanatory variables of DT outcomes (R^2 = .446, p < .001). School context variables—size, type, and pilot status—showed significant moderating effects, particularly in small and remote schools where barriers were high due to limited resources and experience.

These findings align with Schein's (2010) concept of organizational culture and Darling-Hammond et al. (2017), who suggested that innovation flourishes in supportive systems. Qualitative insights revealed that schools with robust leadership, collaborative culture, and policy alignment achieved more consistent DT integration. In contrast, schools with fragmented management structures faced difficulties sustaining DT initiatives, paralleling corporate settings where leadership alignment and strategic commitment determine the success of design-led transformation (Elsbach & Stigliani, 2018; Hubbard & Datnow, 2020).

Managerial adaptability emerged as a mediating factor, with administrators acting as "*design leaders*" who integrated empathy-based management with evidence-informed decision-making, enabling contextualized problem-solving (Gallagher & Thordarson, 2018; Liedtka & Ogilvie, 2011).

3. Context-Based Challenges and Opportunities for DT Implementation

Context was found to have a strong influence on DT practice. *Urban and pilot schools* benefited from structured support, ICT infrastructure, and policy networks, which enabled more systematic DT implementation and observable innovation outcomes. These schools resembled innovation-driven firms using their organizational networks to support ongoing product and process innovation (Daymond & Knight, 2023; Teece, 2018).

Ethnic and remote schools faced contextual barriers—teacher shortages, limited resources, and rigid curricula—yet demonstrated localized creativity, integrating cultural values, community participation, and life-skill learning. Their approaches show how school administrators adapt to local contexts, using limited resources creatively to solve problems and support innovation (Blundell, 2022; Radjou & Prabhu, 2015).

Suburban and small schools faced time and resource constraints but strengthened collaboration through PLCs, showing how teamwork can help overcome limited resources (Boyce et al., 2010).

Qualitative evidence showed that the Prototype and Reflect stages were hardest to maintain due to rigid structures and limited feedback, similarly to Christensen (1997). Expanding the Educational Innovation Area Policy could provide support for experimental learning and iterative design within schools (Brown, 2009; Gallagher & Thordarson, 2018).

4. Strategic Guidelines for Enhancing DT Attributes and Organizational Implementation

Synthesizing the above findings, two strategic directions emerge for fostering sustainable DT practice in education.

Enhancing DT Attributes

Development efforts should focus on deepening knowledge and reflective capacity while reinforcing positive attitudes. DT learning programs should integrate experiential and collaborative learning, mirroring business innovation labs that combine creativity with strategy (Brown, 2009; IDEO, 2012). Administrators require opportunities to practice real-world design projects, fostering both leadership mindset and problem-solving capability.

Enhancing School-Level DT Implementation Capacity

Sustainable DT integration requires parallel capacity building for leaders and teachers. Leaders act as "*design leaders,*" orchestrating change and aligning DT with school vision and policy, while teachers act as "*design thinkers,*" translating DT into classroom innovation.

Context-sensitive approaches should be applied: urban/pilot schools focus on scaling and systemizing innovation; ethnic/remote schools emphasize partnerships with universities and local enterprises to create hybrid learning models and social innovation projects; small/suburban schools strengthen PLC-based ideation and cross-school collaboration networks.

From a business perspective, schools can be viewed as innovation ecosystems, where DT acts as an internal R&D process—turning local challenges into opportunities for value creation (Brown, 2009; Liedtka, 2015; Martin, 2009). Policy implications include expanding innovation zones, investing in leader training, and creating flexible funding mechanisms that empower schools to prototype educational solutions.

The study highlights that DT attributes form the foundation for leadership-driven innovation in schools. Effective implementation depends on contextual and managerial factors, especially policy alignment, learning culture, and leadership adaptability. Challenges in resource-constrained settings underscore the need for structural support and context-based design. Bridging insights from business innovation, education systems can enhance their adaptability, creativity, and sustainability by embedding DT as a strategic management approach—transforming schools into learning organizations that continually design better futures (Daymond & Knight, 2023; Liedtka & Ogilvie, 2011).

RECOMMENDATIONS

Based on the findings, this study offers actionable guidance in three key areas to support the development of Design Thinking (DT) attributes and the effective application of DT in schools: 1) Policy Recommendations – promoting system-level support and leadership standards, 2) Practical Recommendations – enhancing DT understanding and practice within schools, and 3) Future Research Recommendations – guiding studies to close implementation gaps and build capacity across diverse school contexts.

Policy Recommendations

The Ministry of Education should support school leaders in becoming "*design leaders*" who can drive meaningful improvements in learning, even within the constraints of small, rural, or resource-limited schools. These leaders operate much like leaders of small organizations that prioritize developing their people and staying responsive to new technologies in order to remain competitive. They rely on inquiry, experimentation, evidence-based decision-making, and collaboration across diverse roles to deliver improvements that fit their local context.

In practice, this means working with teachers and students to test innovative ideas, making decisions grounded in evidence, and coordinating teams across roles—similar to how a small enterprise invests in staff capability and mobilizes its team to create new solutions, even when operating with limited resources. To thrive in this role, school leaders must provide support that builds confidence and practical capability rather than imposing strict control. This includes flexible design thinking training, problem-solving-focused PLCs, and mentoring adapted to the school's specific challenges.

Structural barriers, such as teacher shortages, frequent transfers, or limited infrastructure, must also be addressed so that leaders can focus on improving learning rather than managing day-to-day crises. Frequent changes in school leadership also disrupt continuity, forcing administrators to repeatedly analyze and restart improvement efforts—unlike businesses, where strong leaders are usually retained—especially in disadvantaged schools, making it harder to sustain DT implementation over time.

At the system level, the Design Leaders framework can be translated into concrete, actionable policies. Leadership standards should include design-thinking competencies and local innovation as core skills, embedded in both induction and ongoing professional learning. Simple metrics—such as the frequency and outcomes of testing innovative approaches—can track progress. Combined with a broader Innovative Area program, these measures provide schools with the flexibility, guidance, and practical support needed to implement design leadership effectively, achieving tangible improvements in student learning and school performance.

Practical Recommendations

There is a need to find effective ways to promote DT understanding, as this influences how well DT is implemented in schools. Relevant agencies should provide resources, funding, and technical support to strengthen DT implementation, especially in primary and small schools where DT practices remain limited. At the school level, DT should be more than just a method—it should become a mindset embedded in both management and teaching. Schools should support experimentation, involve stakeholders, and create an environment with adequate resources and appropriate technologies. Similar to small organizations that enhance their competitiveness by developing staff capability and integrating practical, technology-responsive ways of working, true DT competence arises not from understanding the process, but from practicing it repeatedly, reflecting on real-world applications, and growing creative

confidence over time (Brown, 2009; Kelley & Kelley, 2013; Liedtka, 2015; Schweitzer et al., 2016). This will help scale DT in a sustainable and locally relevant way.

Future Research Recommendations

Future studies should explore how to develop design leadership among administrators and implement DT across different school types. Research should also examine the long-term impact of DT on teaching, learning, and school development, with a focus on narrowing the gap between awareness and actual practice—especially in disadvantaged contexts.

In addition, future research should investigate how to strengthen DT attributes in two key groups: school leaders, who guide change at the system level, and teachers, who design innovative and student-centered learning. It is important to determine whether these two groups require different forms of structure and support for DT development, so capability building can be more targeted and effective.

Importantly, studies should also consider how frequent leadership turnover in public schools affects DT implementation. Unlike businesses, where strong leaders are usually retained, many schools experience regular rotations that disrupt continuity, forcing administrators to repeatedly analyze and restart improvement efforts. Understanding how DT can remain consistent and sustainable under these conditions will provide valuable insights for long-term organizational development.

ETHICAL APPROVAL

This study was reviewed and approved by the Human Research Ethics Committee of Srinakharinwirot University based on the Declaration of Helsinki, Belmont Report, International Conference on Harmonization in Good Clinical Practice (ICH-GCP), and International Guidelines for Human Research, along with laws and regulations of Thailand. Protocol code: SWUEC-682040. Date of approval: 03/03/2025.

CONFLICT OF INTEREST

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Appendix

The ***Construct Validity*** of the design thinking attributes scale was examined using Exploratory Factor Analysis (EFA). The EFA revealed that the Bartlett's test of sphericity yielded a value of 1740.129 ($p < .000$), indicating that the correlation matrix significantly differed from the identity matrix. This result supports the Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy, which was .911—close to 1.00—suggesting that the observed indicators in the dataset were highly correlated and suitable for factor analysis. The EFA was conducted using the Principal Axis Factoring (PAF) extraction method and orthogonal rotation via the VARIMAX technique. The analysis, based on 15 observed indicators of the DT attributes, yielded three extracted components with eigenvalues of 7.679, 1.266, and 1.036, respectively. These components collectively accounted for 66.539% of the total variance. This result aligns with the standard EFA criteria, which require each retained component to have an eigenvalue greater than 1.00 and the total explained variance to be at least 60.00%. Furthermore, the intercorrelations among the observed indicators ranged from .242 to .780, with all pairs of variables showing statistically significant correlations at the .05 level.

Table A: Results of Confirmatory Factor Analysis after model revision

variables	Factor loading		p	R^2
	β	SE		
First-order confirmatory factor analysis				
Knowledge about the concepts and processes of design thinking				
1. Human development must be grounded in an understanding of the feelings of those being developed.	.644	.039	.000	.414
2. Identifying the problem (pain point) and its root causes is the starting point for developing innovation.	.705	.042	.000	.497
3. Generating new and out-of-the-box ideas requires input from individuals with diverse experiences.	.653	.038	.000	.426
4. Any change must begin with the courage to think, act, and experiment.	.849	.026	.000	.721
5. Evaluation-based information through constructive critique helps reflect strengths and weaknesses.	.827	.029	.000	.683
Attitudes and beliefs towards design thinking				
6. Effective school leadership requires understanding the working team and all stakeholders to foster collaboration.	.698	.045	.000	.487
7. Thorough analysis of problems and their causes lead to a deeper understanding of the factual issues.	.794	.035	.000	.630
8. Open conversations and active listening to diverse opinions lead to a variety of ideas.	.733	.041	.000	.538
9. Trying out new approaches promptly, even if they might not succeed, is essential.	.516	.053	.000	.266
10. Evaluation and reflection provide feedback that highlights both strengths and areas for improvement.	.741	.039	.000	.550
Acceptance of working using design thinking				
11. Policies are established to encourage teachers to use creative design thinking in their work development, reflection, and improvement.	.818	.031	.000	.669
12. There is a system for collecting data on teachers, students, and parents to analyze and understand real problems.	.755	.038	.000	.570
13. Parents, community members, and academics are invited to work collaboratively with teachers.	.635	.048	.000	.403
14. Teachers are supported in piloting innovations developed through creative design thinking.	.713	.042	.000	.508
15. Learning exchange and feedback from trials are encouraged for further reflection and improvement.	.826	.031	.000	.682
Second-order confirmatory factor analysis				
1. Knowledge about the concepts and processes of design thinking	.911	.032	.000	.829
2. Attitudes and beliefs towards design thinking	.952	.033	.000	.907
3. Acceptance of working using design thinking	.836	.037	.000	.699

χ^2 ($df = 78, N = 191$) $= 96.842, p = .0729, CFI = .989, TLI = .985, RMSEA = .036, SRMR = .035$

As shown in Table A, the results of the first-order confirmatory factor analysis indicated that the standardized factor loadings (β) of all items (indicators) were statistically significant at the .05 level, ranging from .516 to .849. In the second-order confirmatory factor

analysis, the standardized factor loadings (β) of the latent variables were also statistically significant at the .05 level, ranging from .836 to .952. The most influential latent variable was attitudes and beliefs towards design thinking, with a standardized loading of .952, followed by knowledge about the concepts and processes of design thinking (.911), and acceptance of working using design thinking (.836), respectively. Each component showed substantial shared variance with the overall DT attributes scale, with R^2 values ranging from 26.60% to 72.10%.

A confirmatory factor analysis (CFA) was conducted to examine the model fit of the DT attributes measurement model, which was theoretically constructed by the researcher based on the studiy's conceptual framework using second-order confirmatory factor analysis. The results indicated that the model demonstrated a good fit with the empirical data (χ^2 *(df* = 78, N = 191) = 96.842, *p* = .0729, *CF*I = .989, *TL*I = .985, *RMSEA* = .036, *SRMR* = .035). Specifically, the chi-square statistic (χ^2) was not statistically significant ($p > .05$), and the fit indices met the acceptable thresholds recommended by Hair et al. (2019): *CF*I $\geq$ .90, *TLI* $\geq$ .90, *RMSEA* < .07, and *SRMR* < .08. These results confirm that the hypothesized model based on the research framework fits the empirical data well.