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AN ANALYSIS ON THE SERVICE DIMENSIONS OF NATIONAL YOUTH SKILLS TRAINING INSTITUTES VIA AN INTEGRATED MULTI-ATTRIBUTE DECISION-MAKING PROCEDURE

(Analisis Matra Perkhidmatan Institut Kemahiran Belia Negara melalui Tatacara Pembuatan Keputusan Multi-Atribut Terintegrasi)

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ABSTRACT

It is indeed a challenging undertaking for the key players of Malaysian National Youth Skills Training Institutes (IKBNs, in Malay) to decide the finest possible strategies that could significantly enhance their students' satisfaction over their services. It involves the consideration of various service attributes that naturally carry diverse priorities. Therefore, this study aimed at recommending some efficient strategies to improve student satisfaction in IKBNs by systematically uncovering the relative priorities of service dimensions. In this study, we carried out a Delphi survey involving a group of experts to validate the list of service attributes elicited from past literature. A questionnaire, which was designed based on the finalised 41 attributes, was then used to gather the necessary data from a sample of 636 IKBN students. With the help of factor analysis, these 41 attributes were then grouped into nine independent dimensions. Further analysis using the group-based compromised analytical hierarchy process (C-AHP) has identified training tools, training delivery, tangible amenities, student-centred management, and training instructors as the five most salient dimensions of student satisfaction. trastudy could enable the IKBNs to manage their resource better when improving their services. From the management science perspective, this study has contributed a new hybrid multi-attribute decision-making procedure combining Delphi survey, factor analysis, and group C-AHP. The procedure is appropriate for dealing with any complex decision problems that entail a large set of evaluation attributes.

Keywords: analytical hierarchy process; Delphi survey; TVET services; student satisfaction

ABSTRAK

Ia sememangnya merupakan suatu usaha yang mencabar kepada para pemain utama Institut Kemahiran Belia Negara (IKBN) Malaysia untuk memutuskan strategi terbaik yang dapat meningkatkan kepuasan pelajar terhadap perkhidmatan yang mereka tawarkan. Ia melibatkan pertimbangan pelbagai atribut perkhidmatan yang secara semula jadinya mempunyai tahap keutamaan yang berbeza. Justeru, kajian ini bertujuan untuk mengesyorkan beberapa strategi yang cekap untuk meningkatkan kepuasan pelajar IKBN, dengan mendedahkan secara sistematik keutamaan relatif matra perkhidmatan. Dalam kajian ini, dilaksanakan tinjauan Delphi yang melibatkan sekumpulan pakar untuk mengesahkan senarai atribut perkhidmatan yang dikenal pasti daripada kajian lepas. Suatu soal selidik yang direka berdasarkan 41 atribut, kemudian digunakan untuk mengumpul data yang diperlukan daripada sampel 636 orang pelajar IKBN. Dengan bantuan analisis faktor, 41 atribut ini kemudian digabungkan kepada sembilan matra bebas. Analisis selanjutnya menggunakan proses hierarki analisis kompromi (PHA-B) berasaskan kumpulan telah mengenal pasti alat latihan, penyampaian latihan, kemudahan fizikal, pengurusan berpusatkan pelajar, dan tenaga pengajar sebagai lima matra kepuasan pelajar yang paling mustahak. Menariknya, perkhidmatan sokongan dilaporkan sebagai matra yang paling kurang penting. Hasil kajian ini harus membolehkan IKBN menguruskan sumbernya dengan lebih terurus dalam meningkatkan perkhidmatan mereka. Dari perspektif sains pengurusan, kajian ini telah menyumbangkan suatu tatacara pembuatan keputusan multi-atribut hibrid yang baharu yang menggabungkan tinjauan Delphi, analisis faktor dan PHA-B

berasaskan kumpulan. Tatacara berkenaan sesuai untuk menangani masalah keputusan yang kompleks yang melibatkan sebilangan besar atribut penilaian.

Kata kunci: proses hierarki analisis; tinjauan Delphi; perkhidmatan TVET; kepuasan pelajar

1. Introduction

Malaysia does realise that skilled workforce produced by the technical and vocational education and training (TVET) institutes will undoubtedly be a valuable asset in the future, especially to cater for the needs of Industrial Revolution 4.0 (Alias *et al.* 2018; Halili *et al.* 2019) and to trigger speedy socio-economic development (Bakar 2011). As such, the government has never failed to show its interest to gradually strengthen the nation's TVET system. In fact, a special TVET task force was recently formed mainly to propose some feasible transformation plans that could boost the quantity and quality of graduates produced by the TVET institutes (Rajaendram 2018), including National Youth Skills Training Institutes (IKBN, from Institut Kemahiran Belia Negara). IKBN is a type of TVET institute in Malaysia that operates with the backing of the Ministry of Youth and Sports. Today, there exist 20 IKBNs across the nation, providing a wide spectrum of engineering and entrepreneurial-based training programs.

Reports in past literature suggest that the quantity and quality of IKBN graduates can even be bettered by guaranteeing a satisfying campus living experience to their students. For instance, Boulding *et al.* (1993) claimed that students who are satisfied with their institutes show active engagement in free word-of-mouth marketing, which may subsequently help to increase the number of new enrolments. Besides, Asnul Dahar and Siti Azizah (2011) believe that students with a higher degree of satisfaction can easily conform to the institutes' system and exhibit better involvement during the training, and thus graduate with intense practical skills.

Unfortunately, increasing student satisfaction is deemed to be a very complex undertaking as it involves the presence of various service attributes (Maimunah *et al.* 2009) that naturally hold different priorities. Providing more explicit information about the actual priorities carried by these service attributes may enable the decision-makers of the institutes to be more strategic in their attempts to increase student satisfaction, especially by utilising the available resources more sensibly. For instance, the funds channelled by the government can mostly be utilised to enhance those attributes that carry higher priorities towards satisfaction; instead of treating all the attributes equally.

Sadly, there only exist a limited number of studies relating to TVET institutes that have measured the relative priorities of service attributes against the satisfaction construct. Moreover, most of these available studies simply used objective weighing techniques (e.g. regression analysis), which can automatically estimate the relative priorities through mathematical models. However, these techniques do not incorporate the subjective judgment or preference of the concerned decision-makers (Aalianvari *et al*. 2012; Zardari *et al.* 2015). This study, therefore, mainly aimed at using a combination of few empirical decision techniques, including a suitable subjective weighing technique, to better understand the priorities held by the service dimensions prior to suggesting the strategies to improve student satisfaction in IKBNs. This primary goal was achieved by sequentially addressing the following specific objectives:

a) To determine a comprehensive set of service attributes that could influence student satisfaction in IKBNs.
b) To classify the service attributes into fewer, non-overlapping dimensions.

c) To measure the relative priorities of the service dimensions with respect to student satisfaction.
d) To suggest some workable strategies to improve student satisfaction in IKBNs based on the identified relative priorities.

The remainder of this paper is structured as follows. Section 2 presents a brief survey on the construct of student satisfaction and service components of educational institutes, apart from comparing a few relevant studies to emphasise the existing gap in the literature. Section 3 details the processes involved in the accomplishment of the research, whereas section 4 discusses the derived results. The research implications, limitations, and indications for future research are presented in the final section.

2. A Survey on Related Works

Student satisfaction denotes an individual's temporary attitude that resulted from their experience of educational institutes (Athiyaman 1997). According to Mahapatra and Khan (2007), every tertiary educational institute, including TVET institutes, must chiefly aim at producing satisfied students; this may then transform into various benefits, both for the students and the institutes, as clarified earlier in Section 1.

Indisputably, students express satisfaction only if their overall learning experience meets their initial anticipation. According to Gruber *et al.* (2010), there exist three important aspects influencing student satisfaction, namely service quality, personal factor, and price (i.e., fees). However, the focus of our study is narrowed down to understanding the effect of the service attributes on student satisfaction. In fact, in many cases, the service quality attributes were utilised as the primary base for evaluating student satisfaction. Besides, it is more sensible to propose service-based solutions to the IKBNs as they have better control over this aspect as compared to the other two since personal factors may vary from one student to another, while the ministry usually regulates the fees.

The SERVQUAL model, which has popularly been used in various service-based sectors (Dužević *et al.* 2017), has also been considered in studies involving educational institutes (Arambewela & Hall, 2006; Hasan *et al.* 2009). Several academic works have used the five dimensions of SERVQUAL, namely, reliability, assurance, tangibility, empathy, and responsiveness, as the yardstick to assess student satisfaction. However, it is learned that the dimensionalities of SERVQUAL are not consistent, where the presumed dimensions may vary from one context to another; the items (attributes) do not always load on to the priori. Besides, many scholars regard SERVQUAL as unable to comprehensively capture all the essential service quality attributes since it only focuses on process and not on the outcome quality attributes (Buttle 1996).

On the other hand, Elliott and Healy (2001) had investigated the effects of the three key dimensions of service quality, namely student-centredness, campus climate, and instructional effectiveness, against several other constructs, including satisfaction. The dimension of student-centeredness was constituted by six attributes, defining a university's effort to convey to students that they are important. The campus climate comprises seventeen attributes, describing the extent to which a university provides and promotes a sense of campus pride and belongingness. Instructional effectiveness was made up of fourteen attributes that assessed a student's academic experience, including the curriculum, academic excellence, and the effectiveness of the faculty. The study identified student-centeredness as the most significant determinant of their satisfaction, followed by campus climate and instructional effectiveness.

Meanwhile, Mai (2005) compared the satisfaction of postgraduate business school students in the UK with US-based on a set of 19 service quality attributes. Surprisingly, he discovered that the quality and accessibility of IT facilities attribute does not play a significant role in determining student satisfaction. One may find this claim irreconcilable with the current trend of teaching and learning activities, which are hard to accomplish without the aid of IT facilities. At the same time, the list of attributes used in the analysis was concentrated mainly on academic service aspects. Some important non-academic service aspects (e.g., sports facilities and cafeteria), which may also have a meaningful association with student satisfaction, were ignored.

Zineldin *et al.* (2011) used another version of the questionnaire, developed based on five service quality dimensions, namely technical, functional, infrastructure, interaction, and atmosphere, to evaluate the satisfaction of the students studying in higher education institutes in Istanbul, Turkey. On the other hand, Ibrahim *et al.* (2014) developed a questionnaire comprising nine service dimensions that span over a total of 42 attributes to measure student satisfaction over Malaysian Skills Training Institutes in Klang Valley, Malaysia. The empirical results of the study indicated that the campus environment, management of institutes, and support services are the key dimensions that determine student satisfaction. Unexpectedly, physical facilities and training delivery were found to be insignificant.

Kara *et al.* (2016) explored the relationship between educational service quality and student satisfaction in public universities in Kenya. The study firstly factor-analysed the data collected from 1062 randomly selected undergraduate students, where ten dimensions of educational service quality were statistically extracted. The analysis was then furthered to understand the importance of each extracted dimension on student satisfaction. The results of the study suggested teaching facilities, availability of textbooks in the libraries, administrative services, reliability of university examinations, perceived learning gains, and quality of students' welfare services as the most crucial determinant of student satisfaction.

Recently, Santini *et al.* (2017) carried out a meta-analysis involving a set of 83 pertinent previous studies to examine the relationships between several constructs, including the service quality of an educational institution over student satisfaction. The study elicited seven dimensions of service quality, namely academic, administrative, facilities, professor, support service, teaching, and total service. The strength of relationships between these dimensions and student satisfaction was tested using Pearson correction. Support service was identified as the dimension that has the weakest effect on student satisfaction as compared to other dimensions. Table 1 further summarises the above-discussed studies based on the following three aspects: (1) whether the studies have evaluated the weightage held by the service attributes over the satisfaction construct, (2) the type of quantitative method(s) used to estimate the weightage and (3) type of educational institute involved.

On the whole, three important conclusions were drawn based on the review presented in this section:

a) Firstly, we learned that the choice of service attributes used to measure student satisfaction might vary from one type of institute to another. It is, therefore, crucial for us to collect information from various sources (e.g., past literature and experts) so that none of the significant service attributes are discounted before conducting the real analysis involving the IKBNs.
b) Secondly, considering the list of studies in Table 1 as the sample drawn from the actual existing literature, it can then be expected that the studies which specifically paid attention

to the satisfaction of TVET services are too limited. Note that only one-seventh of the works in Table 1 relate to TVET.

c) Thirdly, the review suggests that most of the existing studies were only preferred to use statistical techniques (e.g., regression) to measure the weightage held by each service attribute. However, such objective methods do not allow the concerned decision-makers to estimate the weightage based on their own experiences, knowledge, and perception of the problem (Yilmaz & Harmancioglu 2010). Therefore, there is a need to demonstrate the use of a proper subjective technique that considers the inputs from decision-makers while estimating the relative priorities of the TVET service dimensions against the student satisfaction construct.

Table 1: Comparison of the related studies

Source	Does the study analyse the weightage held by the service attributes?	The method used to compute the weightage	Type of educational institute involved
Hasan *et al.* (2009)	Yes	Correlation analysis	Non-TVET
Elliott & Healy (2001)	Yes	Regression analysis	Non-TVET
Mai (2005)	Yes	Regression analysis	Non-TVET
Zineldin *et al.* (2011)	Yes	Frequency analysis	Non-TVET
Ibrahim *et al.* (2014)	Yes	Regression analysis	TVET
Kara *et al.* (2016)	Yes	Regression analysis	Non-TVET
Santini *et al.* (2017)	Yes	Correlation analysis	Non-TVET

3. Methodology

On the whole, the implementation of this empirical investigation entails six crucial phases, as depicted in Figure 1. The detailed information on the procedures and purposes involved in each phase are provided in the following sections.

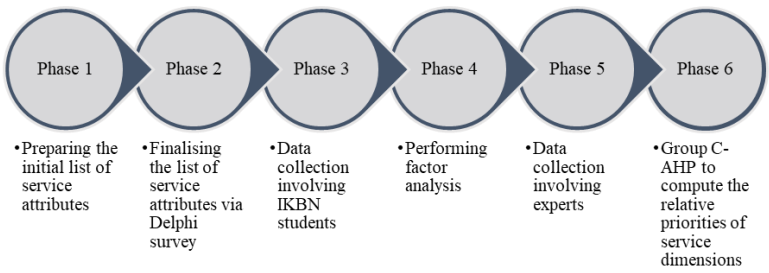

Figure 1: Phases of the research

3.1 *Phase 1: Preparing the initial list of service attributes*

The first phase was aimed at extracting an initial list of service attributes based on the review of past literature. On that note, a total of 47 service attributes were chosen and used as the primary foundation to commence the investigation. Most of these attributes were picked from the work conducted by Ibrahim *et al*. (2014), based on the following grounds: (1) The similarity of both studies in the context of the research setting, and (2) the inclusiveness of the suggested list of attributes which enclose almost all the essential academic and non-academic service attributes of an IKBN.

3.2 *Phase 2: Finalising the list of satisfaction attributes via the Delphi survey*

Delphi is a structured technique used to collect and review responses from a group of experts through a few rounds of the survey to reach a consensus over an indeterminate subject (Fink *et al.* 1984; Loo 2002). In the traditional Delphi technique, the survey is generally commenced by circulating a set of open-ended questions to the panel of experts (Hirschhorn 2018; Hsu & Sanford 2007). The individual responses from each expert are then summarised by the moderator and reported back to the experts during the next round of the survey (Filyushkina *et al.* 2018). At this stage, the experts are permitted to revise their initial responses by considering the responses provided by others. Still, the sources of responses, or to be exact the identity of the experts, are kept anonymous to minimise biased opinions (Ho *et al.* 2018). This process is repeated until the desired level of steadiness in the responses is achieved (Novakowski & Wellar 2008).

Unlike the traditional version, which begins with a set of open-ended style of questions, the modified version of the Delphi survey (Murry & Hammons 1995) is commenced with a set of carefully chosen items. This initial set of items is usually extracted by reviewing the past literature or interviewing a small group of experts (Chen *et al.* 2018). Undeniably, the modified version of the technique is gaining better acceptance among the researchers as it is found to help improve the response rate and provide a solid basis to kick off the survey, as compared to the traditional technique (Custer *et al.* 1999).

There exist a few multi-attribute decision making (MADM) studies (Chang 2015; Hsu & Lin 2013; Hsu & Yang 2000; Jusoh *et al*. 2018; Liao 2010; Perçin 2009; Reza Afshari 2015; Wang *et al.* 2016) which have used the modified Delphi as a tool to finalise the set of evaluation attributes before undertaking the analysis. In some of these studies, the experts were first requested to rate the validity of an initial set of attributes extracted from past literature based on a predetermined Likert scale. The final list of the attributes was then decided by considering some statistical measures of the ratings earned by each attribute after a few rounds of survey (de Meyrick 2003).

In the second phase of this research, a modified Delphi technique, as suggested by Wang *et al.* (2016), was utilised to finalise the list of satisfaction attributes obtained in the first phase. A panel of experts was formed before the commencement of the survey. Specifically, the panel was membered by seven long-serving IKBN management staff and three scholars who have ample expertise in TVET. The survey was structured into two evaluation rounds.

In the first round, the experts were requested to indicate the validity of each attribute (identified in Phase 1) on a student's satisfaction, based on a five-point Likert scale, where one and five represent not valid and very valid, respectively. At the same time, the experts were encouraged to comment if any crucial attributes were missing from the given list or highly redundant to each other. A new list was then formed using the following methods: (1) Eliminating the attributes with the average score below 3.5 or coefficient of variation (CV) exceeding 20%; (2) adding the suggested attributes; and (3) merging the highly overlapping attributes. In the second round, a re-evaluation was conducted, using a similar procedure, but based on the new list of attributes. Table 2 presents the list of 41 attributes that were finalised post the second round of Delphi evaluation, together with their average and CV values.

3.3 *Phase 3: Data collection involving IKBN students*

In Phase 3, a questionnaire was developed based on the attributes finalised in Phase 2. It was used as the instrument to collect the required data from a group of IKBN students before performing the factor analysis. The questionnaire was divided into two sections. Section 1 was

aimed at gathering some basic demographic information from the respondents, while in section 2, the respondents were asked to express their perception on the importance of each listed attribute based on the five-point Likert scale (1=unimportant and 5=important).

It is noteworthy that the content validity of the instrument can be deemed passable as it was developed based on the responses provided by the experts in Phase 2. In addition, as a cautionary measure, before executing the actual data collection process, the questionnaire was pre-tested to detect and amend any ambiguous terms or phrases therein. The pre-testing involved a group of 40 students from the Labuan Institute of Industrial Training. We considered these students as the best representation of the actual respondents due to the similarity in terms of the type of educational system they are engaged with, i.e., TVET institutes.

The cluster sampling approach was adopted to select the respondents for the actual survey. To be precise, each IKBN operating in Malaysia was treated as a different cluster. Since the travelling cost between each is too high, only the two nearest clusters (i.e., IKBNs), located in East Malaysia, were selected for the survey purpose. The management of each selected institute was so supportive that they managed to assemble their entire student population under one roof. This has led to an expeditious data collection process; only a day was spent at each institute. By the end of the survey, we have successfully collected responses from 636 students. According to the rule of 10 observations per attribute, this sample size was adequate for conducting a meaningful factor analysis (Nunnally 1978). As expected, a majority of the sample (~76%) was constituted by male students, indicating its resemblance to the actual population. It is a well-known fact that female participation in Malaysian TVET institutes is less dominant.

3.4 *Phase 4: Performing factor analysis*

In Phase 4, the data collected in Phase 3 were factor-analysed with the aid of statistical software. As a result, the large and complex set of satisfaction attributes was classified into nine independent dimensions. Surprisingly, every attribute loads perfectly to its priori, as assumed earlier, thus reducing the usual difficulty that occurs while interpreting the extracted dimensions. Each dimension was renamed, as shown in Table 3. The loading values in Table 3 indicate the presence of a strong association between each attribute and its respective underlying dimension.

Meanwhile, Cronbach's alpha measures are found to be greater than the recommended value of 0.70, implying that the internal consistency of each dimension was adequate. The average variance extracted (AVE) value of each dimension surpasses the threshold value of 0.50 (Fornell & Larcker 1981). In addition, the composite reliability of each dimension exceeds the suggested value of 0.70 (Hair *et al.* 2012). All in all, these numerical results strongly support the soundness of the dimensionality structure.

Table 2: The finalised list of satisfaction attributes

No.	Attribute	Abbre	Avg	CV (%)
1	The **landscaping** of the institute	LAN	3.8	16.6
2	The **cleanliness** of the institute	CLE	4.5	11.7
3	The **arrangement** of the buildings	ARR	3.7	18.2
4	The institute has a **conducive learning ambience**	CLA	4.2	18.8
5	The **condition** of the **classrooms** and **workshops**	CCW	4.5	15.7
6	**Sports** and **recreational** facilities	SRF	4.1	18.0
7	**Cafeteria** for the students	CAF	4.4	19.2
8	**Accommodation** for the students	ACC	4.7	10.3
9	*Access to the **internet**	INT	4.7	14.4
10	The training tools are consistent with the current **technology**	TEC	4.9	6.5
11	The provided training tools are **suitable** for the given training programs	SUI	4.5	11.7
12	The training tools are **sufficient**	SUF	4.7	10.3
13	Every trainee gets the **chance to use** the training tools	CTU	4.6	15.2
14	The training tools are **functioning well**	FWL	4.6	18.3
15	The instructors are **knowledgeable** in the subjects taught by them	KNO	4.7	14.4
16	The instructors have adequate **skills in teaching** their subjects	SIT	4.6	15.2
17	The instructors promote efficient **two-way communication** with their	TWC	4.4	19.2
18	The instructors are **punctual**	PUN	3.8	16.6
19	The instructors are usually available for **consultations**	CON	3.9	18.9
20	The training modules can **stimulate the students' interest** to learn	SSI	4.5	18.9
21	The **theories** learned are well connected to the **practical training**	TPT	4.6	11.2
22	The learning outcomes of the training modules are consistent with the actual **industrial** needs	IND	4.4	19.2
23	Proper **briefing** for the students before a training activity commences	BRI	3.9	18.9
24	Convenient **training schedules**	TRS	3.8	16.6
25	Efficient **training delivery methods**	TDM	4.1	7.7
26	Usage of **language** in delivering training	LAG	4.6	11.2
27	Attractive yet useful **learning materials** are provided during the training	LMA	4.4	19.2
28	Ideal **assessment** methods	ASM	4.7	10.3
29	**Counseling** services provided by the institute	CSL	3.6	19.4
30	Effective **induction program** for new students	IDP	3.8	16.6
31	**Student welfare** and **safety** measures at the institute	SWS	3.6	19.4
32	**Career guidance services** at the institute	CGS	4.1	13.8
33	The **attitude** of the support staff	ATT	4.2	18.8
34	The library has most of the **important books**	IBO	3.6	19.4
35	The library has an easy book **borrowing** and **returning procedure**	BRP	3.7	18.2
36	The librarians are **user-friendly**	UFR	4.0	11.8
37	The **library** has appropriate **operating hours**	LOH	3.6	14.3
38	The management is committed to fulfilling the students' needs within the **promised time**.	CPT	4.4	19.2
39	The institute appropriately manages the **student record**	SRC	4.3	15.7
40	Each **department** in the institute has ideal **operating hours**	DOH	3.8	16.6
41	The institute has an effective **feedback and response** mechanism	FRM	4.5	11.7

Note: (*) is the attribute added post of round one of the Delphi evaluation

Table 3: The result of factor analysis

Construct	Attribute	Loading	AVE	Composite reliability	Cronbach's alpha
Tangible amenities	CON	0.880	0.706	0.923	0.896
	SRF	0.883			
	CAF	0.840			
	ACC	0.780			
	INT	0.816			
Support service	CSL	0.829	0.767	0.943	0.924
	IDP	0.864			
	SWS	0.907			
	CGS	0.907			
	ATT	0.874			
Training modules	SSI	0.849	0.761	0.927	0.895
	TPT	0.881			
	IND	0.879			
	BRI	0.881			
Student-centered management	CPT	0.891	0.822	0.949	0.928
	SRC	0.898			
	DOH	0.928			
	FRM	0.910			
Institute's ambiance	LAN	0.839	0.750	0.923	0.889
	CLE	0.877			
	ARR	0.873			
	CLA	0.874			
Training tools	TEC	0.900	0.804	0.954	0.939
	SUI	0.911			
	SUF	0.910			
	CTU	0.881			
	FWL	0.880			
Training delivery	TRS	0.887	0.756	0.939	0.919
	TDM	0.898			
	LAG	0.861			
	LMA	0.885			
	ASM	0.860			
Library	IBO	0.887	0.791	0.938	0.914
	BRP	0.907			
	UFR	0.911			
	LOH	0.854			
Instructors	KNO	0.895	0.790	0.949	0.933
	SIT	0.909			
	TWC	0.898			
	PUN	0.867			
	CON	0.876			

3.5 *Phase 5: Data collection involving experts*

In Phase 5, the data required to undertake the Compromised Analytical Hierarchy Process (C-AHP) analysis were gathered. The same group of experts involved in Phase 2 was approached for this purpose. However, this time only five out of the ten experts agreed to participate in the survey due to the issue of unavailability. The questionnaire used at this phase required them to rate the importance of each service dimension over student satisfaction based on a nine-point Likert scale, where one and nine indicate the least important and most important, respectively.

3.6 *Phase 6: Using C-AHP to compute the relative priorities of the dimensions*

Ever since its introduction by Thomas L. Saaty in the 1970s (Saaty 1980), the application of AHP has been making inroads into many disciplines, such as education, healthcare, defence, business, environmental management, and engineering; thanks to its ability in quantifying the relative weight of every element that characterises a decision problem or goal. A review of the past literature reveals that AHP has successfully been employed as a tool to compute the priority ratings held by the decision elements before deciding the finest possible courses of action in achieving a goal.

One significant merit of AHP analysis is that it comes with a formula to measure the degree of consistency in the pairwise evaluations performed by the respondents. The consistency ratio (CR) of each pairwise comparison matrix in the analysis can be computed based on a specific formula, and those matrices with the CR exceeding the threshold of 0.1 can be considered highly inconsistent. The inconsistent matrices may then be excluded from the analysis, or a re-evaluation is performed if the respondents involved can be reached again (Ho 2008).

It is important to note that the AHP technique can even be applied to group decision-making environments that involve the participation of more than one expert or respondent. The group-based AHP methods can be classified into two categories, namely aggregation of individual judgments (AIJ) and aggregation of individual weights (AIW) (Forman & Peniwati, 1998). AIJ is normally performed using the geometric mean, whereas AIW is usually performed via the arithmetic mean (Angiz *et al.* 2012).

By performing factor analysis, the large set of service attributes were reduced into fewer independent dimensions. It is then suitable to weigh these dimensions using AHP as the technique fundamentally assumes that the elements under evaluation are independent of each other (Liu *et al.* 2014; Saaty 1995). Hence, in Phase 6, a slightly modified AHP called C-AHP was applied to quantify the relative priority of each independent dimension. In original AHP, the evaluators are normally required to pairwisely compare the relative importance of the elements involved, where the preferences are expressed by adhering to Saaty's 1/9–9 linear scale, as summarised in Table 4 (Ishizaka & Labib 2011). However, in this modified version of AHP, the type of data provided by the experts was different from the original AHP. To be precise, the experts had simply been requested to rate the individual importance of each dimension based on a nine-point Likert scale (refer to section 3.5) instead of making pairwise comparisons using the common Saaty's AHP scale. The ratings from each expert were then transformed into a complete pairwise matrix by adhering to a particular set of rules, as expressed in (1) (Nazri *et al.* 2016). It was proven that the CR-value of the pairwise comparison matrices, derived using (1), would always be lesser than the threshold value of 0.10. In other words, using this data acquisition method, one should not worry about the presence of undesirable inconsistencies in the experts' judgments. The general form of the pairwise matrix resulted from each expert is denoted by matrix $F(2)$. Table 5 illustrates better how the importance ratings from one of our experts were converted into a complete pairwise comparison matrix using (5).

Table 4: Saaty's AHP scale

Rating	Description
1	Two dimensions, *i* and *j* contribute equally
3	*i* is slightly favoured over *j*
5	*i* is strongly favoured over *j*
7	*i* is very strongly favoured over *j*
9	*i* is most favoured over *j*
2, 4, 6, 8	Used to compromise between two judgments
Reciprocal values ($\frac{1}{2}, \frac{1}{3}, \frac{1}{4}, \frac{1}{5}, \frac{1}{6}, \frac{1}{7}, \frac{1}{8}, \frac{1}{9}$)	If *i* has one of the above ratings when compared to *j*, then *j* has the reciprocal value when compared to *i*

Let $b = r_i - r_j$
If $b > 0$, then $a_{ij} = b + 1$
If $b = 0$, then $a_{ij} = 1$
If $b < 0$, then $a_{ij} = 1/(1 - b)$, where

r_i = importance rating specified by an expert on dimension f_i

r_j = importance rating specified by an expert on dimension f_j (1)

a_{ij} = relative importance of f_i as compared to f_j

i = 1,2,…, 9
j = 1,2,…, 9

$$F = [f_{\mathrm{ij}}] = \begin{bmatrix} 1 & f_{12} & \cdots & f_{19} \\ f_{21} & 1 & \cdots & f_{29} \\ \vdots & \vdots & \ddots & \vdots \\ f_{91} & f_{92} & \cdots & 1 \end{bmatrix}, \text{ where } f_{ji} = \frac{1}{f_{ij}} \tag{2}$$

The pairwise comparison matrices resulted from each expert were then aggregated into a single matrix using the geometric mean formula (3) (Ramanathan 1994; Saaty 1989), where $f_{ij}^1, f_{ij}^2, \ldots, f_{ij}^k$ in (3) represent the relative importance of dimension i over j from k number of experts (in this case, k =5), and $\bar{f}_{ij}$ denotes the aggregated relative importance. Note that this formula was applied repeatedly to compute every entry in the aggregated pairwise matrix.

$$\bar{f}_{ij} = (f_{ij}^1 \times f_{ij}^2 \times \ldots \times f_{ij}^k)^{\frac{1}{k}} \tag{3}$$

Subsequently, the priority of each dimension was calculated using the usual eigenvalue method (Dong *et al*. 2010). The computational process involved in the eigenvalue method can be further explained as follows: First, the values in each column of the pairwise comparison matrix were summed up. Second, each value was divided by its column total to derive the normalised pairwise comparison matrix. Third, the average of the values in each row of the normalised pairwise comparison matrix was computed. These averages represent the priorities of the dimensions. Table 6 depicts the aggregated pairwise matrix obtained using (3), and Table

7 presents the relative priority of each dimension calculated using the eigenvalue method.

Table 5: Conversion of importance ratings into AHP pairwise comparison matrix

	Importance rating	Pairwise matrix	f_1	f_2	f_3	f_4	f_5	f_6	f_7	f_8	f_9
Institute's atmosphere (f_1)	5	f_1	1	1/5	1/4	1/3	1/2	1/3	1/2	3	4
Tangible amenities (f_2)	9	f_2	5	1	2	3	4	3	4	7	2
Training tools (f_3)	8	f_3	4	1/2	1	2	3	2	3	6	1
Instructors (f_4)	7	f_4	3	1/3	1/2	1	2	1	2	5	1/2
Training modules (f_5)	6	f_5	2	1/4	1/3	1/2	1	1/2	1	4	1/3
Training delivery (f_6)	7	f_6	3	1/3	1/2	1	2	1	2	5	1/2
Support service (f_7)	6	f_7	2	1/4	1/3	1/2	1	1/2	1	1/4	1/3
Library (f_8)	3	f_8	1/3	1/7	1/6	1/5	1/4	1/5	4	1	1/6
Student-centered management (f_9)	8	f_9	1/4	1/2	1	2	3	2	3	6	1

Table 6: The aggregated pairwise comparison matrix

	f_1	f_2	f_3	f_4	f_5	f_6	f_7	f_8	f_9
f_1	1.000	0.506	0.461	0.530	0.803	0.488	1.149	1.246	0.922
f_2	1.974	1.000	0.922	1.149	1.516	1.000	2.169	1.947	1.000
f_3	2.169	1.084	1.000	1.320	1.888	1.149	2.268	2.352	1.149
f_4	1.888	0.871	0.758	1.000	1.644	0.871	1.974	2.141	0.871
f_5	1.246	0.660	0.530	0.608	1.000	0.574	1.320	1.516	0.608
f_6	2.048	1.000	0.871	1.149	1.741	1.000	2.091	2.268	1.000
f_7	0.871	0.461	0.441	0.506	0.758	0.478	1.000	0.608	0.461
f_8	0.803	0.514	0.425	0.467	0.660	0.441	1.644	1.000	0.461
f_9	0.758	1.000	0.871	1.149	1.644	1.000	2.169	2.169	1.000

Table 7: The normalised matrix with computed priority rating and ranking of each dimension

	f_1	f_2	f_3	f_4	f_5	f_6	f_7	f_8	f_9	Priority rating	Ranking
f_1	0.078	0.071	0.073	0.067	0.069	0.070	0.073	0.082	0.123	0.079	7
f_2	0.155	0.141	0.147	0.146	0.130	0.143	0.137	0.128	0.134	0.140	3
f_3	0.170	0.153	0.159	0.168	0.162	0.164	0.144	0.154	0.154	0.159	1
f_4	0.148	0.123	0.121	0.127	0.141	0.124	0.125	0.140	0.117	0.130	5
f_5	0.098	0.093	0.084	0.077	0.086	0.082	0.084	0.099	0.081	0.087	6
f_6	0.161	0.141	0.139	0.146	0.149	0.143	0.132	0.149	0.134	0.144	2
f_7	0.068	0.065	0.070	0.064	0.065	0.068	0.063	0.040	0.062	0.063	9
f_8	0.063	0.072	0.068	0.059	0.057	0.063	0.104	0.066	0.062	0.068	8
f_9	0.059	0.141	0.139	0.146	0.141	0.143	0.137	0.142	0.134	0.131	4

3. Discussion

In this section, we mainly discuss the empirical results of C-AHP to recommend the ideal strategies that could be used to improve student satisfaction in IKBNs. Based on the relative priorities computed using the group based C-AHP (refer to Table 7), the influence of the nine independent dimensions extracted via the factor analysis can actually be ordered as follows: Training tools (0.159) ≻ training delivery (0.144) ≻ tangible amenities (0.140) ≻ student-centred management (0.131) ≻ training instructors (0.130) ≻ training modules (0.087) ≻ institute atmosphere (0.079) ≻ library (0.068) ≻ support service (0.063).

It is very logical to see training tools as the most important dimension, as the absence of a proper supply of workshop tools in a TVET institute like IKBN may limit the acquisition of technical skills through hands-on activities. In other words, improper provision of workshop tools may cause the teaching-learning in IKBNs to gradually become more theoretical, thus, violating the fundamental principle of TVET education (Audu *et al.* 2013). In fact, there exist a few scholarly works which admitted training tools as the main determination of student satisfaction in TVET institutes (Anindo *et al.* 2016).

The second most important dimension is training delivery. According to our analysis, student satisfaction on training delivery could significantly be improved by (1) preparing convenient training schedules, (2) implementing various innovative yet efficient training delivery methods, (3) minimising the usage of sophisticated technical terms during the training, (4) furnishing the students with attractive yet informative learning resources, and (5) designing appropriate assessments to test the students' theoretical understanding and practical skills.

About 14% of student satisfaction is characterised by the third most important dimension, namely tangible amenities. This finding contradicts the result reported by Douglas *et al.* (2006), who identified physical facilities as the least essential contributor to student satisfaction. Nevertheless, recently, in conformity to our finding, Napitupulu *et al*. (2018) empirically proven the presence of a strong positive relationship between physical amenities and student satisfaction. Our result further hints that IKBNs could improve their amenities by offering the students with excellent classroom and workshop settings, sports and recreational facilities, cafeteria, accommodation, and internet facilities.

The fourth important dimension, student-centred management, refers to any initiatives from the management that shows their concern or empathy in fulfilling the needs of the students. DeShields Jr *et al.* (2005), based on the findings of their study, urged the educational institutes to apply customer-oriented principles that are used in profit-making organisations in treating their students' needs and demands. They further claimed that such an attempt would benefit both the institutes and students, where students particularly may enjoy a positive and satisfying campus learning and living experience.

The training instructor is ranked as the fifth important dimension of student satisfaction with the priority rating of 0.3010. The prominence of this dimension is also admitted by Xiao and Wilkins (2015). They had empirically proven the presence of a positive relationship between the instructor's commitment and student satisfaction in the Chinese higher educational setting. Meanwhile, based on our evaluation, coupled with the results from other pertinent previous studies (Sunindijo 2016), it can be summarised that the student satisfaction on instructors can be increased if they: (1) continuously upgrade their knowledge on the subject matter, (2) equip themselves with proper teaching skills, (3) encourage active discussions with the students during the training sessions, (4) be punctual when conducting the training, and (5) make themselves available for consultations.

All things considered, on a rational basis, IKBNs should pay greater attention to enhance their performance with respect to these five dimensions if they intend to witness a tremendous

increase in their students' satisfaction. Refining the performance on the remaining, lowermost four dimensions may increase student satisfaction, but not to a considerable extent.

Incidentally, it is indeed surprising to discover support services as the least important dimension since such a finding contradicts the claims made in other similar studies. For instance, in a recent study, Azam (2018) concluded administrative services as one crucial predictor of student satisfaction in Saudi Arabian higher education institutions; probably, the students in TVET intuitions care more about the training-related services than the administrative services.

4. Conclusion

The main purpose of this research was to uncover the actual relative priorities held by the service dimensions over IKBN student satisfaction. The research was commenced by eliciting an initial list of service attributes from the pertinent past literature. This list was then further validated by a group of experts through a two-round modified Delphi survey. As a result, 41 IKBN service attributes were finalised as a base to perform the following empirical analysis. By factor analysing the responses collected from a sample of 636 IKBN students, these 41 attributes were then structured into nine independent dimensions. Subsequently, the group-based C-AHP was applied to measure the relative priority ratings of the extracted dimensions. The C-AHP results suggest that the management of IKBNs should utilise their resources (e.g., available funds or workforce) to enhance the following five most influential service dimensions: (1) Training tools, (2) training delivery, (3) tangible amenities, (4) student-centred management, and (5) training instructors. In doing so, the management may witness a meaningful positive change in their students' satisfaction:

The merit of this research is three-fold. Firstly, this research has contributed a fresh hybrid MADM procedure from the management science perspective, combining three different decision techniques, namely Delphi, factor analysis, and group-based C-AHP technique. Secondly, in the context of TVET literature, apart from presenting a little upgraded set of TVET service attributes, this research can also be regarded as one of the very few attempts which have examined the relative weightage of the service dimensions using the MADM approach. Lastly, from the practical viewpoint, the results discussed herein can be utilised by the key members of IKBNs to rationally improve their services to achieve a meaningful increase in their students' satisfaction.

Similar to every research, this research has its limitations, which can potentially be addressed in the future. The first limitation is concerning the existing interrelationships between the service attributes. Although factor analysis has helped to reduce the large set of service attributes into fewer independent dimensions, the attributes within each dimension are still interrelated to each other. However, this research did not attempt to analyse further the existing interrelationships between the attributes. Future research may, therefore, extend this work to systematically uncover these interrelationships, perhaps by using an interaction modelling technique like DEMATEL or ISM. Discovering such interrelationships may help to furnish better hints to the decision-makers for developing more precise improvement strategies.

The second limitation is related to respondents who were involved in providing the data for C-AHP analysis. In this research, the data for C-AHP analysis were simply collected from a group of experts. However, we suggest that future research should attempt to collect such data not only from the experts in the field but also from the IKBN students themselves; thus, the bias in the final results could be minimalised.

Thirdly, this research was only interested in evaluating student satisfaction with respect to the service factor. Hence, future research is expected to take into account all the possible factors

that can influence the satisfaction construct (e.g. personal and price factor) so that the improvement strategies can be decided from a broader perspective.

Fourthly, the research did not attempt to compare further the results produced by the proposed integrated MADM procedure with any other similar procedures. Although the results were compared with the findings reported in past literature, an additional comparison analysis with similar procedures could have helped reveal the proposed procedure's actual advantages and disadvantages. Thus, further analysis is recommended in the future to carry out such a comparison.

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