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### Research on Service Quality Criteria for UAV Filming and Photography in Taiwan—Dual Perspective

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**Abstract:** In recent years, the service of filming and photography by UAV is getting more and more popular. This research established the service quality evaluation framework based on the SERVQUAL scale, acquired the weights and rankings of criteria by Analytic Network Process from dual perspective: service provider and consumer, and then compared the differences between them. The findings of this research reveal that the most important criterion of UAV filming and photography service is “Employees are professional and get adequate support to do their jobs well”. But the provider pays more attention to the criterion of “UAV service team provides services legally, safely and reliably” than consumer. Therefore, the service provider must take care of the safety and the needs of customer at the same time.

**Keywords:** UAV, service quality, SERVQUAL, analytic network process.

#### 1. INTRODUCTION

In recent years, drone and its applications are getting more and more popular. Among these applications, the service of taking video or photography from multi rotor drone is developing rapidly. But the research about the service quality is non-existent at this time.

Unmanned Aircraft Systems (UAS), or Unmanned Aircraft Vehicle (UAV), also known as Dynamic Remotely Operated Navigation Equipment (Drone), is the aircraft that can fly without human on board. It can fly automatically by computer or by remote control. The categories of UAV include Fix-wing airplane, gyroplane, and multi-rotor aircraft which become very popular in recent years. The UAV was used for military purposes in the initial stage. Since 2012, many scholars and institutions have researched on multi rotor drone design and its advanced control techniques. The number of SCI and SSCI papers that keyword includes quadrotor had increased from 27 to 81 since 2011 to 2014. These researches accelerate the technology

development of multi rotor drone. Therefore, the UAV is not the remote control aircraft that difficult to operate, but the flying robot integrated with camera or other equipment that can self-stabilize and fly according to the waypoints setting by ground station.

There are many applications of UAV. For example, we can detect the efficacy of solar panel or the human heat in the dark for security reason by UAV with thermal sensors. Multi rotor drone can fly over the traffic jam to deliver the medicine to emergency location. With the UAV integrated with a camera, we can have the image of disaster site, the high-resolution map stitched from a lot of pictures taking by UAV automatically, the 3D model constructed by taking pictures around the object 360 degree and the beautiful video recorded from air. Among the applications mentioned above, taking video by drone is the most popular application because the cost is lower than other applications. Nowadays, there are many clips of television programs recorded by UAV. UAV makes some big changes in the film industry including: making aerial shots easier and unique, cost savings and safer (BAA training aviation academy website, 2017). But many times, the organizer that demands for UAV filming and photography doesn't have UAV and therefore promotes the development of this newly services—UAV filming and photography. The websites of Aviator (Aviator website-join operator network, 2017) and Air-Vid (Hire drone pilot website, 2017) match the demand of UAV filming and UAV pilot. The website of Pond5 allows the photographers upload the drone footage with a price between 5 and 5000 U.S. dollars (Pond5, 2017). These websites tell us that there is a large demand for UAV pilot. The popularity of drone footages and pictures interacts with the industry of UAV. The multi rotor drone Company—DJI, with high market share nowadays, was established in 2006. Its revenue had increased 100 fold between 2011 and 2015, with the annual growth rate averaging three to five times (Chinadaily website, 2017). As for the regulation and law of UAV, the United States has implemented UAV registration system. In Taiwan, the pilot of UAV that the weight is more than 15 kilograms must have the licenses according to the ongoing UAV regulatory developments. In a word, the service of taking video or photography from multi rotor drone is developing rapidly and interacts with the market and the regulations without the research about service quality.

Therefore, for UAV filming and photography service quality, based on the SERVQUAL scale, this research established the service quality evaluation framework, acquired the weights and rankings of criteria by Analytic Network Process-ANP from dual perspective: expert and consumer, and then compare the differences between them in order to achieve the following objectives:

1. Analysis weights of the criteria and dimensions of UAV filming and photography service quality from the expert's viewpoints.
2. Analysis weights of the criteria and dimensions of UAV filming and photography service quality from the custom's viewpoints.
3. Compare and discuss the difference of the criteria and dimension's weight of UAV filming and photography service between provider and consumer.

## **2. LITERATURE REVIEW**

Base on the research purposes mentioned above, in this section, the research reviews the literature about service quality and the research methods for decision-making and then compares the difference between Analytic Hierarchy Process (AHP) and Analytic Network Process (ANP).

## Measurement of Service Quality

Quality of services is the comparison between what customers want with what is acceptable to the consumer after the purchase of services (Juhana, Manik, Febrinella, and Sidharta, 2015). Every service, especially the emerging industry—UAV filming and photography services, shall pay attention to the issue of service quality. Quality master—Dr. Kondo said:

“Improving quality in creative ways can lead to lower costs and higher productivity, although the converse is not necessarily true” (Kondo, 2003).

Creating service quality differentiation is the key factor to gain higher market share among competing service providers (Chadha, Tomar, Rai, and Dugar, 2017). Many scholars have been paid attention to the quality of service and researched on this field since 1970 (Martínez-Lorente, Dewhurst, and Dale, 1998). Among these studies, scholars have used the service quality formula that is proposed by Parasuraman, Zeithaml and Berry (P.Z.B.) in 1985 widely (Parasuraman, Zeithaml, and Berry, 1985). The main concept of this formula is that the service quality is the gap between subjective expectation and practical perceptions of custom (Henderson, 2013). The service quality is calculated using following formula:

$$Q (\text{Service Quality}) = P (\text{Perceptions of Service}) - E (\text{Expectation of Service})$$

After proposing the formula of service quality, P.Z.B. introduced the service quality scale with high reliability and validity named SERVQUAL. SERVQUAL then become the most popular scale to measure service quality (Asubonteng, McCleary, and Swan, 1996). There are also many review studies of SERVQUAL that discuss about its high reliability, validity and so on (Buttle, 1996; Coulthard, 2004; Gilmore and McMullan, 2009; Ladhari, 2008; Ladhari, 2009). The SERVQUAL has 5 dimensions and 22 criteria (Parasuraman, Zeithaml, and Berry, 1988). The five dimensions and the explanations are described as below (Lam, 1997):

1. *Tangibility*: physical facilities, equipment and appearance of personnel.
2. *Reliability*: ability to perform the promised service reliable and accurately.
3. *Responsiveness*: willingness to help customers and provide prompt service.
4. *Assurance*: knowledge and courtesy of employees and their ability to inspire trust and confidence.
5. *Empathy*: caring, individualized attention provided to customers.

Integration equation of service quality mentioned above and SERVQUAL, service quality score is calculated using following formula:

$$S_Q (\text{Score of Service Quality}) = P_i (\text{Perceptions of Service}) - E_i (\text{Expectation of Service})$$

Where,

$S_Q$  is the Score of Service Quality.

$P_i$  is the perceptive score of service of  $i^{\text{th}}$  criteria of SERVQUAL ( $i = 1, 2, 3, \dots, n, n = 22$ )

$E_i$  is the expectation score of service of  $i^{\text{th}}$  criteria of SERVQUAL ( $i = 1, 2, 3, \dots, n, n = 22$ )

However, every criterion has different weight and the weight of criteria is different from service to service. Therefore, this research analysis the weights of criteria of UAV filming and photography service in order to calculate the score of service precisely and understand which criteria are important to keep the service quality at high level.

### Research Methods of Multi-Criteria Decision Making

As for the research methods of multi-criteria decision making (MCDM), the Analytic Hierarchy Process (AHP) is proposed by Saaty (Saaty, 1994). And the Analytical Network Process (ANP) is extended from AHP (Saaty, 1996). Those two methods are the most extensively used MCDM methods. They deal with decision-making issues of multiple evaluation criteria and provide priority (weight) of criteria for decision makers to identify best choice. The common research steps of AHP and ANP include: setting the groups (dimensions) and the evaluation criteria under the overall goal to the bottom level in order to construct the hierarchical structure, comparing of the criteria by the evaluation scale, calculating eigenvector as the weight of the criteria and then evaluating the priority of criteria by comprehensive weighted analysis. One of the differences between AHP and ANP is that AHP assumes every criterion and group is independent from each other. ANP considers the external dependency, internal correlation between criteria and feedback relationship between groups. Table 1 shows the difference between AHP and ANP (Hsieh, Lin, and Lin, 2008; Saaty, 2006).

**Table 1**  
**Difference between AHP and ANP**

<i>Research Methods</i>	<i>AHP</i>	<i>ANP</i>
The relationship among the criteria	Independent of each other	Can be dependent of each other
Group feedback	No feedback	Allow feedback
Analytical method	Maximum eigenvalue of pairwise comparison matrix	Limited supermatrix

Many researches acquired the weight of service quality by SERVQUAL combined with AHP or ANP method because the SERVQUAL has high reliability and validity. For example, Gul, Guneri and Derin (2014) determined the difference between the expected and perceived service quality levels of patients via SEVQUAL method. Saeedpoor, Vafadarnikjoo, Mobin, and Rastegari (2015) researched the importance weight of each criterion of life insurance firm's service quality by using SEVQUAL and Fuzzy Analytic Hierarchy Process. Erdođan, Bilipik, Kaya and Baraç (2013) evaluated the service quality in public transportation system using the hybrid methodology that consists of SERVQUAL and fuzzy TOPSIS. Hsieh, Lin and Lin (2008) explored customer's expectations of service quality in hot spring hotels in Taiwan based on SERVQUAL and find the relative weights among the criteria by ANP. Yu, Keng and Chen (2015) measured the service quality for Taiwan commercial banks by SERVQUAL and AHP. Altuntas, Dereli, Yilmaz and Mustafa (2012) measured hospital service quality by using analytic hierarchy process (AHP) and analytic network process (ANP) as a multi-criteria decision making method to acquire the relationship and the level of the importance among service quality measurement (SERVQUAL) dimension.

As for researches about UAV services, although numerous researches in the fields of engineering aerospace, robotics, computer science, artificial intelligence, and automation control systems etc., there are rarely researches in other fields. Demir, Cicibas and Arica (2015) reviewed the existing research areas in the UAV domain and divided them into two main streams: technological and operational research areas. Floreano and Wood (2015) identified scientific and technological advances that are expected to translate, within appropriate regulatory frameworks, into pervasive use of autonomous drones for civilian applications. Boucher and Philip (2016) conducted public engagement activities to explore citizens' visions of civil drones.

Although many researchers analyzed the service quality in many services as mentioned above, the weights of service quality criteria of UAV filming and photography are unclear. To acquire the weights of service quality criteria, SERVQUAL combining with AHP or ANP is reliable approach. Therefore, this research conducted research methodology as described below.

### **3. RESEARCH METHODOLOGY**

In order to achieve the purposes of this research - analyzing the weights of service quality criteria of UAV filming and photography from expert's and consumer's view, this research constructed the hierarchy and network structure base on SERVQUAL, and then acquired the weights of dimensions and criteria by ANP. The research steps are shown in Figure 1.

Analytical Network Process

Develop questionnaire and test

Literature review

Expert discussion for SERVQUAL revision and criteria dependence

Develop questionnaire

Questionnaire:

expert and consumer

Consistency test

Construct super matrix

Compare the weights of dimensions and criteria from expert and consumer

Calculate weight of each dimension and criterion

Analytical Network Process

#### **Literature Review**

According to ANP research method, firstly, this research reviewed and collected the related literature so as to fully understand the relevant research and construct the hierarchy and network structure.

#### **Expert Discussion for SERVQUAL Revision and Criteria Dependence**

Although SERVQUAL is widely adopted, experts must modify it for the specified service or industry. Parente and Anderson-Parente suggest that SERVQUAL shall be modified by at least 10 experts to fit the specified service and then analysis the relationship between criteria and dimensions by related questionnaire to construct the hierarchy and network structure (Parenté and Anderson-Parente, 1987).

#### **Develop Questionnaire**

After constructing the hierarchy network under the goal, it is necessary to develop pairwise assessment questionnaire to analyze the relative importance of criteria by experts. The ANP measures the importance of criteria by using the nine-point assessment scale (Saaty, 1996). In order to understand whether the statement of questionnaire is clear, this research adjusted the statement of questionnaire according to the results of the pretest. Besides pretest, we need to consider the validity of the questionnaire. Validity is the

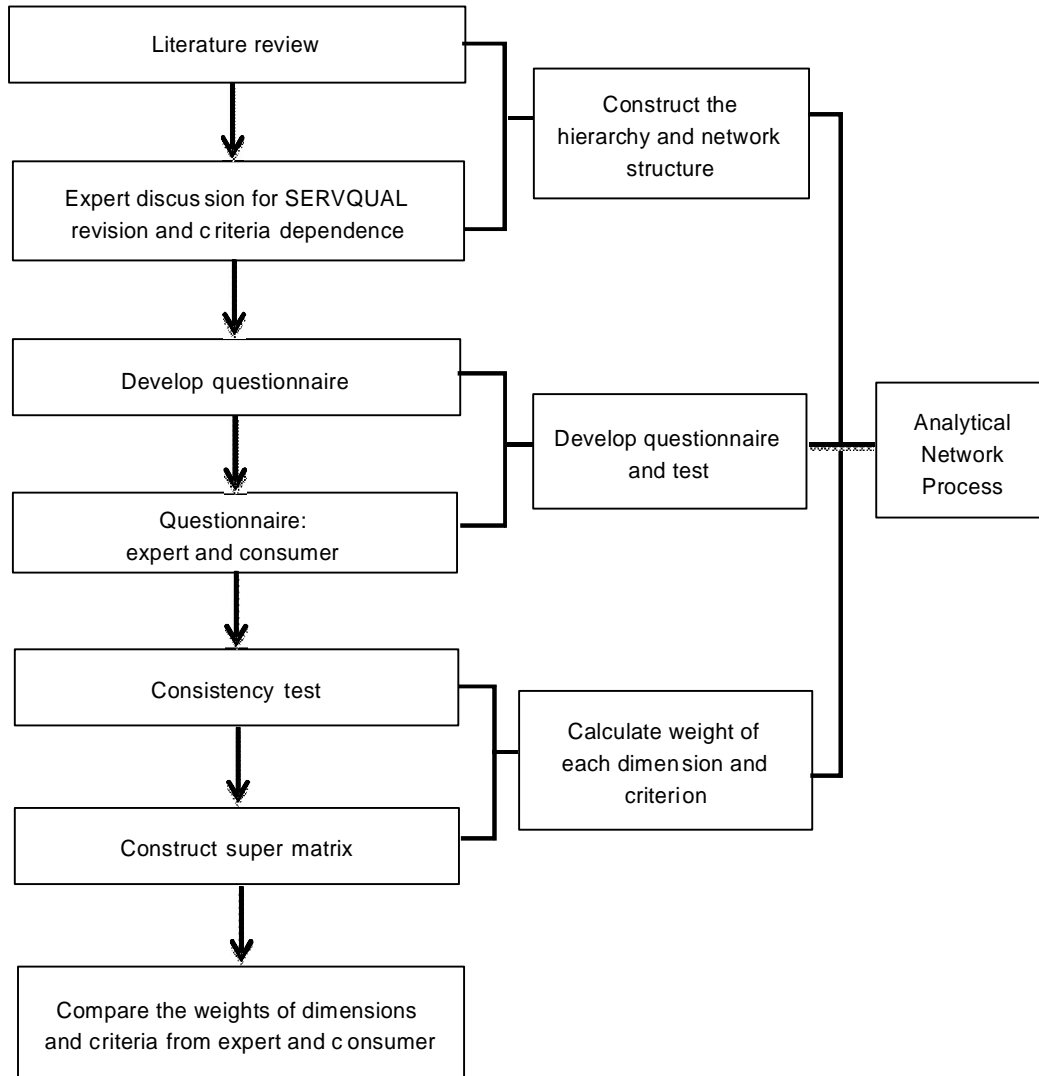


Figure 1: Research Methodology

degree to which it measures what it is supposed to measure. The kinds of validity include content validity, convergence validity and discriminant validity. This research developed the questionnaire of UAV filming and photography service base on SERVQUAL by experts and keeps the original representation when rewrite the statements of dimensions and criteria. Therefore, the questionnaire has high content validity (Babakus and Mangold, 1992). As for respondents of the questionnaire, the respondents include the experts and consumers according to the ANP research method and the purposes of this research.

### Questionnaire

After the questionnaires are filled, the answers from respondents of each question can be different. At this point, it is necessary to measure the central tendency that can be expressed on the behalf of respondents. The geometric mean can represent the average level of the group (Saaty, 1980). After acquiring the geometric mean of each question, the research shall construct pairwise comparison judgment matrix, calculate eigenvalues and eigenvectors of the matrix as weights.



### Consistency Test

The main purpose of the consistency test is to understand whether the questionnaire is judged by the correctness of transferability and whether the consistency of the whole hierarchy is within a reasonable range (Saaty, 2006). The first step of consistency test is calculating the consistency index (C.I.) to determine the degree of transferability, that is, whether the comparisons of assessment are consistent. The formula for computing C.I. is:

$$C.I. = \frac{\lambda_{\max} - n}{n - 1}$$

C.I. = 0 indicates that the judgment is consistent. C.I. > 0.1 indicates that the answers of questionnaire are inconsistent (Saaty, 2006). The second step of consistency test is calculating the consistency ratio (C.R.) to understand whether the consistency of the entire hierarchy within a reasonable range. C.R is calculated by the following formula:

$$C.R. = \frac{C.I.}{R.I.}$$

Where R.I. is random index (RI) whose value increases as the order of matrix increases, as shown in Table 2 (Saaty, 1996). When C.R. < 0.1, the consistency of the hierarchy is within a reasonable range.

**Table 2**  
**Random indexes (R.I.)**

The Order of Matrix	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
R.I.	–	–	0.58	0.90	1.12	1.24	1.32	1.41	1.45	1.49	1.51	1.53	1.56	1.57	1.59

### Construct Super Matrix

Different from the AHP method, ANP uses the super matrix to analyze the weight of each criterion under dependent architecture. The super matrix is a combination of multiple sub-matrices that include the interaction of criteria within or without their dimensions. The eigenvector calculated from the pair of comparison matrices is used as the weight of the sub-matrix to form the super matrix. Super matrix is divided into unweight super-matrix, weighted super-matrix, and limited super-matrix. Unweight super-matrix is the original matrix of pairwise comparison. Weighted super-matrix is the matrix that every criterion weight multiplies by the weight of dimension. The limited super-matrix is the matrix that calculated by raising the weighted super-matrix until every number in the matrix become stable. The convergence value of the limited super-matrix is the weight of each criterion (Saaty, 2006).

### Compare the Weights of Dimensions and Criteria from Expert and Consumer

After the research steps mentions above, the research acquires the index weight of UAV film production service quality from both of expert and consumer's views. This research compares and discusses the difference between the results from binary viewpoints.

#### 4. RESULTS AND DUSCUSSION

##### Construct Hierarchy and Network Structure

For expert discussion, this research invited 10 UAV experts to modify the statements of SERVQUAL and then analysis the relationship between criteria and dimensions by related questionnaire to construct the hierarchy and network structure. UAV filming and photography service qualityevaluation structure that modified from SERVQUAL is shown in table 3. Experts identified the relationship between the criteria and dimensions by related questionnaire. The number in thetable 4 (Criteria dependency relationship score) is the number of experts that agree that the criterion of column has the relationship with the criterion of the row. This research keeps the relationship between criteria if there are more than 7 experts confirm the dependency. The table 5 is the criteria dependency relationshipand criteria dependency chart is shown in figure 2.

**Table 3**  
**UAV filming and photography service qualityevaluation structure**

<i>Goal</i>	<i>Dimensions</i>	<i>Criteria</i>
UAV filming and photography service quality	A Tangibility	A1UAV service team has up-to-dateequipment. A2UAV service team’s physical facilities are visually appealing. A3UAV service team’s employees are well dressed and appear neat. A4Equipment matches the service.
	B Reliability	B1 When UAV service team promises to do something by a certain time, it does so. B2 When consumer has problem, UAV service team is sympathetic and reassuring. B3UAV service team provides services legally,safely and reliably. B4UAV service team provides its services at the time it promises to do so. B5UAV service team keeps its records accurately.
	C Responsiveness	C1UAV service team tells customers exactly when services will be performed. C2 Customs receive prompt service from UAV service team. C3UAV service team’s employees are always willing to help customers. C4UAV service team’s employees are never too busy to respond to customer requests promptly.
	D Assurance	D1 Customs can trust employees of UAV service team. D2 Customs feel safe in your transactions with UAV service team’s employees. D3 Employees of UAV service team are polite. D4Employees are professional and get adequate support to do their jobs well.
	E Empathy	E1UAV service team gives consumer individualattention. E2UAV service team’s employees give custom personal attention. E3UAV service team know what custom’s need are. E4UAV service team has custom’s best interests at heart. E5UAV service team has operating hours convenient to all their customers.



Table 4  
Criteria dependency relationship score

Dimensions	A				B				C				D				E					
	A1	A2	A3	A4	B1	B2	B3	B4	B5	C1	C2	C3	C4	D1	D2	D3	D4	E1	E2	E3	E4	E5
A	4	3	3	5	7	3	3	3	3	2	2	2	2	3	3	3	3	3	3	3	3	3
B	3	4	3	4	3	3	3	3	3	4	4	4	4	10	10	10	4	4	4	3	3	4
C	3	3	3	3	3	3	3	3	3	8	10	10	5	10	3	3	5	5	5	5	3	4
D	3	4	3	2	2	2	2	2	2	3	3	3	3	10	10	10	2	3	4	4	4	3
E	3	3	3	4	4	4	4	4	4	3	3	3	4	9	10	10	6	3	3	3	3	3
A1	4	3	3	5	7	3	3	3	3	2	2	2	2	3	3	3	3	3	3	3	3	3
A2	3	4	3	4	3	3	3	3	3	4	4	4	4	10	10	10	2	3	4	4	4	3
A3	3	4	3	4	3	3	3	3	3	3	3	3	3	10	10	10	2	3	4	4	4	1
A4	3	4	3	4	3	3	3	3	3	2	2	2	2	10	10	10	5	3	3	3	3	3
B1	3	4	3	4	3	3	3	3	3	4	4	4	4	10	10	10	4	4	4	3	3	4
B2	3	4	3	4	3	3	3	3	3	8	10	10	5	10	3	3	5	5	5	5	3	4
B3	4	3	3	2	2	2	2	2	2	3	3	3	3	10	10	10	3	3	3	2	2	3
B4	3	4	3	2	2	2	2	2	2	4	2	2	2	10	10	10	2	3	4	4	3	3
B5	3	4	3	2	2	2	2	2	2	1	1	1	1	10	10	10	1	1	3	3	3	3
C1	3	4	3	3	3	3	3	3	3	4	5	5	4	9	3	3	4	3	3	3	1	3
C2	3	4	3	3	3	3	3	3	2	2	3	3	2	9	2	4	4	5	4	4	3	2
C3	3	4	3	3	3	3	3	3	3	3	3	3	3	10	3	4	3	4	4	4	3	2
C4	3	4	3	3	3	3	3	3	4	3	2	2	2	10	10	2	6	3	3	3	5	9
D1	3	4	3	4	4	4	4	4	4	2	2	2	5	10	10	4	4	4	5	3	2	2
D2	3	4	3	4	4	4	4	4	4	3	3	3	6	9	3	3	3	3	4	3	2	2
D3	3	4	3	4	4	4	4	4	4	3	3	3	3	8	2	2	1	1	3	3	3	3
D4	3	4	3	4	4	4	4	4	4	3	3	3	4	9	10	10	2	2	5	5	4	4
E1	3	4	3	4	4	4	4	4	4	3	7	9	3	9	3	5	5	5	5	5	9	3
E2	3	4	3	4	4	4	4	4	4	2	2	2	3	10	9	5	2	2	6	3	1	1
E3	3	4	3	4	4	4	4	4	4	3	3	3	3	10	9	4	4	3	4	4	9	9
E4	3	4	3	4	4	4	4	4	4	3	2	3	3	10	10	2	2	3	4	4	5	3
E5	3	4	3	4	4	4	4	4	4	1	1	2	2	2	8	2	2	2	3	3	4	4

Table 5  
Criteria dependency relationship table

Dimensions	A					B					C					D					E				
Criteria	A1	A2	A3	A4	A1	B1	B2	B3	B4	B5	C1	C2	C3	C4	D1	D2	D3	D4	D1	E1	E2	E3	E4	E5	
A	A1					V																			
	A2													V											
	A3													V											
	A4													V											
B	B1									V				V											
	B2										V			V											
	B3									V				V											
	B4								V					V											
	B5													V											
C	C1													V											
	C2													V											
	C3													V										V	
	C4													V										V	
D	D1																								
	D2													V											
	D3													V											
	D4													V											
E	E1													V										V	
	E2													V										V	
	E3													V										V	
	E4													V										V	
	E5													V										V	

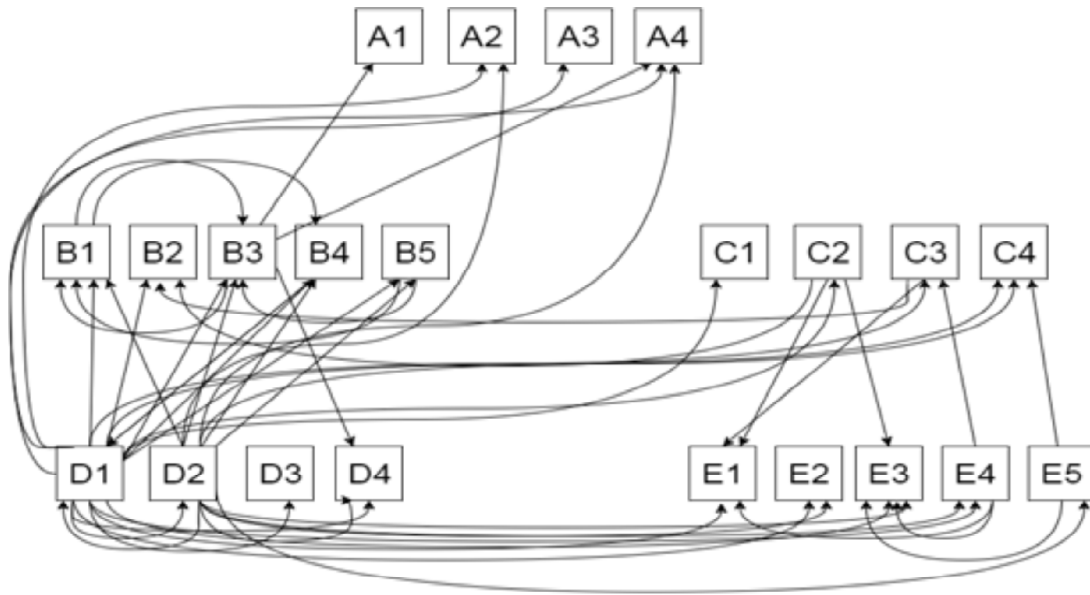


Figure 2: Criteria dependency chart

### Developing the Questionnaire

This research developed questionnaire by the software of Super Decision that developed by Saaty who proposed the research method of ANP. The software generated comparison questionnaire by inputting the hierarchy and network structure according to table 5. The questionnaire is measured by 9-point scale (Saaty, 1980). And then this research modified the statement of questionnaire in order to make it clear according to the results of pretest with effective response rate of 90% (20 questionnaires were sent and 18 were collected).

### Questionnaire and Analysis

After pretest, this research applied 30 questionnaires. The respondents divided into two groups: 10 experts of UAV and 20 consumers of UAV filming and photography service. The effective response rate is 100% because we explained the meaning of this research to every respondent. Table 6 is the questionnaire statistics.

Table 6  
Questionnaire statistics

Groups	The number of questionnaires sent	The number of questionnaires collected	Effective response rate
Expert	10	10	100%
Consumer	20	20	100%
Total	30	30	100%

This research calculated the geometric mean of every answer from all respondents of each question in a group to get the central tendency by Excel and then inputted the value of geometric mean into Super Decisions. Before calculating the super-matrix, we need to check consistency index and ratio. The consistency of questionnaire and entire hierarchy are acceptable because the consistency index and the consistency ratio are both less than 0.1 as shown in table 7.

**Table 7**  
**C.I. and C.R.**

<i>Expert</i>		<i>Consumer</i>					
<i>Compare with respect to</i>	<i>Group</i>	<i>Items of pairwise comparison</i>	<i>C.I.</i>	<i>C.R.</i>	<i>C.I.</i>	<i>C.R.</i>	
Group	Goal	A and B, A and C, A and D, A and E, B and C, B and D, B and E, C and D, C and E, D and E	0.03414	0.05886	0.04804	0.08283	
	B	A and B, A and D, B and D	0.01759	0.03033	0.00105	0.00181	
	C	B and E	0.00000	0.00000	0.00000	0.00000	
	D	A and B, A and C, A and D, A and E, B and C, B and D, B and E, C and D, C and E, D and E	0.03365	0.05802	0.03347	0.05771	
	E	C and E	0.0000	0.00000	0.0000	0.00000	
Criteria	Goal	A	A1 and A2, A1 and A3, A1 and A4, A2 and A3, A2 and A4, A3 and A4	0.04442	0.07659	0.01946	0.03355
		B	B1 and B2, B1 and B3, B1 and B4, B1 and B5, B2 and B3, B2 and B4, B2 and B5, B3 and B4, B3 and B5, B4 and B5	0.04924	0.08490	0.04601	0.07933
		C	C1 and C2, C1 and C3, C1 and C4, C2 and C3, C2 and C4, C3 and C4	0.04748	0.08186	0.05737	0.09891
		D	D1 and D2, D1 and D3, D1 and D4, D2 and D3, D2 and D4, D3 and D4	0.04238	0.07307	0.01140	0.01966
		E	E1 and E2, E1 and E3, E1 and E4, E1 and E5, E2 and E3, E2 and E4, E2 and E5, E3 and E4, E3 and E5, E4 and E5	0.03365	0.05802	0.00132	0.00228
	B1	B	B3 and B4	0.00000	0.00000	0.00000	0.00000
	B3	A	A1 and A4	0.00000	0.00000	0.00000	0.00000
	B5	B	B1 and B3, B1 and B4, B3 and B4	0.00191	0.00329	0.01111	0.01916
	C2	E	E1 and E3	0.00000	0.00000	0.00000	0.00000
	D1	A	A2 and A3, A2 and A4, A3 and A4	0.05156	0.08890	0.00142	0.00245
		B	B1 and B2, B1 and B3, B1 and B4, B1 and B5, B2 and B3, B2 and B4, B2 and B5, B3 and B4, B3 and B5, B4 and B5,	0.04591	0.07916	0.05083	0.08764
		C	C1 and C2, C1 and C3, C1 and C4, C2 and C3, C2 and C4, C3 and C4	0.02271	0.03916	0.00191	0.00329
		D	D2 and D3, D2 and D4, D3 and D4	0.03112	0.05366	0.05156	0.08890
		E	E1 and E2, E1 and E3, E1 and E4, E2 and E3, E2 and E4, E3 and E4	0.02271	0.03916	0.02728	0.04703
	D2	A	A2 and A4	0.00000	0.00000	0.00000	0.00000
		B	B1 and B3, B1 and B4, B1 and B5, B3 and B4, B3 and B5, B4 and B5	0.04544	0.07834	0.03344	0.05766
		D	D1 and D4	0.00000	0.00000	0.00000	0.00000
		E	E2 and E3, E2 and E4, E2 and E5, E3 and E4, E3 and E5, E4 and E5	0.01716	0.02959	0.01618	0.02790
	E4	E	E1 and E3	0.00000	0.00000	0.00000	0.00000

Table 8  
Limited super-matrix of expert

Dimensions	A					B					C					D					E				
	A1	A2	A3	A4	A5	B1	B2	B3	B4	B5	C1	C2	C3	C4	C5	D1	D2	D3	D4	D5	E1	E2	E3	E4	E5
A	0.216	0.216	0.216	0.216	0.216	0.216	0.216	0.216	0.216	0.216	0.216	0.216	0.216	0.216	0.216	0.216	0.216	0.216	0.216	0.216	0.216	0.216	0.216	0.216	0.216
A1	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002
A2	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
A4	0.112	0.112	0.112	0.112	0.112	0.112	0.112	0.112	0.112	0.112	0.112	0.112	0.112	0.112	0.112	0.112	0.112	0.112	0.112	0.112	0.112	0.112	0.112	0.112	0.112
B	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002
B2	0.036	0.036	0.036	0.036	0.036	0.036	0.036	0.036	0.036	0.036	0.036	0.036	0.036	0.036	0.036	0.036	0.036	0.036	0.036	0.036	0.036	0.036	0.036	0.036	0.036
B3	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045
B4	0.006	0.006	0.006	0.006	0.006	0.006	0.006	0.006	0.006	0.006	0.006	0.006	0.006	0.006	0.006	0.006	0.006	0.006	0.006	0.006	0.006	0.006	0.006	0.006	0.006
B5	0.0004	0.0004	0.0004	0.0004	0.0004	0.0004	0.0004	0.0004	0.0004	0.0004	0.0004	0.0004	0.0004	0.0004	0.0004	0.0004	0.0004	0.0004	0.0004	0.0004	0.0004	0.0004	0.0004	0.0004	0.0004
C	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
C2	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
C3	0.0022	0.0022	0.0022	0.0022	0.0022	0.0022	0.0022	0.0022	0.0022	0.0022	0.0022	0.0022	0.0022	0.0022	0.0022	0.0022	0.0022	0.0022	0.0022	0.0022	0.0022	0.0022	0.0022	0.0022	0.0022
C4	0.0035	0.0035	0.0035	0.0035	0.0035	0.0035	0.0035	0.0035	0.0035	0.0035	0.0035	0.0035	0.0035	0.0035	0.0035	0.0035	0.0035	0.0035	0.0035	0.0035	0.0035	0.0035	0.0035	0.0035	0.0035
D	0.0004	0.0004	0.0004	0.0004	0.0004	0.0004	0.0004	0.0004	0.0004	0.0004	0.0004	0.0004	0.0004	0.0004	0.0004	0.0004	0.0004	0.0004	0.0004	0.0004	0.0004	0.0004	0.0004	0.0004	0.0004
D2	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005
D3	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002
D4	0.5602	0.5602	0.5602	0.5602	0.5602	0.5602	0.5602	0.5602	0.5602	0.5602	0.5602	0.5602	0.5602	0.5602	0.5602	0.5602	0.5602	0.5602	0.5602	0.5602	0.5602	0.5602	0.5602	0.5602	0.5602
E	0.0084	0.0084	0.0084	0.0084	0.0084	0.0084	0.0084	0.0084	0.0084	0.0084	0.0084	0.0084	0.0084	0.0084	0.0084	0.0084	0.0084	0.0084	0.0084	0.0084	0.0084	0.0084	0.0084	0.0084	0.0084
E2	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002
E3	0.0042	0.0042	0.0042	0.0042	0.0042	0.0042	0.0042	0.0042	0.0042	0.0042	0.0042	0.0042	0.0042	0.0042	0.0042	0.0042	0.0042	0.0042	0.0042	0.0042	0.0042	0.0042	0.0042	0.0042	0.0042
E4	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002
E5	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003





After inputting the data into Super Decision software and passing the consistency test, the limited super-matrixes are calculated as shown in table 8 (limited super-matrix of expert) and table 9 (limited super-matrix of consumer). The value in each row is the weight of criteria. The weights of dimensions without the influence of dependency of criteria judged by experts are: Tangibility (0.302845209), Assurance (0.289072189), Reliability (0.244893215), Empathy (0.086960918) and Responsiveness (0.076228469). The weights of dimensions without the influence of dependency of criteria judged by consumers are: Reliability (0.358480113), Assurance (0.236582994), Empathy (0.168367959), Responsiveness (0.127054515) and Tangibility (0.109514418). The weights and orders of dimensions of UAV filming and photography services judged by experts and consumers are listed together in table 10.

The top 5 weights of criteria within the influence of dependency judged by experts are: “Employees are professional and get adequate support to do their jobs well” (0.560207), “UAV service team has up-to-date equipment” (0.216335), “Equipment matches the service” (0.111736), “UAV service team provides services legally, safely and reliably” (0.044963) and “When consumer has problem, UAV service team is sympathetic and reassuring” (0.03555).

The top 5 weights of criteria within the influence of dependency judged by consumers are: “Employees are professional and get adequate support to do their jobs well” (0.34718), “Equipment matches the service” (0.175067), “UAV service team has up-to-date equipment” (0.170563), “UAV service team gives consumer individual attention” (0.079092) and “UAV service team provides services legally, safely and reliably” (0.073347). The weights and orders of criteria of UAV filming and photography services judged by experts and consumers are listed together in table 11.

**Table 10**  
**Weights and orders of dimensions**

<i>Dimension</i>	<i>Expert</i>		<i>Consumer</i>	
	<i>Weight</i>	<i>Order</i>	<i>Weight</i>	<i>Order</i>
A Tangibles	0.302845209	1	0.109514418	5
B Reliability	0.244893215	3	0.358480113	1
C Responsiveness	0.076228469	5	0.127054515	4
D Assurance	0.289072189	2	0.236582994	2
E Empathy	0.086960918	4	0.168367959	3

### Discussion

This research compares and discusses the difference of criteria weight of UAV filming and photography service between expert and consumer’s viewpoints. Table 12 is the dimensions of UAV filming and photography service ordered by weight that judged by experts and consumers. Table 13 is the criteria of UAV filming and photography service ordered by weight that judged by experts and consumers.

From expert’s viewpoint, the tangibility is the most important dimension (as shown in table 12) and “UAV service team has up-to-date equipment” is the most important criterion in this dimension (as shown in table 11). This means that the highest priority criterion of UAV filming and photography service quality is

**Table 11**  
**Weights and orders of criteria**

<i>Criteria</i>	<i>Expert</i>			<i>Consumer</i>		
	<i>Weight in Dimension</i>	<i>Overall Weight</i>	<i>Order</i>	<i>Weight in Dimension</i>	<i>Overall Weight</i>	<i>Order</i>
A1 UAV service team has up-to-date equipment.	0.65341	0.216335	2	0.48804	0.170563	3
A2 UAV service team's physical facilities are visually appealing.	0.00596	0.001972	12	0.00879	0.003072	13
A3 UAV service team's employees are well dressed and appear neat.	0.00315	0.001042	13	0.00225	0.000785	22
A4 Equipment matches the service.	0.33748	0.111736	3	0.50093	0.175067	2
B1 When UAV service team promises to do something by a certain time, it does so.	0.02317	0.002048	11	0.04113	0.006788	11
B2 When consumer has problem, UAV service team is sympathetic and reassuring.	0.40217	0.03555	5	0.36851	0.060821	6
B3 UAV service team provides services legally, safely and reliably.	0.50866	0.044963	4	0.44441	0.073347	5
B4 UAV service team provides its services at the time it promises to do so.	0.06197	0.005478	7	0.13189	0.021767	7
B5 UAV service team keeps its records accurately.	0.00403	0.000356	16	0.01407	0.002322	16
C1 UAV service team tells customers exactly when services will be performed.	0.01726	0.000102	21	0.06468	0.001974	18
C2 Customs receive prompt service from UAV service team.	0.01726	0.000102	21	0.06062	0.00185	19
C3 UAV service team's employees are always willing to help customers.	0.36802	0.002175	10	0.45753	0.013963	9
C4 UAV service team's employees are never too busy to respond to customer requests promptly.	0.59746	0.003531	9	0.41716	0.012731	10
D1 Customs can trust employees of UAV service team.	0.00066	0.000368	15	0.00947	0.003373	12
D2 Customs feel safe in your transactions with UAV service team's employees.	0.00095	0.000535	14	0.00759	0.002702	15
D3 Employees of UAV service team are polite.	0.00029	0.00016	20	0.00773	0.002751	14
D4 Employees are professional and get adequate support to do their jobs well.	0.99811	0.560207	1	0.97521	0.34718	1
E1 UAV service team gives consumer individual attention.	0.62994	0.008404	6	0.79937	0.079092	4
E2 UAV service team's employees give custom personal attention.	0.01454	0.000194	19	0.01335	0.001321	20
E3 UAV service team know what custom's need are.	0.31797	0.004242	8	0.15532	0.015368	8
E4 UAV service team has custom's best interests at heart.	0.01589	0.000212	18	0.02186	0.002163	17
E5 UAV service team has operating hours convenient to all their customers.	0.02166	0.000289	17	0.0101	0.000999	21

the equipment from the evaluation of experts. However, from consumer’s viewpoint, the most important dimension of service quality of UAV filming and photography is not tangibility but reliability. And the tangibility dimension has the lowest weight among five dimensions. This means that the consumer of UAV filming and photography service considers the ability to perform the promised service reliably and accurately as the highest priority dimension to keep the service quality. And the reliability dimension is much more important than tangibility from consumer’s viewpoint. Many cases of UAV filming and photography are recording the outdoor activities, for example: the anniversary, wedding, running event or other outdoor competitions.

For recording these activities from multi rotor drone, the opportunity is just one time. In case the service provider operates UAV and related equipment improperly, they cannot ask everyone to react. Therefore, this part of research result reflects the phenomenon that what the consumer is valued is reliability not tangibility. From both of experts and consumers’ viewpoints, “Assurance” is the second highest weighted dimension. This means that knowledge and courtesy of employees and their ability to inspire trust and confidence are very important. “Employees are professional and get adequate support to do their jobs well” is the most important criterion in this dimension (as shown in table 11). Therefore, assurance is the second highest priority dimension to keep the service quality and profession is the most important criteria to keep assurance.

**Table 12**  
Dimensions order by weight that judged by experts and consumers

<i>Expert</i>			<i>Consumer</i>		
<i>Order</i>	<i>Weight</i>	<i>Dimension</i>	<i>Dimension</i>	<i>Weight</i>	<i>Order</i>
1	0.302845209	A-Tangibles	B-Reliability	0.358480113	1
2	0.289072189	D-Assurance	D-Assurance	0.236582994	2
3	0.244893215	B-Reliability	E-Empathy	0.168367959	3
4	0.086960918	E-Empathy	C-Responsiveness	0.127054515	4
5	0.076228469	C-Responsiveness	A-Tangibles	0.109514418	5

The criteria of UAV filming and photography service ordered by weight that judged by experts and consumers and comparison between them are shown in table 13. This research finds that from both of experts and consumers’ viewpoints, top 3 criteria ordered by weight within the influence of dependency are: “Employees are professional and get adequate support to do their jobs well”, “UAV service team has up-to-date equipment” and “Equipment matches the service” (The order of 2<sup>th</sup> and 3<sup>th</sup> is opposite in consumer’s view). However, from expert’s point of view, the priority of “UAV service team provides services legally, safely and reliably” is higher than “When consumer has problems, UAV service team is sympathetic and reassuring”. But from consumer’s point of view, the priority of “UAV service team gives consumer individual attention” is higher than “UAV service team provides services legally, safely and reliably”. This part of research result reflects the phenomenon that the provider of UAV filming and photography service pays more attention to “UAV service team provides services legally, safely and reliably” than “When consumer has problem, UAV service team is sympathetic and reassuring” and “UAV service team gives consumer individual attention”.

**Table 13**  
**The criteria order by weight that judged by experts and consumers.**

<i>Expert</i>		<i>Consumer</i>
<i>Criteria</i>		<i>Criteria</i>
1	D4 Employees are professional and get adequate support to do their jobs well.	D4 Employees are professional and get adequate support to do their jobs well.
2	A1 UAV service team has up-to-date equipment.	A4 Equipment matches the service.
3	A4 Equipment matches the service.	A1 UAV service team has up-to-date equipment.
4	B3 UAV service team provides services legally, safely and reliably.	E1 UAV service team gives consumer individual attention.
5	B2 When consumer has problem, UAV service team is sympathetic and reassuring.	B3 UAV service team provides services legally, safely and reliably.
6	E1 UAV service team gives consumer individual attention.	B2 When consumer has problem, UAV service team is sympathetic and reassuring.
7	B4 UAV service team provides its services at the time it promises to do so.	B4 UAV service team provides its services at the time it promises to do so.
8	E3 UAV service team know what custom's need are.	E3 UAV service team know what custom's need are.
9	C4 UAV service team's employees are never too busy to respond to customer requests promptly.	C3 UAV service team's employees are always willing to help customers.
10	C3 UAV service team's employees are always willing to help customers.	C4 UAV service team's employees are never too busy to respond to customer requests promptly.
11	B1 When UAV service team promises to do something by a certain time, it does so. by a certain time, it does so.	B1 When UAV service team promises to do something
12	A2 UAV service team's physical facilities are visually appealing.	D1 Customs can trust employees of UAV service team.
13	A3 UAV service team's employees are well dressed and appear neat.	A2 UAV service team's physical facilities are visually appealing.
14	D2 Customs feel safe in your transactions with UAV service team's employees.	D3 Employees of UAV service team are polite.
15	D1 Customs can trust employees of UAV service team.	D2 Customs feel safe in your transactions with UAV service team's employees.
16	B5 UAV service team keeps its records accurately.	B5 UAV service team keeps its records accurately.
17	E5 UAV service team has operating hours convenient to all their customers.	E4 UAV service team has custom's best interests at heart.
18	E4 UAV service team has custom's best interests at heart.	C1 UAV service team tells customers exactly when services will be performed.
19	E2 UAV service team's employees give custom personal attention.	C2- Customs receive prompt service from UAV service team.
20	D3 Employees of UAV service team are polite.	E2 UAV service team's employees give custom personal attention.
21	C1 UAV service team tells customers exactly when services will be performed.	E5 UAV service team has operating hours convenient to all their customers.
22	C2- Customs receive prompt service from UAV service team.	A3 UAV service team's employees are well dressed and appear neat.

## 5. CONCLUSION AND SUGGESTION

### Conclusion

The service of UAV filming and photography is getting more and more popular. This research constructed the hierarchy and network structure base on SERVQUAL to evaluate the service quality. And then acquired the weight of criteria and dimension by Analytic Network Process-ANP from dual perspective: experts and consumers. Finally, this research compared and discussed the differences between them.

Corresponding to the purposes of this research list above, findings are given as follows:

1. From the expert's viewpoint, to keep the service quality of UAV filming and photography at high level, the dimensions ordered by priority without the influence of dependency of criteria are: Tangibility, Assurance, Reliability, Empathy and Responsiveness. And the top 5 criteria ordered by weight within the influence of dependency are: "Employees are professional and get adequate support to do their jobs well", "UAV service team has up-to-date equipment", "Equipment matches the service", "UAV service team provides services legally, safely and reliably" and "When consumer has problem, UAV service team is sympathetic and reassuring".
2. From the consumer's viewpoint, to keep the service quality of UAV filming and photography at high level, the dimensions ordered by priority without the influence of dependency of criteria are: Reliability, Assurance, Empathy, Responsiveness and Tangibility. And the top 5 criteria ordered by weight within the influence of dependency are: "Employees are professional and get adequate support to do their jobs well", "Equipment matches the service", "UAV service team has up-to-date equipment", "UAV service team gives consumer individual attention" and "UAV service team provides services legally, safely and reliably".
3. After comparing the weights of dimensions and criteria between service provider and consumer, this research finds that what the consumer is valued is reliability not tangibility and the provider pays more attention to "UAV service team provides services legally, safely and reliably" than consumer.

### Research Contributions and Suggestions

Nowadays, the service of UAV filming and photography is very popular but the analysis of services quality is research gap. This research constructed the hierarchy and network structure for evaluating the service quality by 10 experts, acquired the weights of dimensions and criteria from the expert and consumer's viewpoints by ANP that is more accurate than AHP and then discussed the differences between them. The hierarchy and network structure, the questionnaire for service quality of UAV filming and photography, and the weights of dimensions and criteria are useful for future research.

As for research limitations, although this research is based on the SERVQUAL, the data of this research were gathered from 30 questionnaires. For future research, it is recommended to continue the research with bigger sample and the questionnaire can be verified by confirmatory factor analysis.

The findings of this research include the different points of view from provider and consumer. It is very important for UAV service provider to keep good service quality. The suggestions for UAV service provider are described as follow:

To keep good service, there is a big gap between consumer and service provider. Provider considers the equipment as most important dimension but consumer considers reliability as most important dimension and do not care about equipment after all. Besides, according to the analysis of criteria weight, the provider pays more attention to “UAV service team provides services legally, safely and reliably” than consumer. Therefore, this research suggests that in order to keep the service quality of UAV filming and photography, the service provider must regard the professional skill, the safety of mission and the up-to-date equipment as basic condition and execute the mission legally and correctly.

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