Fuzzy Logic with Engineering Application of Housing Construction Licensing Service Quality

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Abstract*: Public administrative reforms in state agencies should be given foremost attention by developing countries in the context of international economic integration and competitiveness improvement. The impacts of public service administration reform are most clearly seen in the transactions between customers (people, enterprises and society) and state administrative agencies, which are increasingly inclined toward simplification and most effectively satisfying customers, thereby grounding and driving the national socio-economic development. Housing construction licensing service, among others, has become a common public administration service as a result of the increasing population and rapid urbanization that entail growing demand for housing construction permits. This paper presents key factors affecting customer satisfaction with the quality of housing construction licensing service. Research findings will aid state agencies to address the most important influencer of service quality from the customer's point of view, thereby identifying the causes and proposing solutions toward higher customer satisfaction and bolstering the prestige of public service units in districts of Ho Chi Minh City and Vietnam as a whole.

***Index Terms*: Housing Construction, Licensing Service, Customer Satisfaction, Fuzzy Analytic Hierarchy Process**

I. INTRODUCTION

The wave of socio-economic development has pushed the surge of demand for housing construction, especially in the metropolitan cities of developing countries like Vietnam [1-4]. Indeed, the General Statistics Office has noted that the population of Ho Chi Minh City, the most populous city in Southern Vietnam, will experience a sharp increase in the few years to come. It is forecasted that by 2020 Ho Chi Minh City's population will exceed 9.4 million. This implies a striking growth of population in Ho Chi Minh City, accounting for 17% of the country's population. The census by the General Statistics Office from 2009 to 2016 reported that Ho Chi Minh City had 134,000 new households, while Hanoi had 130,000 new households. The increasing number of new families coupled with the deterioration of old houses is robustly increasing the housing demand [5, 6].

Public administration refers to an operation that manages state affairs. It is the process by which decisions and policies are made and legal documents are promulgated and made effective for the enforcement of policies [7, 8]. In other words, it involves activities that enforce the executive power of the state. In an attempt to maintain and develop all aspects of society, economy, politics, order, and the legal needs of citizens, these activities have impacts on the society and govern the behavior of all social classes via the operation of state administrative agencies at every level of authority [9, 10]. Public administration operation is usually performed by civil servants working in public agencies ranging from central to local levels.

Service is distinguished from tangible goods by its intangibility, inseparability, heterogeneity, and perishability [11]. Such characteristics make it hard to quantify a service and impossible to identify it with the naked eye. Public services are the essence of the state apparatus, which involves two primary functions: (i) state management of all socio-economic aspects and (ii) serving organizations and citizens. Public services can also be interpreted as activities that administrative agencies and non-business units of the State perform or authorize to be performed by non-State organizations and units under the State's supervision [12]. These fully non-profit activities aim to cater to the critical needs of people for power, water, transportation and traffic, environment, communications, and so on, as well as to contribute to the community's benefit. The State takes responsibility to the people and society for these public services by elaborating policies and legislation mechanisms, stipulating quality standards and inspecting the implementation.

Public services are typically classified into four categories, as follows: (i) public administrative services, (ii) public non-business services, (iii) public common services, and (iv) specific public services [13]. Specifically, public administrative services are operations where the state directly provides citizens with public goods in accordance

Revised Manuscript Received on May 30, 2019.

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with laws, so as to operate the society within the defined order and discipline. In other words, they are related to the enforcement of laws through which a competent state agency (or authorized organizations and enterprises) grants organizations and individuals papers that are legally valid in the field under such state agency's management. This category of service involves the most regular contact between public authorities and people, resulting in a heavy impact on the image of the state in people's eyes. It is for this reason that this type of service is most in need of quality improvement.

Housing construction licensing service is regarded as a public administrative service in the field of urban management which is carried out exclusively by Districts' Urban Management Departments [13]. This paper reveals the factors affecting customer satisfaction with the quality of housing construction licensing service, in an attempt to enhance customers' expectations and advocate public administration reform in construction licensing. Research outcomes will provide grounds for determining causes and developing solutions to best satisfy customers.

II. LITERATURE REVIEW

The Vietnam Chamber of Commerce and Industry (VCCI), backed by the United States Agency for International Development (USAID), surveyed the quality of economic and business environment administration by 6,977 domestic enterprises and 1,970 foreign-invested enterrises in 63 provinces and cities in 2011 [14]. They gathered research findings and introduced the provincial competitiveness index (PCI) as a gauge for the ability to satisfy and attract enterprises' investment in localities throughout the country. The survey found that: (i) Enterprises' optimism about the business context decreased while administration quality improved, and (ii) market entry saw big changes in past years, and the time for labor training, cost of legal institutions and land regulations was reduced; and (iii) improved transparency, reduced unofficial costs and enhanced efficiency of enterprise support service are important factors affecting the CPI. However, the above mentioned works are at a macro scale that relates to the PCI rather than delving into factors affecting public administrative services for construction licensing.

Rodríguez, et al. [15] surveyed Spanish data on the satisfaction of public service quality at City Hall CastillayLéon and found that there were four groups of factors affecting the quality of public administrative services and customer satisfaction, including: (i) technique, (ii) function, (iii) perception of service quality, and (iv) perceived service quality. In particular, service image has a heavy influence on technique and function, both of which strongly affect the perception of service quality and thereby affect the satisfaction of service users.

Various perspectives and models have been developed to assess customer satisfaction [16]. Customer satisfaction is considered the gap between expectations before and after purchasing a product or service. Bachelet [17] describes satisfaction as an emotional response of customers to their product or service experiences. Meuter, et al. [18] defines customer satisfaction as customers' judgment of whether a product or service meets their needs and expectations.

Academicians have not reach a unanimous agreement regarding the concept of service quality, which is somewhat abstract and difficult to define and measure. Service quality refers to the degree to which needs or expectations of customers are met and the gap between a customer's expectation of service and how he/she perceives that the service was actually performed [19]. Generally speaking, service quality is often defined in terms of what customers feel. In other words, how good a service is depends on the perceptions and feelings of the customer in relation to their individual needs.

Nearly all processes of service delivery involve humans. It can be said that service quality measures how relevant a provided service is to the customers' expectations [20]. It is a common practice that service quality is measured in two aspects: technical and functional. Technical quality is what the customer receives as a result of the interaction with the service provider. It is also called a "service outcome." On the other hand, functional quality is associated with how the service is performed—in other words, the process of service delivery that the customer experiences in attaining the service outcome. In short, service quality includes the quality of the service outcome and the quality of the service delivery process.

So far, numerous models of service quality have been studied, verified and officialized by scientists around the world [21]. One of the first service quality models was developed by Grönroos [22]. He proposed a service quality model comprising the following three main components:

(1) Service quality is examined in two aspects: technical quality and functional quality. Technical quality is the outcome of the service operation (i.e., what the customer receives), whereas functional quality is the result of the interaction between the customer and the service provider (i.e., the result of how the service is performed and delivered);

(2) The image of an enterprise can also be a service quality component that tremendously influences how the customer perceives the service quality, since the customer can access and see images and resources of the service provider during the transaction process;

(3) Service quality is a function that depends on two variables: expectations and service provided.

Brogowicz, et al. [23] proposes a synthesized model of service quality in which the quality gap of a service is proved to exist even if the customer has no service experience yet knows of the service via word of mouth, advertisement or other media, especially marketing activities. Thus, the model should match the customer's awareness and experience of service quality. This model incorporates traditional management, service design, operation and marketing activities as criteria for service quality assessment. It aims to

identify influencers of the service quality in traditional management including planning, execution and control. Three factors to be examined are: the enterprise's knowledge, external influences and marketing activities as influencers of the expectation of technical and functional quality.

A service quality model based on an ideal value standard [24] explores service quality from the perspective of service value and models it as a process of satisfying the customer. It proposes the use of an ideal standard awareness in comparison with consumer's experience. Negativity of an objection is the major driver of customer satisfaction. This point of view remarkably emphasizes the formation and movement of consumer service awareness over the process.

The Three Component Model of service quality was proposed by Rust and Oliver [25]. For this model, the author argues that there are three factors that influence service quality, including: (i) service products, service delivery and service environment.

III. RESEARCH METHODOLOGY

The following section manifests the computational process of the weights of the factors affecting customer satisfaction with housing construction licensing service quality using fuzzy decision making approach [26-32].

Step 1. According to the experts about the relative importance of these indicators, the pairwise comparison matrices can be obtained. We use the fuzzy numbers determined in Table 1.

TABLE 1
Linguistic scales for the relative importance

Fuzzy number	Linguistic	The scale of the fuzzy number
1	Equal	(1,1,1)
2	Weak Advantage	(1,2,3)
3	Not bad	(2,3,4)
4	Preferable	(3,4,5)
5	Good	(4,5,6)
6	Fairly good	(5,6,7)
7	Very good	(6,7,8)
8	Absolute	(7,8,9)
9	Perfect	(8,9,10)

Step 2. We calculated the elements of the synthetic pairwise comparison matrix by using the geometric mean method suggested by Buckley [33]:

$$\tilde{a}_{ij} = (\tilde{a}_{ij}^1 \otimes \tilde{a}_{ij}^2 \otimes \tilde{a}_{ij}^3 \otimes ... \otimes \tilde{a}_{ij}^n)$$

where $\tilde{a}_{ij}$ is the fuzzy comparison value of criterion i to criterion j.

Step 3. To calculate the fuzzy weights of the indicators, we need to calculate [30, 33, 34]:

$$\tilde{r}_i = (\tilde{a}_{i1} \otimes \tilde{a}_{i2} \otimes \tilde{a}_{i3} \otimes ... \otimes \tilde{a}_{in})^{1/n}$$

Moreover, for the weight of each criterion:

$$\tilde{w}_i = \tilde{r}_i \otimes (\tilde{r}_1 \oplus \tilde{r}_2 \oplus \tilde{r}_3 ... \oplus \tilde{r}_n)^{-1}$$

where $\tilde{w}_i$ is the geometric mean of the fuzzy comparison of the i^{th} criterion, which is indicated by a triangle fuzzy number $\tilde{w}_i = (Lw_i, Mw_i, Uw_i)$. Lw_i , Mw_i and Uw_i stand for the lower, middle and upper values of the fuzzy weight of the i^{th} criterion, respectively.

Step 4. The fuzzy weights are defuzzified by any defuzzification method. In this paper, we applied the following CoA method [35]:

$$BNP_{w_i} = [(U_{w_i} - L_{w_i}) + (M_{w_i} - L_{w_i})]/3 + L_{w_i}$$

where BNP_{w_i} is the Best Nonfuzzy Performance (BNP) value of the fuzzy weights of the i^{th} criterion .

IV. RESULTS AND DISCUSSION

The top five of factors influencing affecting customer satisfaction with the quality of housing construction licensing service as in TABLE 2.

TABLE 2. Top five of factors influencing affecting customer satisfaction with the quality of housing construction licensing service

Rank	Factors
1	Tables and guidelines for construction license application are clearly presented
2	The licensing division strictly observes the regulations as stated in the application receipt
3	The construction licensing staff is decently knowledgeable to answer your questions
4	The licensing division always keeps records in careful custody
5	Procedures and attached documents are simple and understandable

The results show that "Tables and guidelines for construction license application are clearly presented" has the highest important factor. "Procedures and attached documents are simple and understandable" is also among the top five important factors. Obviously, "instructions for construction license application procedure are tangible" means that customers' peace of mind is assured when they apply for a construction permit. If the construction license application procedure is ambiguous or troublesome, customers will tend to get the procedure done by "brokers" rather than wasting their time and being bound by "red tape".

"The licensing division strictly observes the regulations as stated in the application receipt", ranking second, and "One-stop mechanism and

rational procedure" are also factors with high scores according to applicants' judgment. This fact will encourage equality and transparency in the construction licensing process. For some civil servants, the scanty remuneration is used as an excuse for acts of corruption, authoritarianism, use of an overbearing manner and mercy-giving behaviour. This is a common shortcoming of employees working in public service agencies, especially monopolistic services.

In a global sphere, service enterprises have to conquer the challenge of needing to provide better services at low prices or exit the fierce market [36]. Meanwhile, Vietnam seems to neglect the quality standards, which triggers customers' dissatisfaction and objection. Therefore, heads of Urban Management Departments should pay more attention to the reform of construction licensing service by reviewing and abolishing unnecessary administrative procedures in order to simplify the procedures and shape a democratic, clean, rigid, professional, modernized, powerful and effective administration. Some solutions to enable this result are to formulate and develop "electronic construction licensing service" or "non-paper offices" and pave the way for "digital signatures". In addition, leaders should encourage, motivate and offer cash rewards to employees working overtime or processing late submissions. This will enhance the prestige of Urban Management Departments while building up people's trust.

"The construction licensing staff is decently knowledgeable to answer your questions" is ranked third, which implies that applicants highly appreciate the capacity of the construction licensing staff. The more the licensing staff can give thorough advice and satisfactory answers to the customers' questions and requests and give help as needed, the more customers feel secure and satisfied in the service capacity. In contrast, if the staff is poorly knowledgeable and inexperienced, they might give inadequate guidance, and the customers' application might be ineligible for license granting due to incomplete procedures. This results in a waste of customers' time. In some cases, inadequately knowledgeable staff give advice beyond their authority and the city's regulations with regard to construction density, limitations of planning and construction area, restriction of floors in some areas, license valid term and many other related regulations. This may lead to information deflection, which harms the prestige of the licensing service providers. Therefore, the staff should be properly trained in the construction licensing process and regularly educated on new processes, procedures or regulations. Moreover, the Investment Management Department should organize fostering courses to sharpen the staff's communication and listening skills, bolster their customer service capacity and guide them toward higher professionalism and sustainability.

"The licensing division always keeps records in careful custody" ranks in the 4th position. This shows that customers appreciate being assured of the convenience of access and assurance that documents will not be lost, especially in the case of large backlog of submissions against the scarcity of staff. This is especially important when the staff is downsized due to the government's streamlining policy while the applications for housing construction licenses continue to pile up, especially during peak hours. A clean and careful storage of documents also hints at the professionalism of licensing staff and completely fits the Japanese 5S principle. In the context of the fourth industrial revolution, the construction licensing division should apply IT in the storage of documents and construct software to enable information search and processing status inquiry via touch screen systems directly at work or online, via phones, or through other channels. This will powerfully facilitate the communication between applicants and licensers.

V. CONCLUSION

This paper has examined the current procedures for construction license application. It also addresses important factors affecting customer satisfaction in applying for housing construction licenses in the Thu Duc District, HCMC, Vietnam at levels from high to low. Such factors include: (1) Tables and guidelines for construction license application are clearly presented; (2) The licensing division strictly observes the regulations as stated in the application receipt; (3) The construction licensing staff is decently knowledgeable to answer customers' questions; (4) The licensing division always keeps records in careful custody; and (5) Procedures and attached documents are simple and understandable. Since the respondents for this study are restricted to one location, the Urban Management Department of Thu Duc District, its generalization should be limited, as public service agencies vary by culture and leadership styles from unit to unit. The findings may be adapted to similar operations of other districts in Ho Chi Minh City. The outcomes of this work may help to lay the groundwork for other researchers to extend the research to the quality of public services in a national or regional scope.

ACKNOWLEDGMENT

The authors gratefully acknowledge Ho Chi Minh City Open University (HCMCOU), Vietnam for supporting this research.

REFERENCES

1. P. T. Nguyen et al., "Construction project quality management using building information modeling 360 field," International Journal of Advanced Computer Science and Applications, Article vol. 9, no. 10, pp. 228-233, 2018.
2. P. T. Nguyen, V. Likhitruangsilp, and M. Onishi, "Prioritizing factors affecting traffic volume of public-private partnership infrastructure projects," International Journal of Engineering and Technology(UAE), Article vol. 7, no. 4, pp. 2988-2991, 2018.
3. P. V. Nguyen, P. T. Nguyen, V. D. B. Huynh, and Q. L. H. T. T. Nguyen, "Critical factors affecting the happiness: A Vietnamese perspective," International Journal of Economic Research, Article vol. 14, no. 4, pp. 145-152, 2017.
4. V. D. B. Huynh, P. T. Nguyen, T. A. Nguyen, Q. L. H. T. T. Nguyen, and T. T. H. Nguyen, "Identifying the key competitiveness indicators for construction contractors," International Journal of Advanced and Applied Sciences, vol. 6, no. 4, pp. 59-64, 2019.
5. P. T. Nguyen, P. Van Nguyen, Q. L. H. T. To Nguyen, and V. D. B. Huynh, "Project success evaluation using TOPSIS algorithm," Journal of Engineering and Applied Sciences, Article vol. 11, no. 8, pp. 1876-1879, 2016.
6. T. A. Nguyen, P. T. Nguyen, and V. Peansupap, "Explaining model for supervisor's behavior on safety action based on their perceptions,"

ARPN Journal of Engineering and Applied Sciences, Article vol. 10, no. 20, pp. 9562-9572, 2015.
7. M. Painter, "Public administration reform in Vietnam: problems and prospects," Public Administration and Development, vol. 23, no. 3, pp. 259-271, 2003.
8. V. D. B. Huynh, P. Van Nguyen, Q. H. T. T. Nguyen, and P. T. Nguyen, "Application of Fuzzy Analytical Hierarchy Process based on Geometric Mean Method to prioritize social capital network indicators," International Journal of Advanced Computer Science and Applications, Article vol. 9, no. 12, pp. 182-186, 2018.
9. A. Z. Katz, "Public opinion and foreign policy: The Nixon administration and the pursuit of peace with honor in Vietnam," in The Vietnam War: Routledge, 2017, pp. 109-126.
10. P. T. Nguyen and V. Likhitruangsilp, "Identification risk factors affecting concession period length for public-private partnership infrastructure projects," International Journal of Civil Engineering and Technology, Article vol. 8, no. 6, pp. 342-348, 2017.
11. V. A. Zeithaml, L. L. Berry, and A. Parasuraman, "The behavioral consequences of service quality," Journal of marketing, vol. 60, no. 2, pp. 31-46, 1996.
12. R. B. Denhardt and J. V. Denhardt, "The new public service: Serving rather than steering," Public administration review, vol. 60, no. 6, pp. 549-559, 2000.
13. E. J. Malesky, C. V. Nguyen, and A. Tran, "The impact of recentralization on public services: A difference-in-differences analysis of the abolition of elected councils in Vietnam," American Political Science Review, vol. 108, no. 1, pp. 144-168, 2014.
14. D. A. Dang, "How foreign direct investment promote institutional quality: Evidence from Vietnam," Journal of Comparative Economics, vol. 41, no. 4, pp. 1054-1072, 2013.
15. P. G. Rodríguez, J. L. V. Burguete, R. Vaughan, and J. Edwards, "Quality dimensions in the public sector: municipal services and citizen's perception," International Review on Public and Nonprofit Marketing, vol. 6, no. 1, pp. 75-90, 2009.
16. R. L. Oliver, R. T. Rust, and S. Varki, "Customer delight: foundations, findings, and managerial insight," Journal of retailing, vol. 73, no. 3, pp. 311-336, 1997.
17. D. Bachelet, "Customer satisfaction research," Measuring Satisfaction, or the Chain, the Tree and the Nest, 1995.
18. M. L. Meuter, A. L. Ostrom, R. I. Roundtree, and M. J. Bitner, "Self-service technologies: understanding customer satisfaction with technology-based service encounters," Journal of marketing, vol. 64, no. 3, pp. 50-64, 2000.
19. A. Parasuraman, V. A. Zeithaml, and L. L. Berry, "Servqual: A multiple-item scale for measuring consumer perc," Journal of retailing, vol. 64, no. 1, p. 12, 1988.
20. B. R. Lewis and V. W. Mitchell, "Defining and measuring the quality of customer service," Marketing intelligence & planning, vol. 8, no. 6, pp. 11-17, 1990.
21. N. Seth, S. Deshmukh, and P. Vrat, "Service quality models: a review," International journal of quality & reliability management, vol. 22, no. 9, pp. 913-949, 2005.
22. C. Grönroos, "A service quality model and its marketing implications," European Journal of marketing, vol. 18, no. 4, pp. 36-44, 1984.
23. A. A. Brogowicz, L. M. Delene, and D. M. Lyth, "A synthesised service quality model with managerial implications," International Journal of Service Industry Management, vol. 1, no. 1, pp. 27-45, 1990.
24. J. Mattsson, "A service quality model based on an ideal value standard," International Journal of Service Industry Management, vol. 3, no. 3, pp. 18-33, 1992.
25. R. T. Rust and R. L. Oliver, "Service quality: insights and managerial implications from the frontier," Service quality: New directions in theory and practice, pp. 1-19, 1994.
26. P. T. Nguyen, N. B. Vu, L. Van Nguyen, L. P. Le, and K. D. Vo, "The Application of Fuzzy Analytic Hierarchy Process (F-AHP) in Engineering Project Management," in 2018 IEEE 5th International Conference on Engineering Technologies and Applied Sciences, ICETAS 2018, 2019.
27. D. L. Luong, D. H. Tran, and P. T. Nguyen, "Optimizing multi-mode time-cost-quality trade-off of construction project using opposition multiple objective difference evolution," International Journal of Construction Management, Article in Press 2018.
28. T. N. Phong, V. N. Phuc, and T. T. H. L. N. Quyen, "Application of fuzzy analytic network process and TOPSIS method for material supplier selection," in Key Engineering Materials vol. 728, ed, 2017, pp. 411-415.
29. P. Van Nguyen, P. T. Nguyen, Q. L. H. T. T. Nguyen, and V. D. B. Huynh, "Calculating weights of social capital index using analytic hierarchy process," International Journal of Economics and Financial Issues, Article vol. 6, no. 3, pp. 1189-1193, 2016.
30. P. V. Nguyen, P. T. Nguyen, Q. L. H. T. T. Nguyen, and V. D. B. Huynh, "Extended Fuzzy Analytical Hierarchy Process Approach in Determinants of Employees' Competencies in the Fourth Industrial Revolution," International Journal of Advanced Computer Science and Applications, vol. 10, no. 4, 2019.
31. Q. L. H. T. T. Nguyen, P. V. Nguyen, P. T. Nguyen, and V. D. B. Huynh, "Using Fuzzy Logic to Develop Employees' Competency Ranking Model," The Journal of Social Sciences Research, vol. 5, no. 4, pp. 888-891, 2019.
32. P. T. Nguyen, N. B. Vu, L. V. Nguyen, L. P. Le, and K. D. Vo, "The Application of Fuzzy Analytic Hierarchy Process (F-AHP) in Engineering Project Management," in IEEE 5th International Conference on Engineering Technologies and Applied Sciences (ICETAS), 2019.
33. J. J. Buckley, "Fuzzy hierarchical analysis," Fuzzy Sets and Systems, vol. 17, no. 3, pp. 233-247, 1985/12/01 1985.
34. T.-Y. Hsieh, S.-T. Lu, and G.-H. Tzeng, "Fuzzy MCDM approach for planning and design tenders selection in public office buildings," International Journal of Project Management, vol. 22, no. 7, pp. 573-584, 10, 2004.
35. K. Vahdat, N. J. Smith, and G. G. Amiri, "Fuzzy multicriteria for developing a risk management system in seismically prone areas," Socio-Economic Planning Sciences, vol. 48, no. 4, pp. 235-248, 2014.
36. M. Milakovich, Improving service quality in the global economy: Achieving high performance in public and private sectors. Auerbach publications, 2005.