Measurement and Measurement Scales

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Measurement and Measurement Scales

Serene Dalati

1 Introduction

In business studies measurement is crucial and required in different situations requesting research. In behavioural management, measurement is crucial in examining employee attitudes including job satisfaction, organisational commitment, organisational trust and motivation at work. In marketing research measurement is also crucial in consumer behaviour and customer satisfaction surveys. Attitudes related to perceived service quality also applies measurement scales. In production management it is also crucial to define tools for measuring quality assurance. The purpose of this chapter is to explore the concept of measurement with a focus on business research. The nature of measurement, types of measurement levels and different types of measurement scales are under examination in this chapter. The scope of this chapter is within business research studies, therefore examples and illustration will be provided from research in business fields. The target audience is focused towards students and researchers of business studies with an orientation towards behavioural management and marketing research. It provides a reliable illustration for undergraduate students of business research.

2 Measurement Defined

Measurement in business research is extensively examined. What is measurement? Why measurement? What is being measured? What is the relation between concepts and constructs, and how are they related to the measurement of objects of study? All these are questions that this chapter aims to answer in the following sections. Examining measurement in studies is comprised of assigning numbers to empirical events, objects or phenomenon, which should be related to specific rules and measurement

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design [1]. The measurement process starts with selecting a subject of analysis or an observable event, then investigating guidelines which include assigning numbers or codes to indicate certain features about subject of analysis. The mapping rules should be applied to each observed phenomenon.

3   Types of Variables and Data

It is argued that concepts and constructs are used at a theoretical level, whereas variables are applied at an empirical level [2]. The study of measurement will, by definition, lead to the exploration of variables and types of data. A variable is a characteristic or attribute that can assume different values. Data, on the other hand are the values that the variable can assume [3]. Variables can be classified as qualitative or quantitative. Whereas qualitative variables can be indicated as distinct according to some characteristic or attribute, quantitative data are numerical and can be numbered. For example, gender is considered as qualitative variable, where the subject of analysis is classified as either male or female. This is an example of categorical data. Quantitative variables can be classified into two categories: discrete and continuous. Discrete variables can assume values that can be counted. For instance, the number of phone calls a customer service representative answers each day is an example of discrete variable; the number of students in a classroom is also another example of discrete variable. Contentious variables, by comparison, can assume an infinite number of values between any two specific values. They include fractions and decimals. For example, age, income, height and weight are quantitative variables.
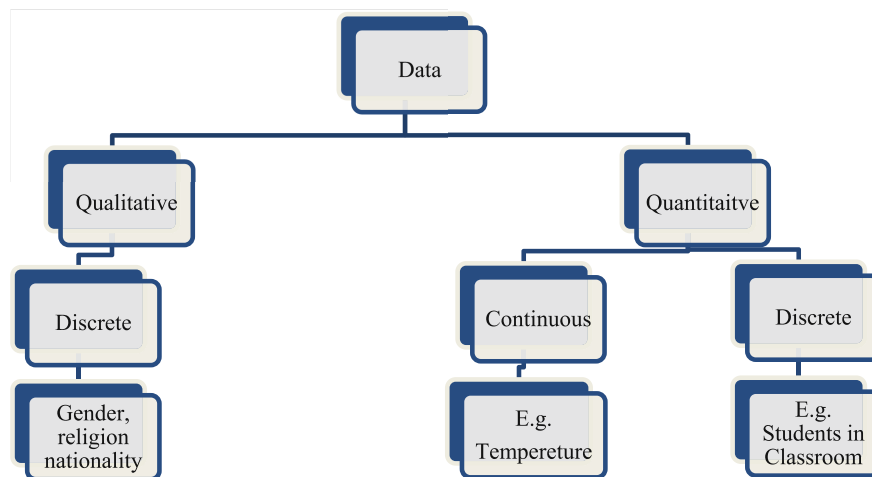

Fig. 1   Difference between quantitative and qualitative data

In Fig. 1, the mentioned variables are also examples of continuous variables. Figure 1 illustrates the classification and difference between Quantitative and Qualitative variables and types of data.

4 Concepts and Constructs

In social research, concepts are the building blocks of theory and they represent the points around in which social research is conducted [4]. The definition of concepts in Business research is not far from the above mentioned approach. A concept in business research is commonly recognised range of connotations or implication related to specific procedures, or phenomenon related to Business studies [1]. For example, a can of coke is an objective concept with characteristic features, which are obviously observable, like weight, height, colour, brand name and label. An abstract concept could include intangible attitudes and feelings (e.g. love). An abstract concept like love requires illustration and exemplification of the specified examples that would better illustrate the meaning of love. An abstract idea like love or personality or vision in organisations is difficult to perceive or visualize and therefore requires further illustration; such abstract concepts are referred to constructs [1, 5]. A construct is defined as a reflection or scientific abstract notion scientifically developed for building theoretical framework. Constructs are developed by joining more basic and concrete concepts, specifically if the phenomenon under investigation could not be directly observed. For example, servant leadership as a constructs is comprised of a set of concepts that would contribute to the building a theory of servant leadership. In a research study on servant leadership across cultures, the construct of servant leadership is developed by identifying core characteristics including egalitarianism, moral integrity, empowering and developing others empathy, humility and creating value for community [6].

4.1 Operational Definitions

An operational definition is a characterisation stated in terms of specific criteria for measurement. Such terms must refer to empirical standards. The subject of definition could be tangible or physical (e.g. a new car model) or intangible (e.g. personality). Operational definitions must identify the characteristics and how they are measured. For example developing an operational definition of charismatic leadership in organisations would require careful design on the components that comprise this variable.

Fig. 2 Measurement levels
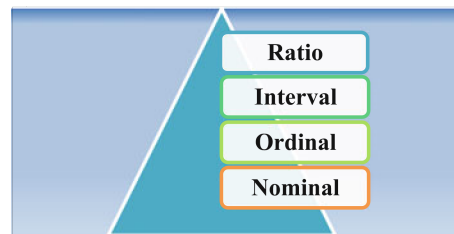
5   Measurement Levels

Measurement can be characterised by four levels, which are comprised of classification, order, distance and zero origin [1, 5, 7]. The combination of the mentioned measurement levels in Fig. 2 produces four measurement scales namely nominal, ordinal, interval and ratio scales. The nominal scale is the simplest level where classification only, but no order, distance or absolute zero level could be applied (e.g. gender). The second would be ordinal level where both classification and order are applied (ranking a quality of service from excellent to bad). Third level is interval scale where classification, order and distance but no absolute zero are applied (e.g. temperature). The highest level of measurement is ratio level where all characteristics of classification, order, distance and zero origin are applied (e.g. income, weight, and height).

5.1   Nominal Level

Nominal scale is the simplest kind of level as the numbers and the letters assigned to objects serve as labels for identification or classification [5]. According to Cooper and Schindler (2014), nominal data involves the collection of information on a variable that can be grouped into two or more categories that are mutually exclusive and collectively exhaustive [1]. Nominal data is widely used in surveys when the data is by major subgroups of the population. Classifications of nominal data are such as respondents' marital status, gender, nationality and other related factors. Figure 3 illustrates an example of nominal level. The use of numerical symbols to identify categories at a nominal scale level, is recognised as tags with no quantitative implication. For example, no. 10 for Wayne Rooney, Manchester United player, is not an indication a chronological order or a certain level of skill. This example emphasis is on specifying certain identification of role playing an offensive forward role in the game of football.

Fig. 3 Nominal level

U.K.	U.S.	E.U.	Japan	CM	IN
2	3	34.5	210	21.0	8 1/4
3	4	35.5	220	22.0	8 5/8
4	5	37	230	22.9	9
5	6	38	240	24	9 1/2
6	7	39.5	250	25	9 7/8
7	8	40.5	260	26	10 1/4
8	9	42	270	27	10 5/8
9	10	43	280	28	11
10	11	44.5	290	29	11 3/8
11	12	45.5	300	30	11 3/4
12	13	47	310	31	12 1/4
13	14	48.5	320	32	12 5/8
14	15	49.5	330	33	13
15	16	50.5	335	33.5	13 1/4

Fig. 4 Ordinal level

5.2   Ordinal Level

An ordinal scale arranges and classifies objects according to their degree in an ordered relationship [5, 8]. A typical ordinal scale in business research asks respondents to rate a certain brand for example as excellent, good, fair and poor. The use of an ordinal scale implies a statement of greater than or less than without stating a fixed distance of how much greater or less. For example in Fig. 4, shoes are assigned numbers to represent size, where larger number indicate bigger size [2]. In the UK, for example shoes size could range from 2 to 15. However, one could not argue that that size 8 is as twice as big as size 4.

Fig. 5 Interval level

5.3 Interval Level

Interval scale comprises principle of fixed distance between 1 and 2 and 2 and 3, which should be equal distance [7, 8]. For example, the calendar time is an interval scale. The time between 12:00 pm and 01:00 pm is the same and equal to the time between 03:00 pm and 04:00 pm. However, one cannot say that 04:00 pm is twice late as 02:00 pm because the zero in this example has relative not absolute origin. A classic example of an interval scale is the Fahrenheit temperature scale, show here in Fig. 5 [5]. However if the temperature is 80° it cannot be said that it is as twice as hot as 40°. Many attitude scales are considered an interval such as intelligence scores, semantic differential scales and other multi-graphical scales. When a scale is interval, the arithmetic mean is used as the measure of the central tendency [1, 7].

5.4 Ratio Level

Ratio scale indicates the highest levels of measurement as it contains all characteristics of classification, order, fixed distance and zero origin. Measures including weight, height, distance, population count and other measures. At a ratio measurement level, zero has absolute meaning and indicates the absence of concrete quantity being examined. Money is an example of ratio level of measurement. Figure 6 illustrates an example of a man who has zero money in his pocket. The zero in this example indicates the absence of money [7, 8].

Fig. 6 Ratio level

6   What Is Being Measured?

It is argued that variables examined at research may be defined or referred to as objects or properties [1]. Objects may be defined as tangible experiences and phenomenon as laundry detergent brand, a vehicle or a trainer; or intangible phenomenon as genes, attitudes or leadership behaviours (see Fig. 7).

Properties on the other hand may be defined as the characteristics or attributes of the object. A human being physical properties may include weight, height, and other physical characteristics. Psychological properties on the other hand may include personality, and perceived phenomenon. Social properties may contain social ranking (see Fig. 8).

**Fig. 7** The measurement of objects
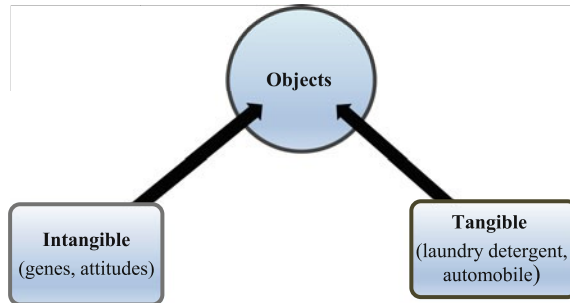
Fig. 8 Measurement of
properties
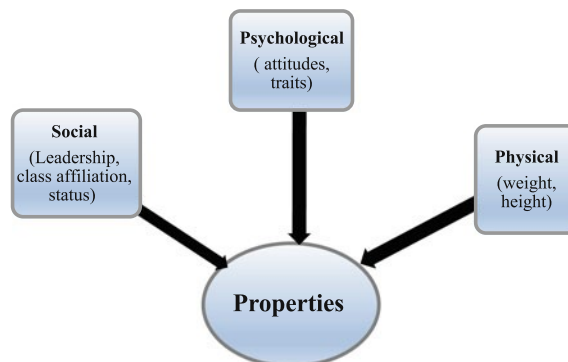
7   The Measurement of Attitudes

The focus of the chapter is **Measurement** and Measurement scales in Business
research. This chapter will focus on measurement of attitudes in behavioural manage-
ment and business research. The study of attitudes in the workplace, in organisational
behaviour and consumer behaviours is frequent and essential in behavioural manage-
ment research. A good investigation of the nature of attitudes could be realised by a
comparison between emotions and attitudes. Emotions are physiological, behavioural
and psychological episodes experienced towards an object, person or event that cre-
ates a state of readiness [9]. Emotions can be directed towards tangible or intangible
events or phenomena. Human beings experience joy, fear, anger, shame, love and
other emotional episodes towards other human beings or products, ideas or events
[9]. Compared with emotions, attitudes represent a cluster of beliefs, assessed feel-
ings and behavioural intentions meant for a person, phenomenon or object (this is
usually known as attitude object). It is argued that attitudes are judgement, whereas
feelings are experiences. Attitudes are developed through a combination of different
forces including feeling, thinking, personal experiences and values which will lead to
shaping behavioural intention and behaviours [10]. An attitude is learned tendency to
respond towards one self, or others or events in a favourable or unfavourable manner
[1].

   This is examined in terms of three cognitive components including beliefs, feelings
and behavioural intentions. Let us consider the example of John, a bank employee
who works for HSBC Bank. John believes that working for such a winning organ-
isation is very good and that there are good opportunities for growth in the future
and career advancement. This is an example of cognitive based attitude. John has an
extremely positive evaluation for working at HSBC. He loves being there and holds
positive feelings about the management and other people who also work there. This
is an example of an affectively based attitude. John also expects to work for years
to achieves promotion and career improvement. This is an example of a behavioural
based attitude. Feelings, beliefs and behavioural intentions are three components of
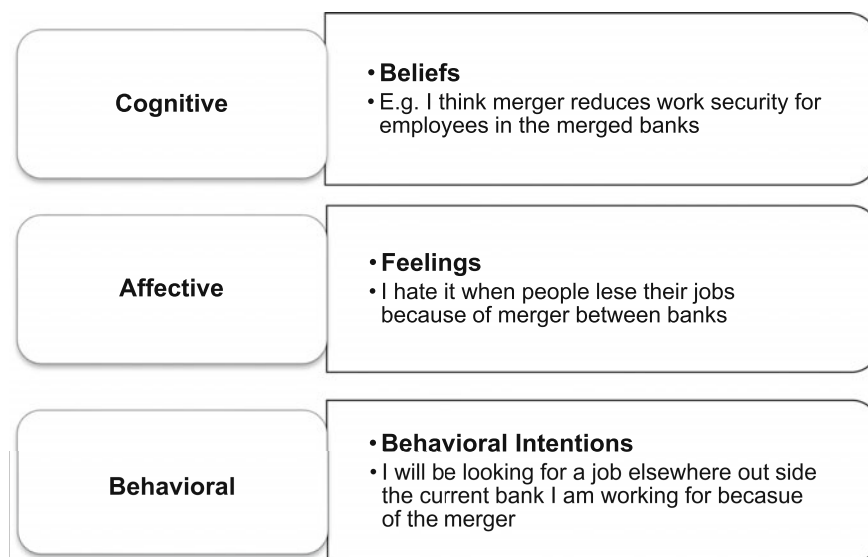
Fig. 9 Measurement of attitudes

attitudes. Figure 9 illustrates three components of attitude. Organisational behaviour studies argues that behavioural intentions are linked to behaviour [7, 9].

The study and measurement of attitudes are significant to behavioural studies in management. The research studies of motivation, job satisfaction, and perceived leadership in organisations are types of research, which require measurement scales related to the above mentioned perceived attitudes. A very frequent example of a measurement scale applied widely in behavioural studies is the Likert scale. Further examination will be provided in scaling response types of the above mentioned scale.

8   Selecting a Measurement Scale

Several factors are to be considered before selecting a measurement scale. These factors include:

8.1   Research Objectives

Research objectives is a crucial factor that needs to be considered before selecting a measurement scale. Considering, for example, the case study of a research, which have the objectives of examining Syrian Consumption patterns before and after 2011,

the year where Syria's political and economic crisis started. The researcher would start with the research question about examining the change in consumption patterns of Syrian consumers before and after 2011. Doing so, the researcher main priority is to develop a methodology where consumption patterns could be measured. This examination will lead to the investigation of consumer needs and desires. Three levels of consumption could identified which includes necessities, substitutes and complementary types of products and services [11]. Consequently, the research should keep in mind the objectives of the research study prior to making decision of the measurement scale, which will be applied in the research study.

8.2 Response Type

Response types can be mainly classified into three types of measurements scales: rating, ranking and categorization [1, 3, 7, 8]. Rating scale is applied when respondents indicates an object without making a direct comparison to another object. A respondent would be requested to code their degree of agreement and disagreement about a certain point on a five-point rating scale. Ranking is used when participants make comparison among two or more objects. A respondent would be asked to compare and select between two or more vehicles. For example, one that is better in qualities or one that that has a more attractive style. Categorization is used as respondents are grouped or categorised according to their gender or ethnic background as the research is directed into certain category.

8.3 Data Properties

The researcher, in the process of identifying the measurement scale in the study, must identify data properties. Data properties include nominal, ordinal, interval and ratio levels. For example, if the research study requires only a simple category scale (yes/no question) then nominal level is applied.

8.4 Number of Dimensions

The number of dimensions could be unidimensional or multidimensional. A unidimensional scale examines the measurement of one attribute of the subject of analysis. A multi-dimensional scale examines the subject of analysis employing several dimensions.

8.5 Balanced or Unbalanced Scale

A balanced measurement scale has an equal number of points above and below the midpoint. For example, the Likert scale (which is one type of the rating scale) is balanced with an equal number of agreement or disagreement response choices. An unbalanced measurement scale has an unequal number of favourable or unfavourable response choices.

8.6 Forced or Unforced Choices

An unforced measurement scale is designed to provide the respondent with the possibility to express an opinion. A forced measurement scale requires that respondents select one of the responses. Responses including "I do not know", "No Opinion", "uncertain" or "neutral" are examples of an unforced measurement scale response choices.

8.7 Number of Points in a Measurement Scale

A measurement scale in a research study should clearly identify the number of points needed to suit the needs of the study.

9 Rating Scales

Rating scales are used to judge properties or objects of study without reference to other similar objects. Different sorts of rating scales contain simple category, multiple choice scales, Likert Scale, Semantic Differential, Numerical, multiple rating, constant sum, staple and graphic rating [1, 8]. Figure 10 illustrates different types of rating scales.

9.1 Likert Scale

Likert scale consists of statements that express either a positive or a negative attitude towards the objects of study [2]. The respondent is asked to agree or disagree with each question. Each response is given a numerical score to reflect its degree of attitudinal favourableness. The score will be calculated totally to measure the respondent attitude. In this research study respondents are asked to code their agreement

Simple Category Scale **Level** : Nominal	Do you have experience in collaboration with business?
	Yes □ No □

Multiple choice single response scale **Level** :Nominal	Which magazine do you read? □ **Financial Times** □ **The Economist** □ **Financial Post** □ **The Financial Express** □ **Other (Specify --------------)**

Multiple choice multiple response scale **Level** : Nominal	In general, what are the evaluation criteria of the academic staff at your faculty? Please check all options that apply. □ **Teaching quality.** □ **Research activity; publications.** □**Research activity; projects with enterprises.** □**Writing textbooks.** □**Supervising Master and PhD students.** □**Other, please specify:**

Fixed Sum scale **Level:** Ratio	Taking into consideration the product provided and considering perceived value gained from the product, what is the relative importance of the following factors to you? (dividing 100 between)
	Price	
	Quality	
	Sum	100

Fig. 10 Rating scales

degree of how frequently the person, they perceive as a leader, is capable of engaging behaviours presented in the questions. The respondent chooses one of the five levels of agreement. The numbers indicate the value to be assigned to each answer with 1 which is strongly agree and 5 which is strongly disagree (see Fig. 11).

Likert scale **Level:** Interval	The working conditions of researchers in your institution /faculty are satisfactory **Scale:** **1-Strongly Disagree** **2-Disagree Agree** **3- Not sure** **4-Agree** **5-Strongly agree**

Fig. 11 Likert scale

SD scale for candidate analysis for criteria of selection										
The Candidate for the current position is										
Friendly	**7**								**1**	**Aggressive**
Frail	**1**								**7**	**Robust**
Proactive	**7**								**1**	**Reactive**
Extrovert	**7**								**1**	**Introvert**
Lazy	**1**								**7**	**Energetic**
Honest	**7**								**1**	**Deceitful**
Professional	**1**								**7**	**Unprofessional**
Emotional	**7**								**1**	**Emotionless**
Communicative	**1**								**7**	**Incommunicative**

Fig. 12 Semantic differential scale

9.2 Semantic Differential Scale

The semantic differential (SD) scale measures the psychological meanings of an attitude object using bipolar adjectives. The method comprises with a set of bipolar rating scales with usually a 7 points where respondents rate the concepts of study on each item scale. Example of a semantic differential scale include marketing research studies. For example marketing research study could explore customer perception of the quality of customer service in the target retail stores under investigation. In some studies, the SD scale is applied for candidate evaluation in a specific business sector. Required attributes and characteristics that the candidates should possess to be successful in performing their work are listed in Fig. 12.

9.3 Numerical and Multiple Rating Scales

The numerical scale is employed to measure equal intervals. The adjectives employed in scale function as labels for extreme values. It provides numerical score of the responses in the scale. Both sematic deferential and numerical scales employ bipolar adjectives. However, the numerical scale provides numerical scores, whereas semantic deferential provides semantic space as a means of identifying response. There is a similarity between multiple rating scale and numerical scale as both are employed to measure equal intervals. The scales differ in the layout (see Fig. 13).

Numerical scale **Level:** Interval	Please evaluate the impact of each of the following factors on the development of your scientific research activity. Please identify using the following scale.					
	Absolutely Influential	**5**	**4**	**3**	**2**	**1**	**Absolutely not Influential**
	1-Availability of knowledge about the existence of open access databases					
	2-Availability of information about international conferences					
	3-Availability of university/faculty scientific journals abroad					
	4-Availability of information about scientific projects					
	5- Availability of statistical databases					
	6- Collaboration with international researchers					

Multiple rating list scale Level: Ordinal or Interval	**Least Preferred Co-worker (LPC) Measure**
	Instructions: Think of the person with whom you can work least well. He or she may be someone you work with now or someone you knew in the past. That person does not have to be the person you like the least but should be the person with whom you had the most difficulty in getting a job done. Describe this person as he or she appears to you by circling the appropriate number for each of the following items.
	Pleasant 8 7 6 5 4 3 2 1 **Unpleasant** **Friendly** 8 7 6 5 4 3 2 1 **Unfriendly** **Rejecting** 1 2 3 4 5 6 7 8 **Accepting** **Tense** 1 2 3 4 5 6 7 8 **Relaxed** **Distant** 1 2 3 4 5 6 7 8 **Close** **Cold** 1 2 3 4 5 6 7 8 **Warm** **Supportive** 8 7 6 5 4 3 2 1 **Hostile** **Boring** 1 2 3 4 5 6 7 8 **Interesting** **Quarrelsome** 1 2 3 4 5 6 7 8 **Harmonious** **Gloomy** 1 2 3 4 5 6 7 8 **Cheerful**

Fig. 13 Numerical and multiple rating scales

9.4 Staple Scale

The staple scale was developed in the 1950s. It is designed to measure the direction and intensity of an attitude. The scale has similarities with the semantic deferential scale. The staple scale positions a single adjective or a statement for analysis at the centre of an even number of numerical values (usually from +5 to −5). The scale measures how close or distant from the adjective a given stimulus is perceived to be (see Fig. 14).

9.5 Graphic Rating Scale

Graphic rating scale is designed to enable respondents to distinguish fine differences. When applying the graphic rating scale, respondents are asked to indicate their answer

Please evaluate the performance of XY organisation according to the following factors and rating criteria where +5 indicate the most accurate and -5 the least accurate description of the organisation		
+5	+5	+5
+4	+4	+4
+3	+3	+3
+2	+2	+2
+1	+1	+1
Product Leadership	**Customer Service**	**Operational Excellence**
-1	-1	-1
-2	-2	-2
-3	-3	-3
-4	-4	-4
-5	-5	-5

Fig. 14   Staple scale

How satisfied are you with quality the service in your institution/ faculty?
Very Much   Not at all
☺ ---☹

Fig. 15   Graphic rating scale

at the scale. The participant response will be measured by millimetres and considered as interval data. Figure 15 illustrates the graphic rating scale.

10   Ranking Scale

The ranking scale is designed to enable respondents to directly compare two or more objects and make evaluation about them. In the case of the ranking scale, the respondent is instructed to indicate the first or ultimate favoured choice. The ranking scale is comprised of three types. They are illustrated in the following sections.

10.1   Paired Comparison Scale

In certain research studies comparison between more than two subjects of analysis is required. In this case there is a need for the application of paired comparison scale. The paired comparison scale enable respondents to compare preference between more than two objects. A paired comparison scale formula is designed to provide comparison between each pairs. The number of response required in a paired comparison is determined through the following formula: $[(n) (n-1)/2]$ where n is the

Considering every couple of the carbonated drink brands, indicate your greater preference of the pair	
-----Pepsi -----Coke	----- Coke ----- Dr. Pepper
-----Pepsi -----Dr. Pepper	----- Coke ----- 7Up
-----Pepsi ----- 7 Up	----- Dr. Pepper ----- 7 Up

Fig. 16 Paired comparison scale

number of objects under examination. For example, according to the above mentioned formula in a marketing research study, with the objective of comparing preferences of four carbonated drinks brands, the number of paired comparisons would be: [(4)(3)/2 = 6]. Figure 16 provides illustration of the paired comparison scale.

10.2   Forced Ranking Scale

The forced ranking scale provides respondents with the ability to rank their preferences. The advantages of this scale include simplicity compared to paired comparison scale, where respondents relatively easily respond preferences choices of the objects of study. However, when the number of stimuli or object of study increases, and possibly exceeds 10 objects, it could be a process where respondents might lose their focus or interest in responding accurately. In the case of MATRE research study on research environment on Syrian Higher Education, some respondents provided duplicated responses in the case of question 15, where they ranked more than a factor as their first choice. The result for this response resulted in duplication of responses [12]. Figure 17 illustrates the forced ranking scale, which was employed in MATRE study in question 15.

Fig. 17 Forced comparison scale

15.Scale your research motivations (Rank from 1 to 5, where no. 1 indicates the strongest one, no. 2 indicates the second, until the last number which is no. 5):
☐Tenure-required conditions
☐Financial benefits
☐Business Request
☐Career improvement
☐Others, specify:

Compared to your consumption before 2011 of necessity, substitute, and complementary products, would you consider your current consumption as more or less. Indicate the change in your consumption according to the following scale **Scale: 1-Much more, 2-More, 3-About the same, 4- Less , 5-Much less**	1	2	3	4	5
1- Consumption of bread	□	□	□	□	□
2- Consumption of medicine (painkillers)	□	□	□	□	□
3- Consumption of tea	□	□	□	□	□
4- Consumption of clothing	□	□	□	□	□
5- Consumption of jewelleries	□	□	□	□	□
6- Consumption of vehicles	□	□	□	□	□

Fig. 18 Comparative scale

10.3   Comparative Scale

The comparative scale is designed to enable respondents to make comparison between two objects of analysis, where usually the respondent is familiar with the standard. In the example of research study, investigating the change of Syrian consumption patterns before and after year 2011, the researcher examines carefully the response types, which best suits the needs of the research study. Figure 18 illustrates comparative scale question with the aim of measuring a comparison of consumption patterns of necessities, substitutes and complementary products before and after 2011, the year in which the beginning of Syrian Crisis is indicated.

11   Conclusion

In conclusion, this chapter examined the subject of measurement and measurement scales in business research. The meaning and significance of measurement is defined with a scope of business research and behavioural management. Measurement in behavioural management and marketing research is investigated. The nature of attitudes is explored differentiating between levels, which establishes the foundation of attitudes such as feelings, thinking and behaviour. Measurement levels are examined including nominal, ordinal, interval and ratio levels. This chapter also examined different levels of measurement scales including rating, ranking and categorization. This chapter provides a simplistic approach of measurement and measurement scales in business research.

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