Identifying Novel Critical Success Factors that Ensure Adoption of Medical Equipment: A Quantitative Multivariate Analysis Study

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Abstract

Healthcare organizations often experience challenges implementing complex medical technology due to end-user reluctance and limited adoption of full device capabilities. These challenges are frequently associated with insufficient prioritization of critical success factors that support effective clinical implementation. The purpose of this quantitative study was to identify and prioritize critical success factors influencing successful medical device adoption and to determine whether perceptions differed across professional roles within a healthcare vendor organization.

A nonexperimental quantitative design was employed using survey data collected from 102 participants representing multiple professional roles within a hospital patient monitoring division of a medical device vendor in the United States. Twenty-seven critical success factors were categorized into technological, organizational, and environmental domains. One-way multivariate analyses of variance were conducted to assess differences in perceptions across roles, and descriptive analyses were used to rank factor importance.

Results indicated no statistically significant differences across roles, suggesting strong organizational alignment. The highest-ranked factors were organizational and included project communication, adequate resources, project planning, project mission clarity, and leadership competence. These findings support the integration of organizational-focused strategies to improve medical device adoption. Recommendations for future research include validating the framework across additional healthcare settings and research designs.

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Chapter 1: Introduction

Healthcare systems across the globe are seeing a higher demand for patient care due to aging populations and an increase in long-term health crises like coronary heart disease, obesity, and diabetes. Life expectancy has increased over the past 20 years. This increase in life expectancy has led to a larger patient population as people are living longer and requiring medical care for longer. As a result, there is a greater demand for healthcare services and resources to meet the needs of this growing population. Healthcare providers and systems have had to adapt and expand their capacity to accommodate increased patient populations and provide quality care to individuals of all ages. Healthcare administrations are placing an onus on medical device vendors to supply the best technology that ensures better patient outcomes and supports end-user adoption of medical equipment (Clark et al., 2020).

The rise in demand for healthcare systems to purchase new medical technology to improve patient outcomes and meet regulations has created a predicted $58 billion market in the United States medical device industry by 2030 (United States Medical Device Outsourcing Market Report, 2023). As a result of this demand, medical device vendors must find ways to ensure delivery readiness and maturity to ensure end-user adoption and continuous improvement in technology and patient outcomes (McDermott et al., 2022). The environment for this study was the Hospital Patient Monitoring (HPM) team of Philips Healthcare in the United States. The HPM team delivers education, configurations, and workflow optimization based on products sold to healthcare institutions. Clinical leadership had identified business concerns stemming from consultants returning to healthcare sites, pushing the boundaries of scope creep, project timelines, and resource allocation (McCormick, 2023).

A few business-related issues stem from a misunderstanding or exclusion of Critical Success Factors (CSF) within a clinical implementation project. The first concern is that there needs to be a higher emphasis on systems and support structures to mitigate problems that create end-user reluctance (Schmidt & Wiil, 2020). Research by Briard et al. (2020) indicated that CSF are the highest priority for organizations to be successful in project outcomes. The lack of inclusion and prioritization of CSF may contribute to poor project performance. The exclusion of these CSF may lead to poorly executed lean practices, accounting for 60-90% of companies failing to sustain lean improvements (Henrique et al., 2021).

The second concern is understanding a CSF and which CSF enables the most success. Factors such as unique patient experiences, patient outcomes, reduction of healthcare costs, and provider experience are part of the Quadruple Aim framework. Identifying CSF for success can help clinical project managers determine the success of any clinical project (Foo et al., 2023). One of the most critical factors in clinical project success is the ability to measure Key Performance Indicators (KPI). Healthcare stakeholders base decisions on these KPI, which can also define CSF within a project plan. CSF can be integrated into any project methodology, including clinical projects. The discovery of the unique variables for projects can assist in aligning and integrating a standardized approach to clinical project success (Alias et al., 2014).

The third concern is that many clinical monitors have high-level user interfaces that end-users do not fully adopt. Many clinical projects require education to ensure end-user competence and help with technology adoption. Applying the foundation of clinical education methodology to a project management program will help measure clinical KPI and CSF. Educators must also understand their classroom teaching styles to achieve the education and project plan goals (Wages, 2022). Understanding the needs for successful education outcomes can build a project management platform with CSF, such as adoption and sustainability metrics. A clinical project manager who applies these CSF to a clinical project framework may yield better results. Furthermore, identifying project management tools for clinical education will save valuable time when turning theory into practice for business applications.

Research by Hadi et al. (2021), Belay et al. (2022), and Gupta et al. (2022) has provided information on how CSF should be integrated for project management success in industries like construction and banking. This CSF integration must be applied to clinical project management to create strategies that clinicians and project managers can use to explore the factors contributing to project management challenges during a medical device implementation and propose best practices to improve project management outcomes. In this study, strategies focused on how research design enables a robust data collection plan within Philips Healthcare throughout the United States. Various clinicians and project managers will use aligned research objectives to understand which factors lead to success and mitigate problems associated with poor project management.

Statement of the Problem

The problem to be addressed by this study was end-user reluctance and lack of adoption of the full capabilities of medical device technology due to clinical vendors' lack of consideration of what CSF are needed for project success. The alignment of CSF is essential for clinical implementation success (Schmidt & Wiil, 2020). A misalignment of CSF can hinder end-user adoption and create unnecessary scope creep, extension of project timelines, and overutilization of resources identified by McCormick (2023). These problems can result in missed opportunities and damage reputations, as struggles with managing processes effectively may lead to delays, cost overruns, and unfulfilled expectations (Project Management Institute, 2021). Furthermore, poor project selection, weak prioritization, and failure to address human factors can lead to project failure and poor adoption (McDermott et al., 2023). Specifically, medical device companies are responsible for delivering medical equipment capabilities aligned with patient care processes provided under Project Management (PM) frameworks; however, finer nuances or factors must be understood when approaching healthcare projects (Bhide, 2023). Schmidt and Wiil (2020) argued that new technology in any clinical implementation project is challenged by addressing the actual workflow that is acceptable to end-users. This argument was supported by Gruber et al. (2009), which suggests that a lack of understanding of workflow and other factors that influence the success of clinical implementations can result in project failure. The findings provided by Schmidt and Wiil (2020) and Gruber et al. (2009) are further supported in the research by Mandal (2023). Mandal (2023) indicated that the COVID-19 pandemic has caused healthcare workers to quit at record rates. This major shift in the healthcare workforce has placed the onus on medical vendors to discover and align on CSF that ensure end-user adoption while considering healthcare resources (Clark et al., 2020).

Purpose of the Study

The purpose of this quantitative analysis study was to determine what CSF are being implemented by vendors providing medical devices and which factors enable the most success for clinical implementation (Schmidt & Wiil, 2020). A quantitative multivariate analysis of variance (MANOVA) was used to measure the perceptions of the factors that affect project success or failure between various roles of the hospital patient monitoring (HPM) division within the United States, Philips Healthcare North American Region. The identified CSF for project performance were investigated for contextualization within the matrixed environment of a medical device vendor (Briard et al., 2020). The intent was to analyze perceived CSF within the clinical implementation of the respondents of this study to provide a prioritized and concise list of CSF that mitigates reluctance and enables end-user adoption. The target population of this study was the post-sales (PS) clinical organization of the HPM division within Philips Healthcare. The respondents consisted of clinical directors, clinical managers, implementation consultants, delivery consultants, workflow consultants, and clinical project managers. Random sampling minimized sampling error from the total population of approximately 200 respondents within HPM. The sample size was 96 based on MANOVA effects and interaction model with an Effect size of 0.0625 and a Type 1 error of 0.8 based on six independent variables of HPM roles and ten dependent variables of suggested CSF with A Priori Power Analysis using G*Power software. The total number of participants was based on the margin of error, confidence level, and estimated size based on standard deviation (Thomas, 2022). The questionnaire was cloud-based, utilizing Smartsheet software. The data were stored for the duration of the research and archived according to the medical device company rules and regulations. The SPSS predictive software analyzed the quantifiable Likert data. The gaps in past literature and recent healthcare evolution have introduced the purpose of this study, which is to provide medical vendors with novel CSF to achieve clinical adoption of medical devices.

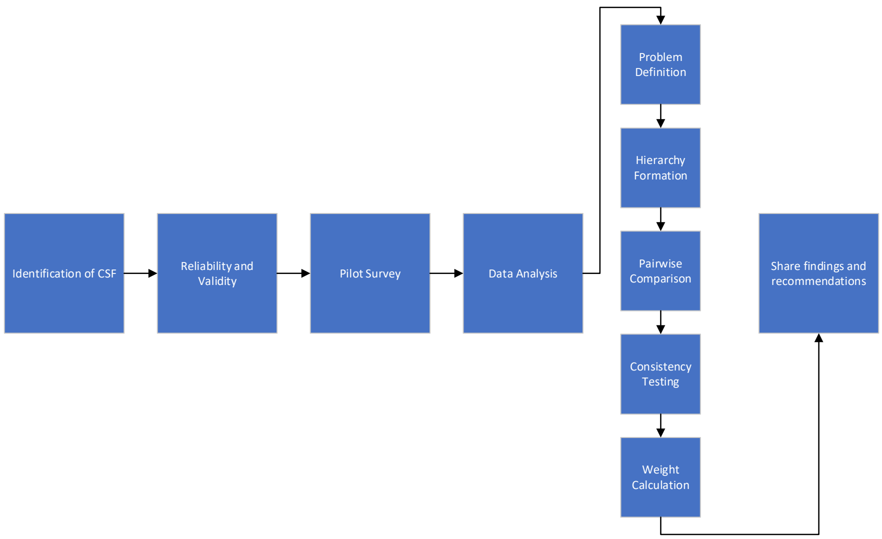
Introduction to Conceptual Framework

The focus of this quantitative study was to explore what clinical directors, clinical managers, implementation consultants, delivery consultants, workflow consultants, and clinical project managers determine as the most critical CSF to mitigate end-user reluctance and enable end-user adoption. The conceptual framework proposed for this study utilized a quantitative method to analyze data using the Analytic Hierarchy Process (AHP). AHP was first introduced in the 1970s by Thomas L. Saaty to identify factors that help make difficult decisions in essential situations (Gupta et al., 2022). Hadi et al. (2021) utilized the AHP model to track project CSF related to project tracking software. Hadi et al. (2021) identified vital concepts that regulate the relationships between CSF and software project performance. Belay et al. (2022) also used AHP to identify and rank CSF in the construction industry. The framework by Belay et al. (2022) incorporated a survey using the AHP. The results included 19 CSF ranked and expanded the understanding of CSF within the construction industry context. The ranking and understanding of CSF revealed that the perception of individuals within a professional paradigm helps identify strengths in project performance (Belay et al., 2022). Similarly, Gupta et al. (2022) demonstrated the ranking of CSF using eigenvector boundaries and weights to analyze survey data.

A conceptual framework was utilized to identify and rank clinical CSF, like the methods used in the frameworks of Hadi et al. (2021), Belay et al. (2022), and Gupta et al. (2022). Furthermore, the five-step AHP framework by Oluleye et al. (2021) guided this study based on the initial step, identifying the problem that there is end-user reluctance and a lack of adoption of the full capabilities of medical device technology due to clinical vendors' lack of consideration of what CSF are needed for clinical implementation success. Oluleye et al. (2021) used hierarchy formation, pairwise comparison, consistency testing, and weight calculation as the final steps to prove CSF are crucial in achieving sustainability in a housing market. The guiding framework from Oluleye et al. (2021) is illustrated in Figure 1. Oluleye Rathore and Elwakil (2020) advocate for the five-step AHP framework. Rathore and Elwakil (2020) suggested developing survey questions that mitigate professional bias and further investigating selecting a finite number of CSF for project success. This shortlisting of CSF was based on a literature review and their impact on a construction organization. The shortlisting selection process used by Rathore and Elwakil (2020) will provide a foundation to identify a shortlist of CSF for medical device implementation without professional bias.

Figure 1

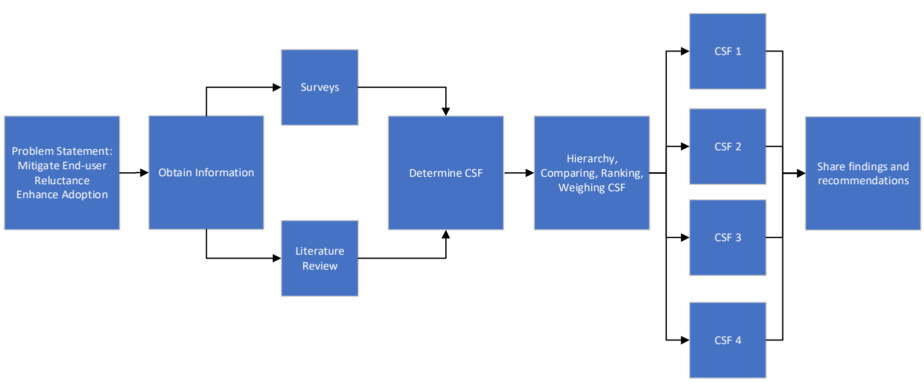
Oluleye et al. (2021) Analytic Hierarchy Process Framework



Note. Adapted from Evaluation of the critical success factors for sustainable housing delivery: analytic hierarchy process approach by Oluleye et al. (2021).

Figure 2

Study Conceptual Framework



The conceptual framework for this study is based on the aforementioned AHP frameworks. The conceptual framework incorporates the AHP methodology before finalizing the recommended CSF list. The recommended CSF determined from this study's results were intended to be shared with other medical vendors to improve medical device adoption. The concepts of the conceptual framework are illustrated in Figure 2.

Introduction to Research Methodology and Design (Nature of the Study)

The proposed research methodology for this study was a quantitative analysis utilizing MANOVA and the AHP framework to determine which CSF are most appropriate to mitigate end-user reluctance and enable end-user adoption. The research design for this study was based on the AHP framework by Oluleye et al. (2021). Oluleye et al. (2021) research evaluated CSF using AHP for housing sustainability. The nature of this study applied the AHP framework illustrated by Oluleye et al. (2021) to the medical device vendors' environment. According to Belay et al. (2022), AHP provides information researchers can use to identify what CSF improves overall project success. In this study, the identification of CSF in medical device implementation was compared to clinical role perceptions of what CSF is most important for medical device adoption. The CSF were ranked through an AHP framework.

Rathmore and Elwakil (2020) revealed that analysis using AHP can determine which factors have a greater effect on organizational performance. This study included an extensive literature review to identify all potential CSF of medical device implementation, which will be considered as possible dependent variables for this study. A survey was used to collect information that was analyzed using MANOVA to measure perceptions of the importance of CSF for medical device adoption from the clinical directors, clinical managers, implementation consultants, delivery consultants, workflow consultants, and clinical project managers within the

HPM organization of Philips Healthcare. The researcher emailed the selection of 96 HPM participants based on A Priori Power Analysis. The emails provided information on survey participation, research intent, privacy, and a summary of the contents. The time commitment to take the survey was approximately 15 minutes. The survey was cloud-based and utilized Smartsheet software. The data were stored for the duration of the research and archived according to the medical device company rules and regulations. SPSS predictive software analyzed the quantifiable Likert data. These data, based on a point scale were essential and gives weights to CSF through pairwise comparisons (Belay et al., 2022).

Research Questions

The following research questions guided this study:

RQ1

To what extent is there alignment between HPM roles of perceived CSF that are the most critical to mitigate end-user reluctance and enable end-user adoption?

RQ2

To what extent is there a hierarchy of recommended CSF perceived by HPM roles to mitigate end-user reluctance and enable end-user adoption?

Hypotheses

$H1_0$

There is no statistically significant alignment between HPM roles of perceived CSF that are the most critical to mitigate end-user reluctance and enable end-user adoption.

$H1_a$

There is a statistically significant alignment between HPM roles of perceived CSF that are the most critical to mitigate end-user reluctance and enable end-user adoption.

H2₀

There is no statistical hierarchy of recommended CSF perceived by HPM roles to mitigate end-user reluctance and enable end-user adoption.

H2ₐ

There is a statistical hierarchy of recommended CSF perceived by HPM roles to mitigate end-user reluctance and enable end-user adoption.

Significance of the Study

This study is essential because it enhances clinical vendors' understanding of CSF needed for clinical implementation success. Professionals ' perceptions of CSF ranking and understanding can strengthen project performance (Belay et al., 2022). Bhide (2023) identifies hospital technology enablement, business processes impacting clinical operational processes, and patient care delivery processes as specific aspects that must be considered in healthcare project management. CSF can be identified and utilized to improve project outcomes if clinical consultant teams can align these clinical aspects with the project management principles of stewardship, team, stakeholders, value, systems thinking, leadership, tailoring, quality, complexity, risk, adaptability and resiliency, and change (Project Management Institute, 2021). This study provides a prioritized and weighted list of CSF essential to clinical implementation, mitigating business concerns and poor project results identified by McCormick (2023). Medical vendors and customers can use the CSF list provided by this study to improve project outcomes associated with medical device implementation.

Definitions of Key Terms

Analytical Hierarchy Process

The AHP is a multicriteria design method that identifies and ranks factors affecting project outcomes (Gupta et al., 2022).

Critical Success Factor

CSF are critical elements that determine whether a project succeeds or fails (Lamprou & Vagiona, 2022).

End-User Adoption

End-user adoption refers to the implementation acceptance of technology by clinical professionals that positively impacts patient outcomes (Yoo et al., 2022).

Key Performance Indicator

KPI are metrics that measure how well an organization performs in a project that is essential to the future success of the organization (Wang, 2019).

Hospital Patient Monitoring

HPM, a division within Philips, is a business that provides services and solutions that improve patient, operational, and economic outcomes (Koninklijke Philips, 2023).

Multivariate Analysis Of Variance (MANOVA)

MANOVA is appropriate when analysis models have multiple dependent variables. MANOVA may also include multiple independent variables or factors in analysis (Kraska, 2022).

Philips Healthcare

Philips Healthcare is a medical device company that delivers innovative healthcare through connected care businesses that improve patient outcomes through clinical delivery and operational outcomes aligned with the quadruple aim (Koninklijke Philips, 2023).

Project Success

Project success is measured by the ability to remain within budget, project quality, staying within timelines, customer satisfaction, and completion of project outcomes (Project Management Institute, 2021).

Reluctance

Reluctance is the barrier to embracing and mastering technology (Gruber et al., 2009).

Resource Allocation

Resource allocation is the distribution and assignment of project resources needed to successfully monitor, deliver, and control deliverables within a project framework (Project Management Institute, 2021).

Scope Creep

Scope creep takes place when additional project demands are met without consideration for adjusting the planned schedule, budget, or resource allocations (Project Management Institute, 2021).

Quadruple Aim

The Quadruple Aim is a model for healthcare quality divided into four distinct categories: improving population health, lowering the cost of care, enhancing the patient experience, and improving provider satisfaction (Young, 2021).

Summary

CSF are vital to clinical implementation success (Schmidt & Wiil, 2020). Vendors must identify and prioritize CSF within medical device implementation projects to mitigate end-user reluctance and ensure adoption (Hadi et al., 2021). The CSF aligned with the Quadruple Aim will help clinical project managers achieve project goals and drive sustainability (Foo et al., 2023).

A quantitative analysis study was conducted to identify and weigh CSF within a medical device implementation project. An AHP framework like Oluleye et al. (2021) was analyzed to determine and weight categorized CSF needed for clinical project success. In Chapter 2 presents a synthesis of literature on CSF and AHP applications in various industries. Like Hadi et al. (2022) and Lamprou and Vagiona (2022), the literature review will helps identify a foundational list of CSF that may be appropriate for medical device implementation. This initial list identified through the literature review will be a foundation for CSF to introduce to clinical leadership to ensure validity and appropriateness for CSF. The research design for this study was based on the five-step AHP framework by Oluleye et al. (2021). The study established a well-defined list of CSF that medical vendors can utilize to ensure clinical implementation success.

Chapter 2: Literature Review

The problem to be addressed by this study was end-user reluctance and lack of adoption of the full capabilities of medical device technology due to clinical vendors' lack of consideration of what CSF are needed for clinical implementation (Schmidt & Wiil, 2020). The purpose of this quantitative analysis study was to determine which CSF can assist medical device vendors in clinical implementation success and end-user adoption. Schmidt and Wiil (2020) suggest that any new technology in clinical implementation projects is challenging to adopt due to end-user workflow. This literature review provides information and context of CSF to help clinical project managers overcome end-user reluctance and other barriers to project success.

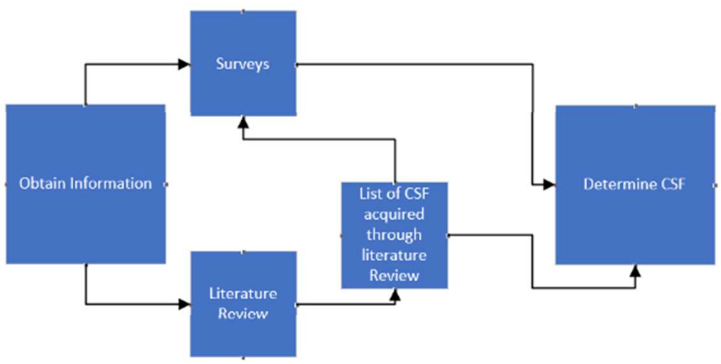
This study researched relevant literature sources (e.g., peer-reviewed journals, articles, publications, and other scholarly works) to synthesize information on CSF to help clinical consultants understand how their perceptions of CSF can be applied using AHP to impact medical device adoption. This study provided clinical vendors with a thorough weighted CSF list for successful medical device implementation; this study will explore other industries (e.g., construction, banking, and other services) to determine the common CSF that led to positive project outcomes.

This literature review examines the theoretical framework of AHP through an extensive review of traditional project management, historical and decision-making methodologies, team constructs, and implementation designs that aid in project success. The literature review also assists in understanding what traditional CSF are necessary to help in the medical device industry with advanced technology implementation, clinical project success, and medical vendor success outcomes.

CSF information in this literature review provides a foundation to query what clinical directors, clinical managers, implementation consultants, delivery consultants, workflow consultants, and clinical project managers determine as the most critical CSF to mitigate end-user reluctance and enable end-user adoption. For clinical project success, many nuances and determinants must be considered (Bhide, 2023). This literature review provided a list of CSF to Philips Healthcare's clinical team, which was then ranked using AHP.

Figure 3

Diagram for CSF Collection in Literature



This quantitative analysis study investigated which CSF were prioritized and implemented by vendors providing medical devices and which factors were perceived to enable the most success for clinical implementation. The literature review was used to provide suggested CSF for the quantitative analysis. Figure 3 illustrates the portion of Figure 2 where the literature review aids in suggesting CSF for clinical teams participating in the survey. The CSF were then entered into the AHP, as depicted in Figure 1.

Two key examples of CSF are effective communication and leadership commitment. According to Qiannong et al. (2019), effective communication among team members was a critical success factor in project management, leading to increased project performance and client satisfaction. In their study, Kulenović et al. (2021) highlighted the significance of top leadership commitment and support as a critical success factor for total quality management. These two examples of CSF were included in a list of CSF that aligns with the theoretical framework of this study.

Literature Review Strategy

Table 1

Literature Review Table of References

Source Type	Year							
	2025	2024	2023	2022	2021	2020	Older	Total
Journal	3	5	11	13	6	6	9	53
Reports		1	3		2			6
Webpage		3	1	2	1		1	8
Book		1	1	1	1		3	7
Conference				1	1	1		3
Total	3	10	16	17	11	7	13	77

Note. Detailed list of sources in References

This literature review examines historical and current research related to CSF and AHP in service industries. The literature was obtained through sources that provide peer-reviewed journals, scholarly articles, and other electronic resources that provide best practices. The academic databases and search directories include the National University Library, *Google Scholar, Sage Journals,* and *ProQuest Central*. The literature review was conducted using the following keywords, terms, and combinations, including *clinical project management, medical device implementation, medical device adoption, CSF, project management frameworks, analytical hierarchy process, clinical project management challenges*, *project change management, project tracking, key opinion leader metrics, and key performance indicators*. Most of the literature reviewed fell within the timeframe of 2020-2023. Seminal literature was included to provide a historical foundation for this study. Table 1 lists the source type and year of references for this study.

Conceptual Framework

The Analytical Hierarchy Process (AHP) is a decision-making methodology developed by Thomas L. Saaty in the 1970s. Saaty initially developed the AHP to address the complexity and subjectivity inherent in decision-making processes. AHP is based on the principle that decision-making involves multiple criteria and alternatives that must be evaluated and compared systematically. The versatility of the AHP allows for its application in a wide range of decision-making scenarios. Whether selecting the best investment opportunity, evaluating project alternatives, prioritizing business strategies, or making healthcare decisions, the AHP provides a systematic framework to support decision-making. The AHP's ability to handle qualitative and quantitative factors makes it particularly suitable for situations involving subjective judgments and trade-offs. By breaking down complex decisions into a hierarchical structure, the AHP enables decision-makers to analyze the relative importance of criteria and alternatives, facilitating a more informed and rational decision-making process (Liu, 2022). Hadi et al. (2021) elaborate that AHP establishes a hierarchy and then sets priorities to ensure consistent results. Research on AHP has continued to increase because the application of AHP provides a structured approach for evaluating and prioritizing multiple criteria in complex decision situations. The AHP has gained popularity across various fields, including business, engineering, healthcare, and public policy, due to its ability to handle subjective judgments and incorporate qualitative and quantitative factors into decision-making processes (Liu, 2022).

AHP framework will be utilized in this study within a clinical environment to determine the success variables in a clinical project plan, specifically those built around medical device implementation. By understanding variables included in CSF within a clinical project plan, vendors and consultants can create a project management framework that improves project success rates. These frameworks include strategies such as stakeholder buy-in, task prioritization, and organizational alignment (Gordon et al., 2022).

Hadi et al. (2021) utilized the AHP model to track project CSF related to project tracking software. The model illustrated by Hadi et al. (2021) targeted identifying CSF in project management of software implementation within the banking industry. People, process, organization, and technology were identified as four critical criteria using the AHP. Hadi et al. (2021) reviewed previous literature to develop a list of appropriate CSF for the banking industry. These CSF were then validated in interviews with a small group of project manager leaders. The results yielded a list of CSF that supported successful software implementation. Lamprou and Vagiona (2022) implemented surveys to analyze CSF, similarly, ranking the success criterion with CSF. Their study identified 40 CSF in the construction industry through extensive literature review. Hadi et al. (2021) and Lamprou and Vagiona (2022) leveraged past research to formulate CSF in various project plans. For this research, a similar process was used to build upon the AHP theoretical framework to develop a clinical project management plan that utilizes top-ranked CSF. CSF, such as unique project procedures, patient outcomes, reduction of healthcare costs, and end-user education, can help clinical project managers determine the success of any clinical project. CSF are areas of focus that are the highest priority for organizations to be successful in project outcomes (Briard et al., 2020).

Hadi et.al. (2021) used AHP for organizing and analyzing complex decisions in the banking industry. The process involved breaking down a problem into its constituent parts, arranging them into a hierarchical structure, and then making pairwise comparisons to establish priorities among the elements. The process began with identifying the problem and the criteria for evaluating the options. These criteria were then organized into a hierarchy, which typically includes the overall goal at the top, followed by the criteria and sub-criteria, and finally, the alternatives at the bottom. Each element in the hierarchy is compared with every other element at the same level using a scale of relative importance, and the results are used to calculate a set of priority weights.

In project tracking software implementation, the AHP process was used to evaluate the CSF across four domains: people, organization, technical, and process. The study identified 20 factors relevant to the successful implementation of project tracking software. These factors were validated through interviews and then evaluated using a questionnaire that asked respondents to compare the importance of each factor using a nine-point scale. The results showed that the people criterion was the most important, followed by process, organization, and technical criteria. The highest priority factors within these domains included self-management and self-discipline, project type, communication, and troubleshooting for the team (Hadi et al., 2021).

Belay et al. (2022) introduced an AHP multicriteria decision technique. The multi-criteria decision model was designed to solve complex technological, economic, and sociopolitical problems through pairwise comparisons. The hierarchical model was divided into several layers, with the goal at the top. The second level of the hierarchy consisted of the main criteria needed to achieve the goal, and subsequent levels included elements with increasing detail. For instance, in the construction industry, a hierarchical model might include categories such as external factors, institutional factors, project-related factors, project management/team-related factors, project manager-related factors, contractor-related factors, and client-related factors. These categories help identify and prioritize CSF for construction projects (Belay et al., 2022).

In the context of Ethiopian construction projects, Belay et al, (2022) identified 19 CSF grouped into six categories: environment-related factors, project-related factors, project management team factors, client-related factors, contractor-related factors, and consultant-related factors. The hierarchy model used in this study was based on three levels: the goal (success-related factors in Ethiopian construction projects), six categories at the second level, and the 19 success-related factors at the third level. The relative weights of criteria at each level were derived using a pairwise comparison matrix with a nine-point scale. Expert opinions were gathered through face-to-face and phone interviews to evaluate the relative importance of each factor and category. The multicriteria included an AHP, but initially defined categories and weights of the CSF based on roles, including clients, consultants, contractors, and academia. Olueye et al. (2021) and Belay et al. (2022) successfully created lists of CSF that improved overall project success.

Oluleye et al. (2021) implemented an AHP five-step approach for sustainable housing delivery. The approach included problem definition, hierarchy formation, pairwise comparison, consistency testing, and weight calculation. Structuring the problem involves defining the objectives, criteria, and alternatives in a hierarchical structure. Hierarchy formation includes appropriate categories for CSF alignment. Pairwise comparison analysis provides information on the relative importance of standards and potential options. Consistency checking helps evaluate the efficacy of pairwise comparisons using consistency indices and ratios. Data analysis weighed the appropriate CSF for project success (Oluleye et al., 2021).

Oluleye et al. (2021) applied AHP in their study to evaluate the CSF for sustainable housing delivery in the Lagos housing market. The process began with a general survey to identify the relative criticality of the success factors. A mean score ranking analysis was used to ascertain the significance of each factor, with a 5-point measurement scale. Factors with mean scores of 4.0 or higher were selected to enter the AHP survey. This step was crucial to reducing the large number of CSF to a manageable size, enhancing the credibility and effectiveness of the AHP survey.

The AHP survey involved selecting experts with more than six years of experience in sustainable housing provision. A five-step AHP approach was adopted, starting with problem definition, which identified the goal of prioritizing CSF for sustainable housing delivery. The hierarchy formation step involved creating a three-stage hierarchy model, with the major goal and sub-criteria at the first and second levels, respectively, and the CSF at the third level. Pairwise comparisons were then made to weigh the CSF against each other using the AHP pairwise scale. The consistency of the judgments was tested to ensure reliability, and the weights of the CSF were calculated by estimating the eigenvector matrix.

The study established that promoting sustainable housing requires several key factors, including government funding, access to low interest housing loans, mandating affordable housing development, community participation, involvement of housing stakeholders, security of life and properties, use of sustainable materials, adaptable housing design, and appropriate land use. These CSF are crucial for promoting government sustainability programs and meeting housing needs. The findings suggest that developers and construction professionals should focus on these CSF to enhance sustainable housing delivery and minimize costs and wastage. The study recommends further research in other states to compare findings and provide a better foundation for sustainable housing delivery in Nigeria. The theoretical framework of this study followed the framework illustrated by Olueye et al. (2021). This choice of framework is based on the logistics of AHP integration and team constructs of Philips' HPM team.

Advantages and Limitations of AHP Theoretical Framework

The AHP offers several advantages that contribute to its popularity among decision-makers. AHP is widely used in academic and practical fields such as engineering, medicine, and other sciences due to its ease of use and comprehensibility. AHP simplifies complex problems by breaking them into smaller, manageable steps, making it easier for individuals to understand and solve intricate issues. Additionally, AHP does not require historical data sets, which makes it accessible for various applications (Karhikeyan et al., 2016). AHP provides a structured and systematic framework that ranks complex, technical, social, and economic decisions to help decision-makers organize their thoughts and consider all relevant criteria and alternatives. Furthermore, the AHP allows decision-makers to weigh the relative importance of criteria, enabling them to focus on the factors that significantly impact the decision outcome (Belay et al., 2022). Similarly, Hadi et al. (2021) suggested the hierarchical structure of the AHP also facilitates transparency and communication among stakeholders, leading to more inclusive decision-making processes.

However, AHP also has its disadvantages. It relies on precise numerical values for judgments, which can be challenging when human emotions and subjective opinions are involved. AHP is limited to linear models and cannot solve non-linear problems. It also requires independent criteria for pairwise comparisons and cannot account for uncertainty and risks in decision-making. Furthermore, AHP is sensitive to changes in the criteria or alternatives, which can lead to inconsistent results. The process can be influenced by the decision maker's experience and preferences, and the number of pairwise comparisons increases significantly with the number of criteria, potentially leading to errors and inconsistencies (Karhikeyan et al., 2016).

One of the main challenges is the restriction of pairwise comparison. AHP can show results only when the problem is consistent (Gamal et al., 2023). Gamal et al. (2023) used an extension of AHP and replaced pairwise with any (n-wise) comparisons illustrated in linear homogeneous equations. This limitation of AHP should not impact the purpose of CSF ranking within the HPM group as the subject nature of the problem is not changing.

Theoretical Framework Summary

The Analytical Hierarchy Process (AHP) is a robust decision-making methodology providing a structured and systematic framework for evaluating and prioritizing criteria in complex decision-making. Its ability to handle subjective judgments and incorporate qualitative and quantitative factors makes it a valuable tool for decision-makers across various fields (Hadi et al., 2021). However, the AHP has certain limitations, such as the subjectivity of pairwise comparisons and the assumption of independence between criteria. Understanding these advantages and limitations is crucial for effectively implementing the AHP and achieving reliable decision outcomes (Gamal et al., 2023).

The theoretical framework for this study is based on the Analytic Hierarchy Process (AHP), a quantitative method introduced by Thomas L. Saaty in the 1970s to aid in decision-making in complex situations. The AHP model has been utilized in various industries, including project management and construction, to identify and rank CSF that influence project performance. For instance, Hadi et al. (2021) used the AHP model to track CSF related to project tracking software, while Belay et al. (2022) applied it to rank CSF in the construction industry1. This study will use the AHP framework to the clinical implementation of medical devices to identify and rank CSF that mitigate end-user reluctance and enable adoption.

Traditional Project Management

History

Project management has deep-rooted origins dating back to ancient civilizations, exemplified by the construction of the pyramids in Egypt around 2560 BC. The pyramids were colossal projects requiring meticulous planning, resource management, and coordination. This historical endeavor showcased early project management principles and emphasized the importance of organization and leadership in overseeing complex projects. In the early 20th century, Henry Gantt introduced the Gantt chart, a visual representation tool that displayed project tasks against a timeline. The Gantt chart provided a simple yet effective method for project managers to track progress, allocate resources, and set deadlines. Gantt's innovative contribution revolutionized project management practices and became a staple tool in project planning and execution. The critical path method (CPM) and Program Evaluation and Review Technique (PERT) emerged in the 1950s as techniques to schedule and manage complex projects more efficiently. CPM identifies the longest sequence of dependent tasks, known as the critical path, which determines the project's minimum completion time (Griffin et al., 2022).

Conversely, PERT emphasizes probabilistic scheduling to account for uncertainties and risks in project timelines, enhancing project managers' ability to plan and allocate resources effectively. The Work Breakdown Structure (WBS) gained prominence in the 1960s as a hierarchical decomposition of tasks, providing a structured approach to defining project scope and deliverables. The WBS breaks down the project into manageable components, enabling project managers to allocate resources, estimate costs, and monitor progress at various stages of the project lifecycle. The Agile approach to project management, originating in the 1990s with the Agile Manifesto, prioritizes flexibility, collaboration, and iterative development over rigid planning and documentation. Agile methodologies promote adaptive planning, continuous improvement, and customer feedback, allowing project teams to respond to changing requirements and deliver value in a dynamic and uncertain environment. In 1969, the Project Management Institute (PMI) was founded, serving as a global organization dedicated to advancing the project management profession. The PMI continues to establish standards, offers certifications, and provides resources for project managers to enhance their skills and knowledge in project management practices. The PMI remains instrumental in shaping the project management discipline and fostering a community of professionals committed to excellence in project management (Griffin et al., 2022).

Decision-Making Methodologies

Decision-making in project management is critical as it forms the backbone of the entire project life cycle. According to Kerzner (2017), effective decision-making can significantly influence the success or failure of projects. Killen et al. (2020) also highlight that successful project outcomes are achieved when there is a well-defined structure to decision-making processes. Alami et al. (2020) illustrate the need for all stakeholders to share a vision that supports the objectives and adaptations needed to achieve outcomes. These shared visions guide a project through its phases.

In contrast, project managers and their teams are confronted with various choices that range from scope definitions and resource allocations to risk management, all of which require a systematic decision-making approach. Decision-making is further emphasized when it comes to resource management, as noted by Lock & Wagner (2019). Project managers must decide how to utilize the best-limited resources, which include staffing, equipment, and capital. The effective distribution of these resources can lead to maximized productivity and reduced costs, while poor decisions can result in resource wastage and budget overruns. By making informed choices, project managers can significantly improve the efficiency of their projects.

There are many decision-making methodologies in project management. Each of methodology has strengths and can suit different decisions and projects. Skilled project managers often select and adapt the decision-making methodology to suit their projects' needs and context.

Multicriteria Decision Analysis (MCDA)

Takar et al. (2024) used MCDA as a structured approach designed to incorporate multiple criteria to evaluate real-world evidence aimed at dealing with uncertainties in cancer drug funding. Decision-makers evaluate the alternatives based on these criteria and use various techniques, such as weighted scoring or cost-benefit analysis, to determine the most beneficial outcome.

Oluleye et al. (2021), Hadi et al. (2021), Belay et al. (2022), and Gamal et al. (2023) all used AHP, which is a type of MCDA. The AHP stands out as the best MCDA method due to its structured approach to decision-making. AHP breaks down complex decisions into a hierarchy of sub-problems, making it easier to analyze and understand each component. This hierarchical structure allows decision-makers to evaluate the relative importance of various criteria and alternatives through pairwise comparisons, leading to more accurate and consistent judgments. Additionally, AHP includes a consistency check to ensure that the decisions made during the pairwise comparisons are logically sound, which helps to identify and correct any inconsistencies in the decision-making process. AHP can be applied to various decision-making problems, from simple to complex, and can accommodate qualitative and quantitative data. This accommodation makes it suitable for multiple applications across different fields. Furthermore, AHP allows for sensitivity analysis, enabling decision-makers to assess how changes in the criteria weights affect the final decision. This analysis helps understand the robustness of the choices made and ensures that the decisions are well-informed and reliable (Theileg et al., 2024).

Theileg et al. (2024) mention the Analytical Network Process (ANP) MCDA; however, they note that the ANP has a high level of complexity and requires very detailed data. ANP involves more intricate calculations and a deeper understanding of the interdependencies among criteria, which can be challenging to implement and interpret. This complexity might deter its use in favor of more straightforward methods like AHP, which still provide robust decision-making frameworks without the added complexity.

Medical Device Project Management

Medical device project management is a specialized field that requires a unique set of skills and knowledge to ensure the successful development and deployment of medical devices. One of the critical aspects of managing such projects is adhering to strict regulatory requirements. Medical devices must comply with various regulations and standards. These regulations ensure that the devices are safe and effective for use. Project managers must be well-versed in these regulations and ensure all project activities align with them (Park et al., 2019).

Park et al. (2019) highlight that stakeholder engagement is another vital medical device project management component. Engaging stakeholders, including clients, team members, regulatory bodies, and other relevant parties, is essential for gathering requirements, gaining support, and ensuring the project meets their expectations. Regular communication and feedback loops help address concerns and make maintain project alignment.

Other critical medical device project management aspects are risk management, resource allocation, and continuous improvement. Identifying and mitigating risks early in the project lifecycle is essential to prevent potential issues impacting the project's success. Proper resource management helps in avoiding delays and maintaining the quality of deliverables. Encouraging a culture of continuous improvement within the project team helps identify areas for enhancement and implement best practices. Learning from past projects and incorporating lessons learned into current and future projects can lead to better outcomes and increased efficiency (Philips, 2024).

Hospital Team Constructs

Schmidt and Wiil, (2020) emphasized that team constructs significantly impact CSF in clinical project management. CSF can be identified and utilized to improve project outcomes if clinical consultant teams align clinical aspects with project management principles such as stewardship, team, stakeholders, value, systems thinking, leadership, tailoring, quality, complexity, risk, adaptability and resiliency, and change. The alignment of these principles with team constructs ensures the clinical implementation is successful and mitigates business concerns and poor project results. Aligning outsourcing governance with vendors' expectations and understanding their CSF is crucial for project success (Wie et al., 2021).

Hospital roles significantly impact project management by defining the responsibilities and expectations of each team member, which in turn influences the success of projects. In hospitals, roles such as project managers, team members, and other professionals are crucial for ensuring that projects are completed on time, within budget, and with the desired quality. The precise definition of roles helps prevent overlaps and gaps in responsibilities, leading to more efficient project execution. Additionally, the competence and experience of individuals in their respective roles play a vital role in project success. For instance, having a dedicated Project

Management Office (PMO) and professionals with specific training in project management can enhance organizational competence and improve project outcomes (Christina et al., 2024).

Hospitals need to invest in developing organizational competence for project success. Christina et al. (2024) also point out that few professionals have certification or specific training in project management. The roles of Christina et al. (2024) study participants are concentrated, with 51% as project team members and 31.4% as project managers. They dedicated an average of 10 hours per week to project activities. The competence of project management in hospitals is not highly developed, despite the existence of a Project Management Office (PMO) and trained people in project management. This research will further explore project management competence in hospitals, which may provide better alignment with the prioritization of CSF with vendors. These internal team constructs also influence how vendor personnel perceive role-based CSF importance during clinical implementation.

Vendor Team Constructs

Wei et al. (2021) discuss the role of contract-based and trust-based control mechanisms in managing relational conflicts in cross-border IT outsourcing from the vendor's perspective. It highlights that relational disputes often arise due to cultural differences and opportunistic behavior. The study finds that vendors' transactional contract schema reduces the effect of trust-based control, while vendors' relational contract schema strengthens outsourcers' contract-based control on relational conflict. Relational conflicts negatively impact project performance. The findings offer insights into the role of outsourcers' control mechanisms and the importance of vendors' psychological contract schemas in managing disputes and improving project performance. The study finds that outsourcers' contract-based control increases relational conflict, while trust-based control decreases relational conflict as perceived by vendors.

Furthermore, contract-based control has a negative effect, while trust-based control has an indirect positive impact on project performance from the vendor's perspective. Limited research offers guidance into this paradigm; however, understanding the team roles of the vendor in this research can help future research in successful medical device implementation (Wei et al., 2021).

The Philips hospital patient monitoring business unit focuses on delivering acute patient management solutions to improve clinical and patient outcomes while achieving operational and economic efficiencies through various services. They leverage a strong presence in the operating theater and intensive care unit (ICU) to enhance customer experience and patient outcomes. This enhancement is achieved through seamless patient data pulled from over 1,000 vendor-neutral devices monitoring from admission to discharge, turning that patient data into actionable clinical insights at the right time and specific to targeted care settings. The matrixed services include various implementation services to maximize value and minimize the impact of technology deployment. These services include project management, installation, technical integration, and application training to facilitate adoption of patient-monitoring solutions in diverse hospital environments. These services span project management, installation, IT integration, interoperability, application training, and construction services (Philips, 2024).

Project Success

Agustus (2024) identified three key themes for successful project management: rigorous planning and monitoring, coordinating stakeholder efforts, and providing leadership and management. These themes can be operationalized into KPI. In the healthcare facilities sector, specific KPI support performance assessment and strategic planning, with integrated models providing a quantitative understanding of facility management performance (Sustainable Construction Engineering and Management, 2021).

Similarly, Pedersen and Heggholmen (2023) highlighted several factors that contribute to the success of a project. These factors include creating support and commitment to the project idea, implementing well-planned workshops and reports, establishing a clearly defined project organization with a project manager, deputy manager, and group leaders for each work area, and ensuring effective communication and meetings. Having shared goals and providing good information, communication, and interaction within and between project groups are critical factors for success.

KPI and Implementation Design

Advancements in project evaluation methodologies, including frameworks and techniques such as fuzzy neural networks and factor analysis, help construction practitioners monitor project competencies and KPI throughout the project lifecycle (Sustainable Construction Engineering and Management, 2021). These neural networks and factor analysis support the need for AHP framework design. Adopting more flexible project methodologies necessitates diverse metrics and KPI, enabling project managers to customize their approaches for different clients. Organizations that lack flexibility stick to strict methods, resulting in extensive paperwork and costs while restricting the project manager's ability to adjust to client needs (Kerzner, 2023).

Project management should not be restrictive to a singular ecosystem. Processes should be flexible, allowing for a wide range of stakeholder satisfaction (Kar et al., 2020). Liu (2022), Hadi et al. (2021), and Oluleye et al. (2021) demonstrated that the AHP framework performs effectively in dynamic ecosystems. The prioritization process enables teams to make commitments, challenge themselves, and make strategic decisions to advance their goals. A flexible process is valuable for measuring the success of projects over time (Kar et al., 2020).

Critical Success Factors

CSF are essential elements contributing to completing a project or achieving business objectives. Lamprou and Vagiona (2022), found that effective project management, including the project manager's competence and the ability to manage resources and mitigate risks, is a primary CSF. Their results highlighted cost, time, client satisfaction, and quality are the most critical success criteria. At the same time, project finance, team competence, and project manager experience are the most CSF.

Grida et al. (2023) identified fourteen CSF categorized into technological, organizational, and environmental. Environmental influences such as law, policies, and competitive pressure, were found to strongly affect blockchain adoption. Similarly, Belay et al. (2022) defined CSF as a series of limited events or activities that are paramount to the success of a business's objectives.

This literature review identifies CSF that are appropriate for implementing medical devices. Because limited CSF research exists in clinical vendor environments, insights from other sectors (e.g., construction, banking, and IT services) inform the identification of transferable CSF. Like Belay et al. (2022), Hadi et al. (2021) confirmed that CSF represent shared enablers of project goal achievement across industries. Hadi et al. (2021) conducted an exhaustive literature review identifying 20 CSF verified as relevant to software implementation. This study will conduct a similar CSF verification with the leadership of the HPM team. A comprehensive list of CSF, identified through a literature review, will be evaluated for this research.

End-User Adoption

Many clinical projects require education to ensure end-user competence and help with technology adoption. Healthcare providers must understand a certain level of project management. Applying project management theory can drive efficiency, primarily through project management software. Clinical Project Managers (CPM) who understand the phases of initiating, planning, executing, monitoring, and closing within clinical education have greater success at meeting project timelines (Dilly et al., 2021). Applying the foundation of clinical education methodology to a project management program will help measure clinical KPI and CSF. Educators must also understand their classroom teaching styles to ensure the education and project plan goals are achieved (Wages, 2022). Understanding the need for successful education outcomes can build a project management platform encompassing CSF, such as adoption and sustainability metrics. A CPM applying these CSF to a clinical project framework will have better results. Furthermore, identifying project management tools for clinical education will save valuable time when turning theory into practice for business applications.

Project Outcomes Strategies

Many healthcare establishments are burdened with improving patient outcomes while reducing economic expenditures. CPM can adopt strategies to bring value to medical equipment and IT upgrades. Six strategies help with project success. These strategies include embracing the organizational structure, stakeholder buy-in, project lifecycles, task prioritization, change management, and communication. Project success is also determined based on project management stakeholders who are accountable, responsible, consultative, informative, authoritative, and realistic in different phases of project management (Gordon et al., 2022). Applying project strategies and roles will help build a successful clinical project plan. Once these goals are identified, they can be molded into CSF for future research and theory applications. The hypothesis would argue that there would be greater project success by transforming strategy and roles into factors that can be measured within a customer-facing dashboard. Real-time performance insights enable timely course correction and enhance stakeholder confidence in implementation progress. Furthermore, dashboards incorporating categories and metrics that allow measurements will help analyze CSF (Geordy et al., 2022).

In addition to the strategies mentioned by Gordon et al. (2022), Philips has developed a comprehensive approach to outcome strategies that focus on patient-centric innovation and supply chain reliability. The company's strategy emphasizes the importance of delivering scalable solutions and prioritizing patient safety and quality. By simplifying workflows and improving supply chain reliability, Philips aims to enhance its medical device implementations' overall efficiency and effectiveness (Philips, 2024).

Philips also strongly emphasizes generating early value and capturing its technology's return on investment (ROI). This value involves creating marketing claims, ensuring customers maximize the utilization of their equipment, and generating data for benchmarking and peer-reviewed publications. By demonstrating the tangible benefits of its technology, Philips can build stronger relationships with customers and drive better outcomes for patients and healthcare providers (Philips, 2024).

Change Management

Project costs and scope can be negatively impacted without change management. Clinical projects involving health information technology (HIT) fail due to a lack of adoption. The lack of adoption creates unwanted expenditures and revamps of clinical project management. A robust change management plan will ensure end-user goals and optimal patient outcomes. The root cause is placing value on technology rather than on people who use the technology. Change management must mitigate adoption failure when considering large IT plans or clinical projects involving medical equipment upgrades. Creating value starts with understanding organizational agility. Vargas-Maldonado (2021) found that organizational agility must have a framework that defines the organization's strategy, capabilities, hierarchy, and people.

Effective change management is crucial for project success as it helps organizations navigate the complexities of implementing new processes, systems, or structures. Leaders can impact by addressing the human side of change and using change management to ensure stakeholders are prepared, engaged, and supportive of the transformation (Tun & Madanian, 2023). Clear communication, training, and support help reduce resistance and foster a positive attitude toward the change. Additionally, involving stakeholders in the planning and implementation phases can enhance their commitment and ownership of the project. Ultimately, successful change management leads to smoother transitions, minimizes disruptions, and increases the likelihood of achieving project goals and objectives (Tun & Madanian, 2023).

Project Management Platform Utilization

When building a clinical project platform that provides up-to-date statuses, understanding leadership styles can help bring value to key opinion leaders and key stakeholders. The research by Geordy et al. (2022) can be leveraged to build dashboards to meet the needs of leadership that align with the project framework and project phase. A firm understanding of leadership styles can assist in future theoretical frameworks and pivots from theory to application. Clinical project platforms must be agile and value the customers versus the equipment.

Clinical project dashboards can be populated from task-tracking software. CPMs must have the means to validate project status. Clinical leadership, IT infrastructures, management styles, knowledge, and project management differ from institution to institution. The diversity in healthcare environments leads to communication problems when completing tasks. The result is poor resource management, undefined deliverables, and unrealistic deadlines. Task-oriented software bridges the communication gap and mitigates task-oriented risks within a clinical environment. Task-oriented software is invaluable when implementing any clinical project management program (Purohit et al., 2017).

Clinical project management impacts all levels of a healthcare institution. One key to successful project management is the ability of all levels to understand informatics and project planning. Nursing staff have an exuberant number of required competencies for employment. One of the most essential competencies is project management. Nursing project management skills can help build design, planning, implementation, follow-up, and evaluation frameworks.

Furthermore, any clinical project impacting patient care should emphasize identifying critical nursing roles requiring additional project management skills (Sipes, 2016). The AHP framework survey questions become the foundation for CSF and project success. Understanding stakeholder roles is essential to build these surveys (Octavianus & Mursanto, 2018). Clinical projects have various stages requiring stakeholders at the executive and patient levels. Nurses are stakeholders in any clinical project management. At the core of any clinical project, nurse informaticists provide critical insights into driving patient outcomes.

AHP In Medical Device Implementation

The Analytic Hierarchy Process (AHP) has the potential to become a valuable tool in medical device implementation despite a relative scarcity of comprehensive research on its application in this specific context. Liu (2022), Hadi et al. (2021), and Oluleye et al. (2021) demonstrated that AHP facilitates multicriteria decision-making by structuring complex problems into a hierarchy, allowing for systematic comparison between various factors such as cost, safety, efficacy, and user experience. This structured approach helps decision-makers prioritize options based on subjective and objective criteria, leading to more balanced and informed choices. However, the lack of extensive case studies and empirical research on AHP's effectiveness in medical device implementation highlights a significant gap in the literature. Addressing this gap could provide healthcare stakeholders with robust methodologies for selecting and integrating medical devices, ultimately enhancing patient care and operational efficiency. Further research is, therefore, necessary to validate and optimize the use of AHP in this domain, ensuring that decision-makers can rely on a credible and tested approach (Park et al., 2019).

Suggested CSF Based on Literature Review

Many industries, apart from the medical sector, have published the use of CSF in project management. One example of CSF use is suggested through the research by Mohamed et al. (2022). CSF factors were ranked based on their degree of prominence and relationships, with environmental factors being the most critical for successful blockchain adoption. Mohamed et al. (2022) suggested CSF are:

- Technological Factors:
    - Scalability
    - Infrastructural facility
- Organizational Factors:
    - Top management support
    - Adequate resources
    - Financial constraints
- Environmental Factors:
    - Law and Policies

- Competitive pressure

Mohamed et al. (2022) provide a high-level categorical list of CSF, which can categorize Lamprou et al. (2022) suggested list of CSF, defined per corresponding literature. Similarly, Lamprou et al. (2022) categorize CSF into project mission and control, senior management support, project communication, and project planning and control. The common CSF in Lamprou et al. (2022) research is listed in Table 2.

Table 2

Common CSF

CSF
Project Mission
Top Senior Management Support
Project Communication
Project Planning
Project Lead Competence
Technology Environment
Project Financing
Political Environment
Social Environment
Monitoring and Feedback
Risk Identification
Project Organization Structure
Economic Environment
Project Team Competence
Project Size and Complexity
Project Plan Level of Details
Problem-Solving
Effective Quality Assurance
Adequate Resourcing
Project Urgency
Project Client Characteristics
Effective Progress Review
Natural Factors
Realistic Project Forecasting

Based on the suggested CSF above, the following categories and CSF will be utilized within the conceptual model indicated in Figure 3. The categorization of CSF for the conceptual model is listed in Table 3.

Table 3

Categorized CSF for the Conceptual Model

CSF	Brief Description
	Technological Factors
Scalability	Ensuring the project can handle growth.
Infrastructural Facility	Having the necessary infrastructure in place.
Technology Environment	Suitable technological environment.
	Organizational Factors
Top Management Support	Commitment from senior leadership.
Adequate Resources	Ensuring sufficient resources are available.
Financial Constraints	Managing the project's budget effectively.
Project Mission	Clear goals and objectives.
Project Communication	Effective communication throughout the project.
Project Planning	Detailed planning and monitoring.
Project Lead Competence	Skilled Leadership.
Project Organization Structure	Effective organizational structure.
Project Team Competence	Skilled project team.
Project Size and Complexity	Managing project scope.
Project Plan Level of Details	Detailed project planning.
Problem-Solving	Effective problem-solving strategies.
Adequate Quality Assurance	Ensuring quality standards.
Adequate Resourcing Management	Managing resources efficiently.
Project Urgency	Addressing project timelines.
Project Client Characteristics	Understanding client needs.
Effective Progress Review	Regular progress assessments.
Realistic Project Forecasting	Accurate project forecasting.
	Environmental Factors
Law and Policies	Compliance with legal and policy requirements.
Competitive Pressure	Addressing competition in the market.
Political Environment	Navigating political factors.
Social Environment	Considering social impacts.
Economic Environment	Understanding economic factors.
Natural Factors	Considering natural factors.

Applying CSF In Absence of Literature

This literature research is limited to models of AHP and MCDA in other industries as there are very few medical device project management resources to model a suggested AHP framework used explicitly for vendors' roles associated with medical device implementation (Park et al., 2019). This limitation in research does not mean that no AHP models have been used in the medical device industry. The AHP literature provides frameworks for end-users, such as hospital stakeholders, to provide insight into the evaluation processes of such devices. An example is the study by Park et al. (2019), which provided insight into the future development of the medical device industry, highlighting the challenges posed by differing perspectives and values of various stakeholders. It emphasizes the need for an evaluation framework that objectively assesses medical devices by considering these diverse viewpoints. The AHP analysis reveals that the importance of evaluation indicators varies among stakeholders, suggesting that a tailored framework can address these differences. The document concludes that such a framework can enhance the evaluation process, improve the selection and development of medical devices, and contribute to the industry's growth by providing objective data on economic efficiency, usability, safety, and effectiveness. The lack of research supports this study and the application of AHP for CSF in medical device implementation. Future studies will benefit as suggested CSF can be reinvestigated for niche clinical areas such as hospital patient monitoring or medical imaging (Park et al., 2019).

Literature Review Summary

As future research around clinical project management evolves, all stakeholder opinions must be aligned in theory and practice. The framework of moving theory to practice with nursing while providing real-time project CSF can synergize the portfolio of clinical project management. Applying the AHP theoretical framework can provide an invaluable foundation in driving clinical project success through research that can bring clinical project management to the bedside and improve patient outcomes. The literature offers a firm application process to identify CSF and KPI within a clinical project implementation plan. CPMs must have the ability to identify all levels of project stakeholders. Understanding stakeholders' roles can then aid in determining which stakeholders to engage with at different project phases. CPMs can succeed better by understanding leadership styles that assist in project decision-making and resource management. CPMs that understand roles and factors to measure project success can create insights and real-time project status updates to ensure project success. Synergizing the research, tools, and the AHP framework will make a successful project management plan for clinical application.

The study addresses the issue of end-user reluctance and lack of adoption of medical device technology due to clinical vendors' failure to consider CSF necessary for clinical implementation. The aim is to determine which CSF can assist medical device vendors in achieving clinical implementation success and end-user adoption. The literature review will provide information and context on CSF to help clinical project managers overcome end-user reluctance and other barriers to project success.

The study will research relevant literature sources to synthesize information on CSF, helping clinical consultants understand how their perceptions of CSF can be applied using the AHP to impact medical device adoption. It will explore other industries to determine common CSF that led to positive project outcomes, providing clinical vendors with a thorough weighted CSF list for successful medical device implementation.

The literature review will examine the theoretical framework of AHP through an extensive review of traditional project management, historical and decision-making methodologies, team constructs, and implementation designs that aid in project success. It will also assist in understanding what traditional CSF are necessary to help the medical device industry with advanced technology implementation, clinical project success, and medical vendor success outcomes.

CSF information in this literature review will provide a foundation to query what clinical directors, clinical managers, implementation consultants, delivery consultants, workflow consultants, and clinical project managers determine as the most critical CSF to mitigate end-user reluctance and enable end-user adoption. The literature review will provide a list of CSF to Philips Healthcare's clinical team, which will then be ranked using AHP.

Chapter 2 detailed an in-depth analysis of the CSF essential for successfully adopting medical equipment within healthcare systems. This chapter elucidated the challenges medical device vendors face, such as end-user reluctance and the necessity for robust education and support structures. By integrating these CSF, we aim to enhance project success and improve patient outcomes. Chapter 3 will provide insight into the research methodology and design. Chapter 3 will detail the quantitative approach employed to identify and rank the most critical CSF, utilizing the AHP framework. Examining the perceptions of various clinical roles within the HPM division of Philips Healthcare, using AHP, will provide a comprehensive analysis of the factors that facilitate successful clinical implementation and mitigate end-user reluctance.

Chapter 3: Research Method

The problem to be addressed in this study was end-user reluctance and lack of adoption of the full capabilities of medical device technology due to clinical vendors' lack of consideration of what CSF are needed for clinical implementation (Schmidt & Wiil, 2020). The purpose of this quantitative analysis study was to determine which CSF can assist medical device vendors in clinical implementation success and end-user adoption. Schmidt and Wiil (2020) suggest that any new technology in clinical implementation projects is challenging to adopt due to end-user workflow.

This study utilized a MANOVA to assess how different roles within the Hospital Patient Monitoring division of Philips Healthcare in the U.S. perceive the factors influencing project success or failure. It examined how the CSF related to project performance are applied within the complex structure of a medical device vendor's environment (Briard et al., 2020). The problem addressed by this study is end-user reluctance and lack of adoption of the full capabilities of medical device technology due to clinical vendors' lack of consideration of what CSF are needed for project success. The alignment of CSF is essential for clinical implementation success (Schmidt & Wiil, 2020). The purpose of this quantitative analysis study is to determine what CSF are being implemented by vendors providing medical devices and which factors enable the most success for clinical implementation (Schmidt & Wiil, 2020).

The chapter begins with an introduction, restating the problem and purpose, and provides an overview of the research methodology and design, which addresses this research's problem, purpose, and hypothesis. The chapter provides comprehensive information regarding the target population and the purposive sampling method to gather sufficient relevant data to support this research. Furthermore, it details the materials and instrumentation utilized and the specific procedures that participants must follow to effectively conduct and contribute to the study. Additionally, this chapter clarifies the methods for analyzing the collected data. It also encompasses sections on assumptions, limitations, delimitations, and ethical assurances, culminating in a summary that concludes the chapter.

Research Methodology and Design

This quantitative analysis study was designed to determine which CSF can assist medical device vendors in clinical implementation success and end-user adoption, as new technology can be challenging to understand (Schmidt & Wiil, 2020). Quantitative analysis was used to measure and rank perceptions of CSF. The research methodology for the study was a quantitative analysis utilizing MANOVA and the AHP framework. This approach is chosen to determine which CSF are most appropriate to mitigate end-user reluctance and enable end-user adoption of medical devices.

The research design is based on the AHP framework by Oluleye et al. (2021), which was used to evaluate CSF for housing sustainability and is now applied to the medical device vendors' environment. A quantitative design is appropriate for the study's problem and purpose as it provides a structured approach to identify and rank the CSF, which is crucial for understanding the factors that lead to successful clinical implementation and end-user adoption of medical devices. MANOVA allows for the analysis of multiple dependent variables, which suits the study's aim to measure perceptions across different roles within the Hospital Patient Monitoring (HPM) division. The AHP framework ranks the importance of CSF, aligning with the study's purpose of providing a prioritized list of CSF.

Experimental design and longitudinal studies are were considered for this study. According to Hassan (2024), experimental research manipulates independent variables to observe effects on a dependent variable, establishing cause-and-effect relationships. It involves control and experimental groups to test hypotheses by isolating and controlling variables to establish causality. Controlling variables was unsuitable for a study aiming to assess perceptions and rank CSF. Longitudinal studies involve continuous or repeated measures to follow individuals over long periods, often years or decades. Longitudinal studies are observational, collecting quantitative and qualitative data on exposures and outcomes without external influence (Caruana et al., 2015). Due to financial needs and the support of a longitudinal study, this type of research is irrelevant to a study focused on current perceptions and the ranking of CSF at a single point.

Other methodologies include mixed methods, which incorporate both qualitative and quantitative methodologies. According to Tenny et al. (2024), qualitative and quantitative research have distinct philosophical paradigms and evaluation criteria1. This paradigm creates potential biases in qualitative research, such as observation bias, and can affect the integration of qualitative data with quantitative data. Although qualitative and quantitative approaches are not necessarily opposites and can complement each other, combining them can be challenging (Tenny et al., 2024). Combining quantitative and qualitative methods can be challenging due to several reasons. Firstly, these methods are often rooted in different philosophical paradigms; quantitative research is based on a positive philosophy, which assumes an objective reality that can be measured, while qualitative research follows a constructivist philosophy, acknowledging that reality is subjective and constructed by individual experiences. Secondly, the evaluation criteria for these methods differ significantly; quantitative research focuses on validity, reliability, and objectivity, whereas qualitative research emphasizes credibility, transferability, dependability, and confirmability. Lastly, qualitative research is susceptible to observation biases, such as the Hawthorne effect and observer-expectancy effect, which can affect the integration of qualitative data with quantitative data, leading to skewed results. While mixed methods offer quantitative and qualitative insights, a mixed methods approach may not be necessary if the primary goal is to measure and compare perceptions quantitatively (Tenny et al., 2024).

Alternative methodologies, such as qualitative research designs, were considered less appropriate because they might not provide the same level of structured, quantifiable data needed for this study's aim. Qualitative research design is valuable for exploring and providing deeper insights into real-world problems by gathering participants' experiences, perceptions, and behaviors. However, its limitations might make it less suitable in specific contexts. The complexity of quantification of qualitative data makes it challenging to generate numerical data points. Non-linearity can make it difficult to replicate the study and achieve consistent results. (Tenny, et al., 2024).

Qualitative designs do not allow for statistical analysis, essential for identifying the most critical CSF across various roles (Tenny et al., 2024). Ethnography and phenomenology are two qualitative methodologies that can assist researchers with data on why certain CSF are perceived to be necessary. Ethnography is a qualitative research approach that allows the researcher to become immersed in the social aspects of the population. Although an ethnographic approach would enable the research to illustrate why certain CSF are perceived to be necessary, ethnographic data would be difficult to gather in this research study due to longevity and inability to interact with the population at Philips (Tenny et al., 2024). Likewise, Tenny et al. (2024) explain that phenomenology is time-consuming as researchers must investigate why individuals have their perspectives.

Population and Sample

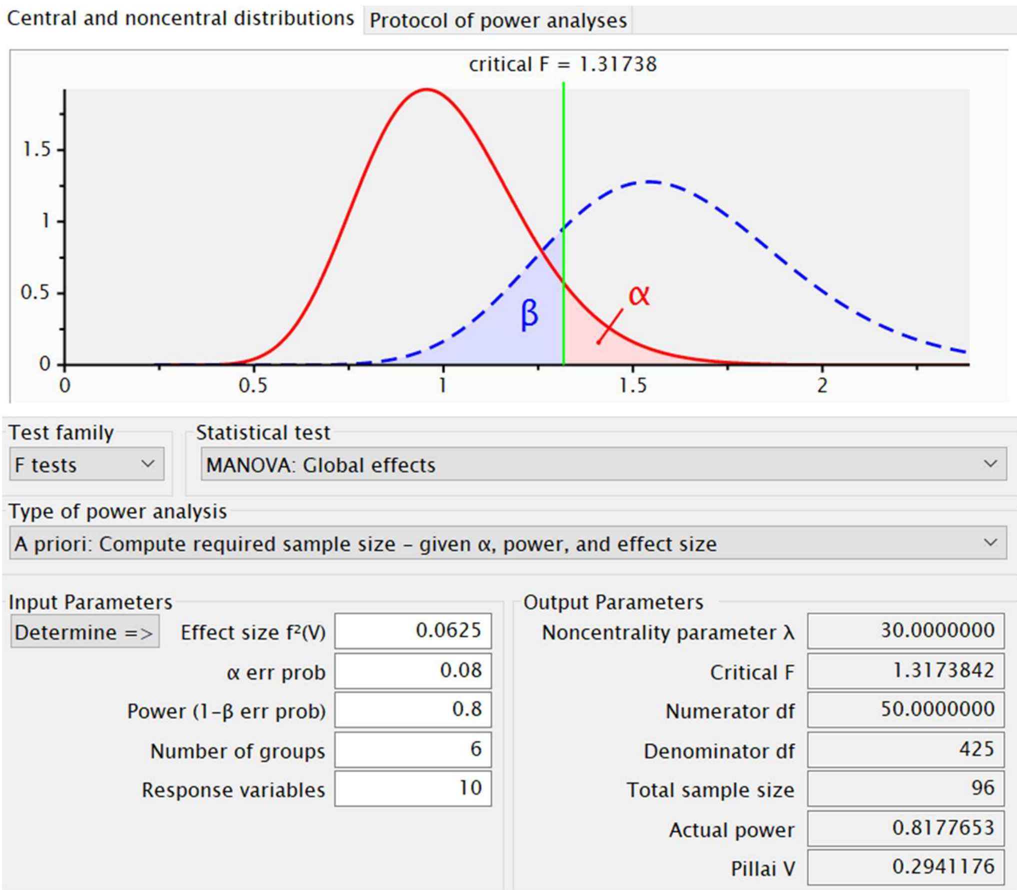
Research depends on data representing the population in the study. Total populations are a logical means to analyze data; however, time and funding constraints often limit whole population representation. Therefore, accurate sampling is essential to conduct research with minimal error and bias. Factors such as population, funding, time, and study design dictate which sampling method is needed to perform the best research (Sarfo et al., 2022). A sample comprises the individuals from whom data is collected and represents a share of the population for whom conclusions are drawn. The sample size, or the number of individuals included, is central to statistical applications in clinical research. Researchers often have limited resources and time, making collecting data from an entire population infeasible. Therefore, they rely on samples to make inferences about the population (Cao et al., 2024).

Statistical power refers to the likelihood of accurately rejecting the null hypothesis. It depends on four factors: the effect size, the model error variance, the Type I error rate (α), and the sample size (Kelley et al., 2023). The population of interest was the post-sales (PS) clinical organization of the HPM division within Philips Healthcare. Random sampling was used to reduce sampling errors for 200 respondents within HPM. A sample size of 96 was determined based on MANOVA effects, an effect size of 0.0625, and a Type 1 error of 0.8, considering six independent and ten dependent variables, using G*Power software. The total number of participants depended on the margin of error, confidence level, and estimated size based on standard deviation (Thomas, 2022).

A Priori Power Analysis

Figure 4

F-Test for Estimated Sample Size



G*Power software was used to calculate the estimated sample size needed in MANOVA with global effects. Figure 4 shows the results when the effect size is small, and the alpha is .08. The beta was 0.0625, indicated by the power of 0.8. The estimated total sample size result is 96, well within the HPM population of 200. The criteria for participating in the survey was to have the job function in one of the following roles: clinical director, clinical manager, implementation consultant, delivery consultant, workflow consultant, or clinical improvement thought leader.

Participants were selected from an email distribution list supplied by Philips. Sampling ensured equal distribution by role and the ability to take an online survey using Smartsheet software.

Materials or Instrumentation

This quantitative study included six independent variables, which are the roles of clinical director, clinical manager, implementation consultant, delivery consultant, workflow consultant, or clinical project manager. The study measured 27 dependent variables which are the following CSF: Scalability, Infrastructural Facility, Technology Environment, Top Management Support, Adequate Resources, Financial Constraints, Project Mission, Project Communication, Project Planning, Project Lead Competence, Project Organization Structure, Project Team Competence, Project Size and Complexity, Project Plan Level of Details, Problem-Solving, Adequate Quality Assurance, Adequate Resourcing, Project Urgency, Project Client Characteristics, Effective Progress Review, Realistic Project Forecasting, Law and Policies, Competitive Pressure, Political Environment, Social Environment, Economic Environment, and Natural Factors. The list of CSF, along with their categorization and description, is illustrated in Table 3. Demographics were based on the current roles of the HPM post-sales team current with Philips (2024). The first section of the survey will collect respondents' profiles, like the work by Lamprou and Vagiona (2022).

Lamprou & Vagiona utilized a survey of questions to rank (dependent variables) CSF and weight perceptions of specific roles, which was adapted based on the guiding framework of Olueye et al. (2021). This established framework provided a standardized and validated instrument (Hassan, 2024). The relative importance of CSF were determined by creating a pairwise comparison matrix using a nine-point scale. This scale ranged from 1 (equal importance) to 9 (absolute importance), with intermediate values of 2, 4, 6, and 8 representing varying degrees of importance between adjacent scale values and to understand the ranking of perception of CSF based on the categorized CSF of the conceptual model illustrated in Table 3 (Belay et al., 2022).

The researcher emailed the HPM team based on a numbered list of the population's last and first names. A random number generator was used to select 96 participants. The initial target of 96 participants was reached, therefore, another random sampling was not conducted from the original email list. This selection process continued until the sample size was met or the entire population had been requested to participate. The email contained information regarding research intent and privacy and a summary of the survey contents. The time commitment to take the survey was approximately 15 minutes. The survey was cloud-based and utilized Smartsheet software. The data were stored for the duration of the research and archived according to the medical device company rules and regulations. SPSS predictive software was used to analyze the quantifiable Likert data. The survey utilized for this research is included in Appendix A.

Validity and Reliability

Validity refers to the extent to which a measure or a set of measures correctly represents the concept of study. Validity can be considered from two aspects: findings and instruments. Internal and external validity should be evaluated for the validity of findings. Two types of validity evidence are highlighted for the validity of instruments: construct validity and content validity (Hou & Aryadoust, 2021). Reliability refers to the consistency of research results and the replicability of the research. Reliability involves evaluating the reliability of instruments and coding processes through internal reliability and test-retest reliability (Hou & Aryadoust, 2021).

To check for validity and reliability using MANOVA, addressing common challenges and ensuring the test assumptions are met is crucial. Hassan (2024) states that normality is achieved when dependent variables are normally distributed between groups. Validity was assessed by normalizing dependent variables through Z-score standardization or Min-Max normalization. Each role within the dependent variable group was asked the same questions to ensure normality. Linearity is a property of a system or function that satisfies two main principles: additivity and homogeneity (Metler, 2022). Additivity means that the response caused by two or more stimuli is the sum of the responses that would have been caused by each stimulus individually. Homogeneity (or scaling) means that if a factor scales the input, the output is scaled by the same factor (Metler, 2022). Mertler (2022) also indicated that dealing with non-normality is essential, and this can be achieved through data transformations or by considering non-parametric alternatives. SPSS was used to screen all data conducted in MANOVA to ensure linearity and homogeneity. Outliers were addressed by identifying and analyzing them using boxplots and Mahalanobis distance to ensure they do not bias the results. Addressing multicollinearity by examining the correlation matrix and considering variable selection or regularization techniques is also essential. Ensuring an adequate sample size through power analysis and striving for a balanced design enhances the reliability of the results (Mertler, 2022).

According to Hassan (2024), MANOVA is appropriate when the dependent variables are measured on a scale to evaluate the impact of independent variables. The dependent variables were transformed into scaled variables based on a CSF ranking of 1-9 from Belay et al. (2022). Cronbach's alpha was estimated for reliability and validity. Coefficients were used to calculate the variables and placed into a range to determine the level of perception. Cronbach's alpha helps determine whether the items in a scale consistently measure the same underlying concept and are free from random error (Benato et al., 2021). The survey also helped gather valuable demographics, including years of experience, role, and geography. This demographic information was nominal and used to investigate constructs of variable relationships.

This research instrument's validity was supported based on the work by Lamprou and Vagiona (2022). Lamprou & Vagiona (2022) identified and evaluated success criteria and CSF in project success. The process involved collecting 250 complete responses, which were recorded, codified, parameterized, and organized in a database for further analysis. Their statistical analysis employed descriptive statistics, correlation analysis, and other statistical tests, utilizing IBM SPSS Statistics v.25 and other appropriate data processing software. This comprehensive approach ensured systematic organization, simplification, interpretation, and presentation of the data, leading to valuable research findings. Lamprou and Vagiona (2022) comprehensively analyzed the various perspectives on project success, highlighting the significant differences and deviations in how stakeholders perceive success. The research emphasized the importance of considering the views of all main stakeholders, including the owner, contractor, project manager, project team, client, user/end user, and community, to interpret project success accurately. Due to the lack of supporting literature on identified CSF for successful medical device adoption, the validity of Lamprou and Vagiona (2022) was utilized in this research.

Operational Definitions of Variables

This study utilized a conceptual framework to identify and rank clinical CSF, like the methods used by Hadi et al. (2021), Belay et al. (2022), and Gupta et al. (2022). The five-step AHP framework by Oluleye et al. (2021) guides this study, addressing the problem of end-user reluctance and lack of adoption of medical device technology due to clinical vendors' lack of consideration of CSF needed for clinical implementation success. The CSF categorized in research by Mohamed et al. (2022) and Lamprou & Vagiona (2022) were classified into technology, organization, and environment categories.

Dependent Variable

The dependent variables (CSF) for the successful implementation of medical device technology are categorized into three main areas: technological, organizational, and environmental. The categories of the variables are listed in Table 3. Technological factors include scalability, infrastructural facility, and a suitable technology environment. Organizational factors encompass top management support, adequate resources, financial constraints, clear project mission, effective communication, detailed planning, skilled leadership and team, project size and complexity, problem-solving strategies, quality assurance, and realistic forecasting. Environmental factors involve compliance with laws and policies, competitive pressure, political and social environments, economic conditions, and natural factors. These CSF will be provided in a list so that respondents can rank their perceptions of importance. The hierarchy of importance will then be divided by role (independent variable), like the AHP of Hadi et al. (2021), Belay et al. (2022), and Gupta et al. (2022). Table 4 illustrates the dependent and independent variables.

Independent Variable

The independent variables of the HPM roles include clinical director, clinical manager, implementation consultant, delivery consultant, workflow consultant, and clinical project manager. The data to identify these roles will be collected in the demographic section of the survey in Smartsheet. These demographics will provide context to RQ1: To what extent is there alignment between HPM roles of perceived CSF that are the most critical to mitigate end-user reluctance and enable end-user adoption, and RQ2: To what extent is there a hierarchy of recommended CSF perceived by HPM roles to mitigate end-user reluctance and enable end-user adoption? MANOVA is appropriate when analysis models have multiple dependent variables and may include multiple independent variables or factors (Kraska, 2022). Independent variables are nominal and dependent, considered ordinal variables, and scoring will be based on a ranking scale of importance from 1- 9 (Belay et al., 2022).

Table 4

Independent and Dependent Variables

Independent Variables (Roles)	Dependent Variables (CSF)
R1 Clinical Director	CSF 1 Scalability
R2 Clinical Manager	CSF 2 Infrastructural Facility
R3 Implementation Consultant	CSF 3 Technology Environment
R4 Delivery Consultant	CSF 4 Top Management Support
R5 Workflow Consultant	CSF 5 Adequate Resources
R6 Clinical Project Manager	CSF 6 Financial Constraints
	CSF 7 Project Mission
	CSF 8 Project Communication
	CSF 9 Project Planning
	CSF 10 Project Lead Competence
	CSF 11 Project Organization Structure
	CSF 12 Project Team Competence
	CSF 13 Project Size and Complexity
	CSF 14 Project Plan Level of Details
	CSF 15 Problem-Solving
	CSF 16 Adequate Quality Assurance
	CSF 17 Adequate Resource Management
	CSF 18 Project Urgency
	CSF 19 Project Client Characteristics
	CSF 20 Effective Progress Review
	CSF 21 Realistic Project Forecasting
	CSF 22 Law and Policies
	CSF 23 Competitive Pressure
	CSF 24 Political Environment
	CSF 25 Social Environment
	CSF 26 Economic Environment
	CSF 27 Natural Factors

Study Procedures

The purpose of this quantitative analysis study was to determine which CSF can assist medical device vendors in clinical implementation success and end-user adoption, as new technology can be challenging to understand (Schmidt & Wiil, 2020). The HHS regulations at 45 CFR part 46 for the protection of human subjects in research require that an investigator obtain the legally effective informed consent of the subject or the subject's legally authorized representative. IRB approval was obtained before sending the survey to participants (U.S. Department of Health and Human Services, 2024). Participants were provided with an introductory consent form within Smartsheet before the survey opened. Participants were permitted to take the survey. Participants were not allowed to proceed with the study without acknowledging having read the consent.

Data Analysis

Survey data were exported into SPSS for screening, cleaning, and statistical analysis. Data was cleaned to provide the ability to make sound, strategic decisions. When an organization has poor data quality, it leads to dissatisfied customers, inefficiencies, and an inability to make a positive change (Sweary, 2019) accurately. MANOVA was conducted to compare perceived CSF importance across clinical roles. This ranking aligned with the AHP model by Mohamed et al. (2022). The data, framework, information, and story provided by research and MANOVA were held to a high personal standard. There was no partiality in the summation of findings. Any decisions were made because of this research was taken with the same guiding principles used for this data analysis. All data aggregation and processing were provided through appropriate channels and reported similar procedures. The information was transparent, and there were no hidden agendas or gains to be made from the misrepresentation of data.

Assumptions

The research conducted in this study was based on several key assumptions. Firstly, it was assumed that participants responded to the survey questions truthfully and comprehensively, ensuring the validity and reliability of the collected data. Additionally, the study assumed that all project manager participants possessed the necessary professional experience to answer the survey questions thoroughly. These assumptions were crucial for substantiating the validity and reliability of the data collected (Lojda, 2019). One final general assumption was that all roles will remain unchanged without a title change. If titles change before conducting the survey, the nomenclature of roles were to be changed.

According to Hassan (2024), MANOVA requires several assumptions for accurate results: normal distribution of dependent variables within each group, homogeneity of variance-covariance matrices, linear relationships among dependent variables, absence of multicollinearity, and independent observations. Dependent variables were evaluated for each independent variable or role to meet the normality assumption. There was no concern about not having homogeneity of variance, as all dependent variables were provided without pairing in groups. All relationships of roles of the dependent variables were linear without concern for multicollinearity. Finally, all surveys were conducted independently from the others (Hassan, 2024).

Limitations

The Hawthorne effect describes the phenomenon where individuals improve their performance when they are observed, noticed, or given attention by researchers or supervisors (Perera, 2024). There are two external validity threats to this research proposal. The first external threat was the Hawthorne effect. The Hawthorne effect could have impacted this study if the participating roles were predisposed to the survey or study intent. Specific roles may have taken more time to rank their responses around medical device clinical decision support to prevent being scrutinized for poor adoption measures. While this scenario may yield great results, this is not realistic, making the design study ineffective in measuring the perception of adoption. Anonymity was preserved by excluding identification.

The second threat to this study was selection bias. Selection bias can cause confounding results. To prevent confounding results, it was essential to use strict criteria and ensure respondents come from the same general population (Popovic & Huecker, 2023). There was a minor threat of selection bias in this research as the nature of the sample size of respondents is held to the HPM division at Philips. In the case of perception, and to mitigate selection bias, all roles, regardless of experience, were considered for selection to respond to the survey. Roles with robust processes should be included to give an accurate, quantifiable assessment of the population of the 200-sample size. External validity threats like the Hawthorne effect can be mitigated with proper communication and explaining the proposed study's intent. Random sampling will reduce selection bias. A researcher must apply external validity excellence in a real-world application (Streefjerk, 2022).

Delimitations

This study focused on the perception of clinical roles on which CSF impacts medical device adoption. Population delimitation refers to a target population within a group (Hassan, 2024). The selection of clinical roles only assisted in making this research manageable and appropriate for a dissertation. This research did not cover any non-clinical role of HPM. Non-clinical roles (e.g., data architect, field service, non-clinical project manager) were excluded because they do not directly influence clinical adoption behavior. The study was limited to clinical roles as these roles influence end-user adoption in a clinical environment. The clinical role limitation ensured alignment with the purpose statement and research questions.

Another delimitation was methodological delimitation. According to Hassan (2024), methodological delimitation is a specific method or approach a researcher may use to impact findings. An electronic survey was used to aid in data collection and speed up the temporal delimitation of this research versus conducting lengthy interviews (Hassan, 2024). There are no other delimitations to consider within this research.

Ethical Assurances

Ethical considerations are guidelines that ensure fairness, transparency, and respect in research or practice. They protect participants' rights, maintain data integrity, and prevent harm. Key ethical considerations include informed consent, confidentiality, conflict of interest, and minimizing risks (Hassan, 2024). The researcher ensured that the study adhered to the ethical and scholarly governance established by National University and the Institutional Review Board (IRB). Data was not collected until approval was received by the IRB. There was minimal risk to any relevant ethical procedures needed to collect participant data. There was a strong alignment with not only personal bias but also professional standards, including values, codes of conduct, and accountability to report any limitations with the data's information. Any data collected was anonymized and discarded once the research had been completed.

Summary

The purpose of this quantitative study was to address the problem of end-user reluctance and lack of adoption of medical device technology due to clinical vendors' lack of consideration of CSF (CSF) needed for clinical implementation and determine which CSF can assist medical device vendors in achieving clinical implementation success and end-user adoption. The study employed a MANOVA to assess how different roles within the HPM division of Philips Healthcare in the U.S. perceive the factors influencing project success or failure. Chapter 3 provided an overview of the research methodology and design, including the target population, sampling method, materials, instrumentation, and data analysis procedures. It also discussed assumptions, limitations, delimitations, and ethical assurances related to the study. The chapter also compared alternative methodologies and explained why they were deemed less appropriate for this study. Chapter 4 will highlight the study's results, ranking the CSF identified through the MANOVA and their impact on adopting medical device technology within the Hospital Patient Monitoring division of Philips Healthcare.

Chapter 4: Findings

The purpose of this quantitative analysis study was to determine what CSF are being implemented by vendors providing medical devices and which factors enabled the most success for clinical implementation (Schmidt & Wiil, 2020). The problem addressed by this study was end-user reluctance and lack of adoption of the full capabilities of medical device technology due to clinical vendors' lack of consideration of what CSF were needed for project success. The alignment of CSF is essential for clinical implementation success (Schmidt & Wiil, 2020). The study addressed several key gaps by providing a comprehensive analysis that includes a diverse sample size and robust methodological approaches, enhancing the generalizability and validity of the findings. Additionally, the research from Lamprou & Vagiona (2022) offered a strong theoretical framework and practical implications, contributing valuable insights and actionable recommendations for future research and real-world applications. This chapter is organized into four detailed sections: (a) the validity and reliability of the data, (b) the results, (c) research question and hypothesis evaluation, (d) evaluation of the findings, and (e) chapter summation.

Validity and Reliability of the Data

The Analytical Hierarchy Process (AHP) is a decision-making methodology developed by Thomas L. Saaty in the 1970s. The AHP integrates qualitative judgments with quantitative weighting, making it well-suited for analyzing structured decision criteria such as the critical success factors in this study. To ensure validity and reliability, data were screened for completeness, evaluated for internal consistency (Cronbach's α), and compared with established CSF constructs from prior research. By breaking down complex decisions into a hierarchical structure, the AHP enables decision-makers to analyze the relative importance of criteria and alternatives. This structured approach facilitates a more informed and rational decision-making process and ensures the quantitative trustworthiness of the results, as it relies on measurable data and systematic comparisons (Liu, 2022; Hadi et al., 2021). A total of 102 completed questionnaires were analyzed, meeting the inclusion criteria described in Chapter 3. Data completeness was 100%, with no missing values across CSF items. These characteristics supported the dataset validity and reliability for quantitative analysis.

Assumptions and Validation

The statistical assumptions for the MANOVA were evaluated prior to testing the research questions to ensure the data met requirements for multivariate analysis. MANOVA assumes that each dependent variable is approximately normally distributed within groups, that relationships among variables are linear, and that variance–covariance matrices are homogeneous across groups. The 27 Likert-type items were treated as continuous, which is acceptable for large samples. Visual inspection of scatterplot matrices and histograms (Appendix C) indicated that normality and linearity were reasonably satisfied, with only mild skewness typical of survey data. Levene's tests confirmed homogeneity of error variances across the dependent variables ($p > .05$), and Mahalanobis Distance ($\alpha = .001$; χ^2 [27] = 55.48) flagged seven potential outliers that were retained because they did not affect overall results. Given the sample size ($N = 102$) and the robustness of MANOVA to moderate deviations from normality, these assumptions were considered adequately met. Pillai's Trace was selected as the primary multivariate statistic due to its reliability under unequal group sizes and minor assumption violations. Collectively, these diagnostics confirmed that the data were appropriate for MANOVA and support the validity of the subsequent analyses (Pillai's Trace = 1.393, F [135, 370] = 1.06, $p = .337$).

The validity of the research instrument is supported by the work of Lamprou and Vagiona (2022), who conducted a comprehensive analysis of success criteria and critical success factors

(CSF) in project success, ensuring systematic organization and valuable research findings. The systematic approach was adopted by Lamprou and Vagiona (2022), with consistency in roles within the clinical organization. Assumptions not met were validated using Pillai's Trace, which is robust when more than one assumption is violated. All respondents were asked the same questions without the ability to change the response variables, and reliability was satisfied by strong linearity, appropriate handling of outliers, and a sample size that exceeded the number of respondents according to A Priori Power Analysis using G*Power software.

Results

The survey respondents' demographics are summarized in Table 5. The sample (N = 102) was balanced by gender, included a range of ages and educational levels, and represented experienced professionals across all organizational zones. Most respondents held a bachelor's or master's degree, had over ten years of experience, and reported working on more than one hundred projects. The represented roles—customer project managers, clinical delivery and implementation consultants, clinical managers, workflow consultants, and clinical directors—reflected a comprehensive cross-section of professionals engaged in patient monitoring implementation.

Table 5

Survey Demographics

Category	Feature	Frequency	(%)
Gender	Female	54	52.9
	Male	48	47.1
Age	31-45 years	35	34.3
	46-60 years	49	48.0
	Greater than 60 years	15	14.7
	Less than 30 years	3	2.9
Level of Education	Associate's degree	10	9.8
	Bachelor's Degree	41	40.2
	Doctoral Degree	1	1.0
	High School Diploma	3	2.9
	Master's Degree	47	46.1
Years of Experience	0-10 years	39	38.2
	11-20 years	39	38.2
	21-30 years	16	15.7
	Greater than 31 years	8	7.8
Zone	Central Zone	55	53.9
	East Zone	23	22.5
	West Zone	24	23.5
Number of Projects	0-25 Projects	6	5.9
	26-50 Projects	11	10.8
	51-75 Projects	10	9.8
	76-100 Projects	7	6.9
	More than 100 Projects	68	66.7
Role	Clinical Delivery Consultant	23	22.5
	Clinical Director (District Service Leader)	3	2.9
	Clinical Implementation Consultant	23	22.5
	Clinical Manager (District Service Director)	13	12.7
	Clinical Workflow Consultant	4	3.9
	Customer Project Manager	36	35.3
Total Respondents		*102*	*100*

Table 5 summarizes the background information of the 102 participants, including gender, age, education level, years of experience, geographic zone, projects completed, and professional role. The demographic profile indicated that respondents were experienced professionals drawn from multiple zones and role types within the HPM division. This diversity supports the reliability and generalizability of the findings by ensuring that perspectives were collected from a knowledgeable, representative sample of individuals engaged in implementation and clinical leadership functions.

Although a few professional roles—such as Clinical Director and Clinical Workflow Consultant—had smaller subgroup sizes than others, combining these categories would not have altered the MANOVA findings or affected the validity of the results. Recent research confirms that MANOVA procedures remain robust when group sizes are unequal, provided that assumptions of homogeneity of variance–covariance matrices are met and an appropriate test statistic is selected (Cole, Smith, & Lee, 2022; Hair et al., 2019). These assumptions were satisfied in the present analysis, and Pillai's Trace was chosen because it provides the most robust protection against violations of normality and equality of covariance matrices (Stanley & Bunn, 2023). The aggregated Likert-scale data across 27 critical success factors (CSF) produced stable within-group variance estimates, minimizing potential distortion from smaller subgroups. Retaining the distinct professional roles also enhances the practical and theoretical interpretability of the findings. Each role—Customer Project Manager, Clinical Implementation Consultant, Clinical Delivery Consultant, Clinical Manager, Workflow Consultant, and Clinical Director—represents a unique layer of decision-making and communication within Philips Hospital Patient Monitoring. Preserving this differentiation aligns with Lamprou and Vagiona (2022), who emphasized that maintaining role distinctions allows organizations to identify targeted success factors and leadership strategies that strengthen governance, communication, and adoption outcomes. Given that the MANOVA revealed no significant role differences, merging smaller categories would not have changed the statistical outcome but would have reduced the contextual insight essential for leadership interpretation and program alignment.

The following research questions were used in this study to measure the perceptions of professionals utilizing CSF. These perceptions can strengthen project performance (Belay et al, 2022). Bhide (2023) identifies hospital technology enablement, business processes impacting clinical operational processes, and patient care delivery processes as specific aspects that must be considered in healthcare project management. The data collected was placed in three categories: technical, organizational, and environmental, to analyze this study's research questions and hypotheses.

Research Question 1. To what extent is there alignment between HPM roles of perceived CSF that are the most critical to mitigate end-user reluctance and enable end-user adoption? / Hypothesis: There is a statistically significant alignment between HPM roles of perceived CSF that are the most critical to mitigate end-user reluctance and enable end-user adoption.

A one-way MANOVA was conducted to determine whether perceptions of CSF importance differed across HPM roles. The results are presented in Table 6. The MANOVA results indicated that perceptions of CSF did not differ significantly by role across the four conceptual domains: technological, organizational, environmental, or overall. This finding aligns with the AHP principles described in Chapter 2. In this study, each professional role appeared to apply a comparable weighting structure across the three AHP domains, suggesting that organizational members operate from a shared mental framework regarding the drivers of success. The absence of statistically significant role effects thus provides empirical support for the AHP model's assumption of group consistency and validates its internal coherence within the context of HPM implementation.

Table 6 presents the multivariate effects of Role on the perceived importance of critical success factors (CSF) across the four conceptual domains: technological, organizational, environmental, and overall. These results assess the degree of alignment across HPM groups and test whether any statistically significant differences in perceptions emerged by role. Because all multivariate effects were nonsignificant, the findings indicate a high level of perceptual consistency across roles, supporting the alignment assumption of the AHP model.

Table 6

Multivariate Test of Role Effects on CSF

Model	Pillai's Trace	F	Num df	Den df	P	Partial n^2
All CSF (1-27)	1.393	1.06	135	370	.337	.09
Technological CSF (1-3)	0.410	0.91	45	460	.635	.04
Organizational CSF (4-21)	1.187	1.12	110	395	.222	.08
Environmental CSF (22-27)	0.385	1.32	30	475	.121	.04

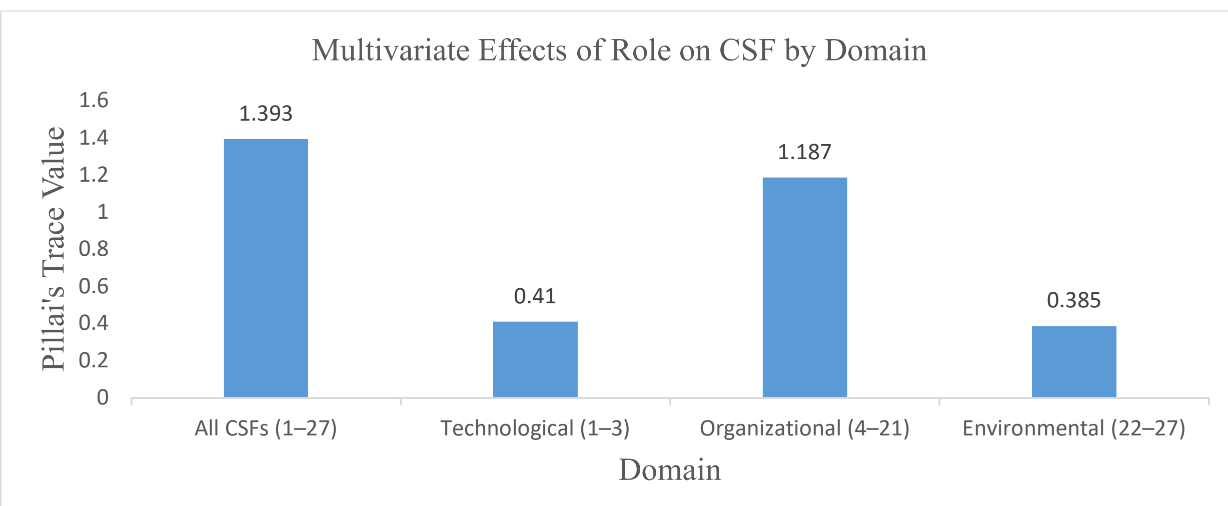
Note. MANOVA was conducted with role as the fixed factor. Effect sizes are reported as partial η^2.

The data in Table 6 present the MANOVA results evaluating whether perceptions of the 27 CSF differed significantly by professional role. This MANOVA was performed to examine the effect of Role on the perceived importance of CSF across four conceptual domains: all CSF, technological, organizational, and environmental. The multivariate effect of Role was not statistically significant in any model. For the whole model of 27 CSF, Pillai's Trace = 1.393,

$F(135, 370) = 1.06$, $p = .337$, partial $\eta^2 = .09$. Similarly, the technological model (CSF 1–3) produced Pillai's Trace = 0.410, $F(45, 460) = 0.91$, $p = .635$, partial $\eta^2 = .04$; the organizational model (CSF 4–21) yielded Pillai's Trace = 1.187, $F(110, 395) = 1.12$, $p = .222$, partial $\eta^2 = .08$; and the environmental model (CSF 22–27) yielded Pillai's Trace = 0.385, $F(30, 475) = 1.32$, $p = .121$, partial $\eta^2 = .04$. The Pillai's Trace statistic ($V = 1.393$, $F(135, 370) = 1.06$, $p = .337$) shows that there were no statistically significant differences among roles. According to Cohen's (1988) conventions, these effect sizes correspond to minor multivariate effects ($\eta^2_p < .10$). While Cohen's (1988) benchmarks are a helpful guide, more recent research from Norouzian & Plonsky (2017) cautions that effect size interpretation should be contextual, considering domain norms, sample size, and study power. Figure 5 illustrates the multivariate effects of Role across the four conceptual domains—technological, organizational, environmental, and overall—based on Pillai's Trace values. This figure visually summarizes the MANOVA results, demonstrating that none of the domains exhibited statistically significant differences by role, thereby supporting the overall alignment across HPM groups.

Figure 5

Multivariate Effects of Role on CSF by Domain



Collectively, the analyses indicate that perceptions of CSF importance were consistent across roles, providing statistical evidence of alignment within the HPM workforce. In practical language, this means that clinical directors, managers, consultants, and project managers generally viewed the importance of CSF in the same way. The shared ratings suggest that across all positions, professionals were aligned in how they prioritize the elements that lead to successful medical-device implementation. This result supports the idea that organizational alignment exists across the HPM teams.

A common pattern observed across models is the consistency of results: perceptions of CSF did not differ by role, regardless of whether the analysis considered the full set, organizational subset, or environmental subset. Means and standard deviations of CSF ratings by role are presented in Table 7. Overall, CSF were rated highly across all groups, with average ratings above the midpoint of the 9-point scale, indicating general agreement on the importance of these factors. The null hypothesis was retained, and no evidence was found for role-based differences in CSF perceptions.

Table 7 reports the descriptive statistics (means and standard deviations) for all 27 CSF, organized by professional role. This table provides a more granular view of how each role rated individual success factors, complementing the MANOVA results. The consistency of mean ratings across roles further supports the absence of significant differences observed in the multivariate tests.

Table 7

Means and Standard Deviations of CSF Ratings by Role

CSF	Clinical Delivery Consultant	Clinical Director (District Service Leader)	Clinical Implementation Consultant	Clinical Manager (District Service Director)	Clinical Workflow Consultant	Customer Project Manager
CSF_1	5.91 (2.7)	6.25 (3.77)	5.43 (2.41)	5.92 (2.07)	6.25 (2.06)	6.31 (2.35)
CSF_2	8.43 (1.34)	7.75 (1.89)	8.17 (1.4)	7.75 (2.26)	8.75 (0.5)	8.25 (1.61)
CSF_3	7.87 (1.49)	7.5 (1.91)	7.52 (2.09)	8.08 (1.31)	8.0 (0.82)	7.64 (1.55)
CSF_4	7.91 (1.86)	8.25 (1.5)	6.83 (2.42)	7.25 (1.42)	8.5 (1.0)	7.58 (2.2)
CSF_5	8.09 (1.24)	9.0 (0.0)	8.7 (0.56)	8.08 (1.51)	8.75 (0.5)	8.56 (0.91)
CSF_6	6.09 (2.52)	6.0 (1.41)	6.0 (2.81)	6.58 (2.02)	7.25 (2.36)	6.81 (2.16)
CSF_7	8.0 (1.81)	8.0 (1.15)	8.3 (1.02)	8.17 (0.94)	7.0 (1.63)	8.14 (1.4)
CSF_8	8.61 (0.72)	8.75 (0.5)	8.78 (0.52)	8.67 (0.65)	8.5 (1.0)	8.64 (0.83)
CSF_9	8.09 (1.95)	8.5 (1.0)	8.3 (1.02)	8.58 (0.67)	8.5 (0.58)	8.17 (1.54)
CSF_10	7.78 (1.44)	8.0 (2.0)	8.13 (1.01)	7.75 (1.22)	9.0 (0.0)	8.06 (1.39)
CSF_11	6.3 (2.87)	7.25 (1.71)	7.22 (1.91)	7.33 (0.98)	7.25 (2.22)	7.36 (1.71)
CSF_12	8.04 (1.3)	7.25 (1.26)	8.35 (0.83)	7.58 (1.24)	8.25 (0.96)	8.03 (1.52)
CSF_13	6.48 (2.71)	7.0 (2.71)	7.17 (1.85)	7.08 (1.08)	7.25 (2.22)	7.44 (2.17)
CSF_14	7.26 (2.09)	7.25 (2.87)	8.13 (1.1)	7.83 (0.94)	6.75 (1.71)	7.47 (1.78)
CSF_15	7.39 (1.92)	6.75 (2.87)	8.09 (1.0)	7.92 (1.0)	7.75 (1.26)	7.64 (1.71)
CSF_16	7.65 (2.06)	8.25 (1.5)	8.3 (0.93)	8.0 (1.41)	7.0 (2.45)	7.86 (2.03)
CSF_17	7.3 (1.66)	7.5 (2.38)	7.57 (1.73)	7.75 (1.36)	7.5 (1.29)	7.92 (1.59)
CSF_18	6.43 (2.57)	7.5 (1.0)	7.39 (2.02)	6.67 (2.02)	6.75 (2.63)	7.39 (1.95)
CSF_19	8.26 (1.32)	8.5 (1.0)	8.04 (1.19)	7.83 (1.27)	6.75 (2.63)	7.81 (2.01)
CSF_20	6.52 (2.68)	7.5 (1.73)	6.87 (2.07)	7.0 (1.13)	6.5 (2.52)	7.61 (1.87)
CSF_21	6.13 (2.87)	6.75 (3.2)	6.91 (2.54)	7.58 (0.9)	7.0 (1.63)	7.67 (1.85)
CSF_22	7.61 (2.31)	9.0 (0.0)	7.04 (2.95)	7.83 (1.19)	7.0 (2.83)	8.22 (1.96)
CSF_23	4.48 (2.84)	6.5 (2.65)	5.3 (2.55)	6.75 (1.54)	5.75 (2.63)	6.22 (2.28)
CSF_24	3.91 (2.45)	4.25 (2.5)	3.74 (2.9)	5.92 (1.93)	5.25 (3.1)	5.72 (2.65)
CSF_25	4.78 (2.83)	4.75 (2.87)	4.09 (2.83)	5.83 (1.99)	4.75 (2.63)	5.94 (2.55)
CSF_26	4.91 (2.56)	5.25 (3.4)	4.91 (2.83)	6.33 (1.92)	5.75 (2.5)	6.25 (2.35)
CSF_27	5.0 (2.49)	3.25 (3.3)	4.22 (2.58)	5.5 (2.39)	5.25 (3.1)	5.81 (2.44)

Table 7 details how each of the 27 Critical Success Factors was rated by role, showing the mean importance scores and variability (standard deviations). Although the means vary slightly, all roles rated most factors above the midpoint of the 9-point scale, reflecting strong agreement on their importance. In plain language, this table indicates that participants—regardless of role—tend to value communication, adequate resources, leadership competence, and planning most highly. The small differences between means show that, while minor nuances exist, no single role diverged dramatically in its perception of what drives project success. Overall, this consistency reinforces the finding that team members across levels share similar views of what matters most for adoption.

Figure 6

Top Five CSF by Role

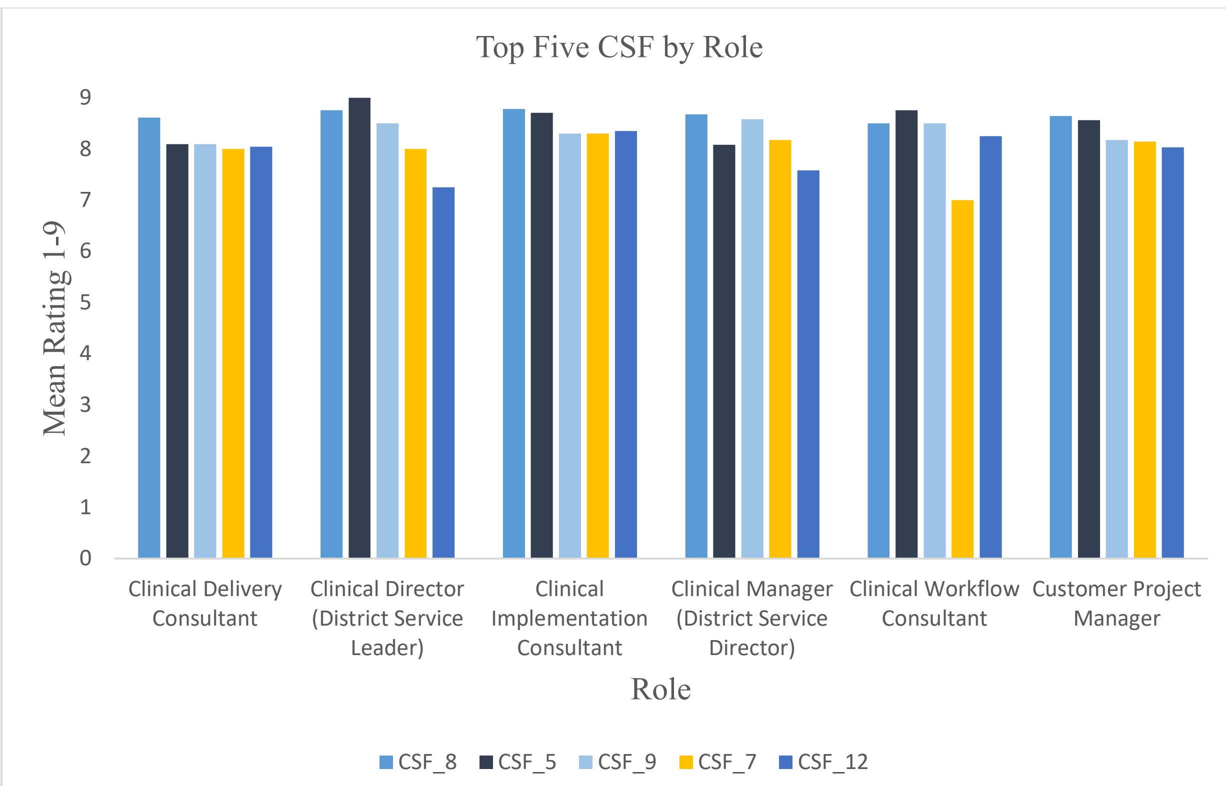


Figure 6 compares the mean ratings for the top five CSF across HPM roles. The figure shows that Project Communication, Adequate Resources, Project Planning, Project Mission, and Team/Lead Competence were consistently rated highly by all roles, with minimal variation in mean scores. This pattern reinforces the MANOVA findings that perceptions of CSF importance were aligned across professional groups. Overall, the uniformity of these ratings indicates a shared understanding of key drivers of project success within the organization, supporting the alignment construct of the AHP model.

Research Question 2. To what extent is there a hierarchy of recommended CSF perceived by HPM roles to mitigate end-user reluctance and enable end-user adoption? / Hypothesis: There is a statistical hierarchy of recommended CSF perceived by HPM roles to mitigate end-user reluctance and enable end-user adoption.

Because no significant role-based differences were found in the MANOVA analyses (see RQ1), the hierarchy of CSF was determined using overall mean importance ratings across all participants (N = 102). Table 8 presents the top 10 CSF ranked by overall mean ratings and standard deviations. A complete ranking of all 27 CSF can be found in Figure 7, and further details of means and standard deviations are in Appendix B. The purpose of these visuals is to identify which CSF were viewed as most critical across all participants. The results reveal that organizational CSF—especially Project Communication, Adequate Resources, and Project Planning—dominate the upper tier of the hierarchy, consistent with the theoretical emphasis on organizational readiness and leadership from Chapter 2. Figure 7 displays the overall ranking of all 27 CSF by mean importance rating, providing a comprehensive view of the hierarchy identified in the study. The figure shows that organizational factors—particularly Project Communication, Adequate Resources, and Project Planning—dominated the upper tier, while technological and environmental CSF generally occupied mid to lower positions. This distribution aligns with the AHP model presented in Chapter 2, which emphasize organizational readiness and leadership competence as the most influential domains for HPM success. The results confirm that participants collectively prioritized internal organizational factors over external environmental or technological considerations, underscoring the central role of managerial effectiveness in successful HPM adoption.

Table 8

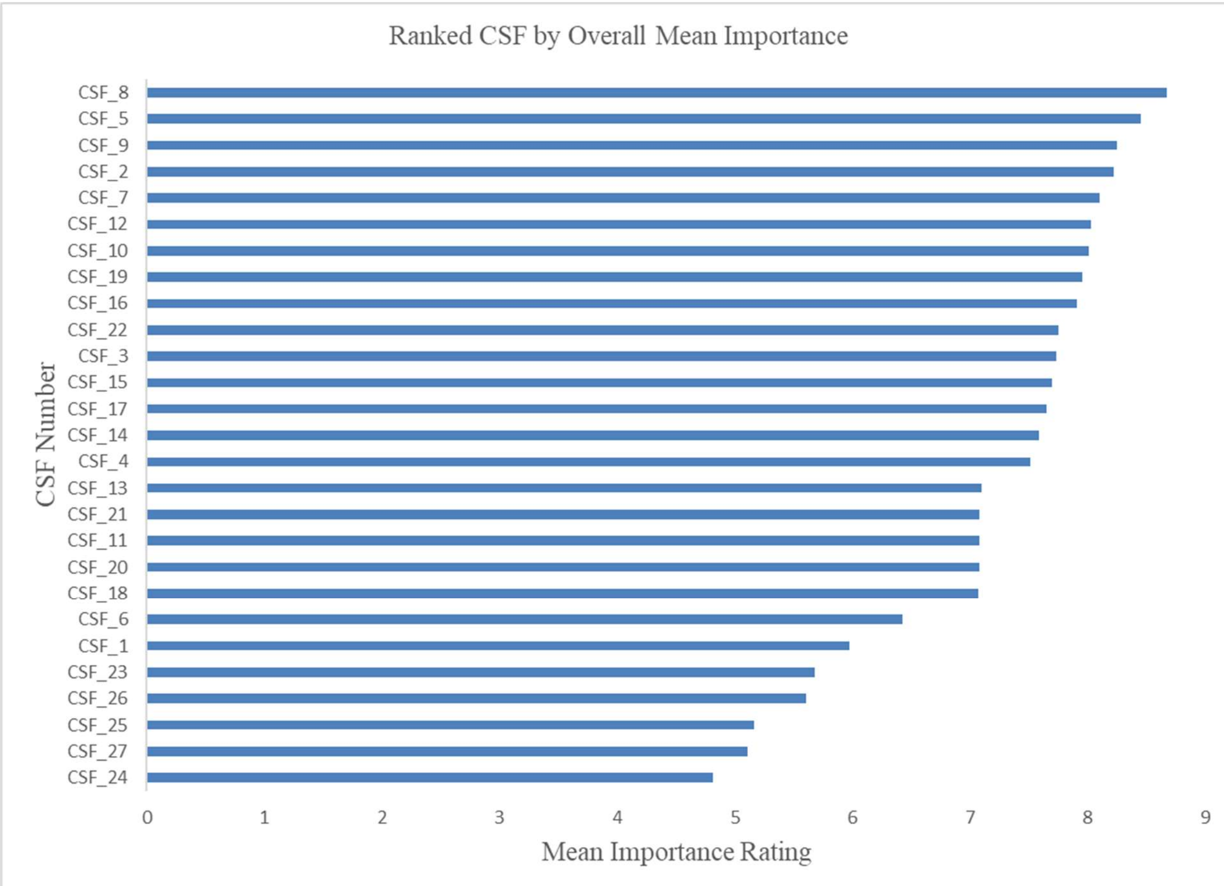
Top 10 CSF Ranked by Overall Mean Importance

Rank	CSF	Description (abridged)	Mean	Standard Deviation
1	CSF8	Project Communication	8.67	0.72
2	CSF5	Adequate Resources	8.45	1.24
3	CSF9	Project Planning	8.25	1.95
4	CSF2	Infrastructural Facility	8.22	1.34
5	CSF7	Project Mission	8.10	1.81
6	CSF12	Project Team Competence	8.03	1.01
7	CSF10	Project Lead Competence	8.01	1.44
8	CSF19	Project Client Characteristics	7.95	1.40
9	CSF16	Adequate Quality Assurance	7.91	1.22
10	CSF22	Law and Policies	7.75	1.05

Note. Ratings based on a 9-point Likert scale.

Figure 7

Ranked CSF by Overall Mean Importance



A typical pattern observed across the dataset is that organizational CSF dominates the top rankings, particularly those associated with communication, resources, planning, and leadership. Only one environmental CSF (Law and Policies; CSF22) entered the top 10, suggesting relative consistency in emphasizing internal organizational readiness as key to HPM adoption. A hierarchy of recommended CSF was identified based on overall means. The top-ranked factors—*Project Communication, Adequate Resources, Project Planning, Infrastructural Facility,* and *Project Mission*—demonstrate that organizational and managerial elements dominate perceptions of success. These results mean that effective communication, sufficient resources, careful planning, and a clear mission are seen as the strongest drivers of medical-device adoption. The inclusion of *Law and Policies* among the top ten also shows that external compliance and regulation remain key environmental considerations. Together, these rankings highlight that strong internal coordination and adherence to external standards are essential to successful clinical implementation.

The second research question sought to determine the empirical hierarchy of CSF derived from mean importance ratings. The ranked results revealed that organizational CSF dominated the upper tier of the hierarchy, with Project Communication (CSF 8), Adequate Resources (CSF 5), Project Planning (CSF 9), Project Mission (CSF 7), and Team/Lead Competence (CSF 12 and 10) emerging as the five most influential factors. These outcomes align closely with the organizational dimension of the AHP framework, which Chapter 2 identified as the most heavily weighted domain based on prior literature and expert judgment.

By contrast, technological CSF (CSF 1–3: Scalability, Infrastructural Facility, and Technology Environment) occupied mid-level positions in the empirical ranking, while environmental CSF (CSF 22–27: Legal, Political, Economic, and Social factors) appeared predominantly in the lower tier. This pattern is consistent with AHP-based expectations that organizational readiness, leadership competence, and communication would carry greater decision weight than external or technological contingencies in mature project environments.

The observed hierarchy therefore reinforces the theoretical weighting scheme proposed in Chapter 2, wherein organizational CSF received the highest relative weights ($w \approx 0.55$), followed by technological ($w \approx 0.27$) and environmental ($w \approx 0.18$) factors. The empirical data uphold this distribution: organizational constructs explained most variance in perceived importance, while technological and environmental domains contributed smaller, context-dependent effects.

Evaluation of the Findings

The first research question examined whether perceptions of CSF differed across HPM roles. The MANOVA model tested the full set of 27 CSF, and the effect of Role was not statistically significant. This result indicates that participants, regardless of role, assigned similar levels of importance to the CSF. These findings are consistent with the study's conceptual framework, emphasizing alignment and shared understanding across functional boundaries as essential for successful HPM adoption. The absence of role-based differences suggests that stakeholders across clinical, managerial, and project-oriented roles converge in recognizing which CSF are important. This convergence echoes prior research noting that project success is more likely when stakeholders share common priorities (Lodja, 2019; Belay et al., 2022; Lamprou & Vagiona, 2022). The findings also align with theories of organizational alignment, which show that congruence in perceptions and practices across roles reduces barriers to implementation and increases organizational readiness for innovation. By finding no significant divergence, the results strengthen the argument that HPM adoption does not require role-specific CSF frameworks but benefits from a unified, organization-wide approach.

The second research question sought to identify the hierarchy of recommended CSF for HPM adoption. Given that no role-based differences were observed in RQ1, the hierarchy was established by overall mean ratings across all participants. The top-ranked CSF included Project Communication, Adequate Resources, Project Planning, Project Mission, and Team/Lead Competence. These factors represent the organizational and managerial pillars emphasized in the conceptual framework. This pattern is consistent with existing literature. Prior studies of project management success highlight communication as a central determinant of performance (Project Management Institute, 2021), while adequate resourcing and planning driven by top management support are highlighted for implementation success (Fareed et al., 2023). The emphasis on leadership and mission clarity echoes leadership theories and project governance frameworks that stress the importance of vision, competence, and stakeholder engagement. The inclusion of Law and Policies (CSF22) as the highest-ranked environmental factor is also notable, reflecting the influence of external regulatory contexts on health-related project adoption. While environmental CSF as a group were not ranked as highly as organizational factors, their presence in the overall hierarchy confirms the framework's assertion that both internal and external drivers matter for sustainable adoption.

Overall, the results were largely consistent with both the conceptual framework and prior empirical research. The finding of no significant differences across roles empirically supports the framework's alignment construct, demonstrating that perceptions of CSF are held consistently across organizational levels and functions. This strengthens the case for a unified, organization-wide approach to HPM adoption rather than fragmented or role-specific strategies. The hierarchy of CSF provides further empirical grounding for the theoretical framework. Organizational factors—communication, resources, planning, mission, and leadership—were consistently identified as the most critical drivers. This aligns with contingency and systems theories of project management, which emphasize that project success depends upon coordinated organizational structures and processes (Kerzner, 2017). At the same time, the presence of regulatory and policy-related CSF in the top tier underscores the influence of institutional theory, which highlights the role of external pressures and compliance in shaping organizational practices (Belay et al., 2022; Lamprou & Vagiona, 2022). The consistency between theoretical expectations and empirical outcomes strengthens the validity of the AHP model as a decision-support framework for HPM adoption. The alignment of role perceptions (RQ1) confirms the

AHP consistency ratio principle—that multiple evaluators reach coherent judgments when criteria are clearly defined. The hierarchy identified in RQ2 provides empirical weighting confirmation, indicating that the organizational domain exerts the greatest influence in the composite structure of success determinants. Overall, the data corroborate the conceptual hierarchy developed in Chapter 2. Organizational CSF: core managerial and leadership capacities represent the dominant success drivers. Technological CSF function as enabling infrastructure but are secondary in perceived importance. Environmental CSF act as contextual moderators that support but do not drive implementation outcomes. These findings collectively validate the AHP framework's predictive ordering of domains and suggest that future decision-analytic applications within HPM can rely on the same tri-level hierarchy to guide prioritization and resource allocation.

Summary

This chapter presented the results of the statistical analyses addressing the study's two research questions. A series of one-way multivariate analyses of variance (MANOVAs) were conducted to test for role-based differences in the perceived importance of critical success factors (CSF). For RQ1, the analyses revealed no statistically significant multivariate effects of Role across the MANOVA model with the full set of 27 CSF. These findings indicate strong alignment across roles in how participants rated the importance of CSF. Assumptions of MANOVA were evaluated and determined to be reasonably met. Levene's tests indicated homogeneity of variances across all dependent variables, while Box's M test was unstable, a common outcome for Likert-scale data. Pillai's Trace was therefore emphasized as the most robust test statistic. Mahalanobis Distance identified seven potential multivariate outliers; retaining these cases did not alter the overall results. For RQ2, a hierarchy of CSF was developed using overall mean importance ratings, as no role-based differences were observed. The top-rated CSF were Project Communication, Adequate Resources, Project Planning, Project Mission, and Team/Lead Competence, with Law and Policies emerging as the highest-ranked environmental factor. A typical pattern identified was the dominance of organizational CSF in the top rankings, reinforcing the emphasis on internal organizational and managerial factors as key drivers of HPM adoption. In summary, the results supported the study's conceptual framework by demonstrating role alignment in CSF perceptions and by confirming a clear hierarchy of CSF. These findings provide the empirical foundation for the discussion, implications, and recommendations presented in Chapter 5.

Chapter 5: Implications, Recommendations, and Conclusions

The problem addressed by this study was end-user reluctance and lack of adoption of the full capabilities of medical device technology due to clinical vendors' lack of consideration of what critical success factors (CSF) are needed for project success. The purpose of this quantitative analysis study was to determine what CSF are being implemented by vendors providing medical devices and which factors enable the most success for clinical implementation (Schmidt & Wiil, 2020). Survey data were collected from 102 participants representing six professional roles within Philips Healthcare's HPM division. The independent variable was role, and the dependent variables were 27 HPM grouped into technological, organizational, and environmental domains. Data analysis was conducted using MANOVA to test for group differences and the AHP framework to interpret the relative prioritization of CSF across domains. The independent variable was role, and the dependent variables were twenty-seven CSF grouped into technological, organizational, and environmental domains.

Results showed no statistically significant differences in CSF perceptions across roles (Pillai's Trace = 1.393, F[135, 370] = 1.06, p = .337), indicating strong organizational alignment. Descriptive analyses revealed a consistent hierarchy, emphasizing organizational CSF—specifically, project communication, adequate resources, project planning, project mission, and leadership competence—as the most critical drivers of success. Law and policies emerged as the highest-ranked environmental factor. These findings demonstrated shared priorities across roles and highlight the central influence of organizational effectiveness on adoption outcomes.

Study limitations included the use of self-reported survey data, the focus on a single organizational division, and the reliance on quantitative rather than mixed-methods approaches. Despite these constraints, the findings provide valuable insight into how medical vendors and healthcare teams can align CSF to enhance technology adoption. The remainder of this chapter discusses the theoretical and practical implications of these results, offers recommendations for practice and future research, and concludes with the study's overall significance.

Implications

This study's findings have several important implications for healthcare technology adoption and organizational performance. Collectively, they demonstrate that consistent perceptions of critical success factors (CSF) across roles strengthen alignment, streamline communication, and promote more effective project execution. These outcomes reflect a mature implementation culture where planning, leadership, and collaboration are integrated throughout Philips Healthcare's Hospital Patient Monitoring (HPM) division.

Research Question 1/ To what extent is there alignment between HPM roles in the perceived CSF that are most critical to mitigate end-user reluctance and enable end-user adoption?

The findings for Research Question 1 indicated strong alignment across roles, with no statistically significant differences in the perceived importance of CSF. This result supported the null hypothesis and underscores organizational convergence across professional functions. Regardless of whether respondents were project managers, consultants, or clinical leaders, perceptions of key CSF—such as project communication, planning, and adequate resources—were consistent, reflecting a shared understanding of what drives implementation success.

A contributing factor to this uniformity may be the division's collaborative team culture and overlapping role structures, which promote shared expectations for planning and communication. These results align with systems-theory perspectives emphasizing coordination and cross-functional communication as essential for organizational effectiveness (Kerzner, 2017). The outcome extends earlier AHP-based studies (Belay et al., 2022; Hadi et al., 2021), which found stakeholder divergence, by showing that mature healthcare organizations can achieve alignment through standardized project governance and consistent leadership practices.

Research Question 2/ What hierarchy of CSF do Philips Healthcare implementation stakeholders perceive as most essential for successful medical device adoption?

The findings for Research Question 2 supported the alternative hypothesis by confirming a clear and consistent hierarchy of CSF. Organizational factors: project communication, adequate resources, and project planning ranked highest, followed by project mission and leadership competence. Law and policies emerged as the top-rated environmental factor. These results underscore the importance of organizational effectiveness and regulatory compliance in the successful implementation of technology.

This ranking aligned with and reinforces prior CSF and AHP research, which also identified leadership, planning, and resource adequacy as crucial factors in determining project outcomes (Lamprou & Vagiona, 2022; Gupta et al., 2022). However, this study contributes new evidence from a healthcare context, demonstrating that organizational determinants outweigh technological or environmental considerations even in highly regulated settings. The results also support organizational-readiness theory, suggesting that shared prioritization of success factors enhances the organization’s capacity to integrate innovations and sustain improvements (McDermott et al., 2023).

Comparison with Prior AHP and CSF Studies

The findings of this study are consistent with, and in some cases extend, recent research on the AHP and CSF conducted in various sectors. Specifically, results were compared with those of Hadi et al. (2021) in information technology, Belay et al. (2022) in construction management, and Gupta et al. (2022) in enterprise performance. The comparison clarifies where this study's results confirm earlier work, where they extend established knowledge, and where they challenge prior assumptions regarding the relative influence of technological, organizational, and environmental domains.

The present study identified the organizational domain—represented by Project Communication, Adequate Resources, Project Planning, Project Mission, and Team/Lead Competence—as the dominant determinants of HPM success. This outcome corroborates Hadi et al. (2021), who found that people and process criteria carried greater weight than technical factors in the implementation of project-tracking software. Both studies underscore that human and organizational enablers, rather than technological tools, most strongly predict implementation success. Belay et al. (2022) also reported that managerial clarity and consultant competence ranked above environmental and technical considerations in the Ethiopian construction sector, reaffirming the primacy of organizational readiness and leadership quality. Similarly, Gupta et al. (2022) observed that innovation (43.1%) and service capability (33.1%) outweighed technology (23.8%) in SME growth, a pattern conceptually parallel to the dominance of organizational CSF in this HPM study. Taken together, these convergent results demonstrate that across industries, organizational and human-centered capabilities remain the most influential drivers of project success. This study, however, extends earlier work by statistically verifying that organizational dominance is role-invariant. Using MANOVA across 27 dependent variables, the current research established that the prioritization of CSF is consistent across all professional roles. AHP-based studies, such as those by Hadi et al. (2021) and Gupta et al. (2022), identify ranking hierarchies but do not test for cross-group alignment. Hence, the present findings provide stronger empirical confirmation of shared prioritization across stakeholder groups within HPM organizations.

The top five CSF in this study—Project Communication, Adequate Resources, Project Planning, Project Mission, and Team/Lead Competence—closely mirror the highest-ranked categories reported in Belay et al. (2022), who emphasized Clear and Precise Goals, Consultant Competency, Track Record, and Adequacy of Funds. This overlap confirms that project clarity, resourcing, and competence form a core organizational cluster that is central to success across various contexts. The inclusion of Project Planning and Team/Lead Competence in the present analysis further refines the organizational dimension by distinguishing leadership and coordination as distinct yet complementary elements. In contrast, Gupta et al. (2022) emphasized innovation and service capability—organizational analogues of adaptability and stakeholder communication—while Hadi et al. (2021) underscored people commitment and process fit. Collectively, these studies and the current research converge on a common principle: effective communication, planning, leadership competence, and adequate resourcing are the structural backbone of successful project delivery.

A significant contribution of this study was the demonstration of cross-role alignment. The MANOVA tests revealed no statistically significant differences in perceived importance of CSF across roles, indicating consensus within the HPM workforce. Belay et al. (2022) identified partial disagreement among clients, consultants, and contractors in construction projects using Kendall's coefficient of concordance. The current findings, therefore, challenged earlier evidence of stakeholder divergence by showing that, in healthcare project settings, alignment across professional roles is already well established. Hadi et al. (2021) and Gupta et al. (2022) did not evaluate group-level variation; thus, this dissertation extends the methodological scope of prior AHP research by integrating both ranking analysis and multivariate hypothesis testing, offering a more rigorous validation of consensus effects within the AHP framework.

Consistent with prior AHP studies, technological factors were found to be important but not dominant. In this study, technological CSF such as Infrastructural Facility (CSF 2) ranked within the upper-middle tier, functioning primarily as enablers of organizational effectiveness rather than primary drivers of success. This mirrors the pattern reported by Hadi et al. (2021), where the technical dimension ranked lowest, and by Gupta et al. (2022), who found that technology carried the smallest domain weight (23.8 percent). Belay et al. (2022) also placed technical innovations, such as Building Information Modeling (BIM), in the middle, below organizational and financial variables. The convergence across these studies and the present results confirms that while technology provides the infrastructure for performance, success ultimately depends on the organizational systems and human competencies that support its use.

The collective evidence positions this dissertation as an extension and refinement of existing AHP-based CSF research. First, it confirms prior findings that organizational and human factors outweigh technical determinants of project success. Second, it extends the literature by providing statistical proof of alignment across roles through multivariate analysis, a dimension previously untested in AHP-focused studies. Third, it challenges reports of stakeholder disagreement by demonstrating internal consistency within a healthcare implementation context. Finally, it introduces the health-sector nuance that regulatory and compliance factors, represented by Law and Policies (CSF 22), though secondary, remain integral to sustaining organizational readiness. Together, these contributions validate the theoretical hierarchy established in Chapter 2 while highlighting the unique configuration of factors that characterize successful HPM adoption.

Recommendations for Practice

The CSF identified in this study provide an actionable framework for healthcare technology vendors seeking to strengthen project outcomes, client satisfaction, and adoption success. Because the highest-weighted CSF were organizational—specifically *project communication, adequate resources, project planning, project mission,* and *leadership competence*—these findings point to clear areas where vendors and healthcare delivery teams can focus improvement initiatives. The following recommendations translate these results into practical strategies aligned with established research in project management and healthcare implementation.

Strengthen Communication Frameworks

Communication emerged as the highest-ranked CSF, confirming that transparent and consistent information sharing is foundational to project success. Vendors should implement structured communication plans that define escalation pathways, stakeholder updates, and shared documentation repositories accessible to vendor, clinical, and technical teams. Evidence from Kerzner (2017) and Lamprou and Vagiona (2022) suggests that early and systematic communication reduces rework, fosters trust, and accelerates technology adoption. Clear communication channels decrease training inefficiencies and promote safer, more reliable integration of patient-monitoring systems, ultimately improving patient outcomes and operational readiness. Tools such as Smartsheet dashboards, integrated task trackers, and standardized status reports can promote visibility and maintain alignment across distributed or multi-site implementations. Strong communication infrastructures also support end-user adoption by reducing ambiguity, ensuring clinicians receive timely updates, and preventing workflow disruption (Creamer, 2024).

Optimize Resource Allocation and Staffing

Adequate resourcing was the second-highest-ranked CSF, emphasizing the need for sufficient personnel, time, and financial support throughout implementation. Vendors should adopt standardized resource planning templates and conduct capacity reviews at each project milestone. Prior research (Belay et al., 2022) demonstrates that properly resourced teams maintain schedule adherence and mitigate burnout during high-demand deployment cycles. Ensuring balanced workloads and clear resource allocation supports more efficient adoption, minimizes downtime, and contributes to safer transitions to new technologies. When clinical and vendor teams are adequately staffed, organizations reduce operational delays, build greater confidence among frontline users, and maintain consistent patient-monitoring reliability throughout the implementation process (McDonald, 2025; Komisarof et al., 2025).

Embed Structured Project-Planning Frameworks

Project planning ranked among the top three CSF and remains central to effective implementation governance. Vendors should embed formalized project charters that define the mission, deliverables, and measurable success criteria before execution begins. Aligning these plans with the AHP-derived CSF hierarchy established in this study ensures that priorities remain evidence-based and informed. Structured planning frameworks—such as gated milestone reviews, risk registers, and clearly defined scope-control processes—can enhance accountability, minimize ambiguity, and maintain project momentum (Gupta et al., 2022). Clear and consistent planning strengthens team alignment and accelerates adoption by reducing uncertainty for clinicians. When project teams articulate purpose, goals, and workflows prior to deployment, clinicians experience smoother transitions, fewer safety concerns, and faster integration of new monitoring technologies into daily practice (Ouyang et al., 2025).

Reinforce Leadership Competence and Mission Clarity

Leadership competence and project mission were also highly rated in this study, underscoring their role in sustaining team alignment. Implementation leaders should consistently articulate project objectives, model effective collaboration, and maintain visibility into project metrics by using transparent dashboards or conducting regular governance reviews. Research by McDermott et al. (2023) links visible, competent leadership to enhanced organizational readiness, faster decision-making, and greater adoption success. Strong leadership also supports end users by providing structure and stability throughout technological change. When leaders communicate clear missions and uphold predictable governance practices, clinicians adopt devices more confidently and consistently, reducing variability in use and strengthening long-term improvements in patient-monitoring continuity and clinical performance (Komisarof et al., 2025).

Integrating Regulatory and Environmental Readiness

Although environmental CSF ranked below organizational factors, Law and Policies (CSF 22) was the highest-ranked environmental factor, emphasizing the importance of regulatory alignment. Vendors can use this insight to strengthen compliance management by incorporating regulatory checklists—addressing HIPAA, FDA, and Ministry of Health standards—into each stage-gate review. Implementing such measures enables companies like Philips Healthcare to ensure regulatory compliance while maintaining the organizational flexibility required for clinical innovation. The inclusion of law and policies as a top 10 CSF reflects the necessity for project teams to proactively address regulatory environments, particularly in healthcare sectors where compliance failures may undermine adoption (Park et al., 2019). Proactive regulatory alignment enhances patient safety by ensuring that system configuration, data flows, and clinical workflows meet mandated standards, which increases clinician trust and strengthens organizational readiness for long-term monitoring stability and clinical resilience (Creamer, 2024).

Tailor Recommendations to Comparable Healthcare Settings

Because these recommendations were developed from findings within Philips Healthcare's Hospital Patient Monitoring division, they are most applicable to similar healthcare-technology environments involving regulated devices, cross-functional teams, and patient-safety considerations. Vendors operating in comparable contexts should adapt these recommendations to reflect local governance and compliance frameworks. Maintaining that specificity ensures that improvement strategies remain practical rather than overly generalized (McDermott et al., 2023).

Summary of Practical Impact

Collectively, these recommendations provide a vendor-focused roadmap to operationalize the top-ranked CSF identified in this study. By strengthening communication, optimizing resources, embedding structured planning, and reinforcing leadership competence, healthcare-technology vendors can improve project execution, enhance staff adoption readiness, and ultimately support better patient outcomes. These targeted strategies transform empirical findings into actionable pathways that bridge project management rigor with clinical impact (Watkins & Johnson, 2023; Ouyang et al., 2025).

Recommendations for Future Research

While this study advanced understanding of the alignment and prioritization of CSF in healthcare project implementation, additional research is needed to expand, validate, and contextualize these findings. Future investigations should strengthen external validity by incorporating broader samples, mixed methodologies, and longitudinal data collection. The following recommendations outline actionable directions for future researchers seeking to build upon this study's framework in alignment with emerging scholarship in healthcare management (Komisarof et al., 2025; Watkins & Johnson, 2023).

Broaden Sample Scope and Context

Future research should replicate and extend this CSF framework across multiple healthcare organizations and divisions to determine whether the observed alignment persists in diverse operational contexts. Expanding beyond the Hospital Patient Monitoring division to include imaging, informatics, and diagnostic domains could clarify whether organizational, technological, or environmental CSF are weighted differently by specialty or workflow type. Comparative analyses across divisions or vendors could also test whether company size, global region, or governance structure influences CSF prioritization. Building on the approach of Ouyang et al. (2025), who emphasized cross-institutional comparison in digital health projects, researchers should test this model with larger and more diverse samples to improve statistical power and enable subgroup analyses by region, professional discipline, and project complexity. Such comparisons may reveal whether the high degree of role alignment observed in this study is unique to mature project-governance cultures or more broadly generalized.

Employ Mixed or Qualitative Methodologies

This study relied solely on quantitative survey data analyzed through MANOVA and the AHP. Future research should employ mixed-method or qualitative designs—such as focus groups, interviews, or longitudinal case studies—to explore how CSF are perceived and operationalized by implementation teams. These methods would enable triangulation between numerical data and experiential insight, enhancing interpretive validity.

Watkins and Johnson (2023) demonstrated that integrating qualitative perspectives within project management research uncovers contextual nuances in communication and leadership behaviors, while Creamer (2024) highlighted the importance of longitudinal qualitative inquiry for tracing behavioral and organizational change over time. Applying these approaches in future CSF studies could yield a richer, multi-dimensional understanding of success factors in healthcare technology projects.

Address Study Limitations and Boundary Conditions

Future researchers should address the limitations of this study, including its focus on a single division, reliance on self-reported quantitative data, and limited generalizability. Incorporating multi-site data and random sampling across healthcare systems would enhance external validity. As McDonald (2025) noted, multi-organizational research designs increase robustness by capturing contextual variability and improving transferability across organizational cultures. Researchers may also link CSF prioritization to objective outcome measures, such as adoption rates, implementation timelines, and performance metrics, to assess the causal relationships between organizational alignment and adoption success. Testing this model across technology sectors (e.g., imaging systems, telehealth, or device integration) would also support generalizability and model refinement.

Explore Cultural and Regulatory Factors

Given that healthcare organizations operate within diverse regulatory and cultural settings, future research should investigate how regional governance, cultural dynamics, and compliance structures shape perceptions of CSF. Building upon the work of Komisarof et al. (2025), who examined intercultural collaboration within multinational healthcare initiatives, researchers can explore how cross-cultural communication and regulatory frameworks influence organizational alignment and readiness for adoption. Comparative studies between regions or nations could reveal whether the relative importance of factors such as *Law and Policies* varies by healthcare system maturity or local regulation.

Summary of Future Research Directions

Future researchers should build upon this study by broadening sample diversity, integrating mixed or longitudinal methods, and addressing current boundary conditions. Aligning with the recommendations of Ouyang et al. (2025) and Creamer (2024), future work should aim to link project governance and organizational readiness models across various healthcare contexts. Through these efforts, scholars can refine the CSF hierarchy's predictive validity and practical relevance, advancing both theory and implementation science by connecting project management rigor to sustainable healthcare innovation and improved patient outcomes.

Conclusions

This study addressed the persistent problem of limited end-user adoption of medical device technology, often caused by vendors' insufficient attention to the CSF that drives implementation success. The purpose of this quantitative analysis was to identify and prioritize the CSF most essential to successful adoption and to determine whether perceptions differed by professional role. Using MANOVA and the AHP, data from 102 participants across six professional roles within Philips Healthcare's Hospital Patient Monitoring division revealed no statistically significant differences in CSF perceptions by role. These findings indicate strong organizational alignment and highlight communication, planning, adequate resources, mission clarity, and leadership competence as the most influential organizational CSF.

The results demonstrated that organizational success factors, rather than technological or environmental variables, have the most substantial impact on adoption outcomes. This confirms that effective communication, structured planning, and visible leadership remain crucial to the success of implementation in healthcare settings. These findings still extend prior AHP and CSF research from industries such as construction and banking into the healthcare technology domain, where empirical validation of vendor-based perspectives has been limited. By demonstrating the consistent influence of organizational alignment, this study provides evidence that collaborative culture, role clarity, and coordinated planning directly enable more sustainable technology integration.

Theoretically, this dissertation contributes to the literature by applying AHP as a robust, quantitative framework for structuring and validating CSF in clinical technology implementation. In this area, prior empirical testing has been sparse. Practically, it advances project-management practice by providing a vendor-oriented framework that healthcare technology teams can use to align communication structures, allocate resources, and strengthen governance models. These practical contributions support evidence-based decision-making and reinforce the organizational conditions that enable successful adoption. These contributions collectively expand the empirical foundation for clinical technology adoption research and offer a practical model for data-driven decision-making in vendor–client partnerships.

Summarizing the core outcome, this research affirms that when organizational factors are aligned across roles, technology adoption becomes more efficient, collaborative, and impactful. The study fulfilled the purpose established in Chapter 1 by addressing end-user reluctance through validated, organizationally focused CSF. The study provides an actionable roadmap for enhancing adoption readiness, enhancing project performance, and facilitating the safer and more effective integration of patient-monitoring technologies. Overall, the findings provide a clear take-home message: organizational alignment—not technological capability alone—is the primary determinant of successful clinical technology adoption. These results provide a solid foundation for both scholarly research and professional development in healthcare project management and implementation science.

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Appendix A

Research Survey Questions

1. What is your gender?

Male, Female, Prefer not to answer

2. What is your age?

Less than 30 years, 31-45 years, 46-60 years, greater than 60 years

3. What is your highest level of education?

High School Diploma, Associates Degree, Bachelors Degree, Masters Degree, Doctoral Degree

4. Do you have any professional certifications or licensure? (Please List)

5. How many years of experience do you have with medical device implementation?

0-10 years, 11-20 years, 21-30 years, greater than 31 years

6. Please select the projects you have been participated in? (select all that apply)

Telemetry, Bedside Monitoring, New Construction, Conversion from other vendors to Philips

7. How many projects have you participated in?

0-25 projects, 26-50 projects, 51-75 projects, 76-100 projects, more than 100 projects

8. What zone do you primarily work in?

West Zone, Central Zone, East Zone

9. Please select the most appropriate role that aligns with your work function.

Clinical Director, Clinical Manager, Implementation Consultant, Delivery Consultant, Workflow Consultant, Customer Project Manager

10. Please provide a level of importance for each of the following project critical success factors (The scale ranges from 1 (equal importance) to 9 (absolute importance),

Scalability

Infrastructural Facility

Technology Environment

Top Management Support

Adequate Resources

Financial Constraints

Project Mission

Project Communication

Project Planning

Project Lead Competence

Project Organization Structure

Project Team Competence

Project Size and Complexity

Project Plan Level of Details

Problem-Solving

Adequate Quality Assurance

Adequate Resourcing

Project Urgency

Project Client Characteristics

Effective Progress Review

Realistic Project Forecasting

Law and Policies, Competitive Pressure

Political Environment

Social Environment

Economic Environment

Natural Factors

Appendix B

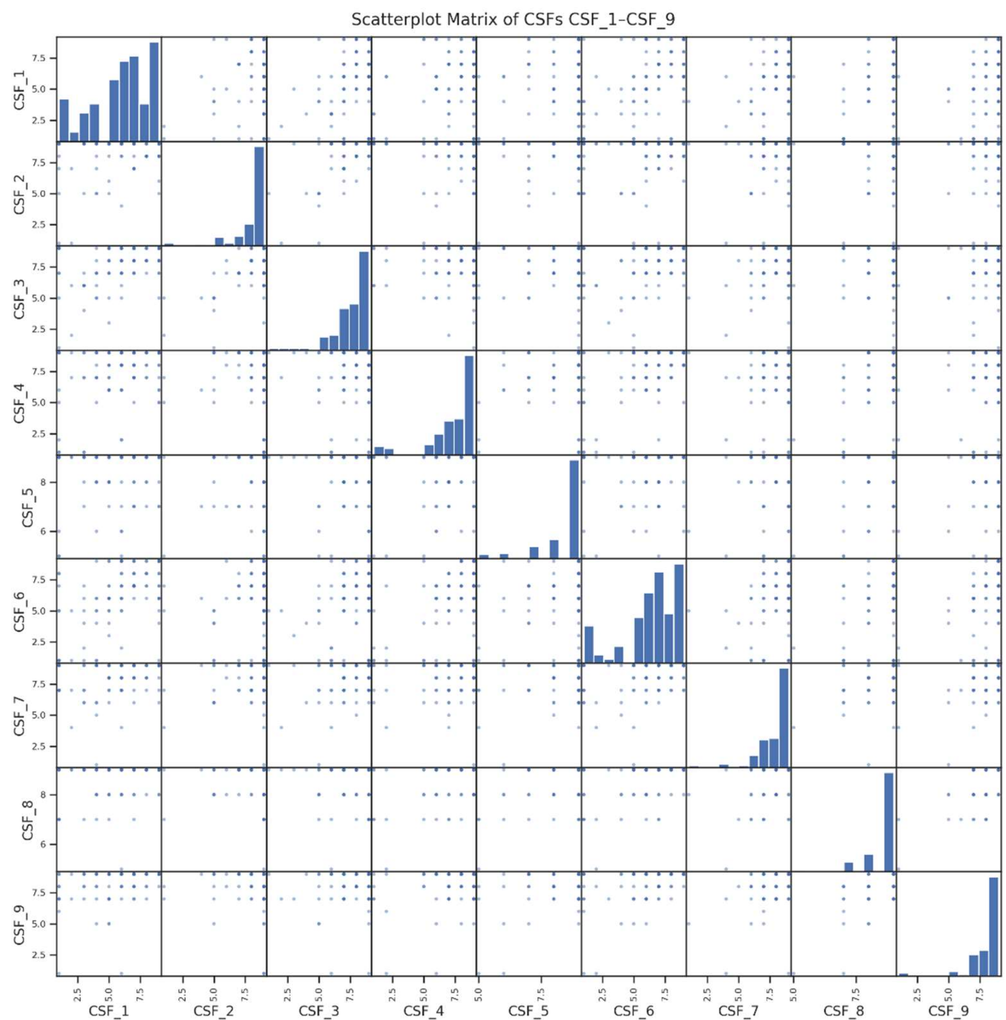
CSF Ranking

Rank	CSF	Mean	Standard Deviation
1	CSF_8	8.67	0.71
2	CSF_5	8.45	1.01
3	CSF_9	8.25	1.41
4	CSF_2	8.22	1.56
5	CSF_7	8.1	1.38
6	CSF_12	8.03	1.28
7	CSF_10	8.01	1.3
8	CSF_19	7.95	1.61
9	CSF_16	7.91	1.76
10	CSF_22	7.75	2.25
11	CSF_3	7.73	1.62
12	CSF_15	7.69	1.59
13	CSF_17	7.65	1.61
14	CSF_14	7.58	1.7
15	CSF_4	7.51	2.06
16	CSF_13	7.1	2.15
17	CSF_20	7.08	2.08
18	CSF_11	7.08	2.03
19	CSF_21	7.08	2.29
20	CSF_18	7.07	2.12
21	CSF_6	6.42	2.36
22	CSF_1	5.97	2.43
23	CSF_23	5.68	2.51
24	CSF_26	5.6	2.54
25	CSF_25	5.16	2.68
26	CSF_27	5.11	2.57
27	CSF_24	4.81	2.71

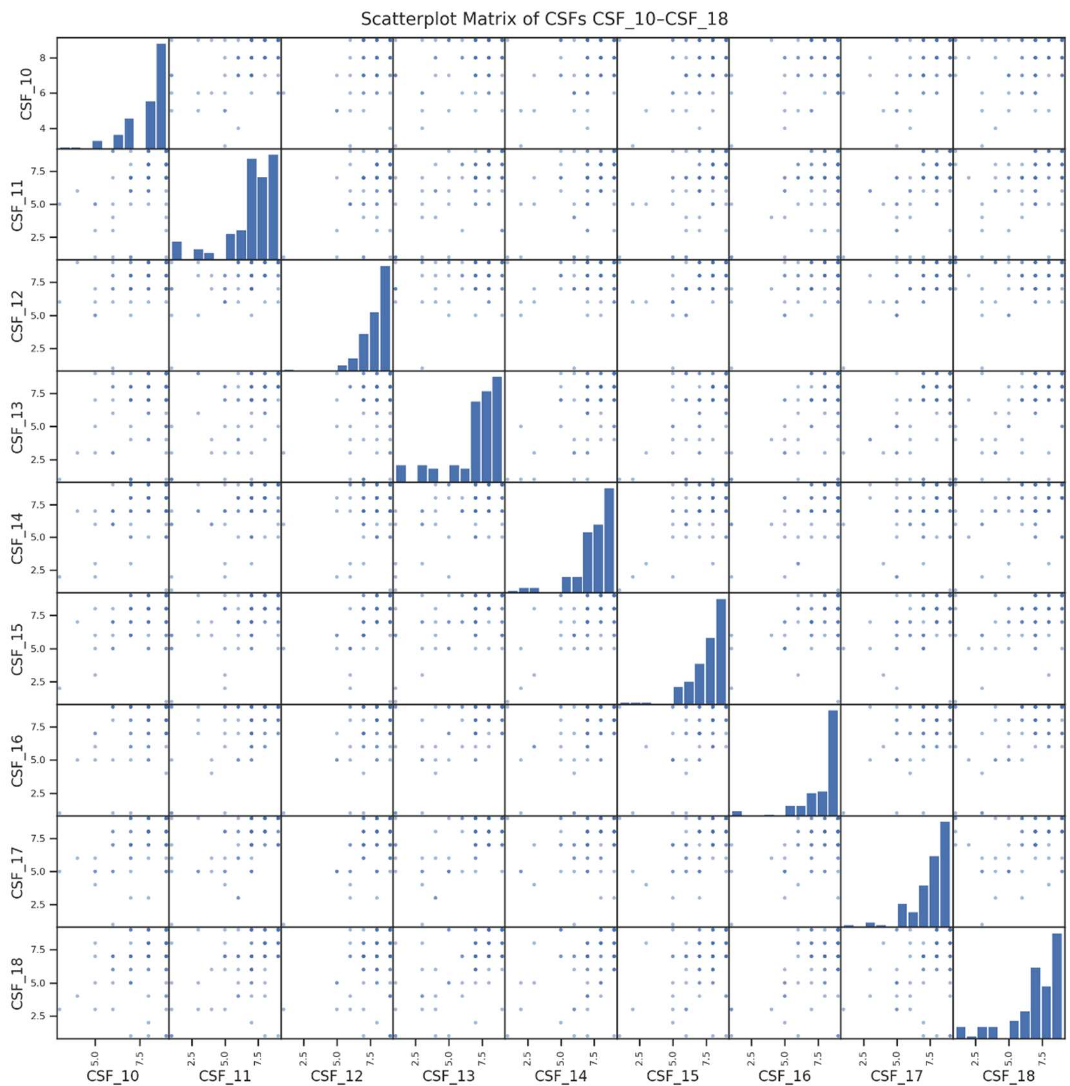
Appendix C

Scatterplot Matrices

CSF 1-9 Matrix



CSF 10-18 Matrix



CSF 19-27 Matrix