

Leadership and quality management measurement models: an empirical study

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Abstract

Purpose – The purpose of this paper is to explore, confirm and verify leadership with regards to quality management measurement models. This research focused on identifying individual staff members' leadership attributes at the Thai National Institute of Health in relation to quality management.

Design/methodology/approach – The research instrument used in this study was a modified questionnaire on self-leadership and quality management that was distributed to the institute's staff. Leadership and quality management construct variables were observed and measured through staff perceptions, attitudes, practices and existing facts at the institute. Exploratory factor analysis (EFA), confirmatory factor analysis (CFA) and structural equation modeling (SEM) were used to examine the data.

Findings – The questionnaire had a 65 percent response rate. EFA revealed six factors from 27 questionnaire items and CFA was used to confirm the measurement models that were fitted to the data. The leadership attributes of staff members at the institute were statistically associated to and impacted on quality management by SEM analysis.

Research limitations/implications – In-depth understanding of leadership and quality management could be done through a longitudinal study because the two factors would change over time. Even though this model is not a longitudinal study, it could help the institute facilitate and manage quality in practice through leadership.

Originality/value – A cross-sectional study is used to examine the effect of leadership on quality management through factor analysis and SEM, which provided empirical evidence for future research. Leadership and quality management measurement models have statistically proven to be appropriately, technically and theoretically correct by design for observing variables used in the leadership measurement model that affects quality management.

Keywords Structural equation modeling, Thailand, Leadership, Quality management

Paper type Research paper

Introduction

There are research studies that focus on the leadership attributes of top management who hold leadership positions, but only few studies focus on the leadership attributes of employees in Thailand's public sector. Some studies have measured quality management in a few of Thailand's public health organizations. However, no research has been published on the leadership attributes of individual staff at the Thai National Institute of Health (NIH). The NIH is a public organization and is regarded as a national reference laboratory functioning under the authority of the Department of Medical Sciences, Ministry of Public Health.

The main missions of the institute are: to develop and improve medical laboratory analysis of medical products and clinical testing provided to the public; to perform research in order to control the quality of medical products used in clinical laboratories; to become a national reference laboratory that provides medical laboratory services to the

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public; to support academically and transfer medical technology to local clinical laboratories of both public and private health providers; last, to collaborate with other concerned organizations or offices regarding health issues in the region with regards to disease outbreaks or disaster mitigation.

The institute has never employed a comprehensive approach to analyze the leadership of its own staff members. This problem was addressed by the researchers who focused on the leadership of the institute's members.

Leadership is an effective way to influence staff members to perform well (Hauschildt and Konradt, 2012). An individual could lead, persuade or motivate others to work or perform tasks on their own in order to meet the organization's goals and objectives. Leadership in this study means self-leadership (Manz et al., 2011) and is defined as the ability of an individual staff member at the institute to achieve his/her goals while working toward the objectives of the organization (Reddy, 2014). It involves each member of staff working on possible quality process and performance that leads to organizational development and achievement through leadership attributes of staff who try to find or stimulate changes to occur in the quality management of an organization. This research study looks at various characteristics or qualities of personnel who exhibit leadership, whether or not they are in leadership positions.

Understanding leadership attributes and how they are related to quality management could help the institute in its policy planning or other innovative strategies. This study aims to examine and confirm the role of leadership with regards to quality management at the institute.

Literature review

Leadership

The institute has not developed its staff leadership skills, which is in line with other public sector institutions in Thailand. Very few English language studies have been conducted on the public sector. However, many studies (in both Thai and English) have been conducted on the private sector (Das *et al.*, 2008; Chaijukul, 2010; Das and Kumar, 2011; Laohavichien *et al.*, 2011; Kantabutra, 2014). Andressen *et al.* (2012) found that individuals who have leadership qualities influence the self-leadership potential of staff members who subsequently improve their daily performance and achieve beyond the organization's goals. Leadership in this study refers to self-leadership. Self-leadership mainly leads to self-direction and control for a person who sets his/her own expectations. Chansatitporn *et al.* (2019) noted that self-leadership can be found in staff members of any level who have leadership attributes within an organization and can facilitate organizational learning (Yukl, 2010).

Studies on leadership found that leadership had a relationship and/or effect on quality management, especially when organizations begin to implement quality management programs (Chaijukul, 2010; Laohavichien *et al.*, 2011; Kemenade, 2014; Boak and Crabbe, 2019). Individual staff members who have leadership proficiency have various leadership attributes, for example, possessing good judgment skills, achieving decisive outcomes, sustaining an intrinsic driving force, maintaining an open-mind regarding change and adaption, and asserting a proactive attitude toward common goals. These leadership attributes have been studied for decades. The theory of leadership has been put into practice and focuses on the relationships of and perceptions among personnel who share benefits when working in an organization (Northouse, 2018).

Leadership can provide staff members with the tools or skills to redefine staff visions and missions through a mutual relationship, communication and can convert other staff into actual leaders. However, there remain many challenges that leaders need to communicate to employees for their engagement in organization performance (Cowan, 2014). People who

have essential leadership attributes will have a positive outlook and think anything is possible (Barker *et al.*, 2006; Ekmekcioglu *et al.*, 2018). Possessing leadership attribute without holding the role as the leader allows trust and relationships to be built amongst other colleagues.

There are other interesting leadership attributes, i.e. valuing expertise or skills of others in an organization, and understanding the personal impact and influence on other colleagues (Hardacre *et al.*, 2011; Kim *et al.*, 2018). Hardacre's study explored the leadership link needed to improve healthcare organizations. Her research team utilized self-reported key indicators of quality leadership among personnel. The indicators measured various aspects of behavior in the workplace, i.e., encouraging creativity, networking shared ideas, facilitating collaboration and trust, and giving confidence to others while inspiring others to be committed. As previously mentioned, this study measured the leadership attributes of individual staff members as observed through their leadership. Leadership is latent and a multidimensional construct (Hauschildt, and Konradt, 2012). The construct also relates to self-management and observation of one's own actions. A person can take control of their own cognitive process in order to make changes.

Quality management

There is no literature at the NIH on leadership and quality management. In the study of a British trust foundation's quality improvement, Lucas and Buckley (2007) and Kim *et al.* (2018) stated that leadership competencies were used to improve staff and organization performance. Other competencies are used to support staff and to integrate quality improvement into an organization's priorities (Powell *et al.*, 2008; Basir *et al.*, 2017; Jurburg *et al.*, 2019).

The quality management at the NIH has been helped by various technologies, i.e., medical technology, health technology and information technology (IT). The institute has several critical limitations, e.g. a lack of consistent funding for ongoing projects and a lack of appropriate IT. A good IT system is essential for medical data analysis, but the institute's current system rarely makes existing data meaningful. Improving IT helps to improve quality in healthcare services (Taylor *et al.*, 2005; Chaudhry *et al.*, 2006).

In the past two decades, the increasing demand on the institute to provide quality services to the public has prompted it to find ways to become a more efficient and effective organization. In many public health organizations, quality management is overlooked because it is a low priority or invokes indifference among employers, employees, top management and human resources. Luke and Zackarie (2011) and Pati (2012) noted that staff members should participate in planning, managing and improving at certain levels of the institute's quality management (Jurburg *et al.*, 2019). Quality is the key performance driver and one of the highest elements in the sustainable leadership pyramid of Avery and Bergsteiner's (2011) study. Organization model behaviors and attitudes of its leadership and changes coming from individual staff help to develop a new, better and safe work environment at the institute, resulting in better quality output.

Technology has changed the nature of today's workforce, and up-to-date quality management concepts such as total quality management, quality management systems, quality assurance or quality control, are essential. Many technological innovations have resulted in organizations becoming more streamlined (Andaleeb and Ali Kara, 2013). As a result, leadership has become one of the most important factors required to ensure the initiation and implementation of quality management and quality improvement systems.

The role entrusted to each staff member, regarding quality management, should be unambiguous and separate from their assigned daily tasks. The responsibilities of quality professionals have changed considerably from managing the day-to-day workload to being largely responsible for the organization's performance (Mauch, 2010). Many work places establish roles and assign responsibilities to individual personnel

based on their job descriptions. Each staff member is also asked to improve the quality management process by identifying problems and suggesting solutions on how to implement quality improvements.

Research design and research questions

This study is a cross-sectional survey. The researchers used an empirical method of exploratory factor analysis (EFA) because it is able to identify small sets of unmeasured variables that can explain correlations among sets of observed or measured variables (Grace, 2006). The observed variables are grouped into components or factors. In EFA, the factors are estimated to explain the common variance among variables and allowed to load on all observed variables.

Later analysis was performed using the confirmatory factor analysis (CFA) and structural equation modeling (SEM) methods. The purpose of performing CFA was to confirm that the refinement factors from EFA were correct and valid for the SEM, or if the hypothesized model is correct. CFA also tested whether the covariance or correlation among variables were consistent with the model. Finally, the researchers would be able to determine if the collected data from the measurement models supports or fits the hypothesized model (Figure 1). If the data do not support the model, the model can be altered and tested again to verify that the hypothesized model is true, or at least not theoretically false (Byrne, 2016).

Leadership as a latent variable

The researchers attempted to measure the attributes of leadership by exploring various observable or measurable variables. Once the data were collected, analysis was performed to identify those different variables reflected to the same latent variable. The researchers had reviewed leadership studies, modified and constructed questionnaire items, and performed a pilot study questionnaire survey before the actual survey. The questions corresponded to leadership attributes reviewed from various studies (Ashkanasy *et al.*, 2011; Franco, 2015; Northouse, 2018; Austin, 2016). The leadership variables were put into measured variables as questions that quantified leadership expressed or performed through the frequency scale of always practice/performed to never practice/performed.

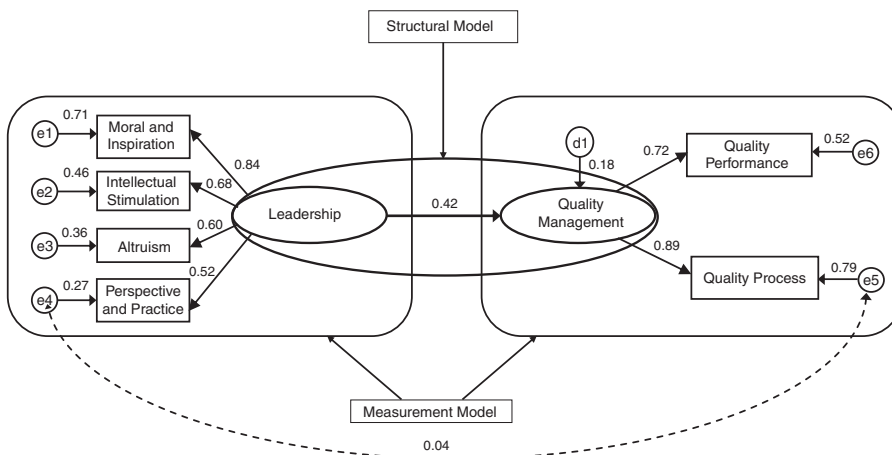


Figure 1.
Hypothesized model of
the study (without
dashed line)

Quality management as a latent variable

The researchers used the term quality management as output and developed questionnaire items for this study. The questions were formulated around objectives, plans or policies, satisfaction of external and internal clients, and staff involvement. Data, information or knowledge regarding quality management were disseminated to institute staff. Quality training, servicing, monitoring and evaluating these activities were performed. The questionnaire asked staff if they had performed any of these items and the corresponding frequency whilst carrying out their tasks. Since the researchers could not measure quality management directly, they reviewed a variety of studies and tried to quantify quality management by seeing if quality management aspects existed on the questionnaire items (Raffaldi *et al.*, 2012; Yu *et al.*, 2012; Andaleeb and Ali Kara, 2013; Campos *et al.*, 2017).

Research questions (RQ)

- RQ1. How many factors will be extracted from the questionnaire items of the study and how much factor loading of variance can be explained in the study?
- RQ2. What factor has the highest impact on each latent variable?
- RQ3. Do the collected data statistically fit the hypothesized models of leadership and quality management at the Thai NIH, and therefore is the hypothesized model proved correct?

Research findings

Prior to performing the two-factor analysis, various statistical assumptions needed to be tested and met, i.e. normality, heteroscedasticity and multicollinearity (Byrne, 2016). The researchers found the data to be relatively normally distributed. There was no heteroscedasticity and no multicollinearity. The correlation between leadership and quality management was 0.18 with a standardized regression weight of 0.42, p -value < 0.001 (Figure 1).

The researchers were permitted to distribute the questionnaire to all 340 staff members of the institute. The questionnaire was scored using a Likert scale from 1 to 5. 223 out of 340 questionnaires were returned, a 65.6 percent response rate. A sample size of more than 200 is acceptable for this type of study, which utilizes factor analysis (Hair *et al.*, 2010). SPSS (version 18.0) was used for EFA statistical analysis, and AMOS (version 18.0) was used to analyze the data using CFA and SEM. The proposed study and questionnaire were approved by the researchers' University Ethical Review Board. The questionnaire items were first examined using the Index of Concordance formula and reviewed by three leadership and management scholars, then distributed to 45 staff members at the institute's field sites, in order to test the validity and reliability of the questionnaire. Data were tested, and using internal reliability (Cronbach's α), the statistics showed a very good reliability of 0.90 (Field, 2013).

Exploratory factor analysis (EFA)

EFA was performed on the 27 original question items. Kaiser–Meyer–Olkin (KMO) measured the sampling adequacy and the result of 0.87 indicated that the number of participants was sufficient for this EFA analysis. If the KMO was lower than 0.70, the analysis would not be statistically appropriate (Hair *et al.*, 2010). Bartlett's test of sphericity was also performed and was found to be significant, p -value < 0.001, which inferred the observed variables in the EFA were associated.

A principal component analysis was performed using a Varimax rotation. This resulted in six-factor loadings above 0.40, which explained the 63 percent variance (Table I; percent cumulative of six components). Factor loading statistics showed a correlation between the variables and the factors. The correlation coefficient and regression coefficient were

considered as the same value in EFA. The importance of factor loading depended on sample sizes (Field, 2013). The sample size of this study was 223, and 0.40 loading was good for analysis because the loading would provide an indication of the considerable significance of a variable to a factor. Field (2013) noted that 0.40 loading would explain 16 percent of variance, and a loading of less than 0.40 would be less explained on study data.

The eigenvalues in Table I associated with the six components are shown in the first column of the table but with 27 components or question items initially (data not shown here). The eigenvalues represented the variances explained by particular linear components. For example, the first component or factor explains nearly 28 percent of the total variance (27.847 percent of Variance in initial eigenvalues), which is a relatively large value. Other components or factors explain lower values of variance with initial eigenvalues. After factor extraction and rotation of the eigenvalues, values of more than 1 were kept in the table and six components or factors were left (Table I). Factors that have an eigenvalue of 1 means there is extensive variation. Kaiser's criterion is accurate, especially when there are less than 30 variables. This study had a total of 27 variables (observed variables/question items) that measured both leadership and quality management. The Varimax rotation helped optimize the component structure and equalized the eigenvalues among the six factors. The eigenvalues of factors 1, 2, 3, 4, 5 and 6 had % variances of 13.919, 12.376, 11.977, 11.308, 8.867 and 4.558 percent, respectively. These variances were equally better distributed than Initial eigenvalues. The variances were much different before the rotation (27.847, 15.129, 5.805, 5.436, 4.983 and 3.805 percent, respectively) (Table I). The total variance explained was around 63 percent for the six components.

Apart from Kaiser's criterion accuracy check, the researchers looked at reproduced correlation values of residuals (or errors). If there is less than 50 percent of non-redundant residuals with absolute values are more than 0.05 the researchers do not have to be concerned about errors (Field, 2013). The reproduced correlation values of residuals in this study were 33 percent (data not shown here). The percentage referred to the proportion of residuals; the smaller percentage, the better the accuracy. In addition, as the sample size is more than 200, Tables I and II showed there were six statistically meaningful factors in this analysis of leadership and quality management (Hair *et al.*, 2010). This is a fairly reliable criterion for factor selection.

The questionnaire consisted of 27 questions, and all questions were refined by their factor loadings, with the first two components having a high loading according to EFA (Table II). Eight questions were derived and called Quality Management Process and four items were called Quality Management Performance. A factor loading of less than 0.4 was not shown in the analysis and the factor loading of higher than 0.6 was considered high for EFA (Williams *et al.*, 2010). The factors or measurement variables were named through their common semantic theme and could have subjective meanings (Field, 2013). In addition, the other four components; Moral and Inspirational, Intellectual Stimulation, Altruism, and Perspective and Practice, were identified as leadership and their factor

Component	Total	Initial eigenvalues		Rotation sums of square loadings		
		% of variance	% cumulative	Total	% of variance	% cumulative
1	7.519	27.847	27.847	3.758	13.919	13.919
2	4.085	15.129	42.975	3.341	12.376	26.295
3	1.567	5.805	48.781	3.234	11.977	38.272
4	1.468	5.436	54.216	3.053	11.308	49.580
5	1.345	4.983	59.199	2.394	8.867	58.447
6	1.027	3.805	63.004	1.231	4.558	63.004

Table I.
Total variance explained

	Rotated Component Matrix ^a					
	1 Quality process	2 Quality performance	3 Moral and inspiration	4 Intellectual stimulation	5 Altruism	6 Perspective and practice
Question 1					0.678	
Question 2					0.775	
Question 3					0.679	
Question 4					0.680	
Question 5			0.585			
Question 6			0.636			
Question 7			0.838			
Question 8			0.710			
Question 9			0.644			
Question 10			0.478			
Question 12				0.803		
Question 13				0.781		
Question 14				0.813		
Question 11						0.467
Question 15						0.518
Question 16		0.791				
Question 17		0.826				
Question 18		0.698				
Question 19		0.638				
Question 20	0.572					
Question 21	0.538					
Question 22	0.521					
Question 23	0.717					
Question 24	0.635					
Question 25	0.475					
Question 26	0.802					
Question 27	0.703					

Table II.
Exploratory factor
analysis

Note: ^aRotation converged in nine iterations

loadings were shown in Table II. Components 3, 4, 5 and 6 had lower factor loadings than the first two components (Quality Management Process and Performance).

Confirmatory factor analysis (CFA) and structural equation modeling (SEM)

From the six components or factors derived from the EFA, four factors (3, 4, 5 and 6) were displayed in leadership measurement model. The other two observed variables or factors (1 and 2) were displayed in the quality management measurement model. When the researchers examined items of the components, they named the observed or measurement variables of the leadership as Moral and Integrity, Intellectual Stimulation, Altruism and Perspective and Practice for components 3, 4, 5 and 6 as mentioned above. The number of question items for each component was six (component 3), three (component 4), four (component 5) and two (component 6) according to their loadings (Table II). Furthermore, the quality management measurement model had two observed or measurement variables as Quality Management Process and Quality Management Performance which consisted of eight items for Quality Management Process and four items for Quality Management Performance. The hypothesized model is shown in Figure 1. The original hypothesized model as the researchers proposed was without a dashed line (with two-way arrows). When AMOS was analyzed, the output recommended adding the line to improve the model to fit the data. The researcher drew a line (as shown by the dashed line) on AMOS graphic and

AMOS analysis was repeated and Goodness of fit statistics are shown in Table III after adjusting the model.

After the model was adjusted, the null hypothesis was accepted because the model had a good fit and the *p*-value had increased to more than 0.05. In addition, χ^2 (CMIN) had decreased and CMIN/DF had declined to less than 2.000. Goodness of fit (GFI) and adjusted goodness of fit (AGFI) had increased. Also, Hoelter (.05) had increased to more than 200, which is considered adequate (Schumacker and Lomax, 2016). Root mean square residual (RMR) decreased to near zero and the root mean square error of approximation (RMSEA) decreased to less than 0.05 (Byrne, 2016). These indices were modified to fit the model (Table III).

Discussion

The results of EFA were put into six factors or components, according to their factor loadings. The higher the values of loading, the more accurate the variables represent factors (Tabachnick and Fidell, 2007). These six factors were deemed significant, even though they did not explain all data variation (only 63 percent, Table I). However, the above-mentioned statistical methods showed they were meaningful and thus should not be discarded. Therefore, this information answered *RQ1*. The factors were anticipated as underlying variables when the researchers constructed the questionnaire items. After the researchers carefully reviewed various leadership and quality management articles, papers and textbooks, some items were developed and some were modified.

The researchers examined two measurement models and a structural model (Figure 1) and originally found that the structural model did not have a good fit. Model identification indicated correspondence between free parameters that were unknown parameters to the researchers and was estimated by the AMOS software program, which decided whether a model was identified (Byrne, 2016). The number of data points was calculated (21) using the formula below and compared to the number of parameter (NPAR) estimates after model was adjusted (15) (Table III):

$$\begin{aligned} \text{Number of data points} &= p(p + 1)/2 \\ &= 6(6 + 1)/2 = 21, \end{aligned}$$

where *p* equals the number of observed variables in the hypothesized model (*p* = 6 in this study).

From Figure 1, the AMOS program recommended to draw a line between e4 and e5 to make the model fit (see Figure 1, a dashed-line). The model showed that there was a covariance between estimated errors of Perspective and Practice of Leadership and Quality Management Process of Quality Management. However, the covariance estimate value was not high (0.04, *p*-value < 0.001). Moreover, the number of estimated parameters after the model was adjusted was 15 (Table III). According to Byrne (2016) and Schumacker and Lomax (2016), SEM may end up with three scenarios:

- (1) Under identified model – the number of parameter estimates is more than the number of data points.

Model	NPAR	CMIN	df	<i>P</i>	CMIN/DF	RMR	GFI	AGFI	RMSEA	HOELTER
Before model adjusted	13	27.659	8	0.000	3.457	0.020	0.954	0.880	0.117	107
After model adjusted	15	11.284	6	0.146	1.880	0.006	0.996	0.986	0.000	277

Table III.
Goodness of fit indices

- (2) Just identified model – the number of parameter estimates is equal to the number of data points.
- (3) Over-identified model – the number of parameter estimates is less than the number of data points and the aims of the SEM would expect scenarios (2) or (3) to occur if the model is accurate (Acock, 2015; Dasgupta, 2018). This study produced an over-identified model because the number of parameter estimates after adjustment (15 from Table III) was less than the number of data points (21 from the calculation above).

The standardized regression weight of Quality Management Process was 0.89, p -value < 0.001 (Figure 1), which was more than Quality Management Performance standardized regression weight (0.72, p -value < 0.001). This meant that the process was more influential than performance on Quality Management. Kanagasabapathy (2010) noted that the process in laboratory contributed to frequency of errors and special attention should be paid to prevent laboratory errors. Planning process was important and also discussed in medical quality management in the American College of Medical Quality textbook (Varkey, 2010). Evidence-based process measures in quality management were carried out at the American Institute of Medicine (Varkey, 2010). In China, the quality management process was found to be important for quality program implementation (Zu *et al.*, 2011). In addition, components 3, 4, 5 and 6 for Leadership had estimated standard regression weights of 0.84, 0.68, 0.60 and 0.52 (p -value < 0.001), respectively. This meant that component 3 (Moral and Inspiration, Table II and Figure 1) had more impact on Leadership than components 4, 5 and 6. This answered RQ2.

Component 1: Quality Management Process

This component was named first according to its loading values, which were high. Eight-factor loadings were found (Table II). Quality Management Process here was noted as a set of procedures that need to be followed to ensure certain tasks would be undertaken to meet the organization's goals. The process can be measured and reported to top management, so any problems can be resolved rapidly (Psomas *et al.*, 2011). Eight items were classified as Quality Management Process:

- (1) plan do check act cycle is applied and used for continuous quality improvement;
- (2) quality data and/or reports are used to help make decisions;
- (3) staff members are involved in different quality management processes and know how to evaluate them;
- (4) quality of service or product at this institute is set;
- (5) quality of service has been evaluated through record keeping of errors, faults or complaints;
- (6) annual monitoring services are conducted through internal and external client satisfaction surveys;
- (7) annual training on quality management is provided to all staff; and
- (8) annual quality reports on the institute are produced.

Process in quality management had a higher impact than Performance (standardized regression weight of quality management process was 0.89, p -value < 0.001). This may be because the process comes before performance in management in general or in SIPOC (Supplier, Input, Process, Output and Customer) management. Process occurs in the middle SIPOC and before Output (Osgood, 2012) as process needs to be planned in four or five high levels or steps.

Component 2: Quality Management Performance

This component focused on the opinions of the institute's internal and external clients. The institute used various tools or techniques on quality work. The researchers asked about existing facts concerning quality management at the institute and classified this component as Quality Management Performance or perception in performance (Campos *et al.* (2017). Four items in this component were refined as the second factor because the questions asked had lower loadings than the first factor (Quality Management Process) and the standard regression weight was lower (0.72, p -value < 0.001, Figure 1):

- (1) the institute considers clients' needs in a systematic way;
- (2) ensures that all stages of medical testing service delivery are well coordinated;
- (3) uses statistics to help evaluate quality control, quality assurance and quality improvement; and
- (4) analyzes management to improve services.

Component 3: Moral and Inspiration

This component refers to any member of staff who performs his/her work in a way that inspires his/her colleagues to improve their performance in the workplace. The person may also help his/her colleagues to complete their tasks. Such a person has various attributes such as: knows what is good, desires what is good and does what good. This type of person could also influence others to create work or strategies for the organization (Chong *et al.*, 2018). A person, who is a role model, or leads by example, exhibits a high level of work ethics and moral conduct. Moral and Inspiration had the most impact on leadership since its standardized regression weight was the highest (0.84, p -value < 0.001, Figure 1) in the leadership measurement model. It could be expected that staff who have high moral and inspirational qualities would exhibit better leadership qualities. The researchers classified and named these attributes as Moral and Inspiration, which consisted of six items:

- (1) have value and faith in one's work or being consistently truthful with others;
- (2) consider objectives of work to be crucial;
- (3) have a positive attitude and outlook;
- (4) work enthusiastically and eager to learn;
- (5) mention or talk about interesting future; and
- (6) think critically and appropriately.

Staff who can inspire (attributed in component 3) other staff to work responsibly could help improve quality across the institute or create and maintain an internal environment and become voluntarily and completely involved in quality management and improvement both in Quality Process and Performance. Moreover, personal involvement of each staff is a precursor to managing quality as well as motivating or stimulating staff to fulfill goals and objectives regarding quality management (Paulova and Milkva, 2011; Berland, 2017).

Component 4: Intellectual Stimulation

This leadership attribute was derived from the questions that asked staff who absorbed an idea or a conversation that one had mastered in such a manner that appropriately communicated a clear ambition about the future. This person has the ability to enhance desire or has a strong drive to accomplish his/her own goals and objectives. The person can convince colleagues to accept organization interests as their own interests. Intellectual

stimulation had the second most impact on Leadership with a standardized regression weight of 0.68 (p -value < 0.001, Figure 1) in the measurement model. These attributes are classified and named as Intellectual Stimulation. There were three items classified in this component:

- (1) change colleagues' way of thinking to help them accomplish their tasks;
- (2) assist others to find their strengths or improve their performance; and
- (3) mentor colleagues and persuade others to acknowledge the institute's concerns and objectives.

The results of the study indicated that each staff member intellectually stimulates each other to generate effort and to help each other feel satisfied with quality management work, to meet quality management needs, to give member confidence in order to conduct effective quality management performance.

Component 5: Altruism

This component refers to staff members who can call on their own experiences to assist colleagues and are willing to help others and the organization. They also provide physical and mental support or are concerned about colleagues' personal needs or feelings. A person who respects others and considers others' talents when trying to help them reach his/her potential. A person who values diversity among others with different cultures and backgrounds, and respects other individuals' rights. The standardized regression weight was 0.60 (p -value < 0.001, Figure 1). These attributes were named Altruism. There were four items in this component:

- (1) think of others more than oneself and do one's best for the team/organization;
- (2) be attentive and listen to other people's views; appreciate others;
- (3) proud of other colleagues in the team; treat others in an impartial or equitable manner; and
- (4) have integrity, which encourages others to be ethical.

In general, staff members like to be inspired by their colleagues. Staff at the institute allow others around them to rise to the occasion. They usually try hard to make decisions, balancing both doing the right thing and doing things right. Staff also help their colleagues by setting concise and realistic goals, missions and vision that fit the culture of the institute.

Component 6: Perspective and Practice

The least factor loading in this study referred to a person who can think thoroughly and/or encourage others to think for themselves. One who can provoke thought or controversial/radical ideas within the boundaries of appropriate behavior. The person looks at issues from various perspectives and can create things via an innovative approach. Leadership perspective could create continual rethinking that reinforces quality management process and performance. Each staff could make a significant contribution to practice quality management. An emergence paradigm in the twenty-first century requires participative, situational and collaborative leadership (Kemenade and Hardjono, 2019). Quality Management needs every staff member of the institute to commit to the need for continuing quality improvement in the way quality process is achieved. The standardized regression weight was 0.52 (p -value < 0.001, Figure 1). Likert's study (Koontz *et al.*, 1984) noted with regards to leadership and management that a manager who supported his/her staff or promoted staff involvement received constructive operation in the organization.

This last component was called Perspective and Practice and there were only two items (question 11 and question 15 in Table II):

- (1) find other ways to solve problems; and
- (2) care for others more than just as a member of a team.

We found the Thai NIH implemented several international standard requirements to serve internal and external clients, stakeholders or various public service users, i.e. ISO 9001:2008 (Quality Management Systems – Requirements), ISO/IEC 17025: 2005 (General Requirements for the Competence of Testing and Calibration Laboratories), ISO 15189: 2007 (Medical Laboratories – Particular Requirements for Quality and Competence) and ILAC-G13:2007. These could help explain why the two observed variables of the quality management measurement model had a higher loading than the four observed variables in the leadership measurement model (Figure 1). Furthermore, the correlation coefficient between Leadership and Quality Management was rather low ($r = 0.18$, p -value < 0.001), which corresponded to the fact that the two variables (constructs) or more had no multicollinearity (Byrne, 2016). In addition, when devising questionnaire items (modifying or developing them), the researchers might have focused on a limited range of Leadership observed variables that were omitted while searching, which could result in the low correlation with Quality Management. However, the standardized regression weight or standardized coefficient between Leadership and Quality Management was 0.42 (p -value < 0.001). This infers that Leadership attributes of individuals at the institute impacted on Quality Management by a factor of 0.42. It was not a small impact, given that there could be other factors or construct variables that impact on Quality Management. The study has broadened the extent of the leadership and quality management perspectives and measures. Importantly, the hypothesized model was proved correct because the collected data had a good fit with the model, which answered *RQ3*.

Conclusion

There is no empirical research study on leadership and quality management at the institute. From this study, the researchers found a possibly explained notion. Previously, there were no statistically valid leadership and quality management scales to assess these factors at the institute. Therefore, the questionnaire items were developed to fit the measurement models, otherwise it would be difficult to advance research in these fields.

Developing leadership attributes and other imperative leadership characteristics does not happen by accident. Staff need to learn, understand and practice to intentionally build particular abilities which are desired or needed for an organization. The researchers determined those refined components according to their common underlying meanings. Two components belonged to the Quality Management measurement model and four components belonged to the Leadership measurement model. The researchers hypothesized and statistically proved that they were correct and that data were a good fit in the structural model. This empirically reliable model could be used in other studies or in other contexts or use these two models or modify to assess Leadership or Quality Management via the refined question items of the study. However, the study had limitations due to time constraints and a small sample size (just over 200). This study was cross-sectional and could be elaborated on by considering a longitudinal study to help review the leadership and quality management that has changed over time.

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Further reading

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