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Md Faisal Alam Khan

**Evaluating Project Management Information System  
Applications and Success Factors in Construction  
Industries of Emerging Economies: A DeLone and  
McLean Success Model Approach**

A Survey Based Study

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**UNIVERSITY OF VAASA****School of Technology and Innovations**

**Author:** Md Faisal Alam Khan  
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**Abstract:**

In emerging economies, there is a lack of construction infrastructure, but for socio-economic advancement, infrastructure development, and economic expansion, the construction sector plays a critical role. This sector experiences a few difficulties in running its project smoothly, which include financial deficit or delay, resource shortage, corruption, and transparency issues. Project Management Information Systems (PMIS) help decision makers in emerging economies to enhance efficiency in project management through improved information systems. The main purpose of this research is to determine the factors that lead to the success of PMIS in the construction sector, especially in emerging economies. For this purpose, a slightly modified DeLone & McLean Information System Success model (DML-INSSM) has been developed. Then, survey questionnaires were developed for all six constructs of DML-INSSM with the help of the previous literature regarding the PMIS of construction projects. Data has been collected for several months from personnel involved in construction projects who frequently use PMIS. After the collection of the data, it was evaluated by several statistical factors, like standard deviation, skewness, and kurtosis. Overall, the results demonstrate that all constructs' variability is well within the permissible range. From the survey results, it is evident that the highest positively rated constructs are information quality, user satisfaction, and system quality. After that, the reliability of the data has been examined by measuring the values of Cronbach's alpha (CA), composite reliability (CR), and validity of the model has been verified by average variance extracted (AVE). Also, the loading factor for each factor is cross-examined against the standard values. Results indicate that the overall data have satisfied all those criteria. Finally, using the data, Hypothesis testing can be employed to develop the DML-INSSM model. From hypothesis testing, it is proven that, use construct of the DML-INSSM has a strong positive impact on the user satisfaction of the PMIS. So, the DML-INSSM has been successfully able to determine the success factor in emerging economies.

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**KEYWORDS:** DML-INSSM, Construction Industry, PMIS, Emerging Economy, Online Survey, PLS-SEM, SmartPLS 4.0, Hypothesis Testing, Success Factors

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## **Abbreviations**

**PMIS-** Project Management Information Systems

**DML-INSSM** - DeLone & McLean Information Systems Success Model

**PLS-SEM-** Partial Least Squares Structural Equation Modeling

**CSF-** Critical Success Factor

**SYSQ-** System Quality

**INFQ-** Information Quality

**SERQ-** Service Quality

**U-** System Use

**NB-** Net Benefit

**USAT-** User Satisfaction

**EMGT-** Effective Management

**CA-** Cronbach's Alpha

**CR-** Composite Reliability

**AVE-** Average Variance Extracted

# 1 Introduction

## 1.1 Research Background of the Thesis

Emerging economies are those countries that have rapid economic growth and a low level of income, but are transitioning from a low to a high level of income (Hoskisson et al., 2000). These rapidly growing and developing countries can enhance their urbanization advancement through the construction industry, which serves as their primary mechanism for economic growth and infrastructure development. The requirements for construction industries often are that the projects must be cost and time-efficient with high quality, implying a robust method for scheduling process planning, coordinating, and controlling the resources (Shehu et al., 2014). So, this is a very complex and multi-modal activity for which there is an extraordinary need for ways of communicating effectively, ways of making good decisions, and coordination of the various stakeholders, such as contractors, subcontractors, architects, and clients (S.-K. Lee & Yu, 2012).

Projects face extensive management issues, coordination problems, and workflow fragmentation because of old-fashioned planning approaches, which cause project delays as well as budget overruns and poor efficiency. The cause of these problems mainly lies in the inadequate use of project management practices, a lack of relevant technological solutions, and a lack of the ability to consolidate data from different parts of the project (Son et al., 2016). The success of modern project execution requires Project Management Information Systems (PMIS) to address these difficulties. PMIS supports efficient resource management that results in better cost management features while making the construction sector easier to understand and more effective. The data coming into PMIS are tools used for data processing, especially for project planning, scheduling, risk management, and communication between projects (Chung et al., 2009).

The DML-INSSM is applied to address the challenges of evaluating PMIS success. This model, introduced in 1992 and updated in 2003, is a very well-known framework to assess information system success in different contexts. The model comprises of six fundamental elements, which

include information quality (INFQ), service quality (SERQ), system use (U), user satisfaction (USAT), perceived net benefits (NBs), and system quality (SYSQ). It suggests that an effective information system must be technically accurate to satisfy user needs and enhance organizational performance. (Delone & McLean, 2003).

This model is very helpful regarding construction as it provides the opportunity to assess PMIS as a whole (from a technical viewpoint), combined with an evaluation of the users' side (expressed in terms such as satisfaction, perceived benefits, and so on). The application of the DML-INSSM can lead to the identification of the factors for PMIS success in the construction industries of emerging economies, as well as to the barriers preventing their successful adoption (Bernroider, 2008).

This study addresses a gap in research on information systems success in emerging economies' construction sectors by considering specifically its implementation in these sectors. Consequently, the research attempts to evaluate the benefits of PMIS for project success in emerging economies using PLS-SEM.

## **1.2 Research Questions**

There are a total of three key research questions in this thesis:

RQ1. What are the vital success factors for the achievement of PMIS success in the construction industry?

RQ2. How do system quality, service quality, and information quality affect the overall success of the PMIS?

RQ3. Does Project Management Information System usage influence users' satisfaction?

### **1.3 Contribution of this Study**

The research provides detailed insights about which factors contribute to PMIS success within the construction field of emerging economies. The study will also advance on the traditional PMIS usage metrics by examining how the usage of PMIS leads to user satisfaction. Lastly, the study provides a customised implementation framework to overcome the bottlenecks of construction projects in emerging markets, and strategic recommendations on better adapting, engaging users, and improving the project outcomes.

### **1.4 Structure of the Thesis**

The study aims to determine the most crucial success factors of PMIS in the developing country's infrastructure sector. The second chapter reviews existing research on the six constructs of DML-INSSM, the applicability of this model, the role of PMIS in the building industry, as well as the suggested framework for this study. Preparation of questionnaires for each of the constructs, data gathering methods and the statistical tools for evaluation are presented in the research methodology chapter. In the results segment, evaluation of the data and hypothesis testing are performed using SmartPLS 4.0. Finally, the research concludes with the justification of the research objectives by the obtained data and further scope to expand this research is explained briefly.

### **1.5 Research Gap**

Previously, research has been done to evaluate the PMIS success factors using the DML-INSSM. However, very little research has been done regarding construction companies in emerging economies. So, this is considered as the research gap.

## **2 Literature Review**

In this segment, previous works regarding the key constructs of the DML-INSSM and its applicability will be studied. In the later portion of this chapter, the importance of PMIS and the elements supporting its success in construction projects will also be reviewed.

### **2.1 DML-INSSM**

DML-INSSM, introduced in 1992, is now the most widely referenced framework for evaluating information system success. The model suggests six elements of success – SYSQ, INFQ, SERQ, U, USAT, NB. Many researchers have over the years applied, tested, refined and extended the model in different IS contexts to develop a large body of research.

#### **2.1.1 Core Components of the DML-INSSM**

SYSQ denotes the technical attributes of the system, such as its trustworthiness, ease of use, and functionality. Some studies underline that system quality influences the effectiveness of U and USAT because it directly affects how users perceive and interact with the system (Delone & McLean, 2003).

INFQ signifies the relevance, precision and timeliness of the information generated by the system. Quality information can positively influence U and USAT (Delone & McLean, 2003). So, this dimension is often found to be positively related with USAT for different areas (Petter et al., 2008).

SERQ includes both technological and operational assistance to system users. For instance, in the case of online learning systems, Lin (2007) had done the research that service quality influences USAT, especially in situations where support is key for fine U (Lin, 2007).

The two dimensions of U and USAT are closely connected. U denotes the extent to which the system is utilized and user satisfaction denotes users' attitude toward the system. Both have been shown to be impacted by SYSQ, INFQ, and SERQ as well as have reciprocal impacts (Petter et al., 2008).

NBs are an attempt to quantify the improvement of the system efficiency, productivity and organizational effectiveness. NBs have been proven to be an important IS success outcome since systems with high net benefits were found to have a greater likelihood of maintaining long term use and satisfaction (Ojo, 2017).

### **2.1.2 Validation of DML-INSSM**

(Seddon, 1997) introduced a model through temporal and causal analysis of the elements and refined understanding of dimension relationships. In 2003, the original model was significantly extended with service quality integration into the core dimensions. Subsequently, these extensions have been validated in studies conducted in different IS environments. (DeLone & McLean, 2004) stated the need to evaluate all aspects of the success model to achieve a comprehensive view of the performance of e-commerce systems.

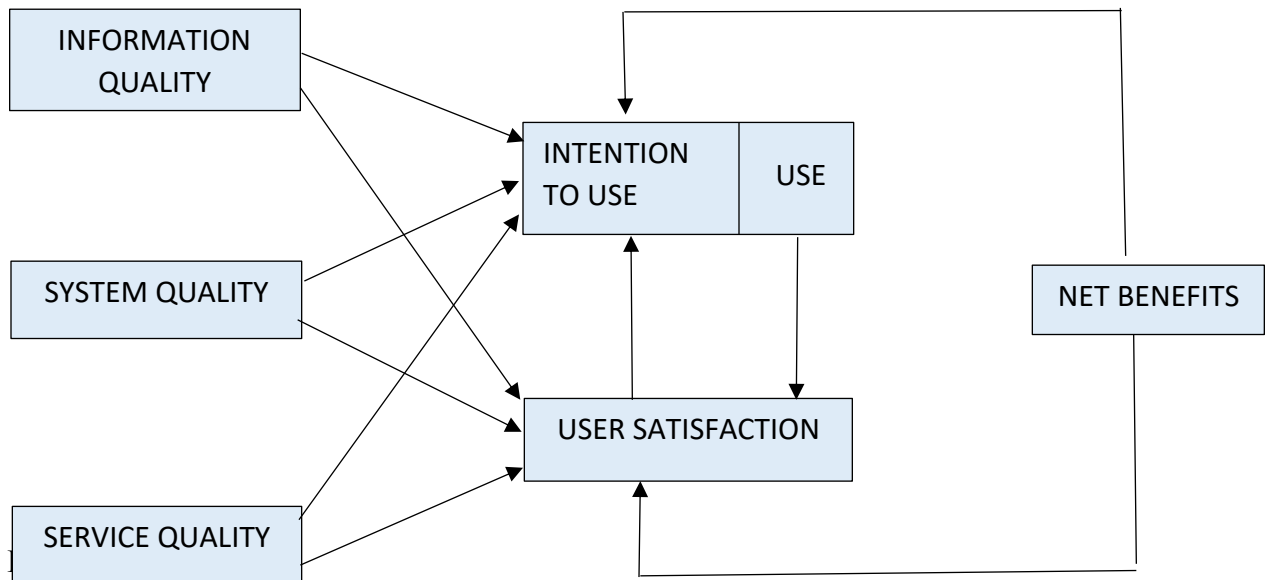
The research uses several traditional information systems success metrics but adds customized metrics which is designed for e-commerce applications. The SYSQ evaluation depends on fundamental measures such as usability, download speed, together with reliability and security, which provide essential user-friendly and seamless experience elements. The quality of information matters in e-commerce because it refers to content relevance alongside accuracy and personalization which ensures specific user needs are met through dynamic materials. The quick response of the customer support team, technical assistance and well-developed online support, credibility represent the vital factors of the service quality that preserve client satisfaction and trustworthiness. Customer satisfaction leads resource businesses to multiple beneficial outcomes which include decreased expenses, elevated operational quality, and loyal

clients. This creates a complete evaluation system for determining e-commerce success (DeLone & McLean, 2004).

Similarly, as (Wang et al., 2019) study on e-commerce systems demonstrated that the DML-INSSM could be adapted to digital environments by adding perceived value as an important determinant of the success of these systems (Wang, 2008). Other research, like Fan and Fang's (2006), considered that for successful ERP implementations, USAT and users play a critical role and also supported by empirical evidence (Fan & Fang, 2006).

The DML-INSSM is considered the most reliable framework to analyze the success of an Information system. As per research, the different factors of this model have consistently been proven as interdependent and have an influence on each other, considering different settings from e-commerce to healthcare. This model has experienced different modifications so far, but it is considered the most applicable and foundation tool in Information systems research.

Figure 1 depicts updated DML-INSSM (Delone & McLean, 2003).



**Figure 1.** Updated DML-INSSM

## 2.2 Application of DML-INSSM

The DML-INSSM has been reviewed down many different literature avenues, from healthcare to education, and e-commerce, in an attempt to determine its effectiveness across contexts. (Lin, 2007) evaluated the use of this model in online learning and confirmed that system, information, and service quality are significant bases of behavioral intention to e-learning platforms.

(DeLone & McLean, 2004) demonstrated application of the model through examination of two case studies. Business success for Barnes & Noble as a bricks-and-clicks retailer depended on website usability combined with quality online content and customer visit frequency and repeat purchase metrics. As a regional retailer ME Electronics built its success around maintaining a solid customer relationship management (CRM) system. The company's performance can be measured by customer reviews, survey response ratings, combined with email response times and improvements in customer transaction value.

Lee and Yu (2012) are arguably one of the foremost construction specific IS researchers, and one of the earlier build-specific applications of the DML-INSSM model was through Lee and Yu (2012) where the model was used to assess the success of PMIS in construction. Their study showed the results for the control of the core construct validity test by validating the effectiveness of SYSQ, INFQ, and SERQ. These qualities greatly improve the project coordination and efficiency. They determined that a PMIS works well and provides timely, reliable information to users, who are consequently more satisfied and, as a result, have better project outcomes. This research established the applicability of the model in high stakes, collaborative environments and suggested further work on IS success in construction (S.-K. Lee & Yu, 2012).

The idea of system reliability and quality of PMIS success is expanded on in the manufacturing SME setting by (Ghobakhloo & Tang, 2015a), with some interesting implications for construction based on their work. The study investigated the impact of SYSQ and organizational support on the success of PMIS in structured project-oriented environments. The key drivers for good PMIS

performance were user engagement and system functionality and were also found to be keys in construction settings where dependent systems are essential for a smooth project execution and operation. The model was reconfirmed in an application to a project-based manufacturing context, and therefore in the necessity of the model for construction, which has a great collaborative need (Ghobakhloo & Tang, 2015b).

(Nugroho & Prasetyo, 2018) further adapt the DML-INSSM by re-specifying the model to incorporate perceived quality and perceived value. This is an adjustment that reflects the need of the construction industry to assess user perceptions in terms of quality, as they are very often a great determinant of satisfaction and willingness to take on new systems. When construction projects focus on quality-based achievement, together with economic value delivery and satisfied user experiences, they become efficient. The study also showed DML-INSSM model can be extended by incorporating elements specific to the industry such as perceived value, making it of wider applicability in construction.

(Angelina et al., 2019) employed the DML-INSSM to evaluate e-construction platforms. System and information quality can directly contribute to user satisfaction and the use of the platform. These qualities also help to improve team coordination among project stakeholders.

The DML-INSSM is also relevant to empirical tests within project-based PMIS settings. This study wasn't specific to construction, but system quality, information quality, and user satisfaction all provided strong predictors of individual and organizational impact. By affirming the DML-INSSM's constructs on a project mean livari found evidence of the reliance on reliable systems and satisfied users for positive outcomes, supporting the model's use for construction projects with strong team dynamics and linkages between project outcomes and team dynamics (livari, 2005).

(Fan & Fang, 2006) directly studied ERP implementation in construction by adapting the DML-INSSM to verify the success parameters of ERP systems. Their results indicate SYSQ, INFQ, and USAT as key elements to ERP effectiveness because each results in better project coordination

and operational efficiency. The DML-INSSM model's structured evaluation was demonstrated to provide significant benefits in evaluating ERP systems that control various construction resources, and these systems depend critically upon system and information quality for functioning in large construction operations.

Several other studies also adopted the DML-INSSM model to measure digital project management platforms. Based on Sharkey et al. analyzed e-construction success, and found that U and INFQ greatly affect USAT. The study pointed out that these qualities are important in the building sector wherein success of the project hinged on good communication and data sharing. The study findings show that the digital systems in construction are improved by good INFQ, and that confirms the need for accurate, up-to-date information on the project (Sharkey et al., 2010).

Halonen et al. have highlighted the evidence of a direct link between SYSQ and users' ability to share knowledge while underlining the connection between two variables first is the SYSQ and second is the USAT when measured. The learning process of construction professionals in digital domains requires investigation because effective learning methods and scaling become crucial for project execution. They claim that the DML-INSSM model is also able to assess how well educational systems in construction work which indicates its adaptability (Halonen et al., 2010).

PMIS were validated in construction by (Urbach & Müller, 2012) who further validated the applicability of DML-INSSM model. Their study identified that U and INFQ are essential to project success because they are required to support complex planning and scheduling tasks in construction. This study affirmed the suitability of the DML-INSSM model constructs to construction projects with requirements of effective project management which is a function of high-quality, reliable systems (Urbach & Müller, 2012).

Seddon and Kiew (1996) made an application of the DML-INSSM to investigate system quality and user satisfaction in a construction context. As the contribution to the literature regarding the factors of user satisfaction is not found in the literature to date, their findings confirmed that

user satisfaction is positively linked to the usability and reliability, since these elements directly affect the outcomes of the project. Through validation of the SYSQ vs USAT relationship, this study added further evidence to the DML-INSSM effectiveness in construction environments where reliable systems are important to the project success (Seddon & Kiew, 1996).

## **2.3 Factors Contributing to PMIS Success**

### **2.3.1 PMIS and its Role**

Successful businesses in modern economies need strategic integration between information systems (IS) and information technologies (IT) to maintain their competitive advantage (Hartman & Ashrafi, 2002). (Nitithamyong, 2003) proposed internet-based project management to improve documentation and efficiency in business management. He also emphasized the importance of non-technical factors for a successful project management system. Basically, project management functions as an essential organizational asset that brings alignment with strategic goals by using rapid execution and flexible adaptability to meet changing market needs and new environmental situations (Amami et al., 1993).

PMIS are studied as tools to effectively address information overload, a usual problem in construction projects; data are streamlined for enhanced managerial decisions through PMIS. Through PMIS, efficient information management helps in quicker reaction to project needs and strategic decision-making to achieve the success of the project (Al Ya'qoubi & Sivadass, 2023).

PMIS can enhance coordination through three systems. These are known as operational integration, adaptive responses, and better team interactions. This tool delivers live updates which streamline the control of intricate assignments while upholding connection between organizational targets. The centralized real-time information database of PMIS functions to enhance transparency and reduce errors (Amami et al., 1993).

PMIS enables quick sharing and live updates of information among clients and their project managers, engineers, and contractors through its centralized platform. Clear point-to-point access through the platform cuts down project communication blinds and creates conditions for successful teamwork. All organization-wide decisions can be made easily due to the PMIS centralized data storage system, which minimizes both data loss and mismanagement. (Raymond & Bergeron, 2008).

### **2.3.2 PMIS in Construction Industries**

As the infrastructure sector is complex and fragmented in nature, it mainly relies on effective coordination among numerous stakeholders. This sector addresses its problems by implementing PMIS which increases efficiency as well as cost management and project success. Extensive construction projects benefit from PMIS deployment which simplifies operations related to scheduling and planning as well as decision-making processes. Better project scheduling together with improved project requirements control become possible through PMIS implementation. An analysis by (Chou & Yang, 2012) revealed that PMIS tools increase infrastructure project management capabilities for timeline management and resource utilization.

Project managers along with contractors and clients can use PMIS to view current project data which minimizes communication errors and scheduling delays. The introduction of web-based PMIS as described by (S.K. Lee & Yu, 2012) promotes both team collaboration and complete transparency between departments. PMIS also maintains comprehensive project records to enhance accountability while reducing disputes and improving team member communication specially in the case of the construction sector (Hamood & Thiruchelvam, 2023).

Through predictive analytics organizations gain the ability to detect and eliminate risks during their first stages. It also helps to minimize project delays and cost inflation (Raymond & Bergeron, 2008). For this reason, PMIS can also be used to strengthen project risk control because it processes historical data to forecast upcoming challenges so managers can implement preventative strategies (S. K. Lee et al., 2010). The integration of advanced PMIS solutions with

both IoT and AI technologies enables improved planning and decision adaptations, which reduce both risks and uncertainties (Rehman et al., 2022).

(Darko & Chan, 2016) demonstrated how PMIS supports environment-friendly building initiatives with their ability to track sustainability metrics. Building Information Modeling (BIM) linked with PMIS systems reduces environmental effects. The integration enables sustainable environmental assessments of construction projects through efficient resource-tracking features and proactive management functions (Raymond & Bergeron, 2008).

Organizations utilized web-based PMIS systems for critical success factor identification during implementation processes when they lacked internal capabilities by working with application service providers (Nitithamyong & Skibniewski, 2004).

(S. K. Lee et al., 2010) examined how PMIS quality relates to PMIS success by exploring the critical success factors (CSFs) and their effect on project success, through regression analysis. Another study by (S. K. Lee & Yu, 2011) identifies and ranks 23 CSFs for PMIS in construction, grouping them into dimensions to enhance understanding of priority factors for successful PMIS deployment.

CSFs are classified by (Asgari et al., 2018) as financial, human resources, contractual deals and project characteristics, based on the viewpoints of project stakeholders, aimed at accomplishing project ends. Another study explores the key success elements for the performance of industrialized building systems and focuses on the point of alignment between organizational strategy and PMIS design. (Choi & Ha, 2022).

## **2.4 Formulation of the Model**

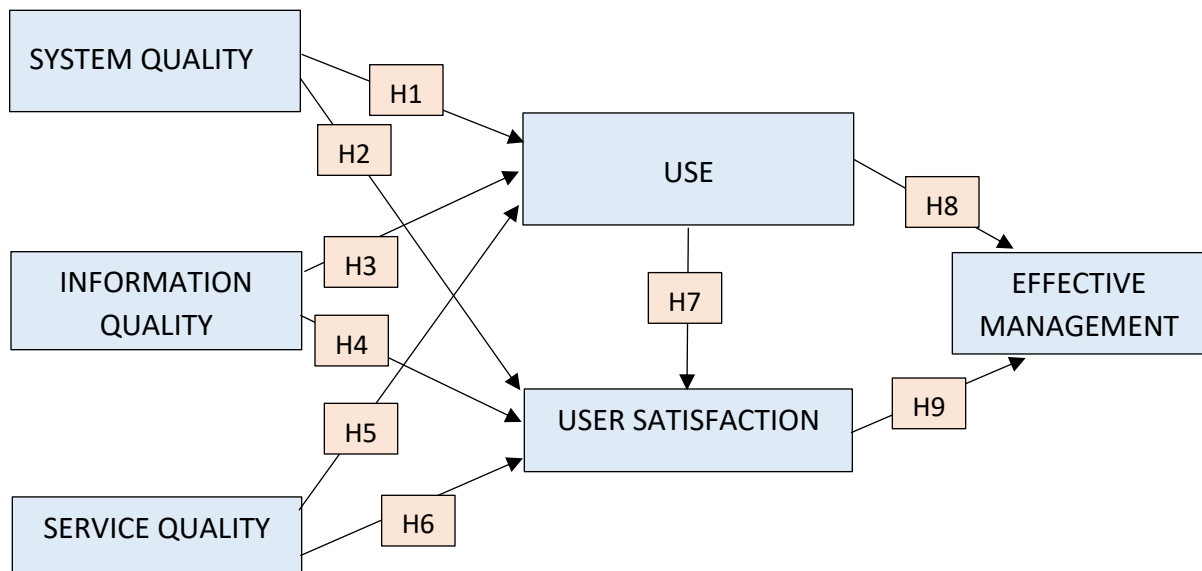
A key goal of this thesis is to evaluate the applicability of the DML-INSSM to determine the success factors of PMIS within the context of construction industries of emerging economies. This evaluation leads to the model adaptation illustrated in Figure 2. This model is developed following the model adopted at (Delone & McLean, 2003), but some modifications have been made to adjust to the changes in the building sector (S.-K. Lee & Yu, 2012). The details will be discussed in the next chapter.

### **2.4.1 Formulation of the Hypothesis**

In this study, nine hypotheses have been developed to evaluate how well the Updated DML-INSSM applies to determine the success elements of construction industries in emerging economies, as shown in Table 1. Additional information about the model exists in Figure 2. The hypotheses represent both model-caused relationships and study-targeted objectives through their formulations. Several links in the model have been left out, and those relationships have not been tested explicitly with hypotheses. Empirical data collected enables the ability to validate through contextual relationships formed in the model.

**Table 1.** Hypothesis of the proposed model

H1	The quality of the system favorably influences the use of the PMIS.
H2	The quality of the system favorably influences user satisfaction with the PMIS.
H3	The quality of the information favorably influences the use of the PMIS.
H4	The quality of the information favorably influences user satisfaction with the PMIS.
H5	The quality of the service favorably influences the use of the PMIS.
H6	The quality of the service favorably influences user satisfaction with the PMIS.
H7	Use will favorably influence user satisfaction with the PMIS.
H8	Use will favorably influence the effective management of the PMIS.
H9	User satisfaction favorably influences the effective management of the PMIS.

**Figure 2.** Proposed DML-INSSM for the study.

### **3 Research Methodology**

A thorough explanation of the research framework used in this thesis exists in this particular section. The data collection section contains a detailed explanation of how the survey was developed, along with information about the survey participants. In the next section, the approach to data analysis is explained which is structured into three key subsections: evaluation of the system, validation of the model, and reliability with validity assessment work as separate sections in data analysis.

#### **3.1 Data Gathering Techniques**

In the data collection phase of the research, there are three key methods: qualitative, quantitative, and mixed techniques (Creswell & Creswell, 2017; Ishtiaq, 2019). Each method exhibits specific advantages based on what the question and situation demand (Weyant, 2022).

Qualitative research approaches provide comprehensive findings related to difficult matters. Research using this method builds themes through data rather than needing fixed research questions before data collection (Twycross, 2004). It uses open-ended inquiries along with interviews and observations, combined with document assessments. So, this considers individual experiences as well as contextual processes and narrative perspectives (Creswell & Creswell, 2017).

According to (Creswell & Creswell, 2017) the quantitative method conducts research by studying numerical patterns through logical analysis. It uses experimental data, survey approaches, and other observation methods. This ensures reliability together with replicability and generalizability in research. Large data examination through statistical instruments helps researchers discover relationships between data points which leads to data-based conclusions.

(Yu, 2009) explains that mixed research combines qualitative interpretation of context with quantitative numeric precision. The approach permits researchers to acquire data

simultaneously or in succession. Research combining the methods achieves accurate findings while enabling a holistic understanding of phenomena by using triangulation approach. The combined research method offers scientists the opportunity to study intricate problems that surpass the individual examination capabilities of qualitative or quantitative methods (Cronholm, 2011).

For the data collection of this research, a quantitative approach has been selected. To do so, we have used survey questionnaires. According to (Kelley et al., 2003), surveys function as research methods that combine structured questions with interviews to acquire data from representative population groups. The standardized data collection approach maintains uniformity of participant responses to make their answers easily comparable to each other. The foremost goal of surveys involves gathering unbiased information from properly representative sample groups for wider population inference (Burns et al., 2008).

Due to digital transformation, web-based survey questionnaires are delivered via email, resulting in a significant improvement in data collection speed and operational effectiveness (Granello & Wheaton, 2004). According to them, for survey data collection, obtaining voluntary consent, safeguarding personal information, and concealing identities establish vital conditions for reliable feedback sharing. A comprehensive survey validation and tool pretesting process stands essential in allowing modern methods to deliver accurate information (Draugalis et al., 2008). These methods achieve both ethical compliance and trustworthy outcomes through a consistent integration of their techniques.

### **3.2 Data Analysis Tool**

SmartPLS 4.0 is a statistical analysis software (Ringle et al., 2005). It helps to implement PLS-SEM (Wong, 2013). It is beneficial for analyzing the relationship among different variables, and a minimal data size can be used (Bacon, 1999). One of the key features of this software is bootstrapping, which can be used to calculate the path coefficients (T statistics and P value) (Wong, 2013), and this value can be used for hypothesis testing. In this research, the free version of SmartPLS 4.0 software has been used.

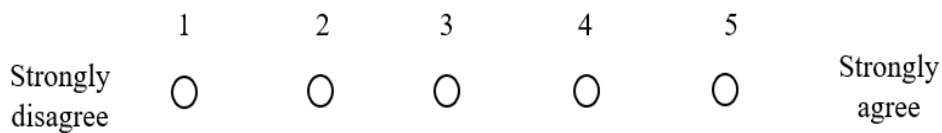
### **3.3 Preparation of Survey Questionnaires for This Study**

The survey questions utilized multiple items from all six constructs of the updated DML-INSSM. The survey questionnaire is divided into a total of seven different parts. The initial part of the questionnaire gathers demographic profile of the survey participants, while the remaining sections evaluate different constructs of the research model. The first requirement to participate in the survey is that all of the survey respondents work in the infrastructure field of emerging economies, and the respondent personnel have experience using Project management software. Different project management personnel from the infrastructure sector, with different ages, genders, designations, and educational qualifications, participated in the survey.

The survey data serves two important research functions: first, it maintains transparency by revealing the study process, and enables comprehensive analysis of the participants' demographic attributes and characteristics.

The survey questionnaires are based on six constructs. Under each construct, there are several questions, and the respondents can answer these questions on an agreement-level scale. A Likert scale measures these statements, which act as multiple Likert items in the questionnaire. Bipolar measurement in the Likert scale allows researchers to analyze quantitative data by using numerical values from the positive to negative spectrum (Joshi et al., 2015).

Survey-based research depends heavily on visualization according to (South et al., 2022) thus it becomes crucial to display Likert scale responses clearly for perfect interpretation. The questionnaire shows the Likert scale through numerical values which allow participants to choose between 1 to 5 to state their agreement levels.



**Figure 3.** Likert scale used in the survey

### 3.3.1 System Quality (SYSQ)

System quality signifies total functionality along with its technological capabilities of PMIS that determine users' satisfaction regarding system performance and usability and dependability. System quality stands as a vital model component (Delone & McLean, 2003) because it determines how users respond to IS implementations and how satisfied they become. PMIS in construction industries of emerging economies need system quality to achieve efficient project performance and effective data handling as well as stakeholder collaboration.

SYSQ includes usability alongside both reliability of functioning and effective connectivity to other applications (Petter et al., 2008). The key elements that ensure PMIS adaptability to changing project requirements and technological progress are accuracy, flexibility and responsiveness (Gorla et al., 2010). (Wixom & Todd, 2005) established system speed together with interface design as essential elements that determine how satisfied users feel about using the system and their intent to keep utilizing it.

SYSQ in enterprise applications consists of three major dimensions according to (Urbach et al., 2010): process efficiency (timely information processing) along with security (relating to data safety), and maintainability (persistent system functionality). According to their research, PMIS should efficiently process information and quickly recover from errors in order to achieve successful project completion within tight deadlines which is common in construction projects. System quality evaluation in emerging economies focuses on interoperability and scalability because these factors help achieve seamless transitions between different project management tools and platforms (Nguyen, 2006). As, we found from discussion, ease of access, ease of use, compatibility, stability/reliability, responsiveness are critical for SYSQ, so for this study, survey questionnaires for SYSQ are as follows:

**Table 2.** Survey questions regarding system quality

<b>Variable</b>	<b>Survey item</b>
SYSQ1	PMIS should be user friendly
SYSQ2	PMIS should be easy to access
SYSQ3	PMIS should be easy to use
SYSQ4	PMIS should be compatible with other software
SYSQ5	PMIS should maintain a stable state

### **3.3.2 Information Quality (INFQ)**

The fundamental objective of information systems is to organize data storage and processing activities which result in useful insights for decision-making purposes. The value of information systems is revealed through the effective implementation of generated data in operational and project execution. As emerging economy construction projects deal with resource limitations and complex stakeholder coordination together with varying regulations (Adekunle et al., 2022), they must have quality information to achieve successful project management.

The DML-INSSM affirms that INFQ functions as the primary indicator for system success because it evaluates the precision and appropriateness and promptness and ease of use among information outputs (Delone & McLean, 2003). PMIS systems with high information quality enable contractors, engineers and managers to make proper decisions by using dependable and current data.

(Y. W. Lee et al., 2002) established four fundamental dimensions that deliver effective PMIS in construction. Data accuracy and consistency along with reliability emerge from intrinsic quality aspects within the system framework. The relevance together with completeness and timeliness of data structure determines Contextual Quality which suits particular project requirements. The representation quality of data focuses on formatting and structuring data to achieve effective interpretation by users. The accessibility quality aspect focuses on enabling simple retrieval and utilization of information between different PMIS systems and construction management platforms to support efficient project execution. So, we can say ease of information access, its use in real time, information reliability, relevance of information are crucial to PMIS success.

So, for this research, the questions of this section are provided in Table 3.

**Table 3.** Survey questionnaires about information quality

Variable	Survey item
INFQ1	The necessary Information is associated with system design and configuration.
INFQ2	The system screen configuration and document format should be compatible with the information use.
INFQ3	The information search options are easy and straightforward.
INFQ4	PMIS users should be able to retrieve information on real real-time basis.
INFQ5	The information stored in the system must be precise and relevant.
INFQ6	The information stored in the system is adequate for the users.
INFQ7	The information stored in the system is associated with project characteristics.

### 3.3.3 Service Quality (SERQ)

The SERQ proves essential for long-term system adoption together with user satisfaction (Son et al., 2016). The conventional success models according to (Pitt et al., 1995) focus primarily on system outputs instead of evaluating the quality of service delivered by both vendors and support teams. The exclusion of service reliability, along with quick technical support and system training, from PMIS effectiveness assessments creates fuller assessments of the system in construction industries (S. K. Lee et al., 2010). (S. Lee & Kim, 2017) support the integration of service quality into IS success models because they understand its powerful effects on user trust, together with system usability and system performance. Considering these factors, the following survey items have been developed:

**Table 4.** Survey questionnaires about service quality

Variable	Survey item
SERQ1	PMIS service provider responds very promptly when required.
SERQ2	PMIS service provider must provide prompt technical assistance for maintenance-related issues.
SERQ3	Sufficient education related to service is provided to the PMIS users.
SERQ4	PMIS service providers have sufficient knowledge about the construction field in emerging economies.
SERQ5	PMIS service providers are reliable and consistent.
SERQ6	PMIS service provider user professionalism and expertise are trusted by the user.

### 3.3.4 System Use (U)

U stands as a CSF for project completion in the building industry field of emerging economies because it influences decision processes, operational effectiveness, and execution quality (Petter et al., 2008).

The usage of PMIS in construction projects relies on how functional systems are and how easy they are to operate alongside their availability and user training. An effective implementation of PMIS leads to control of expenses while maintaining documentation organization alongside improved relationship management between stakeholders (Son et al., 2016).

The utilization of PMIS by construction firms will improve when they emphasize better system usability together with sufficient user training and robust support services (S.-K. Lee & Yu, 2012). The DML-INSSM employs the U construct as a significant indicator to evaluate how well PMIS systems are adopted by organizations and their impact on project efficiency and achievement. So, the questionnaires for the use of the system are shown in Table 5.

**Table 5.** Survey questionnaires about use of the system

Variable	Survey item
U1	The existing PMIS should be recommended to others.
U2	The existing PMIS should be used in the future

### 3.3.5 User Satisfaction (USAT)

User satisfaction serves as an end outcome from system quality, information quality, and service quality as well as functions as a mediator to affect system effectiveness (Delone & McLean, 2003). User satisfaction represents the level at which systems meet both user anticipations and information demands (Bailey & Pearson, 1983). Multiple construction personnel rely on PMIS performance and usability levels to execute their projects efficiently including project managers together with engineers and contractors. System utilization increases when decision-making support and workflow enhancement are effective in PMIS (Al Ya'qoubi & Sivadass, 2023).

**Table 6.** Survey questionnaires about user satisfaction

Variable	Survey item
USAT1	The user has good experience in utilizing the current PMIS available in the market.
USAT2	The information and data gathered from the PMIS meet the user's demand.

### 3.3.6 Effective Management (EMGT)

The success of project completion in construction management depends on effective project management practices but efficient project management results from factors that produce success. The various influencing variables arrange themselves within the frameworks of uncontrollable elements together with elements that are controllable. The type of project and contract structure represent uncontrollable elements because these aspects are already determined before managers can intervene. Projects yield better results when organizations strategically improve the competence of project managers and their support systems which fall under the category of controllable elements (S.-K. Lee & Yu, 2012).

Traditional project management mainly focuses on time, expense, and quality elements of the project (Atkinson, 1999). However, satisfaction by the stakeholder incorporate with strategic alignment adds substantial value to success indicators for the project management success (Albert et al., 2017). Successful project evaluation combines objective measurement of criteria with subjective comprehension of stakeholder evaluation objectives while acknowledging stakeholders possess different successful performance metrics (Ika, 2009).

(Sanchez et al., 2017) & (Williams et al., 2015) demonstrated that project completion within stated deadlines along with cost reduction serve as fundamental factors while project success evaluation now centers on sustainability performance and client relationships. (Agarwal & Rathod, 2006) demonstrated that external stakeholders and internal project team members have varying perceptions of software project success leading to the necessity of including scope

fulfillment together with stakeholder trust and adaptability in current project success framework models. So, the following questions have been prepared in Table 7.

**Table 7.** Survey questions regarding effective management

<b>Variable</b>	<b>Survey item</b>
EMGT1	Management of time should be properly executed.
EMGT2	Management of cost should be properly executed.
EMGT3	Management of quality has been properly executed.
EMGT4	Management of the environmental issues has been executed properly.

### **3.4 Data Evaluation Metrics**

To evaluate the success factors of PMIS, descriptive statistical tools have been used in this study. The fundamental role of descriptive statistical analysis is to help researchers understand datasets by the summarization of quantitative data to detect patterns and trends (Vetter, 2017). Descriptive statistics can achieve its primary objective by displaying quantitative data through numerical and visual representations form (Sonnad, 2002). The visualization techniques include histograms alongside gives with frequency distributions that show data point distribution utilizing relative measurements, percentage distributions, and cumulative distributions (Miller & Brewer, 2003).

Central tendency indicators include mean, median, and mode along with standard deviation, range, and skewness statistics which support data dispersion examinations (Whitley & Ball, 2002). Research experts use frequency distributions together with cumulative distributions and histograms to study survey participant answers across Likert scales (Stratton, 2018). The computation of mean together with median and mode helps calculate average responses to develop a collective understanding of study population opinions (Groth & Bergner, 2006).

The combination of graphical and numerical analysis through descriptive statistics leads to precise information analysis that helps researchers share research results through a structured yet easy-to-understand presentation (Gaddis & Gaddis, 1990).

PLS-SEM functions as a popular predictive modeling method dedicated to handling high-dimensional datasets that exhibit collinearity problems (Hair et al., 2012). The assessment of latent constructs along with observed variables for the theoretical framework representation happens through this method (Kono & Sato, 2023).

PLS analyzes construct measurement validity in the measurement model and establishes the connection patterns between constructs within the structural model (Lin et al., 2020). The makes use of latent constructs to depict IS success factors and uses structured questionnaire items to generate observed variables (Hair et al., 2012).

### **3.5 Validation and Reliability**

The foundation of quantitative research consists of ensuring both validity and reliability to verify that measurement instruments correctly assess their targeted concepts across different uses. Different studies emphasize that Cronbach's Alpha (CA), along with Composite Reliability (CR), and Average Variance Extracted (AVE), should be used to validate research instrument quality.

The research community performs model assessment with established guidelines by using important reliability and validity indicators which include CR, CA, AVE, construct correlations and cross-loadings (McIntosh, Edwards, & Antonakis, 2014). The predictive accuracy of the model derives from path coefficients together with  $R^2$  values which show the level of congruity between theoretical associations and real-world measurements (Shmueli et al., 2019).

**Table 8.** Measurement of validity and reliability

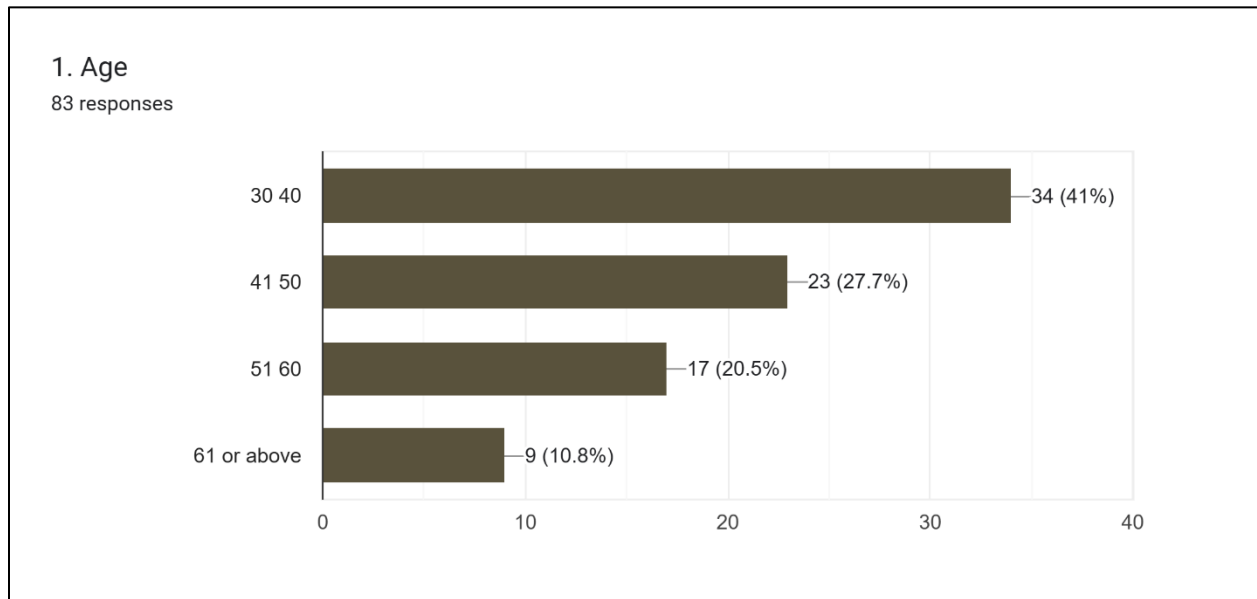
<b>Metrics</b>	<b>Purpose of use</b>	<b>Acceptable Range</b>
CA	It measures the degree of internal consistency between the elements.	$\geq 0.70$ (Peterson, 1994), $\geq 0.60$ may also be acceptable, (Hair et al., 1998)
CR	It evaluates how well a construct is explained by its indicators.	$\geq 0.70$ (Peterson & Kim, 2013)
AVE	It indicates how well the indicators of a construct correlate with the construct itself.	$\geq 0.50$ (Campos et al., 2012)

## 4 Results

The research data was obtained through questionnaires, as detailed in the prior chapter. The data were also collected using an online survey that lasted over two months. In total, 83 responses were received, which have been summarized in this chapter. Then, the data was analyzed using previously discussed statistical methods.

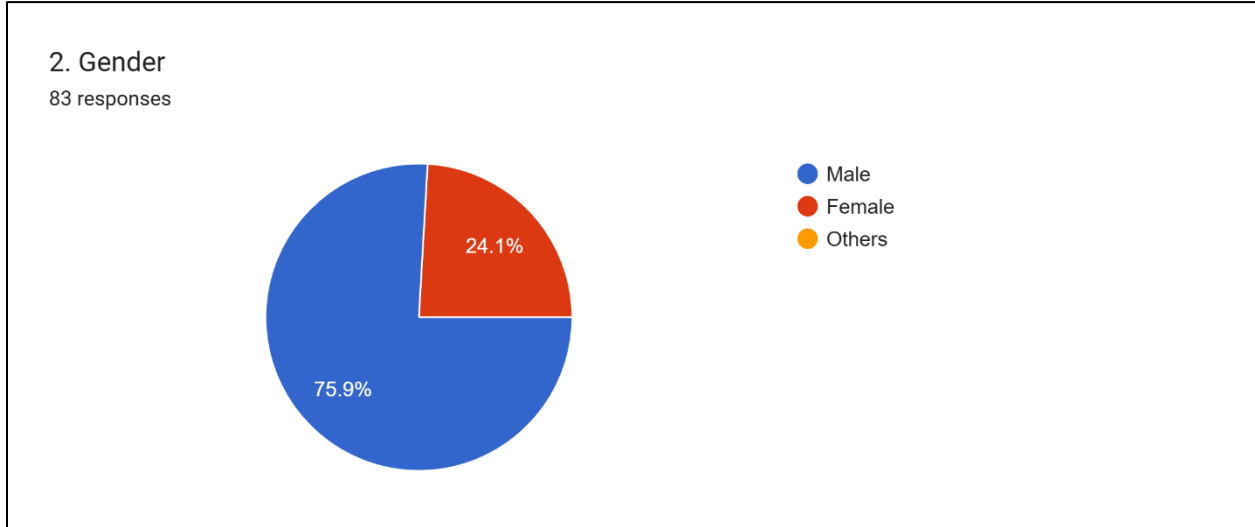
### 4.1 Demographic Profile

The research evaluates statistical information regarding the participants' demographic profile, which includes gender breakdown, age group categories, and sector-based groups. Figure 4 visualizes the respondent distribution by age. Most of the study participants are aged between 30 to 40, and they form the biggest demographic group. The distribution shows minimal participation of respondents over 61.



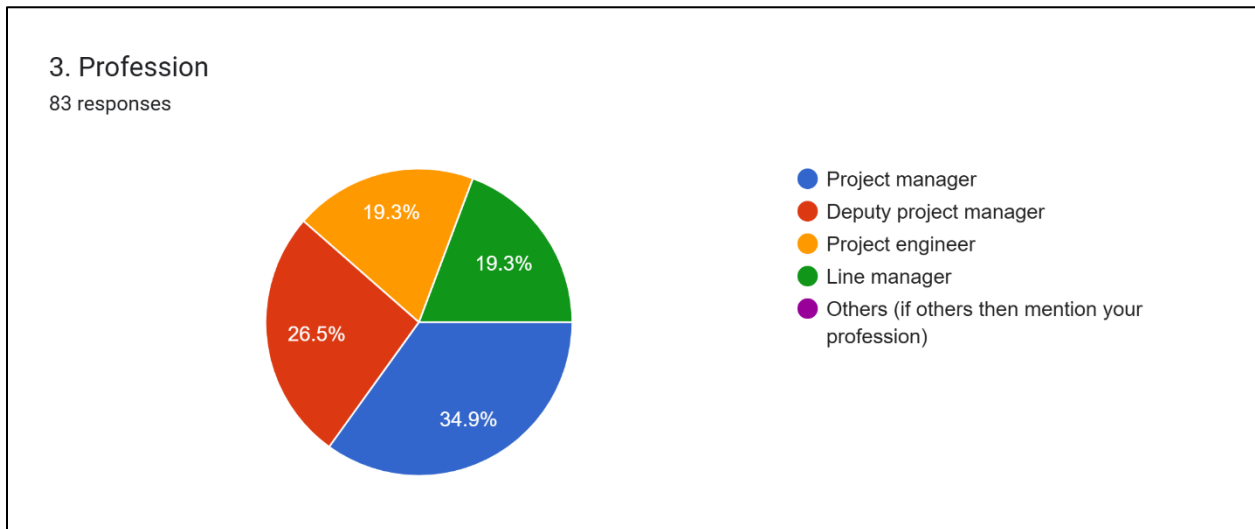
**Figure 4.** Age profile of the survey respondents.

Figure 5 shows a distribution of male and female participants through its pie chart. The implemented selection criteria did not select participants based on gender. There were 63 male participants and 20 female participants in responses obtained for the study.



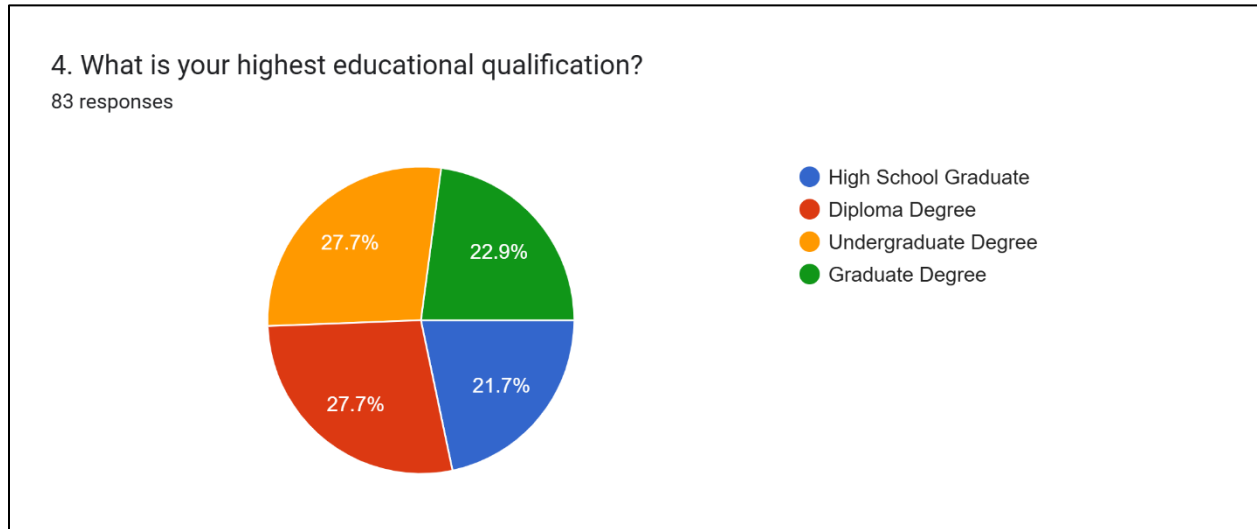
**Figure 5.** Gender profile of the survey respondents.

Then, Figure 6 shows the professions of the participants. The project manager and deputy project manager participated mostly, whereas the project engineers and the line manager were fewer among the respondents.



**Figure 6.** Professional profile of the survey respondents.

Figure 7 displays the distribution of the participants' professional degrees. Most of the participants had Undergraduate and Graduate degrees. On the other hand, the fewest had high school degrees.



**Figure 7.** Academic qualifications of the survey respondents.

## 4.2 Data Evaluation for the Model

Here, the mean and standard deviation are evaluated for each criterion of all six factors to get an overview of the collected data. Then, skewness and kurtosis are also measured to check whether the data are normally distributed. The generally accepted range for a dataset to be considered normally distributed is:

**Table 9.** Acceptable values for skewness and kurtosis.

Metric	Acceptable Range	Source
Skewness	-1 to +1	(Jones, 1969)
Kurtosis	-2 to +2	(Ryu, 2011)

For systems quality, the statistical metrics in Table 10 reveal important perceptions of the respondents through mean scores, standard deviation, skewness, and kurtosis analysis. The participant responses indicate strong agreement as all mean scores exceeded 3 in these assessments. The system quality construct receives overall positive ratings based on the summated mean of 3.7 and a standard deviation of 0.78. Here, all skewness values are negative, which means the distribution is left-skewed. But they are within the range according to Table 9, except for SYSQ5, which is also close to 1. The average skewness is -0.842, which is well within the acceptable range. On the other hand, the average kurtosis value is also in the acceptance zone, which is 1.646.

**Table 10.** Statistical analysis for system quality constructs

Variable	Mean	Standard Deviation	Skewness	Kurtosis
SYSQ1	3.84	0.77	-0.90	1.74
SYSQ2	3.72	0.72	-0.93	2.04
SYSQ3	3.69	0.76	-0.70	1.27
SYSQ4	3.49	0.86	-0.56	0.53
SYSQ5	3.75	0.77	-1.11	2.65
<b>SYSQ (Average)</b>	3.7	0.78	-0.84	1.65

Table 11 shows that for information quality, the mean is 3.87, which shows that this construct received overall positive ratings. Despite one of the values of skewness and two of the values of kurtosis falling just outside the range the overall average is well within the limit.

**Table 11.** Statistical analysis for information quality constructs

Variable	Mean	Standard Deviation	Skewness	Kurtosis
INFQ1	3.67	0.84	-0.60	0.47
INFQ2	3.9	0.72	-0.83	2.35
INFQ3	3.81	0.81	-0.61	0.8
INFQ4	3.92	0.71	-0.93	2.59
INFQ5	4	0.78	-0.82	1.62
INFQ6	3.93	0.72	-0.90	2.42
INFQ7	3.88	0.8	-0.82	1.37
<b>INFQ (Average)</b>	3.87	0.77	-0.78	1.66

For service quality, the overall mean score is 2.94, and the standard deviation is 0.73, which shows that this construct received neutral ratings overall. All of the values of skewness and kurtosis are well within the permissible limit, indicating an overall normal distribution of the data.

**Table 12.** Statistical analysis for service quality constructs

Variable	Mean	Standard Deviation	Skewness	Kurtosis
SERQ1	2.98	0.73	0.05	1.66
SERQ2	2.9	0.74	-0.04	1.34
SERQ3	2.95	0.71	0.26	0.87
SERQ4	3	0.71	0	0.19
SERQ5	2.84	0.69	-0.28	1.49
SERQ6	2.99	0.8	0.17	0.45
<b>SERQ (Average)</b>	2.94	0.73	0.03	1

As the overall mean score is 3.01 and standard deviation is 0.71, use construct received overall neutral ratings. From Table 13, we can also say that, all skewness and kurtosis values of the distribution stay within the established statistical boundaries.

**Table 13.** Statistical analysis for use constructs

Variable	Mean	Standard Deviation	Skewness	Kurtosis
U1	3.06	0.75	-0.1	-0.25
U2	2.95	0.66	-0.2	1.74
<b>U (Average)</b>	3.01	0.71	-0.15	0.745

From Table 14, it appears that the kurtosis value of US1 is slightly outside the permissible range. However, the average user satisfaction is within the range, so that the value can be accepted.

**Table 14.** Statistical analysis for user satisfaction constructs

Variable	Mean	Standard Deviation	Skewness	Kurtosis
USAT1	4.01	0.72	-1.03	3.01
USAT2	3.57	0.89	-0.88	0.01
<b>US (Average)</b>	3.79	0.81	-0.96	1.51

Table 15 shows that, all the data are within the permissible range.

**Table 15.** Statistical analysis for effective management constructs

Variable	Mean	Standard Deviation	Skewness	Kurtosis
EMGT1	3.08	0.73	0.43	1.29
EMGT2	2.94	0.77	-0.22	0.38
EMGT3	2.98	0.71	-0.37	1.34
EMGT4	3.01	0.57	-0.4	1.64
<b>EMGT (Average)</b>	3.0	0.7	-0.14	1.162

So, from the data, it can be said that, the overall data follows a natural distribution and the CSFs of the PMIS of construction projects in the emerging economies are: information quality, user satisfaction & system quality.

### 4.3 Assessment of the Model and Hypothesis Testing

To evaluate the model, its reliability and validity will be measured. To do so, the metrics mentioned in 3.4 (Table 8) will be used. SmartPLS 4.0 software has been used to carry out the calculations. A loading coefficient above 0.600 is regarded as high, whereas values below 0.400 are considered low (Chin, 1998). Table 16 presents the results of loading factors which indicate

an acceptable level of unidimensionality as all the values are greater than the permissible value of 0.6. And here none of the value is less than 0.400.

**Table 16.** Loading factor for each variable

	EMGT	INFQ	SERQ	SYSQ	U	USAT
EMGT1	0.845					
EMGT2	0.657					
EMGT3	0.642					
EMGT4	0.842					
INFQ1		0.625				
INFQ2		0.813				
INFQ3		0.724				
INFQ4		0.828				
INFQ5		0.827				
INFQ6		0.856				
INFQ7		0.783				
SERQ1			0.893			
SERQ2			0.825			
SERQ3			0.836			
SERQ4			0.735			
SERQ5			0.772			
SERQ6			0.721			
SYSQ1				0.635		
SYSQ2				0.753		
SYSQ3				0.662		
SYSQ4				0.822		
SYSQ5				0.686		
U1					0.87	
U2					0.845	
USAT1						0.925
USAT2						0.734

Then, the internal consistency was measured through CA computation to identify how consistently the construct's items create uniform outcomes. The value of CA presents a strong indication that all items from the construct maintain consistency.

(Chin, 1998) suggests CR instead of CA because it stands as the preferred reliability metric. A Cronbach's Alpha score exceeding 0.600 marks an acceptable reliability threshold according to (Hair et al., 1998) although (Peterson, 1994) indicates a more stringent standard of 0.700. The measurement of reliability achieves an acceptable level through CR scores greater than 0.700 according to (Peterson, 1994).

All the constructs in the model show both CA and CR values above the standard thresholds except for user satisfaction which is also close to 0.6. The user satisfaction construct has an acceptable reliability score according to CR as its value is 0.75. The values are shown in Table 17.

The measure of convergent validity can be performed by evaluating AVE. As mentioned in Table 8, the values of AVE should be greater than 0.5 (Campos et al., 2012) Table 17 depicts that the values for all constructs met the criteria. So, this model satisfies convergent validity.

**Table 17.** Internal consistency and validity

	CA	CR	AVE
<b>SYSQ</b>	0.79	0.853	0.507
<b>INFQ</b>	0.894	0.908	0.614
<b>SERQ</b>	0.893	0.959	0.636
<b>U</b>	0.64	0.702	0.729
<b>USAT</b>	0.591	0.75	0.695
<b>EMGT</b>	0.767	0.826	0.568

To evaluate the proposed hypothesis testing model from (H1 to H9), in SmartPLS 4.0 Bootstrapping function is used. The bootstrapping result is mentioned in Table 18.

Hypothesis: H1 (SYSQ->U) and H2 (SYSQ->USAT)

Here, for H1, the relationship between the SYSQ and the USAT is not supported. Because the T-statistics and P-value obtained from SmartPLS 4.0 are not statistically significant. So, this hypothesis is rejected. And for H2, the T-statistic value is 0.300, and the P value is 0.764, which

indicates a non-significant relationship (Ridley et al., 2007) between SYSQ and USAT. As the p-value is higher than the acceptable value of 0.005, this proposed hypothesis is also rejected.

Hypothesis: H3 (INFQ->U) and H4 (INFQ->USAT)

Here, for H3, T statistics is 0.542 and P value is 0.588, this hypothesis is also rejected. H4 has a p-value of .059, meaning there is a weak favorable effect of INFQ on USAT of PMIS. It might also be possible to eliminate this hypothesis, considering emerging economies.

Hypothesis: H5 (SERQ->U) and H6 (SERQ->USAT)

Here, both H5 and H6 have a weak favorable effect between SERQ on U and SERQ on USAT, respectively. So, this hypothesis is rejected

Hypothesis: H8 (U->EMGT) and Hypothesis: H9 (USAT->EMGT)

Here, considering the T statistics, P value and emerging economic nature, this hypothesis might also be rejected.

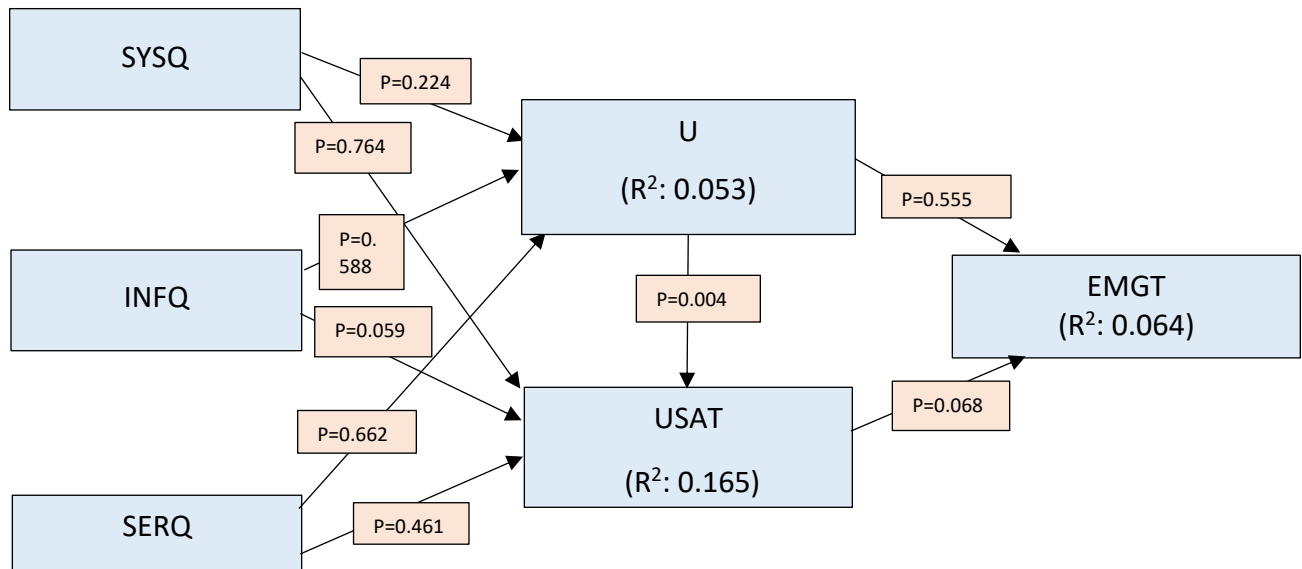
Hypothesis: H7 (U->USAT)

From Table 18, it is observed that H7 has a p-value of .004, meaning use has a strong favorable effect on USAT, as a p-value less than or equal to .005 indicates a strong relation (Ridley et al., 2007). It also has a higher T value (2.885).

**Table 18.** Results of the Hypothesis Test

Hypothesis	Original sample (O)	Sample mean (M)	Standard deviation (STDEV)	T statistics	P values
H1	0.222	0.205	0.182	1.217	0.224
H2	-0.054	-0.104	0.182	0.300	0.764
H3	-0.093	-0.105	0.172	0.542	0.588
H4	0.254	0.255	0.134	1.891	0.059
H5	0.076	0.053	0.174	0.437	0.662
H6	0.096	0.101	0.131	0.737	0.461
H7	0.303	0.286	0.105	2.885	0.004
H8	-0.115	-0.095	0.195	0.591	0.555
H9	0.261	0.258	0.143	1.83	0.068

The value of  $R^2$  is shown the Figure 8.

**Figure 8.** Result of hypothesis testing

## 5 Discussion

The main goal of this research was to identify the PMIS CSFs of the building sector from the perspective of emerging economies. To achieve the main objectives, all three research questions need to be addressed.

The first research question was about identifying the key success factors contributing to PMIS's success in the construction domain. To answer this question, all six constructs of the DML-INSSM have been thoroughly reviewed from the previous literature. According to those findings, appropriate questions specially modified for construction projects and applicable to developing countries have been developed. Then, through the results of the survey, the answer to this question has been determined. After the uniformity and validity of the data are satisfied, it has been identified that the participants tend to think INFQ (average score 3.87), USAT (average score 3.79), and SYSQ (average score 3.7) as the most important factors for PMIS success.

If we further analyze those factors, the reliability of information, adequate information in the system, real-time usability of information, and configuration of the system have the highest score among information quality attributes. It signifies that the ability to receive the accurate information in time is the most crucial element for PMIS success. Then, the second most important element, user satisfaction, leads to better compliance with project tracking processes, improved collaboration, and more accurate project monitoring. And, the attributes of system quality reflect the performance of the PMIS software itself. A user-friendly system allows its users to input, access, and analyze project data efficiently. This will eventually result in PMIS success of the infrastructure sector.

Then, the impact of SYSQ, SERQ, and INFQ on the overall success of the PMIS has been evaluated. To determine that, several hypotheses have been formulated. H1 to H6 measure the influence of those three on U and USAT, thus indirectly on the whole model. INFQ and SYSQ have a higher

average value, meaning that users think of them as more important and critical to PMIS success. So, the service quality of PMIS has less importance among the three of them.

H7 measures the impact of U on USAT, H8 & H9 measure the impact of U and USAT on effective management of PMIS. Hypothesis H7, having the smallest p value and highest t-value, indicates that the answer to our third and final research question is that the factors of use of PMIS have a very high influence on the satisfaction of the users. It signifies that, the more consistently and effectively project team members use the PMIS, the more satisfied they are with it. This means proper training, user engagement, etc., can directly boost satisfaction and engagement with PMIS.

## **5.1 Strategic Project Management Applications**

This research will help to identify some strategic project management applications. It is evident that project officials can perform their tasks efficiently by using good project management information system tools. As per survey data, it is clear that companies from the construction sector in emerging economies emphasize information and system quality for the PMIS software. Moreover, as per hypothesis testing in this research, it is evident that project management authorities will be enthusiastic about using PMIS when they feel satisfied while using this software. Consequently, project management personnel will use PMIS software to monitor the real time progress of the project, budget allocation, scheduling and make right decision quickly. So, the construction sector of emerging economies prioritize user satisfaction, information quality and system quality for selecting the PMIS. So, by knowing which factors make PMIS successful, managers can choose the right PMIS. Consequently, they can make the right decision and make a project successful. Managers should choose that type of PMIS platform which system is fast, reliable and reduce the frustration of the user. The manager must ensure that PMIS provides accurate information so that the decision will be correct. It also helps managers understand that employees need regular training about PMIS usage so that they can feel satisfied and confident when using it.

## 5.2 Limitations

The main limitation of the study was the number of survey participants. As the time frame was limited, it wasn't easy to gather data from more participants. A large dataset could provide more accurate insight. Another notable feature was that many of the hypotheses were rejected. That might be due to the smaller number of participants. It could also be due to the uniqueness of the emerging countries' nature of projects. These issues require further investigation in the future.

## 6 Conclusion

The survey-based quantitative analysis of this research is based on PLS-SEM and the information system evaluation framework. The framework used in this study was developed following the DML-INSSM. Nine hypotheses have been developed to evaluate how well the model applies to determine the success factors of the construction industries.

For the quantitative analysis, a total of 30 survey questions were introduced based on the six constructs of the updated DML-INSSM. Then, an online survey was conducted for the collection of data, where 83 responses were received. To determine whether the data are normally distributed, skewness and kurtosis are measured. The mean and standard deviation for each criterion were also calculated to get an overview of the collected dataset.

Subsequently, the study determines model validity and reliability through CA together with CR and AVE. SmartPLS 4.0 software is used to conduct the calculations. As all the metrics fall inside the acceptable range, finally, the nine hypotheses have been tested using the previously obtained data to conclude this study.

In the future, some unique constructs can be integrated into the information system evaluation model. This includes integration of update technologies in PMIS software, sustainability, multicultural corporate environment etc. To cope with the rapid change in the nature of the building sector, inclusion of those factors can be helpful. Furthermore, this study can be extended by including a comparative analysis across different emerging economies and finding out the reasons behind the differences in the CSFs. Also, a qualitative analysis can be performed to determine whether the factors are universal or region-specific.

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## Appendices

### Appendix 1. Google Doc Questionnaires



## Survey Questionnaires on Evaluating PMIS Applications and Success in Construction Projects of Emerging Economies

I am Md Faisal Alam Khan, a master's student in Strategic Project Management at the University of Vaasa. As part of my thesis, I am conducting research on **Evaluating Project Management Information System**

**Applications and Success Factors in Construction Industries of Emerging Economies: A DeLone and McLean Success Model Approachs.** This study aims to explore how PMIS applications contribute to project success, identify key challenges, and assess their overall impact on project performance.

Your valuable insights and experiences will help shape a better understanding of PMIS implementation in this sector. The survey is **completely anonymous** and will take only a few minutes to complete.

Thank you for your time and support!

**Part A Questions****PART A****About yourself (the participants in the survey):****1. Age**

- 30 40
- 41 50
- 51 60
- 61 or above

**2. Gender**

- Male
- Female
- Others

**3. Profession**

- Project manager
- Deputy project manager
- Project engineer
- Line manager
- Others (if others then mention your profession)

**4. What is your highest educational qualification?**

- High School Graduate
- Diploma Degree
- Undergraduate Degree
- Graduate Degree

**Part B Questions****PART B****System Quality (SYQ):**

1. PMIS should be user friendly:

	1	2	3	4	5	
Strongly disagree	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Strongly agree

2. PMIS should be easy to access:

	1	2	3	4	5	
Strongly disagree	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Strongly agree

3. PMIS should be easy to use :

	1	2	3	4	5	
Strongly disagree	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Strongly agree

4. PMIS should be compatible with other software:

	1	2	3	4	5	
Strongly disagree	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Strongly agree

5. PMIS should maintain a stable state:

	1	2	3	4	5	
Strongly disagree	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Strongly agree





**Part E Questions**

<b>PART E</b> Use (U)						
1. The existing PMIS should be recommended to others:						
	1	2	3	4	5	
Strongly disagree	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Strongly agree
2. The existing PMIS should be used in the future:						
	1	2	3	4	5	
Strongly disagree	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Strongly agree

**Part F Questions**

<b>PART F</b> User Satisfaction (US)						
1. The user is pleased with the experience of using the existing PMIS:						
	1	2	3	4	5	
Strongly disagree	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Strongly agree
2. The user is satisfied with the information received from PMIS:						
	1	2	3	4	5	
Strongly disagree	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Strongly agree

**Part G Questions****PART G**  
**Effective**  
**Management (EM)**

1. Management of time should properly be executed:

	1	2	3	4	5	
Strongly disagree	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Strongly agree

2. Management of cost should properly be executed:

	1	2	3	4	5	
Strongly disagree	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Strongly agree

3. Management of quality has properly been executed:

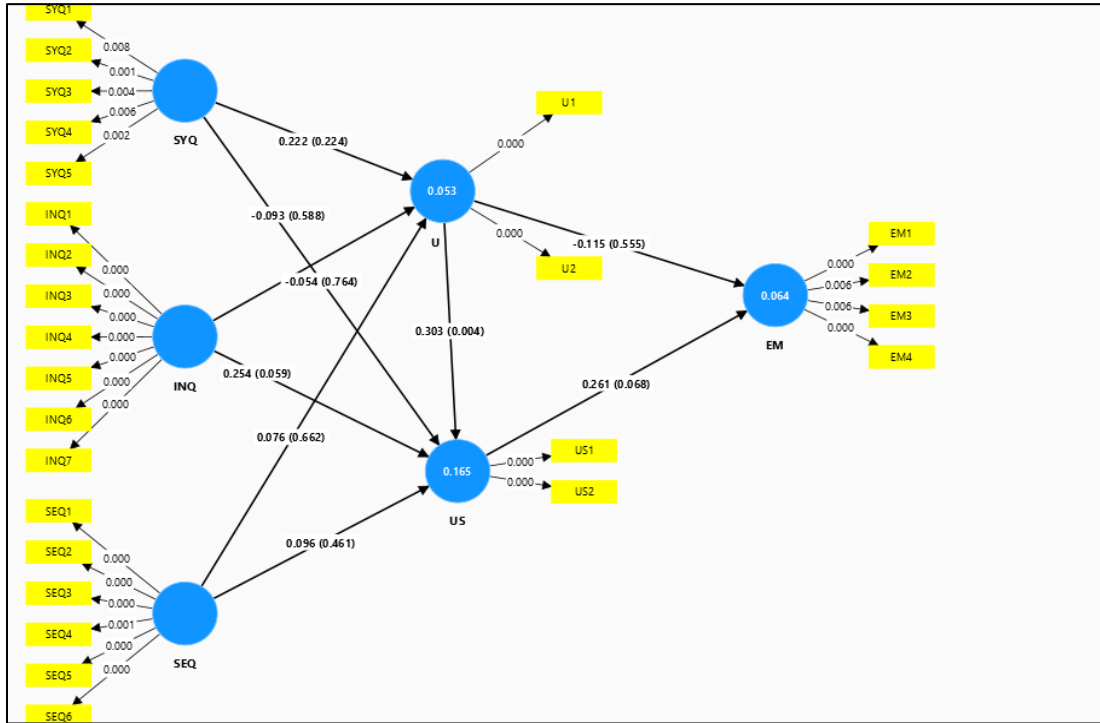
	1	2	3	4	5	
Strongly disagree	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Strongly agree

4. Management of the environmental issues has properly been executed:

	1	2	3	4	5	
Strongly disagree	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Strongly agree

## Appendix 2. Analysis using SmartPLS 4.0

### Model in SmartPLS 4.0



### Internal consistency and validity

Construct reliability and validity - Overview					
	Cronbach's alpha	Composite reliability (rho_a)	Composite reliability (rho_c)	Average variance extracted (AVE)	
EM	0.767	0.811	0.837	0.567	
INQ	0.894	0.912	0.917	0.613	
SEQ	0.893	0.959	0.913	0.639	
SYQ	0.790	0.844	0.838	0.511	
U	0.640	0.643	0.847	0.735	
US	0.591	0.725	0.819	0.697	

## Outer Loadings

Outer loadings - Matrix						
	EM	INQ	SEQ	SYQ	U	US
EM1	0.845					
EM2	0.657					
EM3	0.642					
EM4	0.842					
INQ1		0.625				
INQ2		0.813				
INQ3		0.724				
INQ4		0.828				
INQ5		0.827				
INQ6		0.856				
INQ7		0.783				
SEQ1			0.893			
SEQ2			0.825			
SEQ3			0.836			
SEQ4			0.735			
SEQ5			0.772			
SEQ6			0.721			
SYQ1				0.635		
SYQ2				0.753		
SYQ3				0.662		
SYQ4				0.822		
SYQ5				0.686		
U1					0.870	
U2					0.845	
US1						0.925
US2						0.734

## Results of the Hypothesis Test

Path coefficients - Mean, STDEV, T values, p values						
	Original sample (O)	Sample mean (M)	Standard deviation (STDEV)	T statistics ( O /STDEV)	P values	
INQ -> U	-0.093	-0.105	0.172	0.542	0.588	
INQ -> US	0.254	0.255	0.134	1.891	0.059	
SEQ -> U	0.076	0.053	0.174	0.437	0.662	
SEQ -> US	0.096	0.101	0.131	0.737	0.461	
SYQ -> U	0.222	0.205	0.182	1.217	0.224	
SYQ -> US	-0.054	-0.104	0.182	0.300	0.764	
U -> EM	-0.115	-0.095	0.195	0.591	0.555	
U -> US	0.303	0.286	0.105	2.885	0.004	
US -> EM	0.261	0.258	0.143	1.830	0.068	