Knowledge-Based Innovative Lean Service Life Cycle Evaluation Model for Training System

Rui-Yang Chen

***Abstract*—Good quality of the knowledge-based innovation training process is a challenge for training system. What is needed is evaluation of how well the training system explores business training process. This study aimed to integrate lean service life cycle and Taiwan Training Quality System (TTQS) with European Foundation for Quality Management (EFQM) and quality function deployment (QFD) in order to evaluate the critical training service quality factor for business performance. The case study and experiment compared with lean/non-lean were discussed. The findings also allude to the exploration strategy for evaluated five groups in TTQS training certification.**

***Index Terms*—Training assessment system, EFQM, lean service life cycle, knowledge innovation.**

I. Introduction

Good quality of the knowledge-based innovation business training process has been shown to make an important contribution to organizational success [1], [2]. The Taiwan Training Quality System (TTQS) is based on the concept of UK's investors in people and the ISO10015 to ensure the quality and performance of the business training process. Taiwanese government plays a major role in promoting training operation through TTQS, but the evaluation model often neglects knowledge intensive business services for TTQS performance. Knowledge intensive business services have played an important role in comprising various contributions of knowledge input to organization operations in recent decades. The competitive advantages of knowledge intensive business services rely on innovative activities [3]. From an innovation perspective, knowledge intensive business services may create the added value and competitive advantages of organization. John *et al*. [4] identifies key research challenges that must be addressed over the next decade from services, innovation, employment and organization. Knowledge services enhance their customers' capacity for improving their evolutionary capabilities and producing tangible innovative cycles [5]. Augusto [6] found that organizations might want to consider directing their innovation investments towards management aspects such as processes. Aboelmaged [7] found that high levels of innovation contribute to creating the organizational performance. The lean service of TTQS should include innovation related to organizational operation and strategy planning [8]. The TTQS aims to help organization to raise business performance, which is closely connected with training process. Achieving business performance results from training is a challenge for the knowledge-based TTQS. What is needed is evaluation of how well the knowledge-based TTQS explores business training process. Thus, this study adopts lean service life cycle and lean ecosystem with knowledge innovation for proposed evaluation model and reason is described as followings.

Carlborg *et al*. [9] proposed a conceptual analysis of the six most commonly used lean principles in manufacturing to conceptualize how these principles impact service productivity. Although lean approaches were developed and applied in service operation, they are being used successfully in training system. Lean approach has been very important in improving training service efficiency in response to rapidly changing organization needs.

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II. Literature Review

A. Lean Service Life Cycle

The service life cycle aims to measure and increase the productivity of a service involved partners [10] in a dynamic TTQS, training stakeholder as partners influence common core value and performance. Consequently, TTQS has powerful effect on the performance measurement of services throughout service life cycle. Considering the involvement of the lean service in the measurement of TTQS performance is crucial in the knowledge factor where innovation is created through lean service life cycle. As the focus of this article is on knowledge-based lean services, considering lean service life cycle is also crucial. Lean features from literature review described such as value-added, continuous improvement and organization strategy.

B. TTQS Lean Service Ecosystem

Service ecosystem illustrates the function of value co-creation as they affect stakeholders, especially in industry environment. By applying Chen's [11] service life-cycle concept of ecosystems, this article proposes lean service ecosystem for TTQS. It divides the lean life cycle with stakeholders into four stages such as ready stage, implement stage, assessment stage and action stage in the Fig. 1. These stakeholders consist of government, training institution, lecture, consultant, assessment committee, and counseling companies.

In the ready stage, organizations and their related training institution build a training system to provide lean service for employments or customers, and achieve business performance through plan, design, do, review and outcome (PDDRO) cycle. In the implementation stage, the consultants, lectures and organizations are integrated

internally by industrial network and interact with the TTQS document to create value chain for lean service. In the assessment stage, a highly standard assessment subsystem break through TTQS boundaries and generates scorecard as standard framework that lead stakeholders in the ecosystem to further explore more high-quality training document and activities on the basis of lean service, with the goal of business strategy and training plan. In the action stage, the original TTQS's lean service ecosystem may be replaced by a continuous improvement lean service ecosystem that has a new higher-quality TTQS than the original TTQS.

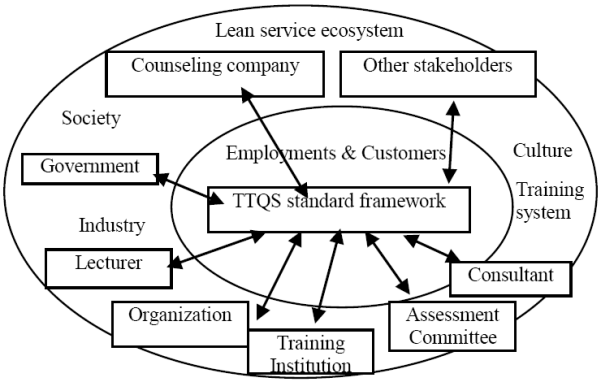

Fig. 1. A model of a TTQS's lean service ecosystem.

From above-mentioned discussion, the proposed evaluation model in this article is to systematically connect TTQS with knowledge innovation through lean service life cycle under European Foundation for Quality Management (EFQM) framework for improving business performance. This model aims to transfer the TTQS into the EFQM-based quality function deployment (QFD) model. This study aimed to integrate lean service life cycle and TTQS with EFQM and QFD in order to evaluate the critical training service quality factor for business performance. The concept design of lean service life cycle for knowledge innovation EFQM-based QFD is exploratory and conclusive. An exploratory approach is to provide lean service insights into the TTQS, and a conclusive approach is to assist the TTQS in evaluating the business performance.

C. EFQM Excellence Model and QFD Method

EFQM Excellence Model has been widely applied [12], [13]. The EFQM has also been empirically verified as a well-known quality evaluation model used to improve business performance [14]. Gouthier *et al.* [15] proposed service excellence model to achieve companies' quality performance using three approaches such as Johnston's conceptualization, the EFQM Model and the Kano model. Quality function deployment (QFD) is a quality concept that provides a means of translating customer requirements (VOC, voice of customer) into the appropriate technical requirements (VOE, voice of engineering). QFD is an important tool in transmitting the customers' voice into the product/service technique, and is also a key process in developing the product/service and meeting their requirements. Doeleman *et al.* [16] suggested that the leadership aspects of change need further investigation. Chang & Chen [17] proposed the evaluation of the PDDRO cycle using EFQM excellence model to examine the criterion weights for the TTQS excellence model.

III. KNOWLEDGE INNOVATION LEAN SERVICE LIFE CYCLE EVALUATION

The proposed lean service life cycle referred to in this study consists of three phases based on lean service ecosystem, namely lean service deployment, lean service evaluation and lean service action in Fig. 2. In the lean service deployment phase (phase 1), the influence of interaction between lean service and TTQS on knowledge innovation should be explored using EFQM-based QFD method. In the lean service evaluation phase (phase 2), TTQS result, PDDRO aspects and characteristics of the lean service have been considered to enhance TTQS performance evaluation using EFQM-based QFD method. In the lean service action phase (phase 3), benchmarking is required to be investigated to incorporate it into action plan in the future. Benchmarking is getting important as a method which evaluates service quality measurement and identifies best practices. Thus, phase 3 aims to predict the TTQS's lean service performance value (y) by multiple linear regressions (MLR). It has been employed by many service processes [18]. A performance approach is to assess TTQS's strengths of leading competitors. This determination to measurement performance of TTQS lean service adopts three features such as consistency, integrity and sustainability using regression model. From business performance perspectives with lean approach, the TTQS emphases three features such as integrity, consistency and sustainability. The integrity focuses on training plan to meet organization vision, strategy and target. The consistency is to ensure that the training program links to the training plan. The sustainability is to enhance training reengineering for continuing improvement. These features include lean feature from their context. According to the three features, we know that the TTQS should explore lean service because of lean features.

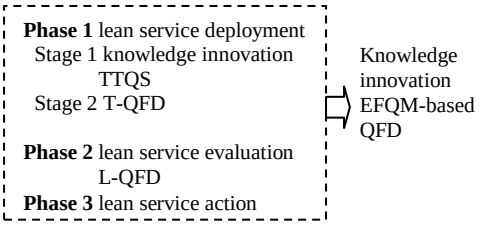

Fig. 2. Lean service life cycle.

To evaluate the performance of the TTQS, this article proposes a Knowledge-based TTQS structure integrated EFQM and QFD in Fig. 3. In a structure sense, it consists of three sections: EFQM, T-QFD, and L-QFD. EFQM-based QFD was developed based on the lean service technique matrix (T-QFD), lean service leadership matrix (L-QFD) for phase 2, and a combination of the two matrixes. The procedures of the EFQM-based QFD were formulated based on two phases such as lean service deployment and lean service evaluation. The first phase comprises two stages. The stage 1 of Phase 1 is to establish knowledge innovation TTQS structure. The stage 2 of phase 1 explore T-QFD matrix using lean service technique. Both stages in phase 1 were conducted through questionnaire and semi-structure expert interview. The measurement of QFD semi-structure interview was separated into six levels (0, 1, 2, 3, 4, 5),

labeled from "no correlation" to "extremely high-level of correlation".

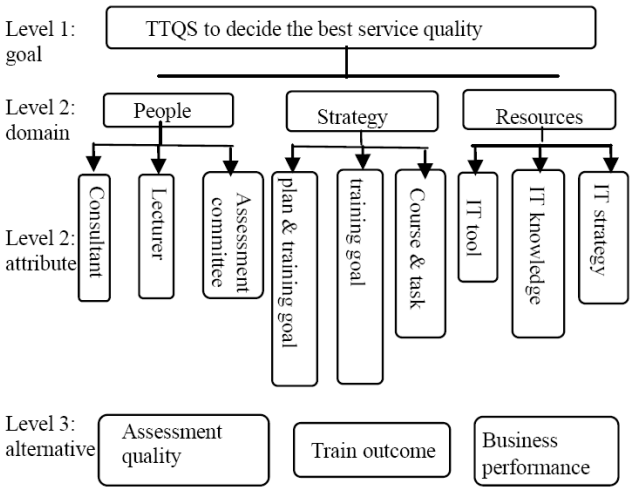

Fig. 3. Knowledge-based TTQS structure.

Finally, multiple linear regressions (MLR) were used to predict the TTQS's lean service performance value (*y*) using integrity, consistency, and sustainability in the phase 3. The general equation is as follows:

$$y = p_0 + p_1 e_1 + p_2 e_2 + p_3 e_3 \quad (1)$$

where p_0, p_1, p_2 and p_3 are the parameters generally estimated by least squares and e_1, e_2, and e_3 are the explanatory variables (predictors) such as integrity, consistency , sustainability. These values of the parameters will be influenced by different weighted method such as five groups (A, B, C, D, and E) for TTQS certification. Group A (white gold medal) is as benchmarking. Group B (gold medal) is as excellent. Group C (silver medal) is as good. Group D (bronze medal) is as fair. Group E (threshold) is as pass. However, the parameters of classical regression model with lean and non-lean are estimated by MLR in this article.

IV. Discussion

A. Case Study for Exploration Strategy

The case study of proposed model distributed a total of 70 copies of the questionnaire, 66 copies were valid. The intra-matrix in F-QFD and L-QFD was converted into an expert semi-structure interview and nine experts from the related stakeholders were invited to give the correlation points of the relational matrix. The result of this case study is described followings as. In establishing T-QFD, the top three factors for knowledge-based TTQS structure required by VOC were 'plan & training goal', 'IT knowledge', and 'Assessment committee'. Ranking the lean service techniques by degree of importance, the top two lean service techniques were 'ECR' and 'continuous improvement'. It is believed that if these factors are implemented, TTQS service quality will be satisfied and organization can enhance training performance through knowledge innovation. In establishing L-QFD as shown in Fig. 3, the top one factor for three alternatives (level 3) required by VOC were 'business performance'. Ranking the lean service leadership by degree of importance, the top one lean service leadership was 'plan' and 'outcome'. It is believed that if these factors are implemented, TTQS service quality will be satisfied and organization can meet related stakeholders needs.

Strategic decisions are crucial for services. Thus, this article tries to develop the exploration strategy as strategy decision. The proposed model tries to explore knowledge-based lean service matrix (Fig. 4) with strategy for TTQS service quality evaluation based on this model processing result. This matrix consists of two axes: x-axis as lean performance degree (LP), y-axis as knowledge innovation degree (KI). The degree of lean performance reflects the value-added degree to impact business performance. The degree of knowledge innovation in a given organization reflects the newness degree of creativity to incorporate value-added ideas which impact the organization, its production and quality capabilities. Rather, the outcome of innovation must be affected in the business performance to qualify the lean service in terms of the evaluation of the TTQS. The exploration strategy denoted by the four quadrants of this matrix is shown in Fig. 4.

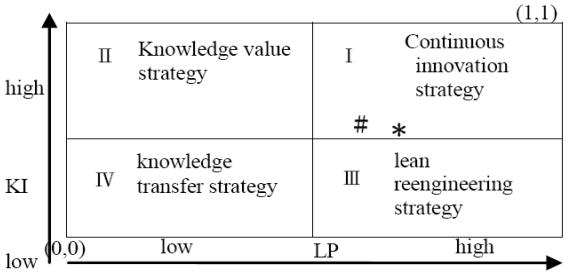

Fig. 4. The exploration strategy.

From this result, it shows that the exploration strategy is "continuous innovation strategy" for evaluated TTQS based on this case study. The role of benchmarking is getting important as a continuous innovation process for service quality in TTQS. Benchmarking provides significant value as a training process for accumulating measures of business performance. These four strategies is described following as:

- *Knowledge value strategy*

The knowledge value strategy is a strategy decision based on knowledge intensive business services (KIBS). The KIBS have emerged as a major business evolution in recent decades. This strategy is valid for knowledge value which depends on some stakeholder's ability to transfer the knowledge of business performance into TTQS. However, the knowledge value strategy require more interaction and involvement among these stakeholders in order to strengthen TTQS's knowledge value and enable them to provide improved training operation for TTQS.

- *Continuous innovation strategy*

The continuous innovation strategy is aiming at capability both creating both innovation TTQS and continuous improvement based on business performance perspectives. The capability of a TTQS to achieve business excellence along multiple competitive factors such as high quality lean service and knowledge innovation activities is increasingly regarded as a source of benchmarking.

- *Lean reengineering strategy*

The lean reengineering strategy is to reduce waste and non-value added activities for increasing productivity, enhancing quality, shortening lead time and so on. In this strategy we argue that for TTQS, a way to enhance or even improve TTQS's lean service level through business process reengineering is to adopt an image of stakeholders as a source of added value. The stakeholders participate in PDDRO circles to contribute to continuous improvement activities. This strategy's objective is to determine whether training process reengineering of lean thinking in TTQS improves efficiency and productivity.

- *Knowledge transfer strategy*

Knowledge transfer is a mainly activity of knowledge management when organization recognizes a lack of knowledge. For example, TTQS needs operation knowledge of PDDRO. Knowledge consists of two types such as explicit knowledge transferred by database and tacit knowledge transferred by interpersonal. Knowledge transfer strategy uses these two types to facilitate PDDRO knowledge sharing and achieve TTQS goal.

B. *Experiment Compared with Lean and Non-Lean*

This article tries to find the lean service TTQS and non-lean service TTQS and determine whether there is a significant difference between their enablers and results from EPQM model through experiment. This experiment uses original 60 cases from the evaluated organization result to study the impact of the organization's lean service performance with before and after. The goal of the experiment was to improve TTQS's quality, which operates as lean service composed of five groups (A,B,C,D,E) for TTQS certification that use the three features such as integrity, consistency and sustainability.

Table I compares 60 organizations case evaluated for the year 2011, through 2014 using the three features measurement (0-10 scores) through assessment result. Perceived TTQS index importance and expert assessment are explored with certification classification to help organizations review difference of classification into improvement with 5 groups. The impact of the experiment is shown as the calculated differences before and after lean service implementation in the three features of TTQS. For example using group B in Table I, this result is described followings as. The integrity after the lean implementation is 7.5 and more than before (5.5). This represents a valuable training, plan which able to achieve organization goal through lean-based training service. The consistency after the lean implementation is 7 and more than before (6.0). This represents an efficient training course which able to finish the needs of training plan. The sustainability after the lean implementation is 7.3 and more than before (5.6). This represents a continuous improvement effect which able to enhance the next training performance.

TABLE I: EVALUATED CASE BEFORE AND AFTER LEAN SERVICE WITH THREE FEATURES

Group	after lean implementation (lean)			before lean implementation (non-lean)		
	Integrity	Consistency	Sustainability	Integrity	Consistency	Sustainability
White gold medal	8	7.8	8.2	6	6.5	6
Gold medal	7.5	7.0	7.3	5.5	6	5.6
Silver medal	7	6.5	6.8	5	5.5	4.8
Bronze medal	6.5	6	6.3	5.1	4.5	4
Threshold	6	5.5	5.5	3.5	3	3
Average	7	6.56	6.82	5.02	4.9	4.68

C. *Regression Model for Lean and Non-Lean*

However, the parameters of classical regression model with lean and non-lean are estimated by MLR and shown followings as. This article has considered the five groups for evaluating TTQS models in the Table II. Substituting evaluated values from the (integrity, consistency, sustainability) values from Table II into the regression will yield the performance value shown in Fig. 5 for comparison and the equation is followings as:

$$\text{performance values(lean)} = 0.681 + 0.005 * \text{integrity} + 0.004 * \text{consistency} + 0.002 * \text{sustainability} \quad (2)$$

$$\text{performance values(non-lean)} = -0.351 + 0.074 * \text{integrity} + 0.011 * \text{consistency} + 0.071 * \text{sustainability} \quad (3)$$

The adjusted-R square and p-value of the regression model for lean are 0.999 and 0.002, respectively. The adjusted-R square and p-value of the regression model for non-lean are 0.910 and 0.012, respectively. They mean that the evaluating model reaches the significance level in the TTQS.

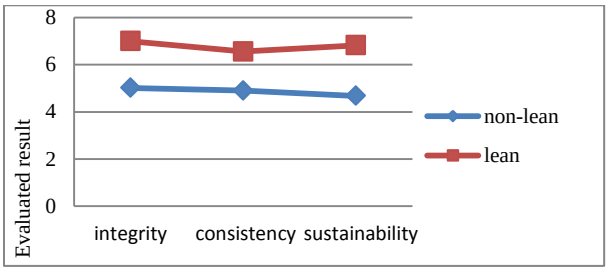

Fig. 5. The trend of performance value.

It is clear from MLR result that lean is getting better than non-lean for performance value in the Fig. 5. However, lean services are good approach, and they provide nearly the evaluating performance value. A good TTQS evaluating method should be able to consider the performance value and thus predict the entire trend well in TTQS lean service life cycle.

- *The exploration strategy for evaluated case*

Table II highlights the exploration strategy based on different group type about the impact of the lean service and the three features of lean-service-based TTQS from the above-mentioned experiment result using F-QFD/L-QFD and KI/LP matrix method. In this KI/LP matrix method, the

larger the distance between the factors and the matrix center (1, 1), the more critical it is to make improvement for service quality. The analysis process of the knowledge-based lean service matrix of exploration strategy included the calculated results from L-QFD and T-QFD. This performance value in Table II is calculated from equation (2) and (3) using average of the lean-based three features from evaluated result by five groups. From Table II, group C and D actually adopt strategy III but increased performance value by enhancing lean reengineering implementation.

TABLE II: THE EXPLORATION STRATEGY FOR EVALUATED CASE

Group Medal	exploration strategy	performance value (Lean)
White gold	I	0.77
Gold	II	0.75
Silver	III	0.74
Bronze	III	0.74
Threshold	IV	

V. CONCLUSION

Based on the empirical case study and experiment result of this study, the knowledge innovation-based lean service life cycle evaluation model for TTQS was established. This paper integrated EFQM and QFD algorithm into the proposed model. In this QFD model, it consists of T-QFD and L-QFD. The T-QFD and L-QFD are to identify the voice of customer/engineering and related importance weight according to knowledge-based TTQS structure which are considered to be impacted by lean service technique. The model is divided into three phase. Simultaneously, the lean service factors are extracted, and the priority lean service quality for improvement are clarified to provide a framework for business performance evaluation. The proposed lean service life cycle mechanism was quickly transformed to achieve measurable evaluation performance improvement in TTQS. Furthermore, this article emphasizes the meaning of knowledge innovation-based lean service life cycle with the goal to measure and enhance TTQS procedure productivity. This can be realized by the common performance value of all involved stakeholders throughout the lean service ecosystem and knowledge innovation transfer in TTQS. Hence, in order to measure and enhance TTQS quality, lean factors knowledge innovation and EFQM items of both TTQS's lean three features and the PDDRO cycle should be considered. In this article, the integration of lean service life cycle and knowledge innovation into the TTQS process is an important contribution for TTQS deployment in the future. TTQS needs operation knowledge innovation of PDDRO. Knowledge innovation consists of two types such as explicit knowledge transferred by database and tacit knowledge transferred by interpersonal. Knowledge innovation strategy uses these two types to facilitate PDDRO knowledge sharing and achieve TTQS goal. Therefore, it is crucial to make these organizations aware of the benefits resulting from the implementation of a knowledge innovation-based lean service life cycle.

The findings of this research have implications for both researchers and practitioners. For researchers, the findings highlight the best evaluation method in the TTQS. Such best evaluation method should be considered in the lean service life cycle and the EFQM-based QFD development of PDDRO cycle. Furthermore, the training system can enhance more continuous improvement for good quality from the experiment result of knowledge innovation activities. In a TTQS, continuous improvement is a cycle; it is not an only act. Therefore, the importance of leadership (EFQM element) linkage from the top management to basic employment through PDDRO cycle is highlighted. According to these findings, this study adopts PDDRO as leadership in the training system. It is important implication. Simultaneously, this study found that the best evaluation result (EFQM element) of training system should consist of assessment quality, training outcome, and business performance from EFQM-based QFD experiment. The findings also allude to the exploration strategy for evaluated five groups in TTQS certification. For practitioners, this article highlights the need to verify practical feasibility of performance value prediction model to explore training performance of practical viewpoints in lean service-based TTQS operation. The findings can serve as guidelines regarding future research directions. This knowledge innovation-based lean service life cycle evaluation model is valuable for practical implementation in service industries and as an importance reference for academic research on service quality field. Generally, the implications of the findings for this study include the following objectives such as the establishment of internal human resources training, the amount of government subsidies, the implementation of corporate strategy competitive advantage and corporate brand quality.

In the future research, after improvement of the lean service elements may refer to the more items of QFD with fuzzy data for knowledge innovation as the basis for the evaluation of TTQS quality scale.

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