

An Analytical Review of Visual Research Method in Environmental Perception Studies

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Abstract: Among the huge numbers of techniques used in environmental perception studies, Visual Research Method (VRM) is mentioned as one of them to capture the perception of people. This paper analytically reviewed 67 studies on environmental perception and recognition where visual instruments were used in data collection stages. Studies were selected based on the time, key words and indicated fields of study through various research engines. Data was analyzed based on three important phases in these researches namely data collection, data documentation and data analysis with their parameters and techniques. Reliability and validity of this method was proved in these selected studies, and advantages and disadvantages of VRM were discussed. This study concluded that indeed there are several significant parameters and techniques those are frequently used as part of VRM in environmental perception researches. It also showed that VRM could be changed to more dynamic formats instead of previously used static formats by using advanced technological instruments.

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1. Introduction

Vision is the foremost among all the perception activities and is the major perceptual sense (Xinyu Yu, BA, 2007). Humans always assign meaning or exercise their own visual concepts. On the other hand, visual concepts have a great ability to transfer information, emotion, and data (D. M. Moore & Dwyer, 1994). Therefore, visual perception is determined as an ability to gather and organize information through the human visual sense, in order to create meaning of external environment (Stern & Robinson, 1994).

Visual Research Method (VRM) is a constantly progressing and developing set of approach which has employed visual concepts in research and representation (Pink, 2012). This method has an extremely long record as Collier in 1957 explained a restatement of reality of life around us. Prosser (2005) identified VRM as “the production, organization and interpretation of imagery”, while Emmison and Smith (2000) defined VRM as “any object, person, place, event or happening, observable to the human eye”, and not only limited to photography (Awan, 2008). Visual instruments allow people to realize their environment entirely. Visual concepts in these researches operate in order to get people’s perception and preference about the features portrayed with the visual representations (Pole, 2004). It helps people to simply describe their perception about the environment. VRM stands more on people’s capacity of interpreting their environment through sight sense

as a rich source of data in the social world than merely collecting and displaying visual materials (Prosser & Lewis, 2005). A series of theoretical shift was occurred in VRM as an important feature of the contemporary advances in the last two decades. Phenomenology, space and place, practice, the senses and movement are some theories and philosophies that have appeared in ‘visual’ researches. These Contemporary approaches could promote the field of VRM by providing theoretical paradigms in an interconnected way through vision, images and media practices (Pink, 2012).

However, despite the contemporary tendency of the researchers to use visual stimuli in their data collection process, VRMs are rarely used by environmental scientists (Van Auken, Frisvoll, & Stewart, 2010) even though they have potential to provide enormous benefits and advantages. Lack of comprehensive instructions and guidelines that could lead researchers to use graphical representations as stimuli in their research processes should be the main reason. Therefore, this study tried to eliminate the barriers of serving VRM in environmental perception studies. It searched for relevant researches those had reliable and valid method and accumulated different parameters and technics used as VRM. It aims to encourage environmental, urban and regional designers, architects, environmental psychologists and researchers in housing, planning and urban design studies to use VRM to its highest potential to achieve more significant findings.

2. Background of study

Research has shown that environment and people's relation to environment are one of the main concerns of environmental perception studies. This study began with an explanation of various aspects of environmental perception methods as part of environmental evaluation. Then it presented wide range of visual research method (VRM) used in relevant researches those can be used in environmental perception studies. After illustrating the advantages and disadvantages of VRM in environmental perception studies, it highlighted the validity and reliability of these methods.

2.1. Environmental perception and evaluation studies

The built environment is a setting that affects visitors senses, emotions and activities in everyday lives (Rapoport, 1985). Research advocated that people and settings are dependent to each other (Bonaiuto & Bonnes, 1996) and events in the world involve characteristics of people and of the settings in which they are embedded. Users of environment and their choice of place, preferences, evaluation and assessments as individual responses, considered as measuring instruments for identifying the quality of different environment (Kirst-Ashman, 2007). As Zube (1987) advocated that user's perceptions and satisfactions are certainly the criteria and goal of evaluation. Therefore, Environmental evaluation research investigates the mutual relationship between human beings and the physical environment, and focuses on the interdependence of physical environmental systems and human systems (G. T. Moore, Tuttle, & Howell, 1985). Data in these studies could be obtained through direct contact with people and it would reveal that how humans relate to and use, influence or are influenced by nature and built environment. Environmental evaluation studies establish comprehensive conceptual and methodological framework to explain and predict the association between characteristics of place with cognitive, affective, and behavioral reaction of respondents (Craik & Feimer, 1987). Moreover, the concept of Environmental Perception studies as subsets of environmental evaluation encompasses the awareness and understanding of the environment by people in a broadest sense, involving much more than a single sensory perception, such as vision or hearing. They access the opinions, feelings, attitudes, preference and values of people regarding the environment around them (Kowaltowski et al., 2006).

2.2. Using VRM in various research area

A wide range of research studies have used VRM as their main research approach (Pink, 2012). At first, anthropologists used photography in scientific human researches in order to document granted

“racial types” in a discipline's projects (Banks, 2001; Collier & Collier, 1986; Pink, 2004a). Nowadays, this method by using visual materials such as photograph, film and video seems to be extremely simple and unproblematic in human based research disciplines such as sociology (Knowles & Sweetman, 2004; Pink, 2004a), education (Coates, 2002; Pole, 2004) and mass communication (Kyle, Mowen, & Tarrant, 2004). Increasing interest on VRMs in scientific research fields advocated that these methods may be used as an interdisciplinary as well as multidisciplinary field with great collaboration. Many researchers from various disciplines contribute their different perspectives in this field (Leeuwen & Jewitt, 2004; Pink, 2003; Rose, 2007), especially by further changes in digital technologies and focus on mobility, flows, the senses, spatial theory and practice as theoretical shifts in this century (Pink, 2012).

2.3. VRM in environmental perception and evaluation studies

As mentioned before, visual methodologies have a great capability to transfer people's emotion and perception about their surrounding environment. Moreover, it could adopt and synthesize with every stage and piece of research. Therefore, it successfully applied to environmental perception studies (Pink, 2012). Previous studies proved that VRM could encourage a metaphoric communication of knowledge which is impossible through word alone (Pink, 2004b). Searching in environmental perception studies that served VRM as their main method of research shed light on the various types of issues in this field that could be assessed through these methods. Environmental preference (Wang, Weng, & Yeh, 2011; Wherrett, 2010), perception (Clough & Pasley, 2010; Nordh, 2012) and attachment (Lokocz, Ryan, & Sadler, 2011; Walker & Ryan, 2008) are demonstrated as the most significant enquiries in this area. Visitor's norms and conventions (Chenoweth, 1984; Packard, 2008; Pitt & Sube, 1979), appreciation and acceptance (R. E. Manning, Lime, Freimund, & Pitr, 1996; R. Manning, Johnson, & Kamp, 1996; Nelessen, 1994) are other factors that could be judged by VRM. This study advocated that, VRMs could be most effective for serious decision making stage of a design process, especially in community agreement about preferred design features in complex issues.

2.3.1. Advantages of visual survey methods

Researchers have recognized the advantages of using VRMs in their environmental perception studies. Collected from various relevant literatures, the important benefits of using VRM are listed below. It shows that VRM can:

- Elicit rich descriptions about environment can be more comprehensive and in-depth than other methods (Pullman, 2007; Van Auken et al., 2010)

- Bridge the gap between researcher and respondents and reduce the differences in knowledge and class between them (Chaplin, 1994; Pink, 2011; Van Auken et al., 2010).

- Combine and sharpen memory, and reduce areas of misunderstanding (Harper, 2002).

- Reduce time of interview in environmental perception surveys.

- Prepare a wide opportunity for epitomizing the perception of people about the environment and equivalency of presentation condition to participants (Kim & Kaplan, 2004; Shuttleworth, 1980)

- Offer experimental control over environment context and procedure of research (Daniel & Meitner, 2001)

- Provide an accessible and inexpensive way to collect the perception of people about their environment (Huang, 2006).

- Enable the respondents to “draw on their own concepts” instead of relying on researchers’ constructs (Jacobsen, 2007)

- Encourage participants to involve in research activities (Van Auken et al., 2010)

- Have the possibility to present many identical space (Davis, 1993)

- Have the possibility to compare a subject simultaneously (Real, Arce, & Manuel Sabucedo, 2000).

- Be specifically used for the research variables that are extremely difficult and complicated in narrative description or situations that are extremely hard to find or do not exist yet (Robert E. & W. A. F. Manning, 2004).

- Evoke deeper elements of people consciousness and focus about environment (Harper, 2002).

- Be less stressful for participants and more electrifier and captivating (Taylor, 2008).

- Encourage unrestrained and ‘different’ discussion which is not appeared in narrative methods.

- Give opportunity to people to release from reality and observe the large or different sight.

- Add vividness and lucidity to arguments.

- Provide a permanent and readily available record of research site (Pink, 2011).

- Have the ability to reveal the values and meanings that hide behind the images (Beilin, 2005; Harper, 2002; Steen Jacobsen, 2007).

2.3.2. Disadvantages and limitation of visual survey methods

Despite, many studies shed light on advantages and benefits of VRM, some disadvantages features were also described by other researchers in their studies to mention that VRMS may:

- Omit the non-visual indicators of the environment such as texture, sound, motion, smell and weight (Huang, 2006).

- Limit to present a real environment, Because of fossilisation moment in time and their static not dynamic essence like a snap shot. (Crisman, 2006; Eroglu & Harrell, 1986; Pallaasmaa, 2001; Pole, 2004).

- Develop false expectation or misinterpretation specially in computer based rendering images (Pullman, 2007).

- Have time consuming preparation process of visual material.

- Depend on respondents’ skill.

- Dismiss the content by respondents due to low quality of visual materials compare to visual mass media (Ruto-korir, 2012)

- Be limited to be used for people with visual impairments.

However, with visual and virtual technology developing everyday, scholars are finding the ways to overcome the shortcomings of VRM. For example, some hidden aspects of environment have been discovered in images to rectify the weaknesses such as social climate or noise, by considering visual signs such as graffiti or a broken window as a logical solution (Dunstan, 2007; Wilson & Kelling, 2003). Also, it is not unexpected that some new kinds of visual material such as digital video and virtual reality promote the visual methods in environmental perception studies.

2.3.3. Validity and reliability

VRMs are considered to be valid by representation of environment in comparative methodological research (Canter, 1983; Daniel & Meitner, 2001; Shuttleworth, 1980; Wherrett, 2010). The results of different VRMs have shown that people’s response to a physical environment positively and strongly correlates with their response to comprehensive photographs of that place (Stamps, 1990, 1993). Validity of visual instruments in environmental perception research were proved by using a verbal protocol analysis that ask people how the image based survey were easy and acceptable to understand and rate (Bishop & Iv, 1991), even by using high quality images (Daniel, 1990; Paar, 2006; Perkins, 1992). On the other hand, correlation between study findings proved the validity of visual instrument in some studies (Daniel & Meitner, 2001). Also, consistency was found between respondents’ stated preferred judgment based on images and equal reaction to an immediate experience of a specific setting. Moreover, construct validity illustrated that visual study questions were able to measure what it claimed to measure. Numerous researches have shown

that VRMs commonly show the validity in conventional tests because they may result in more realistic estimates of quality of participants based on standards (Robert E. & W. A. F. Manning, 2004).

Cost is the first and foremost reason of reliance on images, because bringing a large number of respondents to a real site is generally expensive. According to this fact, repeatability of study in VRM researches became extremely valuable, and it could be reachable by accurate documentation and data collection procedure with using the map locating sites, marked camera position, height and condition, time and weather condition (Clay & Marsh, 2001; Hall, 2001).

3. Method of study

This study has attempted to report and analyze data from relevant and empirically-based researches which used VRM in environmental perception studies. At the first stage, it provided a comprehensive review of the body of literature concerning the usage of visual method in environmental perception studies and then proceeded by outlining the various types of VRM. To find the relevant studies from 1975 until the end of 2013, it searched for English language studies

in social environmental science databases, especially for quantitative and qualitative empirical studies that served visual instruments as a main source of data collection source. Key words such as Visual survey, Image based survey, Image based questionnaire, photo based survey, Photo based questionnaire, Picture based survey in environmental perception, preference and environmental design studies were used for the search.

Studies were chosen on the basis of possessing two mandatory criteria in the content. The first one was that it must contain the evaluation process of environmental perception of people in relation to the social or physical qualities or characteristics of environment. Secondly, it must use virtual instruments in its research procedures. At the end of the search procedure, 67 references were found to be relevant that could satisfy the aim of study. After that, several parameters and techniques were identified which were used during data collection, documentation and analysis phases in researches (Figure 1). Several parameters were identified those were used during the data collection phase, while several other techniques were listed those were used during data collection, data documentation and data analysis phases.

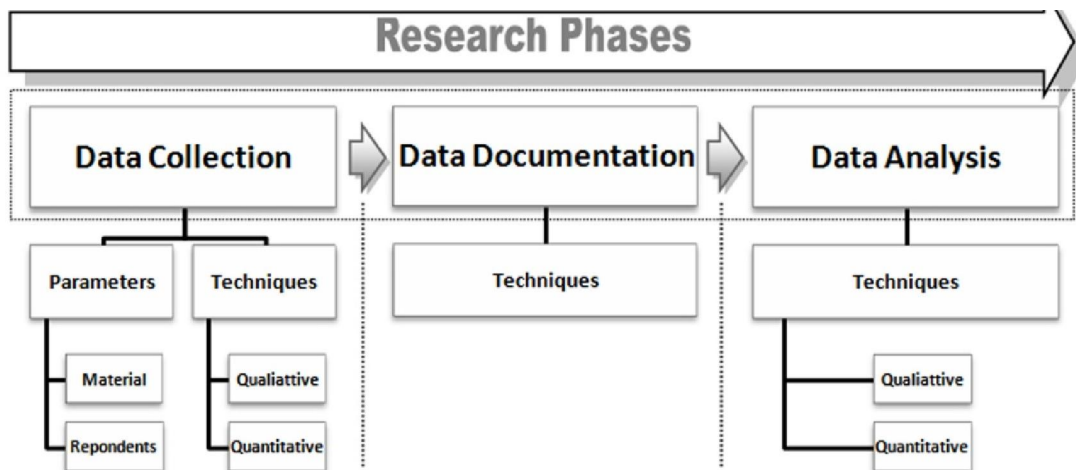


Figure 1. Environmental perception researches phases and their parameters and techniques

4. Parameters used in data collection phase

The following parameters were explored those were used during data collection phases. They were categorized under two sub-parameters namely those which are related to visual materials, and those which are related to the respondents.

4.1. Visual material

Visual materials such as photographs, film, video, paintings, drawings, cartoons, prints, designs, and three-dimensional art such as sculpture and architecture especially are found to be used for illustration or promotion of an idea or reality in environment.

4.1.1. Type

Among various type of visual material used in environmental perception studies, photographs are known as the most preferred material because of simple production process and understandable meanings. Video got less attention due to lack of people's time and interest to be heavily involved in (Petheram, High, Campbell, & Stacey, 2011). The photographs often were taken by camera and might be edited through computer software by the researcher or respondents to estimate the preference or perception of people about a special issue in their surrounding

environment (Kaplan, 2001). Hand written drawings, maps, plans or bird's eye view images, artistic renderings, computer aided images, simulation and 3 dimensional images, digital maps, color slides, projected images, and digital animations were mentioned as examples of other visual materials which were employed in environmental researches. Computer aided design (CAD), geographic information systems (GIS), virtual reality (VR) and Adobe Photoshop software were some other digital techniques that could produce virtual materials and qualify to edit images virtually even a realistic and precise representation of potential setting and future condition (Pole, 2004). Table 1 showed that among 67 environmental visual surveys that were reviewed through this study, 66 percent employed photos as visual materials. Color photos, black and white and panoramic view photos were mentioned in this category. Computer simulated images were used in 20 percent of studies that had searched about environments which were unreachable or non-existent. This review research illustrated that only 4 percent of studies choose slides, 5 percent hand-drawings and just 3 percent showed video to participants to understand their perception about environment.

4.1.2. Production or selection process

The impetus of image making or selection in VRM and image production process are vital aspects to make judgment in visual research (Becker, 1974). Concept of research theory, research objectives, variables and context and author's intentions are factors that influence image selection (Anthamatten, Wee, & Korris, 2012). Theoretical framework in visual studies could reveal the significance and relevance of each visual material in various sequences of the research. Research project may flow into impressionistic description without a theoretical framework in image gathering process which is clear and systematically applied. In environmental perception studies which employed VRM, image production process is done through the instructions or task given to the image-makers (Banks, 2001; Marcus Banks, 2008). Images may be generated by respondents, by researchers or derived from secondary sources (such as the media), by respondents or researchers (Pink, 2004b).

4.1.3. Number

Reviewing the cases studies, it was found that that the number of images or videos used in environmental perception studies is various between 1-360, depending on the respondents and the objects of the studies.

Table 1. Type of visual materials in environmental perception studies

Type of visual material	Number(Range) of Images used	Percent (%)
Photo, black & white photo , panoramic view photo	24 to 360	66
Slide photograph	3 to 40	4
Color drawing, pen and ink drawing	4 to 14	5
Computer simulated images, photographs edited using micro computers	16 to 340	20
Video tape	1 to 3	3
GIS	1	2

However, the critical issue in using visual materials is to be understandable and imaginable for respondents and having the ability to be interpreted by the researcher. Through representing the objects of a particular environment by an image, viewers may explain different meanings because of the double iconic and symbolic sides and polysemous nature of image (Barthes, 1977) or respondents' personal experience and cultural background (Pink, 2004b). To decrease the level of misjudgment of images by participants, researchers have to obey some constraints in providing and choosing visual material such as showing eye-level front view, minimum presence of people, control the weather and sunlight (Herzog, 1985; Ulrich, 1981) and using 360° or panoramic photographs with environment sounds. Juxtaposition with the verbal text of a title or caption could explain, develop and expand the significance of

image meaning (Barthes, 1977). Text could fix one among several possible meaning, while clearly rejecting the others (Nelessen, 1994).

4.2. Respondents types and numbers

Type of VRMs could affect the type and number of participants in research procedure or vice versa (Robert E. & W. A. F. Manning, 2004). For example, Williams (2003) used video tape and selected 257 people to respond to the questions, whereas James J. Ponzetti (2003) choose the voluntary photography and ought to select just 32 people to capture photos. On the other hand in the study with less picked images, researchers had a chance to get response from a large number of people. Table 2 showed that there was a significant negative correlation between the number of respondents and the number of visual materials. Therefore by increasing the population of participants in research studies, researchers decided to choose less

visual materials in the process of data collection. It may be influenced by limitation of time and cost in

each project.

Table 2. Coloration between respondents' number and visual material number or extension

Correlations		Respondent NO	Visual material NO
Respondent NO.	Pearson Correlation	1	-.443**
	Sig. (2-tailed)		.003
	N	44	44
Visual material No.	Pearson Correlation	-.443**	1
	Sig. (2-tailed)	.003	
	N	44	45

** . Correlation is significant at the 0.01 level (2-tailed).

In addition, this study showed that although most researchers employed VRMs to extract adult perception about environment, this method could capture the authentic voices of children as well (Dierkx, 2003). It could be seen as a door for the (adult) researcher into the thinking world of children and as an aid in getting them to talk about their own perspectives (Banks, 2007; Catherine Burke, 2003; Leeuwen & Jewitt, 2004; Pink, 2012; Wiles et al., 2008) by employing the children's own photographs, drawings and maps combined with talking and observing (Clarke, Parks, & Crane, 2000). Consequently, VRMs could easily be adapted with the characteristics and situation of participants and are able to cover all the respondents irrespective of age, gender and qualification even including those having any disability and deficiency.

5. Evaluation techniques during data collection phase

As an image is essentially a qualitative source of data, scholars mostly used qualitative methods for visual research. Especially in researched that stood on the visual materials which was produced by participants such as, volunteered photography or hand drawing or mapping enquiries (Harper, 2002). Whereas in studies that researchers selects the images, they would be able to transfer the method of research to quantitative by determine the features of each photo as the study-variable, and invite participants to explore their perspectives or perception about matters depicted in visual materials by rating each numerically as their agreement or disagreement (Crisman, 2006). However, visual perception survey can be applied in a focus group or semi-structured interview or discussion, a written checklist, a structured self-reported questionnaire, or be a part of other perception collection methods such as voting techniques or contributed in a public hearing or public meeting process. One of the most important differences of various visual evaluation process is the production or preparation of visual materials by the

respondents or the researchers (Rose, 2007). Although producing the image by researchers or professionals provides high quality materials but they may limit the voice and perception of the participants. Below, the different quantitative and qualitative techniques used in data collection process are elaborated.

5.1. Quantitative Techniques

Quantitative methods have a significant contribution in visual environmental perception studies and architectural evaluations (Nordh, 2012).

5.1.1. Numerical ranking based on quantified photos

Most VRMs used rating system for evaluating the images by respondents. The researchers included visual materials in survey questionnaires or personal/focus group interviews, showed the sequence of images to viewers, and asked them to rank or rate each numerically as 'preferred and accepted' or 'non-preferred and unaccepted' according to some criterion on a Likert scale questionnaire. This typical numerical ranking method was developed first by Daniel, & Boster (1977) as scenic beauty estimation (SBE) method. In order to evoke various types of responses, they included open-ended replies. Then they tabulated and analyzed the result based on valued calculated for each image (Crisman, 2006). Therefore, as Echtner & Ritchie (2003) advocated, a structured questionnaire could be a sufficient instrument to measure images by using Likert system. Some studies used bio-polar scale with adjectives like exciting, sad, beautiful, and ugly or choice model techniques (Verma, Plaschka, & Louviere, 2002).

5.1.2. Sorting

In photo sorting approach, pre-selected visual materials were employed as stimuli and interviewees were asked to sort the provided materials according to the specific instructions or their own constructs and perceptions, degrees of likes and/or dislikes (Green, 2005; John R. Fairweather, 2001) and revealing their subjective viewpoints (Brown, 1999). Scholars proved that, this method which also has various types such as Q-sort, and the multiple or free sorting task, could be

extremely impressive in extracting environmental conceptualizations and judgments (Canter, 1983; Green, 2005; M. J. Scott, 1997; Real et al., 2000; Ervine H. Zube, 1974). Q-sorting technique, originally proposed in 1953 by Stephenson generates an ordinal ranking based on various subjective criteria in a personal evaluation process. It combines qualitative analysis with quantitative principal component factor analysis (Watts, S. & Stenner, 2003). In free sorting task, researchers rely on people's categorization of image that showed their perception of a particular environment. This method theoretically stands on Kelly's (1955) 'personal construct theory', which explains that evaluation and preference of people is the result of their construct which they grab from the world.

5.2. Qualitative techniques

Scholars used many unstructured and qualitative ways of collecting data in environmental visual enquires. This approach included visitor employed methods, individual or group interview with photo elicitation and eye tracking (Harper, 2002; Wang et al., 2011).

5.2.1. Photo interviewing (Elicitation)

The first and long established method of visual research in environmental perception studies is asking respondents to discuss about a certain set of images and explain the meanings (Hurworth, Clark, Martin, & Thomsen, 2005; Hurworth, 2003), demonstrate a concept or interpreting their perceptions or feelings about the offered images (Petheram et al., 2011). This technique could be broadened by inserting video or any type of visual material (Pink, 2012). It could produce rich and thick descriptive data, change the tenor and tone of the interviews and create more effective, engaging and emotional data collection process. This special technique recall sharpen memory, simplify the communication (Collier, quoted in Hurworth, 1994) and excavate different aspects of participants' perception than narrative interviews or questionnaire (Harper, 2002).

5.2.2. Visitor employed photography (VEP)

VEP or 'photo voice' is also one of the most frequent used methods in VRMs (Garrod, 2008; Jorgensen & Stedman, 2006; Wang et al., 2011) especially in environmental perception studies (Dakin, 2003; Franzini et al., 2009; Loeffler, 2004; Oku & Fukamachi, 2006; Stedman, 2004; Yamashita, 2002). It successfully assess respondents' perception about their surrounding environment, their preferred scenes, acceptable number of people and their process of experience (Taylor, 2008). In this method, Participants might be asked to take photographs or videos from a particular place and provide written responses (Anthamatten et al., 2012a) to express their preference, desire or concern about the experienced

environment. It could record their observation, their reasons for capturing the picture and meaning of images (Pullman, 2007). The main advantage of this method is the ability to empower respondents to involve meaningfully in data collection and take control in its process (Harper, 2002). It can capture some aspects that might not be considered by researcher (Jorgensen & Stedman, 2006), and can be more engaging than other techniques (Klitzing, 2004). One of the main usages of this technique is in children's place perception and experience studies (Aitken & Wingate, 1993; Dodman, 2004). But it may appear in low technical quality in clarity, lighting and frame (Pink, 2012).

5.2.3. Eye tracking

This method has a long usage in researches in psychology. It tries to clarify the reaction of respondent's eyes against the visual materials and investigate the visual perception of visitors in relation to their points of view (Martinez-Conde, Macknik, & Hubel, 2004). Previous studies showed that this method could be served as a useful method in environmental psychology and environmental perception studies (Duchowski, 2007). Psychologists expressed that the points respondents implied or focused more have a direct relation with their positive or negative feelings, thoughts and emotion to that particular subject. Therefore, this technique registers the eye movements of participants when they look at a picture and interpreted their desire and perception about the component of images through the points that captured by the eyes first.

5.2.4. Rich picture diagramming (PRD)

Scholars proved that PRD method could be an effective method in environmental perception studies. In this approach, participants were invited to draw a map or an image of what they liked or disliked in their existing environment or preferred space, or epitomize a picture of what might occur based on a special scenario (Petheram et al., 2011). Researchers could achieve a precise interpretation from this special data through explaining the reason of respondents' opinions and views about their drawings. This techniques have a great capability to capture children's opinion about their environment (Punch, 2002; Young & Barrett, 2001) that could be enriched with story-telling proceeding by children.

5.2.5. Photo diaries

In this technique, researchers have asked respondents to keep a photo diary, which then becomes the focus of an interview (Latham, 2003). In this case, using the camera gave the interviewees some distance from their ordinary routines and enabled them to articulate their knowledge and perception about their everyday environment (Rose, 2007). Use of the camera helped to make familiar and

unstated evident (Hogan, 2012). Respondents should write something about the images prior to detailed discussion of the photos in interviews. Legibility of the photos was very much dependent on the verbal accounts.

This study by reviewing previous VRMs depicted that although visual materials are a valuable source of data collecting, for a high-quality visual research, it is compulsory to accompany of other techniques and materials to engage participants, become understandable for them and enrich the data collected, each carefully supported for accuracy and fit all together coherently. Many researchers have served structured or semi-structured interview, questionnaire with open and close-ended questions, mental mapping, observation or GIS models to complements the data collection process in visual surveys. Moreover, there are other various types of visual techniques that are increasing as researchers' creative methods such as participatory sculpturing, matrix ranking and visual choice modelling.

6. Techniques used during data documentation phase: (visual material translation)

As Pole (2004) stated, images are the collection of assumptions, axioms and characters of the 'image-maker' and the 'image-reader', and are consequently more difficult to dig than words. At the first step to employ images in visual studies as a source of data, researchers need to consider how images create meanings in order to produce interpretations of visual images. Developing a list of facts about the subject matter within the image or 'description' was suggested to be done at the beginning of critically examining the image (Young & Barrett, 2001). It is simply known as denotation (Barthes, 1977). The subject of the image occurs at a second level of understanding, which is connotative. Many scholars tend to develop a scientific way to extract the meaning of images. Rose (2007) introduced three critical area or sites to consider when analyzing photographs. They are image production, the image itself, and the audience of the image. She envisioned technological, compositional and social modalities concurrently contributing at various levels of each sites to understanding visuals (Ownby, 2013). Rose claimed that most studies tend to concentrate on the image itself as the most important site of its meaning, although in focusing on the meaning of signs and their interpretation at the connoted level, compositional and social modalities also play an important role. This study extracted data through review of previous visual studies and illustrated different techniques of

translating a visual material (Table 3), which could be employed in environmental perception researches. These techniques are described below:

6.1. Gridding technique

In this technique researchers used grids to quantify the content or components of the environment presented in the photo (Nordh, 2012; Tveit, 2009; Wang et al., 2011). A grid of a constant number of squares was laid over each image, and the percentages of different components such as grass, bushes and trees were quantified on each image. This technique was inspired by Shafer and colleagues in 1969. As manual quantification of environmental components is a time consuming process, many researchers developed new methods based on computer. For example, Wherrett (2010) used ERDAS Imagine 8.2 (ERDAS, 1994) software to count digitally the components of grids.

6.2. Counting presented subjects

Chenoweth, (1984); Gobster, Nassauer, Daniel, & Fry, (2007); Kaplan, 2001; Malczewski & Rinner, (2005); R. E. Manning et al., 1996; R. Manning et al., (1996); Orland, Budthimedhee, & Uusitalo, (2001); Pitt & Sube, (1979); Wang et al., (2011) counted the number of people or any other specific subjects that appeared in each photo either manually or by using computer software such as GIS in working with maps (Laven & Krymkowski, 2005).

6.3. Descriptively coding the items and categorizing

The most used method of translating the visual material is coding and subsequent counting of each code on every image. Especially in studies that used the images which was produced or captured by respondents such as Volunteer-Employed photography or hand drawing, researchers usually elicited the respondents' opinions and thoughts that were behind the images. The researchers extracted the features drawn in images, developed a coding system as qualitative data they contain, and categorized them in groups that related to the variables and objectives of their studies. As interpreting the respondents' viewpoint through drawings seemed difficult, further discussion to understand their thoughts and imaginations would be helpful in this area in order to avoid misinterpretation, especially if it was related to children's enquiry (Coates, 2002). One of the useful methods in coding system is serving experts' opinion. In this technique, researchers prepared questionnaires with multiple choices of themes and codes for each image and collect data from a few number of experts. Fuzzy or hierarchical analysis could help the researcher to find the items that experts proved for each images.

Table 3. Techniques in image translation and quantification

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	N	44	44
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	N	44	45

** . Correlation is significant at the 0.01 level (2-tailed).

In a VRM process, quantification and translation of visual materials is the most important stage of the study. Depending on the type, number and production process of visual materials researchers might choose one of above methods or mix some of them.

7. Techniques used in data analysis phase

In fact, the advantage of pictorial evidence is that it can be analyzed quantitatively, qualitatively or by using both approaches (Rosalind Hurworth, 2003).

7.1. Qualitative data analysis

As mentioned before, visual materials are essentially qualitative data. They are subjective and could be analyzed through content analysis methods (Pullman, 2007). In qualitative visual research, coding systems and categorizing the meaning behind the images and respondents' interpretation navigate researchers to use content analysis. Two main coding systems may be determined. An 'object code' based on the important objects in an image and a 'meaning code'. Codes should have 3 main criteria: (1) Exhaustive (cover every aspects of concern) (2) Exclusive (not overlap); and (3) Enlightening (interesting and coherent) (Collier & Collier, 1986). Researchers should move from general descriptive codes of data chunks to more focused analytical codes, similar to axial coding used in grounded theory research, which could allow to recognize recurring ideological themes and patterns within the data

(Ownby, 2013). Nowadays there are various qualitative data analysis software packages such as Atlas-ti, Hyper RESEARCH, Qualitative Media Analyzer, or Visual Text, which could be employed specifically in analyzing the visual materials.

7.2. Quantitative data analysis

On the other hand, in quantitative visual approach like rating, numerical ranking and sorting, analysis software methods such as frequency-descriptive analysis, T-tests, correlation and regression, factor analysis and hierarchical cluster analysis could be served. For example, Choice-based conjoint analysis was used in visual studies to evaluate the features which got more weight from viewers' perspective (Sugiyama, Thompson, & Alves, 2008). Regression analysis also predicts which variables in the environment could affect more the participants' perception. In this method, variables must be quantified for each image. Principal component factor analysis explored the results, in rating questionnaires of visual preference studies. Table 4 showed the different methods of data analysis in VRM studies that are dependent on their methods of data collection. It illustrated that more than 69 percent of visual studies employed statistical software to analyze the data gathered by VRMs. Content analysis was also mentioned as the most preferred approach for qualitative enquiries in visual researches.

Table 4. Frequency of different methods in analyzing the visual enquiries

Analyzing method		Percent (%)
Qualitative	Content analysis	31
Quantitative	ANOVA	7
	Correlation	8
	Factor analysis/	14
	Hierarchical cluster/ Multi-criteria decision analysis	4
	Regression	20
	T test	16
Total		100

8. Discussion

This research discussed different valid VRMs used during different phases in research. Figure 2

shows the analytical review of environmental perception studies that shed light on different parameters and techniques of VRM in more detail:

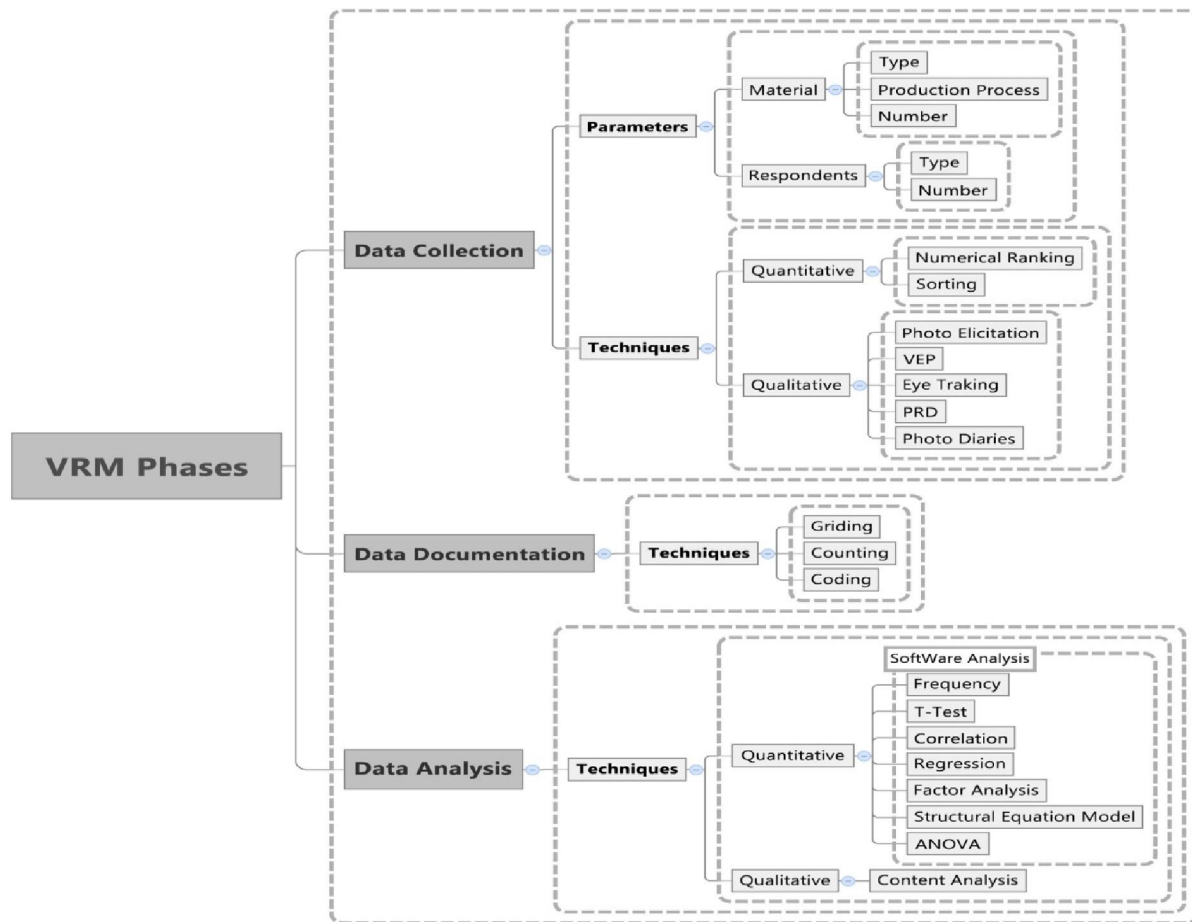


Figure 2. Visual parameters and technique during each phase of environmental perception researches

8.1. Parameters used in data collection phase

8.1.1. Visual material

According to findings of this study, different types of visual material from simple black and white photographs to computer aided images, animations and virtual reality products was served in VRMs. Although photographs, through this wide variety of visual materials, were known as the most employed type, scholars advocated that according to the research aim and objectives, specific variables of study, respondents, setting and area of research and other research limitations, the choice of visual material may become different. For example, in a real situation, photographs pursue the existing condition of place as opposed to a drawing; whereas for a non-existing situation, use of computer aided image could be easy accessible (Stamp, 1993a;1990). Whereas in children related studies, children drawing with their

descriptions could be the best choice as data collection instruments.

8.1.2. Respondents

One of the strong points of this review study is to show the possibility of using VRM in environmental study for a wide range of respondents from particularly young children (Anthamatten, Wee, & Korris, 2012b) to elderly people (James J. Ponzetti, 2003). On the other hand, sampling sufficient number was estimated base on the type and number of visual material and qualitative or quantitative nature of evaluation. For example in qualitative evaluation method such as capturing interpretation and perception of participants, the number of respondents could be as less as 30 people instead of participating a large population in quantitative numerical ranking visual methods.

8.2. Techniques used in data collection phase

Through different evaluation methods in VRM data collection process, numerical ranking based on quantified photos was proved as the most preferred method by researchers. Type of respondents and visual materials, study variables and settings could influence the choice of evaluation technique. For example, for respondents with speech disability, eye tracking is the best way of evaluation especially in computer aided visual materials or web based surveys (Henderson, 2003; Itti & Koch, 2001). Moreover, in children's environmental perception studies, the most effective method is involving children through drawing or volunteer-employed photography.

8.3. Techniques used in data documentation phase

This study advocated that the most popular translating system for visual materials is descriptively coding the value of each photo and categorizing them rather than gridding, counting subject or using specific software. However, researchers may decide to employ other methods depending on the study variables or type of visual materials. For example, in crowding acceptance studies, scholars commonly used counting

system (Manning et al., 1996); in landscape preference studies, they employed gridding system to discover the percentage of each environmental component illustrated in the images.

8.4. Techniques used in data analysis phase

Reviewing previous studies indicated that Statistical Softwares were employed as the most common analytic methods in visual environmental perception studies. It is clear that coding and categorizing system and content analysis were the only way in some specific VRM such as children related studies which served children's drawings, getting interpretation of participants, and visitor employed photography. Nowadays with some special software like NVivo, Quarlus and QDAMiner that could organize and analyze unstructured information and narrative data by coding, annotating, retrieving and analyzing collections of documents or images.

Eventually, Table 5 illustrated a comprehensive summary of parameters and techniques were served in reviewed environmental perception studies.

Table 5. Summary of visual techniques and their specification

Visual technique	Materials used	Producer of material	Data documentation	Description	Advantages	Disadvantages	Analytic method
Numerical ranking matrix / ranking	Photograph slide simulated images drawing video	researcher	gridding, counting, coding and categorizing	Respondents rank visual materials numerically as preferred or non-preferred, on a Likert scale questionnaire, Bio-polar scale or Matrix ranking exercises	Reduce misunderstanding; accessible, inexpensive; present identical space for not exist situation; Less stressful; able to use analyze software	Omitting the non-visual indicators; Limitation to present reality	frequency, T-test, ANOVA, Factor analysis, Correlation, Regression, Structural equation model
Sorting - Q sorting	Photograph simulated images	researcher	coding and categorizing	Respondents sort pre-selected visual materials according to the specific instructions or their own constructs and perceptions	Less refusal, more engaging; Combine sharpen memory accessible and inexpensive possibility to compare a subject simultaneously suitable for not exist setting	Time consuming; Limitation to present reality	Free Q method software; Mean finding, Regression, Hierarchical cluster analysis
Photo interviewing (Elicitation)	Photograph video	researcher or participant	coding and categorizing	Respondents discuss about a certain set of images and explain the meanings, demonstrate a concept or interpreting their perceptions	Produce rich description engaging and emotional recall sharpen memory simplify the communication	Leave too much value behind the frames; Limitation to present reality	Coding and Content analysis
Visitor employed photography (VEP) - photo voice	Photograph video	participant	coding and categorizing	Participants take photographs or videos from a particular place, and provide written responses	let respondents take control eliminate barriers between researcher and participants capture aspects not considered by researcher less refusal more engaging	No clear themes are informed; Weak technical quality	Coding and content analysis; Frequency and T-test
Eye tracking	Photograph Slide Simulated images drawing	researcher	Gridding coding and categorizing	This technique registers the eye movements of participants when they look at a picture and interpreted their desired and perception about the component of images	Reduce misunderstanding; Less stressful more electrifier; Suitable for participants with speech disabilities	Time consuming; Difficult to interpret	Regression, Choice-based conjoint analysis
Rich picture diagramming	Map Diagram sketching drawing	participant	coding and categorizing	Participants draw an image of what they like or dislike in their existing environment or preferred space or what may occur based on a special scenario	Achieve a precise and rich data; Able to capture children's opinion	Limitation to present reality; Depends on participants' skill; Difficult to interpret	Coding and Content analysis
Photo diaries	photograph	participant	coding and categorizing	Respondents keep a photo diary and write something about the images, prior to detailed discussion of the photos in interviews.	Give respondents distance from their ordinary routines make familiar and unstated evident	Depends on participants' skill; Limitation to present reality	coding and content analysis

9. Conclusion

Searching in many studies had advocated that VRMs are valid methods in analyzing the relationship between people and environment with a great capacity to shed light on different ways of exploring the environment. Scholars proved the advantages of VRMs such as the ability to control the experiment of environment and interpreting the meanings, possibility to represent an unreachable or non-existed environment, and getting the data from respondents with disabilities or weaknesses to interpreting by narrative explanation. Although the limitation and drawbacks of this technique should be considered by researchers, nowadays professionals tried to employ the different parallel methods in order to reduce the amount of error and overcome the weaknesses.

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