Which Aspects of Leadership Are Associated with a Trustful Use of Bim and Other Digital Technologies in Construction?

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Posted Date: 31 March 2025

doi: 10.20944/preprints202503.2299.v1

Keywords: Digital transformation; Digital work systems; BIM; AI; Trust; Leadership; COPSOQ III; Leadership

Article

Which Aspects of Leadership Are Associated with a Trustful Use of BIM and Other Digital Technologies in Construction?

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Abstract: The AEC industry is currently undergoing a digital transformation, and leadership and trust are considered important factors in the successful use of digital work systems within organizations. There are indications that certain leadership qualities can promote a Trustful use of digital work systems, however, there is limited research on what these specific characteristics are. Therefore, it was of interest to investigate which aspects of leadership specifically promote the trustful use of digital technologies. The purpose of this study was to investigate which aspects of leadership are associated with Trustful use of digital work systems. An online survey was completed by 314 experts from various fields of expertise at Sweden's largest infrastructure owner. The main findings showed that the most important factors for the Trustful use of digital work systems were Role clarity and Digital literacy of the management team. Based on the results, it is recommended that the construction industry educate management teams at all levels of the organizational hierarchy about what digital transformation entails in terms of new technologies, changing ways of working and roles. This will make it easier for managers and leaders to support employees by clarifying their roles and responsibilities in a complex organization.

Keywords: digital transformation; digital work systems; BIM; AI; trust; leadership; COPSOQ III

1. Introduction

The AEC (architecture, engineering, and construction) industry is undergoing a digital transformation [1], which involves a comprehensive change process enabled by the innovative use of digital technologies [2], where organizations integrate digital technologies into all aspects of their business. It has been described that digital transformation is not only about upgrading technology but also about developing ways of working and skills and creating a culture that adapts to the digital age. Motivated goals for organizations to engage in digital transformation have been framed as improving business efficiency, creating new value, and meeting changing customer needs [2], making organizations more competitive, efficient, and adaptable in a rapidly changing world [3]. Research suggests that a key to achieving digital transformation with the intended positive outcomes is a systems approach to implementing new technologies, including organizational support for individual employees to accept and learn to trust and use new technologies [4]. To achieve this, previous research points to the importance of organizational change management, including providing clear goals, processes, and ways of working, but also creating a culture that integrates digital technology [5–7]. In particular, leadership from a more human-centered perspective that encourages a holistic understanding of digital development and creates an organizational culture of trust is positively related to user acceptance and adoption of new technologies such as BIM (building information modeling), robotics, and AI (artificial intelligence) [8–11]. Overall, leadership has emerged as one of the most important factors for successfully implementing digital work processes

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[12,13]. In this paper, we focus on leadership that promotes employee trust in and use of digital work systems.

There are established and common core leadership qualities that overall have been shown to promote trust and development in AEC-organizations. These core leadership qualities include ensuring that employees have good development opportunities, effective work planning, and decisiveness, i.e., making timely and firm decisions, even under pressure and when dealing with conflict [14–16]. Research has furthermore pointed out specific leadership traits that support a digital transformation. Haroon et al. [17] point to the importance of leaders' growth mindset, i.e., the ability to view failure as a learning experience, to believe that all people can develop their ability to do new things, to accept new challenges, to use feedback, and to provide timely feedback to subordinates. Furthermore, the interplay between trust and the ability of leaders to promote role clarity seems to be important in digital transformation processes. Research suggests that clear definitions of roles and responsibilities, combined with strong management support, can increase trust, which in turn fosters effective collaboration and contributes to the success of digital initiatives [8,18,19].

In general, research suggests that leadership can promote learning and employee confidence in achieving goals through the ability to provide social support and empathize with people's feelings when needed [20], as well as fostering open communication by speaking clearly, listening actively, and showing empathy, i.e., listening, helping, and supporting when problems arise [21–24]. As an example, according to Omer et al. [13], pro-social behavior can be beneficial in managing construction teams that intend to implement BIM. Examples of such behavior could include a sense of concern and care for others, being open-minded and receptive to opinions, being tolerant and patient, and understanding [13]. Omer et al. [13] conclude that such leadership strategies promote a constructive digital culture in construction projects including followers who can better cope with stress and difficulties.

Leadership is also identified as a key factor in shaping a culture based on the trustful use of digital technology in the AEC industry, which is essential for the successful digitalization of an organization. A lack of trust is an obstacle for an organization that intends to adopt digital technologies and work systems [13,25,26]. While digital tools and processes have the potential to transform project organization and execution, trust issues arise due to a lack of understanding and misinterpretation of the technology among team members. This can lead to mistrust and hinder project success [27]. In contrast, an organization characterized by digital trust can foster innovation [28,29], facilitate team collaboration, and enhance the decision-making process during a construction project [25]. In line with this, for successful digital transformation, Haroon et al. [17] specifically mention honesty, humility, and courage as critical leadership behaviors. In general, trustworthiness, ethical behavior [30], and integrity are important leadership qualities that build trust and ensure that followers believe in the leader's decisions and actions [31]. The development of employees' trust in and willingness to adopt new digital work systems can also be seen as a dynamic process in which a general and reciprocal climate of trust and support between leaders and employees creates psychological safety, which in turn can promote innovation and adaptation to new ways of working in knowledge-intensive sectors [32]. Vertical trust is defined in this paper as trust between leaders and employees within an organization, including mutual norms of social reciprocity and recognition, which research has shown to promote engagement in developmental work [33], and innovation within a work organization [34].

Moreover, leadership in digitally transforming organizations appears to require additional characteristics beyond traditional leadership characteristics [29]. Although many core leadership skills remain the same, the unique demands of digital disruption also require some new skills [3]. The management team needs digital literacy, i.e., the necessary competencies to implement a digital strategy and digital development, and these competencies include specific behaviors and characteristics rather than just technical skills and a business orientation [29].

In summary, the AEC industry is currently undergoing a digital transformation, and research shows that leadership and trust are important factors for successful digital transformation. There are

 doi:10.20944/preprints202503.2299.v1

indications that certain leadership qualities can promote a trustful use of digital work systems, however, there is limited research on what these specific characteristics are. Therefore, it is of interest to investigate which aspects of leadership specifically promote the trustful use of digital technologies. The purpose of this study was to investigate which aspects of leadership (digital literacy of the management team, general leadership qualities, vertical trust, role clarity, and social support from the supervisor) are associated with trustful use of digital work systems.

2. Materials and Methods

A quantitative research design was applied, including an online questionnaire survey targeting employees in the construction industry.

2.1. Context and Participants

A single-stage sampling method was used for this study. Participants were employed in the same department at Sweden's largest infrastructure owner, the Swedish Transport Administration (STA), and had expertise in one of five different areas: construction, design, digital information management, environment, or technical systems. This selection of groups was considered valuable for the study because the organization is currently in the preliminary stages of adopting building information modeling (BIM), artificial intelligence (AI), and automation. In addition, these professionals are expected to incorporate digital work practices into their routine tasks in the near future.

The organization was selected for its significant role in establishing standards within the Swedish construction industry. Due to its considerable size and complex nature, this organization encapsulates a wide range of viewpoints on digital advancements and applications within the Swedish construction industry. In addition, the experts involved in this research came from different professional fields, each bringing unique experiences, methodologies, and levels of proficiency in the use of digital work.

2.2. Data Collection

A total of 746 individuals received an email with a link to an online survey. Of the 339 responses received, 25 were identified as incomplete, resulting in 314 valid responses for analysis. Table 1 shows the distribution of invited experts along with the number of respondents within each expert category. The questionnaire was developed and administered using SurveyMonkey, following the data collection methodology outlined by Creswell and Creswell [35]. The first communication consisted of a brief pre-announcement, which was sent to all participants by the department heads. The second email contained both the formal invitation and the survey link. Three weeks later, a reminder email was sent to all individuals who had not yet responded.

The invitation was sent to 746 individuals, with one email returned as undeliverable and two participants declining to participate. A total of 314 responses were collected, resulting in a response rate of 42%. A detailed description of the sample is provided in Table 2.

Table 1. Distribution of respondents in each expert area, numbers of respondents, and numbers of invited experts.

Expert Area	Employees	Total Number of Invited Experts
Constructions	61	156
Design	49	142
Digital information management	84	160
Environment	70	170
Technical systems	50	118
Number of respondents included for analysis	**314**	**746**

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Table 2. Demographics of respondents.

	Category	N.	≈ %
Gender	Woman	115	37
	Man	198	63
	Other/do not wish to specify	1	<1
Age	< 30	10	3
	30-39	57	18
	40-49	84	27
	50-59	103	33
	> 60	48	15
	No response	12	4
Experience in current job skills	Less than 1 year	34	11
	1–2 years	30	10
	3–5 years	70	22
	6–10 years	73	23
	More than 10 years	106	34
	No response	1	<1
Experience of work in digital work systems	Less than 1 year	55	17
	1–2 years	34	11
	3–5 years	78	25
	6–10 years	53	17
	More than 10 years	37	12
	No response	57	18

2.3. Ethics

Ethical approval was obtained from the Swedish Ethical Review Board (2023-03239-01) prior to initiating the study and distributing the questionnaires. In addition to the e-mail correspondence, participants received an information sheet detailing the objectives of the study, the handling of personal data, and the voluntary nature of their participation. Consent was implied by the completion and submission of the questionnaire, with the option to withdraw at any time without giving reasons.

2.4. Questionnaire

A questionnaire survey with approximately 50 questions covering a range of topics related to digital transformation, digital work systems, organizational and social factors including leadership was sent to the study population in November 2023. The outcome variable was formulated as a single question: I trust and use our digital work systems, to examine overall trust in digital work systems within the organization. A single question was also chosen to measure the first explanatory variable, our management team has the necessary skills to implement a digital strategy and develop a digital business, in order to get an idea of how respondents perceived the digital literacy of the management team. The 5-point Likert scale consisting of the following items was used for single items: (1) To a very small extent; (2) To a small extent; (3) Somewhat; (4) To a large extent; (5) To a very large extent.

COPSOQ III provides reliable and distinct measures of a wide range of psychosocial dimensions of modern working life [36], and the Swedish validated version of COPSOQ III used in this study has good psychometric properties for its intended use [37]. The questionnaire included four indices from the Copenhagen Psychosocial Questionnaire (COPSOQ III) were selected as explanatory variables: Role clarity - the extent to which there are clear objectives, responsibilities and expectations for the individual role, Vertical trust - perceived trust between leaders and employees, Social support from managers - perceived help and support from superiors when needed, and Leadership quality - how well supervisors plan work, resolve conflicts, and provide development opportunities. The 5-point Likert scale was used, consisting of the following items: (1) strongly disagree; (2) strongly disagree; (3) neither agree nor disagree; (4) agree; (5) strongly agree. See Table 3 for questions.

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Table 3. Survey question per index.

Variable type	Variables	Source Questionnaire
Outcome variable	**Trustful use of digital work systems**	**Single item**
	I trust and use our digital work systems	
Explanatory Variable	**Digital literacy of the management team**	**Single item**
	Our management team has the necessary skills to implement a digital strategy and to develop a digital business	
Explanatory variable	**Role clarity**	**COPSOQ**
	Does your work have clear objectives? Do you know exactly which areas are your responsibility? Do you know exactly what is expected of you at work?	
Explanatory Variable	**Vertical trust**	**COPSOQ**
	Does the management trust the employees to do their work well? Can the employees trust the information that comes from the management? Are the employees able to express their views and feelings?	
Explanatory Variable	**Social support from supervisor**	**COPSOQ**
	How often is your immediate superior willing to listen to your problems at work, if needed? How often do you get help and support from your immediate superior, if needed?	
Explanatory Variable	**Leadership quality**	**COPSOQ**
	To what extent would you say that your immediate superior makes sure that the members of staff have good development opportunities? To what extent would you say that your immediate superior is good at work planning? To what extent would you say that your immediate superior is good at solving conflicts?	

Cronbach's alpha was tested for all indices. The number and percentage of valid responses, as well as Cronbach's alpha and the number of questions per index, are shown in Table 4.

Table 4. Number and percentage of valid responses, number of items and Cronbach's alpha per index.

Index	Valid N	%	N of Items	Cronbach's Alpha
Role clarity	305	90	3	0.813
Vertical trust	302	96	3	0.765
Social support from supervisor	298	95	2	0.805
Leadership quality	294	94	3	0.848

2.5. Analysis

A multiple linear regression analysis was performed to determine the variables significantly associated with Trustful use of digital work systems. A threshold p-value of less than 0.05 was used

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to indicate statistical significance. Before the regression analysis, normal distribution and multicollinearity assessments were performed for each variable.

First, a correlation analysis was performed to analyze the associations between the explanatory variables (i.e., the indices) and the outcome, Trust in digital work systems, as shown in Table 5. A backward elimination procedure was then applied within the framework of multiple linear regression. In the initial model (Model 1, Table 6), variables with significant correlations were included. Variables were systematically removed until the remaining variables reached statistical significance.

Table 5. The indices' correlations with use and trust of digital systems.

Index	Correlation with Trustful Use of Digital Systems
Digital literacy of the management team	0.395**
Role clarity	0.378**
Vertical Trust	0.301**
Social Support from Supervisor	0.176**
Leadership Quality	0.145*

*. Correlation is significant at the 0.05 level. **. Correlation is significant at the 0.01 level.

Table 6. Regression results. Unstandardized B-Coefficients. Standard errors in parentheses.

	Model 1	Model 2	Model 3	Model 4
Constant	0.784 (0.418)	0.773 (0.413)	0.810 (0.397)	1.293** (0.298)
Digital literacy of the management team	0.257** (0.061)	0.253** (0.060)	0.230** (0.059)	0.257** (0.057)
Role clarity	0.320** (0.093)	0.320** (0.092)	0.321** (0.091)	0.374** (0.087)
Vertical trust	0.188 (0.111)	0.168 (0.108)	0.187 (0.101)	
Social Support from Supervisor	0.049 (0.092)	0.009 (0.074)		
Leadership quality	-0.075 (0.113)			
R Square	0.266	0.261	0.247	0,234
Adjusted R Square	0.246	0.246	0.236	0.226
Number of observations	193	195	199	200

*. Correlation is significant at the 0.05 level. **. Correlation is significant at the 0.01 level.

To further explore additional factors associated with Trustful use of digital work systems, potential confounding variables such as age, gender, discipline, familiarity with current job responsibilities, and experience with digital work systems were controlled for

3. Results

The first step in the analysis was to determine which variables were associated with the outcome variable, and all indices, Digital literacy of the management team, Leadership Quality, Social Support from Supervisor, Vertical Trust, and Role clarity were found to be associated with Trustful use of digital systems (Table 5).

In the second step of the analysis, the backward multiple linear regression was performed. This resulted in three models (1-4), see Table 6. Across all models tested, *Digital literacy of the management team* and *Role clarity* were found to have a statistically significant association with *Trustful use of digital systems*. *Leadership quality*, *Social Support from Supervisor*, and *Vertical trust* showed no significant associations with *Trustful use of digital systems* (models 1-4).

All models (1-4) explained approximately 20% of the variance of *Trustful use of digital systems*.

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Finally, to better understand if potential confounding factors - *age, gender, area of expertise, experience with current tasks, and experience with digital work systems* - influenced the results, they were analyzed as a last step in the analysis. Of the potential confounders controlled for, none of them was found to be significant.

4. Discussion

This study aimed to investigate which aspects of leadership (Digital literacy of the management team, General leadership qualities, Vertical trust, Role clarity, and Social support from the supervisor) were associated with the outcome Trustful use of digital work systems. Previous studies have examined the importance of leadership for digital transformation in general and the Trustful use of digital work systems specifically, but to our knowledge, no study has focused on which leadership characteristics are of most importance for the Trustful use of digital work systems in the construction industry. All variables showed unilateral correlations with the outcome, while the results from the multiple linear regression analysis in this study showed that Digital literacy of the management team and Role clarity were statistically significantly associated with the outcome, while Vertical Trust, Social Support from Supervisor and Leadership Quality were not. None of the potential confounders controlled for (age, gender, area of expertise, experience with current tasks, and experience with digital work systems) were found to have any influence on the associations between Trustful use of digital work systems and explanatory variables (Digital literacy of the management team and Role clarity).

Vertical trust (perceived trust between leaders and employees), *Social support from managers* (perceived help and support from superiors when needed), and *Leadership quality* (how well supervisors plan work, resolve conflicts, and provide development opportunities), showed only significant associations with *Trustful use of digital work systems* in the unilateral correlations. While these aspects of leadership are generally important, our findings suggest that other additional aspects accompany digital transformation. Several leadership qualities have been identified in previous research as beneficial for successful digital transformation, for example, a change-oriented mindset [3], forward-looking, experimental, and innovative thinking [38]. In addition to these future-oriented characteristics, softer characteristics such as transparent communication, tolerance, engagement, being ethical, trust-building, inspiring, self-awareness, and role modeling [13,29,39–42]. This study contributes to the list of important leadership characteristics by highlighting the importance of the ability to develop role clarity and digital literacy. Depending on the context, certain traits may be more important in building trust in digital technologies; however, in this study, we focus on which specific leadership characteristics may contribute to employee trust in the use of digital work systems in the AEC industry.

Previous research identified *Role clarity* as critical to building trust in professional settings, as it reduces uncertainty and increases commitment and innovativeness. The connection between *Role clarity* and trust emphasizes the necessity for organizations to establish clear roles to cultivate a trustful environment within the workplace [43–45]. As the results of our study show, *Role clarity* is also an important factor in the development of trust in digital tools. By providing users with a transparent understanding of their responsibilities and the capabilities of the tools at their disposal, *Role clarity* can increase user trust and participation in digital environments and capability to adapt [46–48]. *Role clarity* was the factor that was consistently found to be most strongly associated with *Trustful use of digital work systems* in this study, and the results suggest that addressing issues around clear role descriptions and ensuring that employees understand their responsibilities can significantly improve the industry's ability to adapt to digital transformation. This suggests the importance for large and complex organizations of clarifying digital strategies and goals, as well as the responsibilities associated with different roles, as more digital work systems are implemented.

In line with Khamiliyah et al. [49], the results of this study suggest that the digital literacy of management teams is essential for fostering a culture of trust in the context of digital transformation initiatives. The results may be explained by the fact that the perception that the management team

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does not have the necessary skills also implies distrust in management's strategies for digitalization, including distrust in the digital work systems chosen by the organization. Furthermore, members of the management team can also be seen as important role models [29] for leading the way in the use of digital work systems, and digital literacy can be seen as an important aspect of being able to be such a role model.

By creating an environment that fosters digital skills and knowledge in management teams, organizations appear to be able to increase employee trust and thus facilitate the adoption and use of digital work systems. Just as employees need development opportunities and training in new digital work systems, it may be necessary to improve the digital skills of management teams, for example through targeted training, fostering a culture of continuous learning, and maintaining the adaptability of training strategies.

Method Discussion

The survey is largely based on indices from a validated survey instrument. However, there are two single-item questions included. The use of single-item measures, Trustful use of digital work systems and Digital literacy of the management team, has both advantages and disadvantages. As Allen et al. [50] point out, arguments against single item measures include that reliability of single-item measures is simply unknown in most cases. On the other hand, they can be beneficial by reducing respondent effort and thus respondent frustration [50], which in turn should promote reliability. According to Bergkvist and Rossiter [51], the predictive validity between multiple and single-item measures is equivalent.

To be noted is that the analysis models explained the variance of the outcome to a more limited extent ($r2 = 0.23–0.27$), which suggests that there are other explanatory factors in addition to the study's included leadership characteristics that are important for the outcomes. For example, factors such as perceived value of digitization, user attitudes, usability of digital work systems, and communication and collaboration within construction project teams could also influence Trustful use of digital work systems [4].

The response rate of 42% can be considered low, but still normal for online surveys. According to Wu et al [52], the typical response rate for online surveys is around 44.1%.

Although the survey was conducted within one organization, the results can still be considered representative due to STA's large and complex organization, which includes experts with diverse backgrounds, experiences, and areas of work.

5. Conclusions

This study examines leadership characteristics that benefit organizations in the AEC industry undergoing digital transformation and specifically addresses leadership characteristics that are associated with the Trustful use of digital work systems. The result points out the specific importance of Role clarity and Digital literacy of the management team for the outcome. Role clarity, including identifying clear roles and responsibilities, emerged as the most important factor for the Trustful use of digital work systems. The results indicate that by eliminating ambiguity in job descriptions and ensuring that employees understand their roles, organizations can improve their ability to navigate digital transformation. This underscores the need for large and complex organizations to clarify their digital strategies and goals, along with the associated responsibilities of different roles, especially as the implementation of digital work systems expands. The importance of Digital literacy of the management team for the Trustful use of digital work systems points at the need of managers to develop specific skills and knowledge on how to lead a digital transformation. Members of management teams serve as important role models, exemplifying leadership in the implementation of digital work systems, and digital literacy can be regarded as a crucial element of this role modeling.

This study focuses primarily on the perspective of experts on trust in digital transformation. However, there is scope for future research to include leaders' perspectives to explore their potential as role models in the digital transformation of the construction industry.

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Organizations that want to create a culture of trust in digital transformation should adopt a systems perspective, of which leadership is an integral part. In addition, ambiguity and lack of purpose and direction should be addressed through deliberate implementation strategies that are embedded throughout the organization. Based on the results of this study, it is recommended that the construction industry educate management teams at all levels of the organizational hierarchy about what digital transformation entails in terms of new technologies, changing ways of working and roles. This will make it easier for managers and leaders to support employees by clarifying their roles and responsibilities in a complex organization.

Author Contributions: Conceptualization, KOH. and AE.; methodology, KOH, AE and MF.; validation, KOH., AE. and MF.; formal analysis, KOH.; investigation, KOH, AE and MF.; resources, KOH.; data curation, KOH.; writing—original draft preparation, KOH and AE.; writing—review and editing, AE and MF.; visualization, KOH.; supervision, AE.; project administration, KOH.; funding acquisition, KOH. All authors have read and agreed to the published version of the manuscript.

Funding: The Swedish Transport Administration (Trafikverket) funded this work.

Data Availability Statement: The data that support the findings of this study are available from the corresponding author, Katarina Olofsson Hallén, upon reasonable request.

Conflicts of Interest: The funder had no role in the design of the study; in the collection, analyses, or interpretation of data; in the writing of the manuscript; or in the decision to publish the results.

Abbreviations

The following abbreviations are used in this manuscript:

AEC	Architecture, engineering, and construction
BIM	Building information modeling
AI	Artificial intelligence
STA	Swedish Transport Administration
COPSOQ III	Copenhagen Psychosocial Questionnaire

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