# Reliability and Validity of Measurement Instrument
# for Business Factors Influencing Adult Patients' Selection of Orthodontic Services

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**Abstract**

As orthodontic treatment has become more accessible and the healthcare industry has become more patient centered, it is beneficial to know why patients choose to have their orthodontic treatment done at a specific clinic/hospital. This study aims to develop a standardized instrument to identify and measure factors affecting patients' selection of orthodontic services in adults and assess its validity and reliability. The items in the questionnaire were developed based on previous literature derived from Service Marketing Mix (7Ps) and orthodontic concepts. Three qualified orthodontic and marketing experts reviewed and scored each item, then item-objective congruence (IOC) indices were calculated. The preliminary questionnaire was then piloted in 31 active adult orthodontic patients, and retested again two weeks apart. The data were then analyzed for test-retest reliability. The final questionnaire comprises a total of 35 items, covering 7 factors in accordance with Service Marketing Mix (7Ps) framework with 5 items in each factor. The internal consistency reliability test (Cronbach's alpha) was performed. For each factor, the Cronbach's alpha was 0.898, 0.729, 0.717, 0.880, 0.897, 0.816 and 0.802 respectively, which passed the standard for internal consistency reliability test. This questionnaire was designed to measure adult patients with 7-point Likert scale.

In conclusion, this study developed a standardized instrument for identifying business-related factors affecting patients' selection of orthodontic services in adults. This can be utilized in further study for identifying factors affecting patients in orthodontic service selection in different settings.

**Keywords:** *Orthodontic Treatment, Reliability, Validity, Service Marketing Mix*

## 1. Introduction

Nowadays, more adults are seeking orthodontic treatment. Adults, unlike children and adolescents, have the purchasing power and are the decision makers themselves. In the current competitive healthcare market, there is a strong economic advantage for orthodontists and hospitals to understand patients' purchasing behavior and differentiate their practices from the others.

As the healthcare industry has become more patient-centered, it is beneficial to know why patients chose to have their treatment done at a specific practice. Like all organizations, dental clinics/hospitals should utilize marketing strategies to improve business performance and patient satisfaction. Further, consumer behaviors in the digital age have been heavily influenced by the rise of social media. A significant number of social media users have made it a powerful tool for businesses to reach and engage with their customers, including orthodontic services. A study by Nelson et al (2015) has found that social media is increasingly influencing patients' selection of orthodontic services. Orthodontic practices should also consider social media marketing to reach potential patients and showcase their services. A classic marketing theory by Kotler and Armstrong (1994), service marketing mix (7Ps), is one of the most used marketing frameworks in healthcare industry. Sintani, Manurung, and Sanuri (2017) pointed out that market research is useful for the healthcare industry to get insightful information about patients' expectations regarding healthcare services. Ivy (2008) stated that marketing mix is a controllable marketing tool that the company uses to produce the response it wants from target markets. The service marketing mix includes product, price, place, promotion, people, process, and physical evidence. By utilizing this framework, all aspects that factored in patients' decision will be thoroughly investigated and systematically analyzed.

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Understanding patients' decision to receive their treatment in a specific clinic/hospital will provide insightful information for executives, which could be implemented to improve the service in response to patients' expectation, and ultimately increase their satisfaction with the clinic/hospital and treatment received. However, no previous studies have developed a standardized instrument to assess these service marketing factors in patients' selection of orthodontic services.

## 2. Objectives

To construct and validate a standardized instrument derived from orthodontic and business concepts with a purpose of investigating factors affecting patients' decision on different orthodontic services.

## 3. Materials and Methods

The questionnaire was constructed from previous literature. (Badran & Al-Khateeb, (2013), de Sousa, da Silva, Maia, Forte, & Sampaio (2016); Oh, Park, Kim, Kim, & Cho, (2021); Tuncer, Bavbek, Tuncer, Bani, & Çelik, (2015); Wędrychowska-Szulc & Syryńska, (2010)) The preliminary questionnaire of service marketing mix (7Ps) that influence patients' decision making is divided to 7 parts: Product, Price, Place, Promotion, People, Process, and Physical evidence. The preliminary instrument consisted of 42 items in total.

### 3.1 Content validity

Content validity is the extent to which the items in a questionnaire are representative of the entire theoretical construct the questionnaire is designed to assess. The items in the questionnaire were reviewed, edited, and scored for content validity by Item-Objective Congruence (IOC) index by 3 experts. The expert group comprises two qualified orthodontists and one marketing consultant. The qualified items should have the IOC equal to or greater than 0.50. Some items were also edited in accordance with the experts' comments.

The adjusted questionnaire was then piloted in 31 adult active orthodontic patients over 18 years of age at Orthodontic clinic, Faculty of Dentistry, Mahidol University. The respond data were then collected and analyzed for validity and reliability of the questionnaire. All items were measured on a seven-point Likert scale. According to Taherdoost (2019), six or more response categories resulted in higher convergent validity, ease of use for respondents and odd number options are preferred for neutral opinion option.

### 3.2 Test-retest reliability

Test-retest reliability was used to reveal the degree to which the results are consistent over time. The pilot questionnaire was tested and retested in the same subject two weeks apart. The data were analyzed by correlation analysis. Each item over 0.7 is considered to have acceptable reliability. However, Bland and Altman (1996) pointed out that a reliability coefficient of 0.5 is considered sufficient if the consequences of measurement error are not severe, particularly in subjective measurements.

### 3.3 Internal consistency reliability

Internal consistency is a reliability measurement in which items on a test are correlated to determine how well they measure the same construct or concept. The internal consistency was tested with Cronbach's alpha and is judged to be reliable if the value is 0.70 or more.

## 4. Results

The preliminary questionnaire is divided into 7 parts with a total of 42 items. It was reviewed, edited, and scored for content validity by Item-Objective Congruence (IOC) index by 3 experts. The content-validated questionnaire was then pilot tested in 31 adult active orthodontic patients and retested two weeks apart for test-retest reliability. Table 1 shows characteristics of the participants. Table 2 shows the result of IOC index score and test-retest reliability correlation.

**Table 1** Characteristics of the participants

| Characteristics | Total (n = 31) |
|---|---|
| **Sex** | |
| Male | 11 (35.5) |
| Female | 20 (64.5) |
| **Age (years)** | |
| 18-29 | 14 (45.2) |
| 30-39 | 11 (35.4) |
| 40-49 | 4 (12.9) |
| 50-59 | 1 (3.2) |
| 60-65 | 1 (3.2) |
| **Occupation** | |
| Government employee | 7 (22.6) |
| Private company employee | 11 (35.5) |
| Freelance | 1 (3.2) |
| Business owner | 3 (9.7) |
| Student | 7 (22.6) |
| Others e.g. unemployed, retired | 2 (6.5) |
| **Monthly income** | |
| Less than 20,000 THB | 12 (38.7) |
| 20,000 – 50,000 THB | 9 (29.0) |
| 50,001 – 100,000 THB | 8 (25.8) |
| More than 100,000 THB | 2 (6.5) |
| **Highest level of education** | |
| Secondary school or lower | 1 (3.2) |
| High school | 1 (3.2) |
| Vocational school | 2 (6.5) |
| Bachelor's degree or higher | 27 (87.1) |
| **Frequency of dental check-up** | |
| Every 6 months | 16 (51.6) |
| Every 1 year | 9 (29) |
| Over 1 year or only when symptomatic | 6 (19.4) |

**Table 2** Preliminary items in questionnaire with IOC index and test-retest reliability

| Item | Question | IOC Index | Test-retest reliability |
|---|---|---|---|
| **Part 1** | **Product** | | |
| 1.1. | Clinic/hospital is reputable | +1 | 0.721 |
| 1.2. | Good quality of treatment | +1 | 0.763 |
| 1.3. | Equipment and materials follow safety regulations and standards | +1 | 0.721 |
| 1.4. | Variety of services offered e.g. metal braces, clear braces, Damon, Invisalign | +1 | 0.823 |
| 1.5. | Use of high technology equipment e.g. intraoral scanner, 3D printing machine | +0.67 | 0.532 |
| 1.6. | Short waiting time to start treatment | +0.67 | 0.770 |
| **Part 2** | **Price** | | |
| 2.1. | Reasonable price | +1 | 0.715 |
| 2.2. | Cheaper than other clinics/hospitals | +1 | 0.768 |
| 2.3. | Explicit information of total price before start of treatment | +1 | 0.774 |
| 2.4. | Installment option available | +1 | 0.842 |

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| Item | Question | IOC Index | Test-retest reliability |
|------|----------|-----------|-------------------------|
| 2.5. | Payment by credit card accepted | +1 | 0.749 |
| 2.6. | Payment by bank transfer accepted | +1 | 0.788 |
| **Part 3** | **Place** | | |
| 3.1. | Convenience | +1 | 0.831 |
| 3.2. | Location is close to residence | +1 | 0.832 |
| 3.3. | Location is close to work or school | +1 | 0.814 |
| 3.4. | Location is close to community, market or department store | +1 | 0.593 |
| 3.5. | Accessible by public transportation | +1 | 0.708 |
| 3.6. | Enough parking space | +1 | 0.828 |
| **Part 4** | **Promotion** | | |
| 4.1. | Advertise through public channels e.g. social media, TV, internet | +1 | 0.771 |
| 4.2. | Positive review in online media e.g. Facebook, Google, Pantip | +1 | 0.717 |
| 4.3. | Recommended by influencers/famous people | +1 | 0.842 |
| 4.4. | Attractive promotion e.g. price reduction, free retainer | +1 | 0.715 |
| 4.5. | Discount on other dental services e.g. filling, cleaning, extraction | +1 | 0.514 |
| 4.6. | Free promotional items e.g. toothpaste, toothbrush, mouthwash | +0.67 | 0.877 |
| **Part 5** | **People** | | |
| 5.1. | Treated by a specialist/orthodontist | +1 | 0.787 |
| 5.2. | Knowledge and experience of the dentist | +1 | 0.807 |
| 5.3. | Interpersonal skills of the dentist | +1 | 0.910 |
| 5.4. | Skills of dental assistants and receptionists | +1 | 0.612 |
| 5.5. | Politeness and friendliness of dental assistants and receptionists | +0.67 | 0.799 |
| 5.6. | Dentists, dental assistants, and receptionists dress politely | +0.67 | 0.762 |
| 5.7. | Adequate staffing of dentists, dental assistants and receptionists | +0.67 | 0.792 |
| **Part 6** | **Process** | | |
| 6.1. | Short waiting time in each appointment | +0.67 | 0.772 |
| 6.2. | Fast treatment and services | +1 | 0.736 |
| 6.3. | Available appointment time as desired | +1 | 0.775 |
| 6.4. | Systematical flow of service | +1 | 0.754 |
| 6.5. | Provide advice or follow up after each appointment | +1 | 0.537 |
| **Part 7** | **Physical evidence** | | |
| 7.1. | Clean and organized establishment | +1 | 0.762 |
| 7.2. | Good ambiance and decor | +1 | 0.743 |
| 7.3. | Enough seating in the waiting area | +1 | 0.701 |
| 7.4. | Clean restroom available | +1 | 0.598 |
| 7.5. | Clear and easy to understand signage | +1 | 0.734 |
| 7.6. | Drinking water/Wi-fi/TV/magazines available | +1 | 0.758 |

The piloted results were analyzed. Seven items were rejected for questionable test-retest reliability, with less than the acceptable reliability standard of 0.70, or possible redundancy. With the exception of item 6.5, despite having only a sufficient reliability coefficient of 0.537, was included in the final questionnaire to maintain consistency across all factors. The final 35 items, with 5 items in each factor, were then tested for internal consistency reliability. The Cronbach's alphas for each factor were 0.898, 0.729, 0.717, 0.880, 0.897, 0.816 and 0.802 respectively, which are higher than the standard for internal consistency reliability of 0.70. The final items included in the questionnaire and their statistical value are presented in Table 3.

**Table 3** Final items included in the questionnaire

| Item | Question | Test-retest reliability | Cronbach's alpha |
|---|---|---|---|
| **Part 1** | **Product** | | |
| 1.1. | Clinic/hospital is reputable | 0.721 | |
| 1.2. | Good quality of treatment | 0.763 | |
| 1.3. | Equipment and materials follow safety regulations and standards | 0.721 | 0.898 |
| 1.4. | Variety of services offered e.g. metal braces, clear braces, Damon, Invisalign | 0.823 | |
| 1.5. | Short waiting time to start treatment | 0.770 | |
| **Part 2** | **Price** | | |
| 2.1. | Cheaper than other clinics/hospitals | 0.768 | |
| 2.2. | Explicit information of total price before start of treatment | 0.774 | |
| 2.3. | Installment option available | 0.842 | 0.729 |
| 2.4. | Payment by credit card accepted | 0.749 | |
| 2.5. | Payment by bank transfer accepted | 0.788 | |
| **Part 3** | **Place** | | |
| 3.1. | Convenience | 0.831 | |
| 3.2. | Location is close to residence | 0.832 | |
| 3.3. | Location is close to work or school | 0.814 | 0.717 |
| 3.4. | Accessible by public transportation | 0.708 | |
| 3.5. | Enough parking space | 0.828 | |
| **Part 4** | **Promotion** | | |
| 4.1. | Advertise through public channels e.g. social media, TV, internet | 0.771 | |
| 4.2. | Positive review in online media e.g. Facebook, Google, Pantip | 0.717 | |
| 4.3. | Recommended by influencers/famous people | 0.842 | .880 |
| 4.4. | Attractive promotion e.g. price reduction, free retainer | 0.715 | |
| 4.5. | Free promotional items e.g. toothpaste, toothbrush, mouthwash | 0.877 | |
| **Part 5** | **People** | | |
| 5.1. | Treated by a specialist/orthodontist | 0.787 | |
| 5.2. | Knowledge and experience of the dentist | 0.807 | |
| 5.3. | Interpersonal skills of the dentist | 0.910 | .897 |
| 5.4. | Politeness and friendliness of dental assistants and receptionists | 0.799 | |
| 5.5. | Dentists, dental assistants, and receptionists dress politely | 0.762 | |
| **Part 6** | **Process** | | |
| 6.1. | Short waiting time in each appointment | 0.772 | |
| 6.2. | Fast treatment and services | 0.736 | |
| 6.3. | Available appointment time as desired | 0.775 | .816 |
| 6.4. | Systematical flow of service | 0.754 | |
| 6.5. | Provide advice or follow up after each appointment | 0.537 | |
| **Part 7** | **Physical evidence** | | |
| 7.1. | Clean and organized establishment | 0.762 | |
| 7.2. | Good ambiance and decor | 0.743 | |
| 7.3. | Enough seating in the waiting area | 0.701 | .802 |
| 7.4. | Clear and easy to understand signage | 0.734 | |
| 7.5. | Drinking water/Wi-fi/TV/magazines available | 0.758 | |

The questionnaire developed in this study with confirmed validity and reliability can be utilized to measure these service marketing factors affecting patients' decision making. The use of this instrument

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could provide insightful information to dental clinics/hospitals and ultimately improve the service in response to patients' expectations and improve their satisfaction.

## 5. Discussion

This study developed and validated a standardized questionnaire to identify the factors of the service marketing mix (7Ps) that influence patients' decision making when selecting orthodontic services. According to Sintani, Manurung, and Sanuri (2017), comprehending the factors behind patients' decision to opt for a particular clinic or hospital can furnish valuable insights for the business. This information can be utilized to enhance the services offered by the facility in line with patients' expectations, thereby boosting their satisfaction levels with the practice and the treatment received (Aaker, Kumar and Day, 2007). The content validity assessment by three experts using the Item-Objective Congruence (IOC) index confirmed that the items in a questionnaire are indicative of the overall theoretical framework that the questionnaire aims to evaluate. Test-retest reliability, done by administering the pilot questionnaire to the same group of subjects two weeks apart, was employed to assess the extent to which the outcomes remain consistent over time. Lastly, the internal consistency reliability was tested using Cronbach's alpha to determine the extent to which items on the questionnaire measured the same construct or concept. By methodically validating this questionnaire with content validity, test-retest reliability and internal consistency as suggested by Bryman (2016), the reduction of response bias risk was ensured.

The final questionnaire in this study consists of 35 items. It covers 7 different factors, with 5 items each, based on the Service Marketing Mix (7Ps) framework: Product, Price, Place, Promotion, People, Process, and Physical evidence. The internal consistency reliability test results were satisfactory, with Cronbach's alpha values of 0.898, 0.729, 0.717, 0.880, 0.897, 0.816, and 0.802 respectively. All items in the questionnaire have sufficient test-retest reliability and good internal consistency reliability, therefore suitable for implementation as a standardized instrument for measuring service marketing factors affecting patients' decision when selecting orthodontic services.

It should be noted that the validation of this questionnaire was conducted in a single center dental school. This instrument was developed as a part of further research in patients of orthodontic clinic, Mahidol University. If this instrument is to be used in other settings, further validation may be necessary in different populations to confirm its applicability. Additionally, it should be acknowledged that the study's sample size was limited, which may have introduced some degree of error when extrapolating the findings to the wider population. Future studies with larger sample sizes can build on the instrument developed in this study to identify influential factors affecting patients' selection of orthodontic service in different settings and assist orthodontic offices in developing appropriate business strategies accordingly.

## 6. Conclusion

This study developed a standardized questionnaire that can be utilized to identify the service marketing mix factors (7Ps) that influence patients' decision making when selecting orthodontic services. This questionnaire, with confirmed reliability and validity, is expected to serve as a standardized tool for future studies to identify practice-specific factors that affect patients' decision-making when choosing a dental clinic or hospital to receive orthodontic treatment.

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