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Residents' perception of local brownfields in rail corridor area in the City of Roanoke: the effect of people's preconception and health concerns factors

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This article examines preferences of residents for nearby brownfield sites and the factors affecting preferences. 200 residents in neighborhoods along the railyard in the City of Roanoke, Virginia, participated in a survey of their preferences for different brownfield scenes. Results indicate that scenes with historical landmarks and maintained landscapes received the highest ratings, regardless of preconceptions and health concerns. These are viewed less critically and thus could mask possible harms. In contrast, scenes with scruffy vegetation and rundown buildings revealed mixed preferences. For these types, participant preferences for change versus preservation fluctuated. Lastly, scenes with industrial remnants were preferred the least. Participants tended to associate these types with toxic pollutants that may adversely affect health. This suggests that planners need to convince people that these sites can be reused if they are cleaned up. The results are used to develop more effective engagement strategies for increasing support for brownfield redevelopment projects.

Keywords: residents' perception; local brownfield; preconception; health concern

1. Introduction

1.1. Paradigm shift in brownfield planning and management

The focus of brownfield policies and programs in the United States has been changing from the cleanup of national priority sites to the reuse of local-level brownfields. In the past, most brownfield cleanup has focused on large, highly polluted Superfund sites, based on the hazard rating system (HRA) under the Comprehensive Environmental Response, Compensation, and Liability Act, enacted in 1980. This left many smaller, less polluted sites, often in urban or suburban areas, relatively neglected. In order to encourage the voluntary cleanup of these neglected areas and support the reuse of local brownfield sites, the government has changed its approach. The Small Business Liability Relief and Brownfields Revitalization Act was enacted in 2001, and the legal liabilities of involved parties were lessened (Collins 2002; Eisen 2007; Mintz 2002). Under this act, a range of funding has been made available to assist brownfield reuse planning, including site assessment grants, revolving loans for cleanup, and pilot project grants for selected cities (Bartsch and Collaton 1997; Russ 2000). In addition, since 2000, many localities

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currently run their own area-wide brownfield planning programs to assess and manage brownfields with increasing federal support (Kim and Miller 2015). In this new environment, reuse planning and public engagement has become more important. However, while the approaches to assess and clean up national priority sites have been refined (ICMA 2001), differentiated approaches that involve nearby community for local-level, lightly toxic brownfields are lacking.

1.2. Contamination risk-based assessment and expert-oriented procedure

There are clear differences in the way brownfield sites are perceived in different regional contexts. For example, European countries emphasize the unoccupied condition or vacant state of the land of the brownfield site for reuse because there are fewer developable areas. In the US, there is less focus on land availability and more attention on the potential contamination of the land due to public demand for protection from environmental hazards (Alker *et al*. 2000; Kim and Miller 2015; Oliver *et al*. 2005) and due in part to the highly publicized disasters, such as Love Canal, New York.

The contamination risk-based assessment (the hazard rating system), the portion of the Superfund law, has dominated US brownfield assessment. Based on an HRA, a site that scores a 28.5 or higher will be designated a Superfund site and be placed on a national priority list (ICMA 2001). However, the assessment and level that were set up for Superfund sites are inappropriate for local-level lightly toxic brownfields (Kim, Miller, and Kim 2015). Moreover, the assessment procedure itself attaches a stigma to brownfield sites regardless of actual existence of contamination. This stigma causes property owners and prospective developers to fear liability, slowing the redevelopment process. The negative stigma associated with brownfield sites has been recognized by planners and policy makers (Berger 2007; Hayek *et al*. 2010; Hollander, Kirkwood, and Gold 2010). In addition, because of the potential contamination and legal liability issues, it is not surprising that pollution experts most often lead the redevelopment process.

In this new environment, the focus moves toward the reuse of lightly toxic, local brownfields by engaging nearby communities and understanding their interests. Improvements in amenities at brownfield sites can lead to a better quality of life for local residents (Jenkins, Kopits, and Simpson 2006). Since 2010, federal grant recipients have noted that community engagement is one of the most important objectives in area-wide brownfield planning in the majority of localities (EPA BF AWP program fact sheet, 2012). Community engagement can help to change public perception of brownfield sites, lessening the stigma (Carlson 2011). Moreover, early stage communication with local people was found to generate support for government plans (Turvani, Paccagnan, and Tonin 2007; Greenberg and Lewis 2000). In order to develop effective strategies for community engagement, planners need to understand the attitudes and perceptions of local residents toward different types of brownfields, brownfield reuse, and planning processes.

2. Theoretical background

2.1. Perceptual studies of brownfields

Despite the importance of public perception and community engagement in brownfield management, there are few studies that explore public attitudes and perception toward brownfield sites. Past perception research on landscapes and sites has generally focused

attitude and preference differences between city governments and the public (Greenberg and Lewis 2000; Solitare 2005; Turvani, Paccagnan, and Tonin 2007). In one study, government bodies placed the highest value on a brownfield site reuse potential for economic revitalization and job growth that will increase property values. In contrast, the public placed greater value on environmental, public health, and aesthetic aspects of a site (Greenberg and Lewis 2000; Turvani, Paccagnan, and Tonin 2007). These studies suggest that understanding public interests and encouraging public participation are important in developing effective brownfield project engagement strategies.

Planners and designers are more likely to benefit from visual preference studies that are useful in understanding public attitudes and preferences for various types of brownfield sites, that can range from abandoned industrial buildings to green, vacant parcels that were once used for gas stations or dry cleaners, as well as for sites undergoing different stages in the brownfield recovery process, including pre-reclamation, post-reclamation, and remediation (Hofmann *et al*. 2012; Lafortezza *et al*. 2008; Ruelle, Halleux, and Teller 2013; Sklenicka and Molnarova 2010; Svobodova *et al*. 2012).

Past perceptual and preference studies explore environmental characteristics that influence landscape perception of brownfield sites (Hofmann *et al*. 2012; Lafortezza *et al*. 2008; Ruelle, Halleux, and Teller 2013; Sklenicka and Molnarova 2010; Svobodova *et al*. 2012). However, these studies investigate urban and natural landscapes more generally; it is unclear how much these findings can be particularly useful for brownfield landscapes. This study fills this knowledge gap by conducting a visual preference survey (VPS) of brownfield sites with a wide range of different conditions, including industrial remnants and leftover built-structures that have not been explored much in previous research.

2.2. Landscape assessment

Visual preference studies are part of a larger field of research, landscape perception and assessment. Historically, landscape assessment has been an important area of study due to the need to manage scenery along with other resources. In the 1960s, there was a movement to protect the natural scenery as a natural resource from timber harvesting and mining (Gobster 1999). Understanding people's preferences for natural scenery and landscapes was an important part of that movement. The theoretical background of landscape assessment is based on a model of shared human and landscape interactions (Zube, Sell, and Taylor 1982). In this model, scholars recognize that experts and non-experts perceive landscapes differently (Daniel 2001; Daniel and Vining 1983; Lothian 1999; Zube, Sell, and Taylor 1982). Expert paradigms emphasize the importance of a trained professional's ability to judge the landscape according to the meanings it holds for them, whereas non-expert paradigms emphasize the role of humans to understand and function in a landscape. This potential for use is called affordance (Gibson 1979). This is also based on psychological models, which suggest that landscape assessment or perception is influenced by emotional and cognitive reactions to a place (Appleton 1975; Daniel and Vining 1983; Gibson 1979; Herzog 1995; Kaplan, Kaplan, and Wendt 1972; Kaplan 1990). To measure people's reaction to different types of landscapes researchers use a content identifying methodology (CIM) developed by environmental psychologists, Steven and Rachel Kaplan (Kaplan, Kaplan, and Wendt 1972; Kaplan 1990). CIM asks people to provide their preference for different landscape scenes or photographs. Using photographs of landscapes is an accepted approach to understanding people's perceptions of various environmental settings (Hanyu 2000; Herzog and Chernik, 2000; Shuttleworth 1980).

2.3. Research objectives

The purpose of this paper is to understand the attitude and preference of local residents to brownfields and the factors affecting these attitudes and preferences. The objective of this study is to develop a brownfield landscape typology which may provide a useful framework for local-level brownfield management (site assessment and prioritization) and develop a public engagement strategy for early stage area-wide planning. The results of this study are expected to contribute to a more balanced approach by complementing existing contamination risk-based assessment and expert-oriented approaches presently being used. The objectives of this research are as follows:

- To develop a brownfield typology based on landscape assessment in order to establish multiple assessment criteria for local-level brownfields;
- To understand attitudes and preferences of local residents toward different types of brownfield landscape that might be useful in early stage public outreach and engagement;
- To identify the relationship of residents' preconceptions and health concerns and their attitude and preference toward different types of brownfield landscapes.

3. Methodology

3.1. Study area and context

The study location is the Railway Corridor Revitalization Project area in the City of Roanoke, Virginia, a city with a well-known industrial history (Figure 1). After the railroad was completed in 1882, the city's economy emphasized manufacturing industries. However, as transportation modes changed, industries closed, leaving workers unemployed. Roanoke's rates of economic and population growth have been below the state and national averages since the 1960s. Roanoke has been a recipient of EPA's Brownfield Area-wide Planning Program since 2010. This federal grant, in its most recent phase, has supported a more localized approach. The rail corridor area is located about 1.5 miles west of the downtown area and includes approximately 60 brownfield sites surrounded by the eight neighborhoods of Loudon-Melrose, Harrison, Gilmer, Gainsboro, Hurt Park, Old Southwest, West End, and Mountain View (Figure 1). The brownfield types are fairly typical and largely consist of the remnants of small- to medium-size industries, including manufacturing industries (steel manufacturing, pharmaceutical manufacturing, automobile manufacturing, and chemical manufacturing), light industries (text mills, tannery factory, utility substation, corner gas station), and small vacant commercial and housing lots.

3.2. Visual preference survey (VPS)

The first part of the study, a VPS, was conducted for residents near the rail corridor. Since one of the research objectives was to identify brownfield typology, a wide range of brownfield sites were used. During June and July 2013, more than 300 scenes were photographed using a digital camera with 16.2 megapixels and an optical zoom lens. An area-wide planning map of the City of Roanoke was used to decide the location of the photographs.

The 300 scenes were put through a screening procedure to eliminate scenes that had poor exposure or content not relevant or common to brownfields. A total of 60 scenes

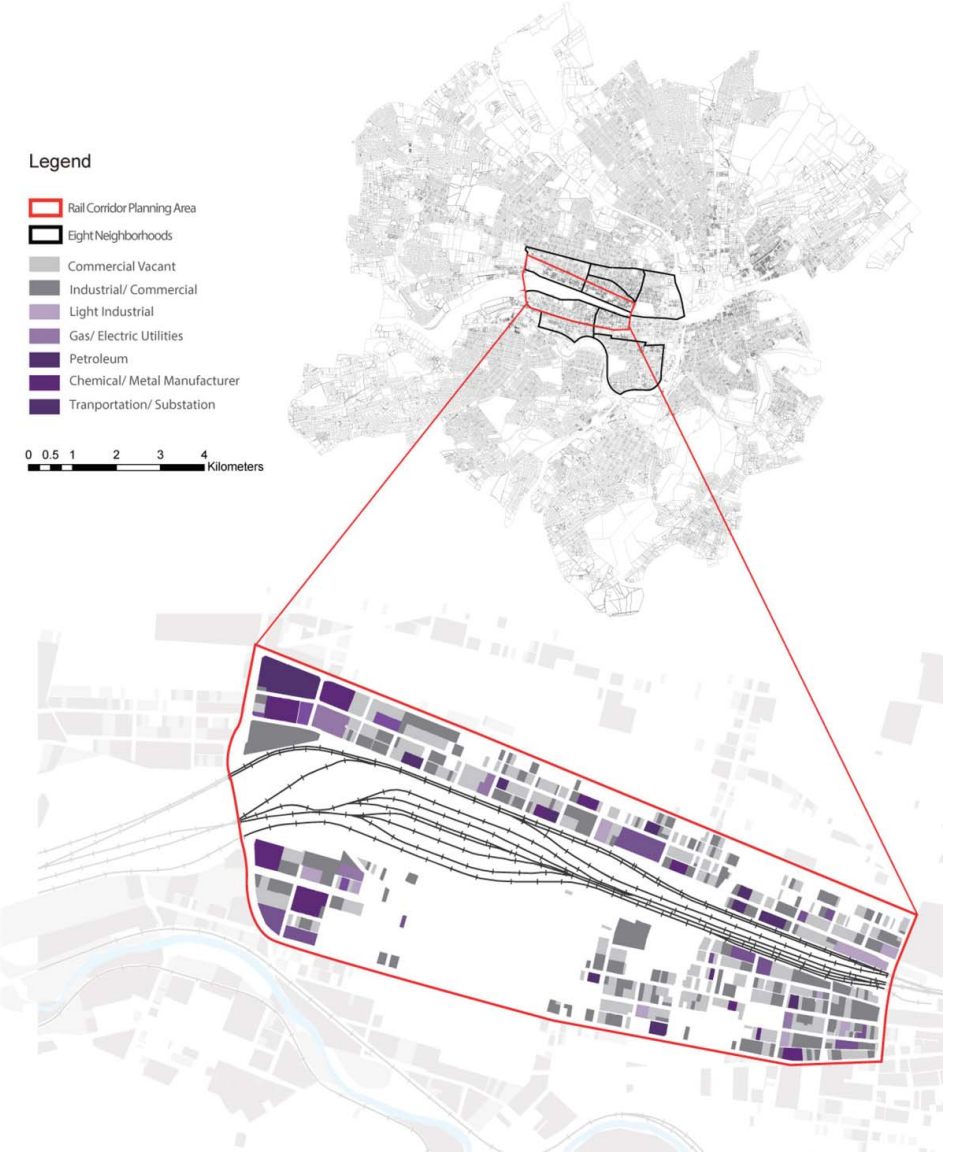

Figure 1. Rail corridor area, City of Roanoke. (See online color version for full interpretation.)

were selected to represent the range of brownfield landscapes that were present and to assure that there was some repetition needed for statistical analysis. It is important in the scene selection to make sure there is sufficient repetition of scene types. Instead of using simple random sampling that can exclude important, but infrequently occurring, types of brownfield, a stratified random sampling method was used. This method partitions the scenes into subsets called strata and selects a simple random sample from each stratum (Pedhazur and Schmelkin 2013).

The scenes collected were categorized into 14 groups representing a range of conditions: enclosed wild nature areas, open wild fields, wild natural areas with topographical changes and coarse ground texture, wild natural areas with leftover structures, neat and enclosed green areas, neat medium-sized open spaces with clear access, historical buildings with natural vegetation, abandoned buildings surrounded by wild nature, industrial facilities and automobiles, and so on. Additional photographs were taken to remedy gaps identified in the content. Then, four to five scenes from each category were selected using a random number generator. As a result, a set of 60 scenes was created for the survey. In addition, for the scene description survey, 14 brownfield scenes, one from each category, were randomly selected from each category.

Sixty brownfield scenes, presented in an $8.5'' \times 11''$ booklet with two scenes per page, were shown to the participants. To reduce the effect of neighboring scenes, no more than two consecutive scenes from the same categories or conditions were placed adjacent to each other. To reduce 'order effect,' two variants of the scene booklet were created, one based on the original order (scene booklet A) and the other with the order reversed (scene booklet B). Participants were asked to rate a set of 60 scenes using a seven-point Likert scale (-3 = dislike very much, -2 = quite dislike, -1 = dislike, 0 = neutral, 1 = somewhat like, 2 = quite like, 3 = like very much). Participants were also asked to provide a word or two that best described a subset of 14 scenes. These verbal labels are intended to reveal particular environmental stimuli in different scenes that the participants reacted to when they rated the scenes. Scene description was used because this method reduces the bias of the researcher by guiding their interpretation process (as cited in Woods 1995).

3.3. Questionnaire survey

Another purpose of the survey was to test the effect of participants' preconceptions and health consciousness level on preference ratings for different types of brownfields. Sixteen items related to *attitude toward brownfield sites* were included in the survey to measure preconceptions of the participants. For example, they were asked to respond to statements such as 'Brownfields are not safe places to go,' 'Brownfields pollute our water supply,' 'Brownfields are opportunities waiting to happen,' and 'Brownfields are interesting places to explore.' A seven-point Likert scale was used for this rating (-3 = strongly disagree, -2 = disagree, -1 = somewhat disagree, 0 = neutral, 1 = somewhat agree, 2 = agree 3 = strongly agree).

To measure participant health concerns, the participants were asked about their beliefs in the likely presence of pollution on a brownfield site (e.g. gas stations, dry cleaners, housing, grocery stores, hardware stores, steel manufactures, and chemical manufacturing plants) and how these brownfield sites might impact their health (e.g. asthma, birth defects, cancer, chemicals in drinking water, and lead-poisoning). For example, the participants were asked to what extent the participants believed that someone living next to a brownfield site should be concerned about different types of health-related problems, including: asthma, birth defects, cancer, chemicals in drinking water, lead-poisoning, eye and skin diseases, and physical hazards to children. A seven-point Likert scale was used for rating both sets of items (-3 = not at all concerned, -2 = very low concern, -1 = slightly concerned, 0 = neutral, 1 = moderately concerned, 2 = very concerned, 3 = extremely concerned).

In total, 200 residents in eight neighborhoods participated in the survey. Based on household addresses within a certain neighborhood boundary, a systematic sampling

Table 1. Survey participants.

Participants		Number	Percent
Total participants		200	100.0
Sub-category			
Gender	Male	89	44.5
	Female	111	55.5
Ethnicity	Black	95	47.5
	White	81	40.5
	Mix	7	3.5
	Other	8	4.0
Age	10−30	58	29.0
	30−50	84	42.0
	Above 50 years	57	28.6
Income level	Less than $25,000	97	48.5
	$25,000−50,000	46	23.0
	More than $50,000	33	16.5
Education level	High school	80	40.0
	College	70	35.0
	More than graduate	47	23.5
Living period	Less than 1 year	52	26.0
	1−10 years	70	35.0
	More than 10 years	71	35.5
Neighborhood meeting attendance	Never	121	60.5
	More than once every 6 months	42	21.0
Home	Owner	67	33.5
	Renter	125	62.5

method was used. Going door-to-door, we visited every household. Households who did not answer the door, or declined to participate, were excluded. A sample size of more than 180 participants was deemed acceptable for statistical analysis. For dimensional analysis, a sample three to five times the number of variables (60 scene variables for this study) is considered adequate (MacCallum *et al*. 2001; Hatcher 2005). The participants' backgrounds were reasonably balanced for most categories: gender, ethnicity (white and non-white), age (10−30, 30−50, above 50 yrs), income, education level, and length of time in the neighborhood (Table 1). The income level was fairly evenly divided into two groups; those earning less than $25,000 (48.5%) and more than $25,000 (39.5%). For education level, 40% of participants graduated from high school, 35% were college graduates, and 23.5% had some postgraduate education. The length of time they had been living in their neighborhood was evenly divided between three major groups: less than 1 year (26%), 1−10 yrs (35%), and more than 10 yrs (35.5%).

3.4. Data analysis

Four different types of data analysis procedures were used in this research: dimensional analysis, content analysis, mean rating and frequency analysis, and analysis of variance

(MANOVA and ANOVA). All the collected survey data were entered into a Microsoft Excel database, after which the Statistical Program for Social Scientists (SPSS) software program version 21 was used for further data analysis. All the statistical analyses were tested at the 95% significance level.

In accordance with the purpose of this study, to identify a brownfield landscape typology, a dimensional analysis (factor analysis) was conducted to determine whether useful scene categories could be identified based on preference rating patterns. The factor analysis followed a specific set of guidelines: (1) The eigenvalue of the factor analysis was set to at least 1.0. As the eigenvalue increases, the sensitivity of the grouping rationale decreases. The factor analysis was conducted twice with two eigenvalues (1.0 and 1.5) and the results compared. (2) Varimax was used for the rotation procedure. (3) The scenes with a loading factor under 3.0 were excluded from the dimension groups. (4) Each dimension had to have at least three scenes. If not, the dimensions were excluded.

Through a content-identifying method, different descriptive labels were given to each dimension based on scene content and spatial qualities. The content analysis of the participants' verbal descriptions ensured the author's interpretations were accurate. A mean preference was calculated using the scenes in each dimension and then was ranked. To identify the effect of preconception and health concern factors, multivariate analysis of variance (MANOVA), one of the general linear model procedures, and analysis of variance (ANOVA) were conducted. The MANOVA analysis was conducted with all the dependent variables (preference dimensions), and independent variables (preconception and health concern) involved to determine if mean preference ratings in any dimension differ significantly among the various sub-groups. Based on the MANOVA results, an ANOVA analysis was conducted to examine each particular preference dimension to determine whether mean preference ratings differ significantly among the sub-groups. Lastly, if the ANOVA analysis did reveal significant differences among sub-groups in a particular dimension, a multiple comparison analysis was conducted to compare how the various sub-groups differed from one another.

4. Results

4.1. Six types based on preference rating pattern

Factor analysis yielded six different brownfield landscape types. The number of scenes belonging to each dimension varies from 3 to 17. Figure 2 depicts the factor loading for each scene. To identify internal consistency among items in each type, a reliability test was conducted. Results show moderate to high internal consistency using Cronbach's alpha values among items (Figure 2). The alpha value ranges from 0.71 to 0.94. This means that the scenes in each dimension are highly correlated and reliable. The histograms in Figure 3 present the rating distribution of selected individual scenes.

Based on the content analysis, a descriptive name for each landscape type was determined. The first type identified consists of clean-looking buildings of a historical style ('historical landmark' type). These scenes are commonly characterized by landmark-type buildings with an interesting exterior, a pitched roof, three-dimensional relief details in the façade, window, and door frames, and different materials for the foundation.

The second type consists of six scenes of empty, managed green spaces resembling a small neighborhood park ('maintained landscapes with scattered structures' type). These scenes are commonly characterized by a well-maintained landscape with a textured

Figure 2. Six dimensions based on factor analysis.

groundcover and a pleasant-looking background, with well-maintained houses and mature trees, implying human influence. The dominant feature is a flat, expansive open lawn at the front without any plantings to block the view. Clean-cut edges such as sidewalks define the space in the scenes.

The third type consists of 14 scenes of highly natural green areas with diverse planting species resembling natural landscape (‘scruffy vegetation’ type). These scenes are commonly characterized by overgrown, tangled vegetation with rough ground texture and topographical changes. The dominant features are natural, overgrown vegetation and a dynamic mix of species. The scenes rarely contain visible paths or buildings; however, there is some visual penetration.

The fourth type consists of 12 scenes of old, plain buildings that were previously used for commercial, residential, and industrial purposes (‘plain modest rundown structures’ type). The dominant feature here is a series of non-industrial purpose buildings. Most of the buildings have outworn parts and a battered look (i.e. peeling paint, broken windows

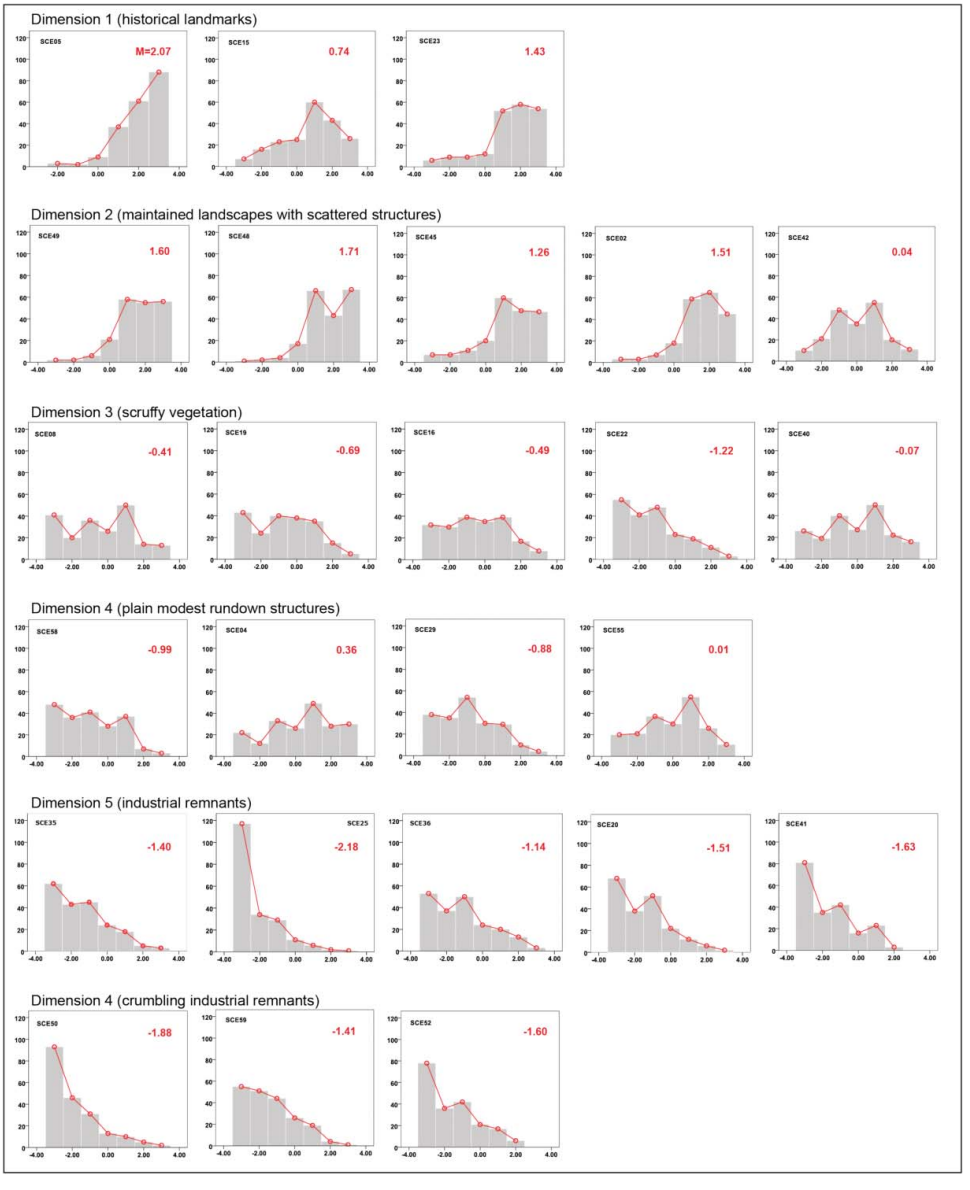

Figure 3. Rating distribution of individual scene.
Note: X (horizontal) axis indicates the range of score from -3 to $+3$; Y (vertical) axis indicates the number of respondents assigning the specific score; top three to five scenes selected in each dimension based on factor loadings; red text = mean of scene rating. (See online color version for full interpretation.)

and entry doors, and old or empty signboards). The scenes present clear evidence of a lack of human care.

The fifth type consists of 17 scenes representing strong industrial characteristics with visible evidence of industrial operations ('industrial remnants' type). The dominant features of the scenes in this category are noticeable industrial facilities, such as factories, machines, and containers. Some scenes include overgrown, tangled vegetation. The

scenes contain both partially active industrial areas with high accessibility and closed industrial areas or junkyards that no longer operate and rarely contain visible access points. However, both areas commonly contain unique industrial objects, structures, and buildings that remind people of the area's industrial history.

The sixth type consists of six scenes of industrial remnants that are being encroached upon by overgrown, tangled plant species ('crumbling industrial remnants' type). Unlike the industrial remnants type, in which the clear focus was unique industrial features, the dominant features of this group are overgrown weeds covering buildings, paved surfaces, containers, and fences. These scenes contain either no clear access paths or broken paths that are encroached upon by overgrown weeds. The scenes present clear evidence of a lack of human care (i.e. weeds, broken windows, outworn building exteriors, and trashed containers).

4.2. Ranking of preference dimensions and three major groups

To identify the magnitude of participants' preference, six types were ranked using mean ratings of the scenes in each type (Figure 4). The highest rated type was 'historical landmarks' (mean = 1.41, SD = 1.13), followed by 'maintained landscapes with scattered structures' (mean = 0.99, SD = 0.96), 'scruffy vegetation' (mean = −0.50, SD = 1.26), 'plain modest rundown structures' (mean = −0.60, SD = 1.10), 'industrial remnants' (mean = −1.37, SD = 1.09), and lastly, 'crumbling industrial remnants' (mean = −1.55, SD = 1.09). Based on the magnitude of mean preference and rating distribution, the six types of brownfield sites are largely divided into three major groups: the 'commonly more preferred' group, the 'in-between' group, and 'commonly less preferred' group, each of which would benefit from a specific type of planning and management.

Each group exhibits a different rating distribution, as shown in Figure 5. The scores for scenes in the commonly more preferred and commonly less preferred group, as shown

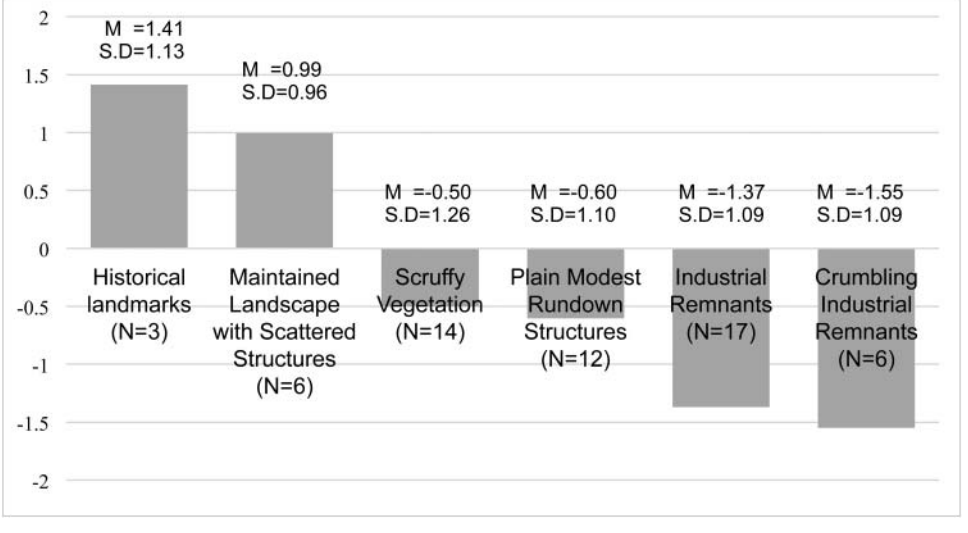

Figure 4. Histogram of rankings of preference means; N = number of scenes.

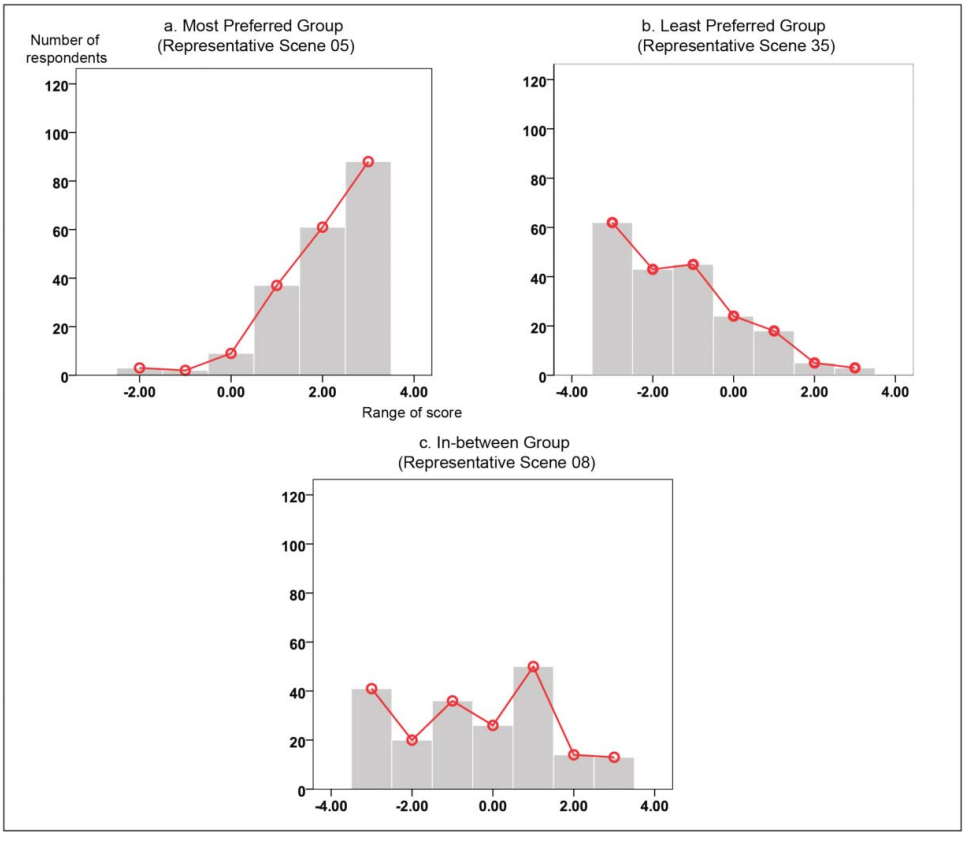

Figure 5. Rating distribution of representative scenes in three groups.
Note: *X* (horizontal) axis indicates the range of score from −3 to +3; *Y* (vertical) axis indicates the number of respondents assigning the specific score; scenes '05,' '35,' '08' received the highest factor loading in dimensions.

in representative scenes (scene 05, 35), present a more concentrated rating range distribution (from +1 to +3 or from −1 to −3). In contrast, scenes in the 'in-between' group had a wider rating range distribution (+3 to −3). These results indicate that participants had widely varied preferences for scenes belonging to the in-between group ('scruffy vegetation' and 'rundown structures') compared to the other two groups that present relatively consistent rating patterns.

4.3. The effect of preconception

People's preconception of brownfields is one of the challenges experienced by local brownfield program managers in their community outreach activities (Kim, Miller, and Kim 2015). This study assumed that participants with different preconceived ideas about brownfields may have different preferences for certain types of brownfield landscapes. Participants were asked to indicate their level of agreement for 16 statements presenting a range of problems and opportunities associated with brownfield sites. To identify the preconceptions and health concerns influencing participants' preferences, we analyzed this data using MANOVA and ANOVA.

Table 2. Three types of preconception.

Statements	Factor loading 1	2	3	Categories
Lower property values	0.88			Broad-based problem
Discourage community pride	0.73			
Are eye-sores in the neighborhood	0.65			
Are not safe places to go	0.61			
Pollute our water supply	0.60			
Encourage vandalism	0.60			
Provide places for unsavory individuals to hang out	0.50			
Often contain dangerous objects for children		0.75		Maintenance difficulties and dangerous objects
Are difficult to maintain		0.74		
Are interesting places to explore			0.80	Development opportunities/natural and cultural assets
Are important parts of our industrial heritage			0.69	
Are opportunities waiting to happen			0.58	
Provide needed trees and greenery			0.53	

Using factor analysis, the statements are grouped into three categories: one group with positive statements (development opportunities, natural and cultural assets), one group with negative statements about broad brownfield site problems (broad-based problems), and one group with statements about more specific brownfield problems (maintenance difficulties and dangerous objects) (Table 2).

The MANOVA and ANOVA results (Table 3) show that participants' preconception of specific brownfield problems (maintenance difficulties and dangerous objects) significantly influenced their preference of certain types of brownfield landscape (F 2.704, $p < 0.016$). In particular, the results from the ANOVA test show that there are significant preference rating differences among the three agreement level groups for types 4 (plain modest rundown structures), 5 (industrial remnant), 6 (crumbling industrial remnant).

Results from multiple comparison analysis indicate that preference means for above three types decrease significantly when participants agree with statements about specific brownfield problems (maintenance difficulties and dangerous objects). This indicates that participants with strong preconceived notions that brownfields are difficult to maintain and contain dangers might focus on those aspects, leading to lower preference ratings for the above three brownfield landscape types. In addition, based on the scene content and spatial organization of these landscape types, the results also suggest that people might be influenced by maintenance difficulties and dangers from leftover building structures, industrial remnants, and scruffy vegetation (types 4, 5, 6).

As presented in Table 4, participants' preconceived ideas of the potential benefits of brownfields (development opportunities, natural and cultural assets) significantly influenced their preference toward certain types of brownfield landscapes (F 3.221,

Table 3. MANOVA and ANOVA for agreement on maintenance difficulties and dangerous objects.

Preconception type	MANOVA				Multiple comparison		
Maintenance difficulties and dangerous objects	F	Sig	ANOVA		Disagreed	Neutral	Agreed
	2.704	0.016					
1. Historical landmark				0.231 (not sig.)	1.65	1.47	1.31
2. Maintained landscapes with scattered structures				0.375 (not sig.)	0.99	1.13	0.87
3. Scruffy vegetation				0.07 (not sig.)	−0.31	−0.31	−0.77
4. Plain modest rundown structures			4.304	0.015	−0.27	−0.73	−0.82
5. Industrial remnant			4.458	0.013	−1.02	−1.49	−1.56
6. Crumbling industrial remnant			3.183	0.044	−1.31	−1.47	−1.79

Note: For analysis, three groups were considered, based on mean scores for categories (maintenance difficulties and dangerous objects) identified during factor analysis. The participants were divided based on the category percentile, specifically, the 33rd and 66th percentiles in order to evenly distribute the participants, since MANOVA analysis produces the best outcome when there are a similar number of variables assigned to each group. Using a seven-point Likert scale (−3 to +3) for all of the questions, scene preference means show both positive and negative magnitude.

Table 4. MANOVA and ANOVA for agreement on opportunities and assets of brownfield.

Preconception type	MANOVA				Multiple comparison		
Development opportunities, cultural and natural assets	F	Sig	ANOVA		Disagreed	Neutral	Agreed
	3.221	0.005					
1. Historical landmark			4.269	0.016	1.10	1.59	1.59
2. Maintained landscapes with scattered structures				0.308 (not sig.)	0.77	0.90	1.03
3. Scruffy vegetation			3.105	0.047	−0.80	−0.48	−0.24
4. Plain modest rundown structures			7.734	0.001	−1.05	−0.55	−0.30
5. Industrial remnant			5.739	0.004	−1.74	−1.20	−1.13
6. Crumbling industrial remnant			6.200	0.003	−1.91	−1.31	−1.29

Note: For analysis, three groups were considered, based on mean scores for categories (development opportunities, cultural and natural assets) identified during factor analysis. The participants were divided based on the category percentile, specifically, the 33rd and 66th percentiles in order to evenly distribute the participants, since MANOVA analysis produces the best outcome when there are a similar number of variables assigned to each group. Using a seven-point Likert scale (−3 to +3) for all of the questions, scene preference means show both positive and negative magnitude.

$p < 0.005$). In particular, the ANOVA results indicate that there are significant preference rating differences among the three agreement level groups for all types except type 2.

Results from multiple comparison analysis also indicate that mean preferences for all types, except type 2, increase significantly when participants agreed with positive statements (development opportunities, natural and cultural assets). This indicates that participants with strong preconceived ideas that brownfields provide opportunities for development, nature, and culture may focus more on those aspects and be more likely to prefer brownfield landscape scenes than other participants. In addition, based on scene content and spatial organization, these results also suggest that these participants are more likely to see development, natural, or cultural opportunities in rundown buildings, industrial remnants, and structures covered with natural vegetation. However, since types 5 and 6 were some of the least preferred types, the number of participants who see these industrial remnants as opportunities may be small.

4.4. The effect of health concern

People's health concerns regarding brownfield sites may be one of the most important influences on brownfield preference. This study tested the possible relationship between health concern and brownfield landscape preference. Participants' level of concern for the effect of brownfield sites on the health of those living nearby was measured using a list of seven different types of illness or health problems (Table 5). The mean analysis revealed that participants were moderately to extremely concerned about brownfield sites' potential for adversely affecting nearby residents' health. For example, the participants were extremely concerned about 'physical hazard to children' (mean = 2.46, SD = 0.94), 'chemicals in drinking water' (mean = 2.27, SD = 1.23), 'lead-poisoning' (mean = 2.26, SD = 1.17), and moderately concerned about 'birth defects' (mean = 1.49, SD = 1.66).

Table 6 shows that participants' health concerns associated with brownfields (concern level on health problems of those living nearby brownfield sites) significantly influenced their preference toward certain types of brownfield landscape (F 2.996, $p < 0.008$). In particular, the results from the ANOVA test show that there are significant preference rating differences among the high concern, moderate concern, and low or no concern groups for the scruffy vegetation type, the plain modest rundown structures type, the industrial remnant type, and the crumbling industrial remnant type.

Table 5. Health problem types.

Types	*n*	Mean	Std. deviation
Physical hazard to children	195	2.46	0.94
Chemicals in drinking water	195	2.27	1.23
Lead-poisoning	195	2.26	1.17
Asthma	195	1.91	1.48
Cancer	194	1.84	1.44
Eye and skin disease	195	1.78	1.50
Birth defects (i.e. premature birth, infant mortality)	195	1.49	1.66

Table 6. MANOVA and ANOVA for belief in effect to health.

Categories	MANOVA				Multiple comparison		
Effect to health	F	Sig	ANOVA		Low or no concern	Neutral	Concern
	2.996	0.008					
1. Historical landmark				0.095 (not sig.)	1.58	1.16	1.46
2. Maintained landscapes with scattered structures				0.301 (not sig.)	1.07	0.81	1.00
3. Scruffy vegetation			3.302	0.039	−0.23	−0.53	−0.78
4. Plain modest rundown structures			5.171	0.007	−0.27	−0.62	−0.91
5. Industrial remnant			6.902	0.001	−1.05	−1.40	−1.72
6. Crumbling industrial remnant			5.613	0.004	−1.25	−1.58	−1.86

Note: For analysis, three groups were considered based on mean scores for effect to health, composite value calculated using mean concerns about seven different health problem types. The participants were divided based on the category percentile, specifically, the 33rd and 66th percentiles in order to evenly distribute the participants, since MANOVA analysis produces the best outcome when there are a similar number of variables assigned to each group. Using a seven-point Likert scale (-3 to +3) for all of the questions, scene preference means show both positive and negative magnitude.

Results from multiple comparison analysis indicate that preference means for the four types decrease significantly when participants' health concern level increases. Based on the scene content and spatial organization, these results also suggest that people may be reminded of harmful substances from the leftover rundown structures, industrial facilities, and scruffy vegetation that are present in the scenes (types 3, 4, 5, 6). For example, regardless of the actual pollution level in the brownfield sites, a highly natural appearance (type 3), leftover building structures (type 4), evidence of industrial operations (type 5), outworn industrial facilities with scruffy vegetation (type 6) in a brownfield might be thought to indicate the presence of toxic materials and thus evoke a feeling of unsafety in health-conscious participants.

5. Discussions

The most recent changes in the approaches to brownfields motivated this research, highlighting the crucial turning point that has revolutionized our thinking about the importance of adopting the new ways of dealing with brownfield sites to reveal the opportunities they offer and to enable planners and designers to engage more effectively with community interests.

5.1. Theoretical significance

In regard to the theoretical significance of this research, the identified environmental factors related to the patterns of preference for brownfield landscape fit well with existing theories concerning environmental perceptions. Some of the important similarities between the factors identified in this research and the precedent environmental perception theory, such

as Kaplans' information processing theory and Nassauer's neat and orderly landscape were found. More importantly, this research expands the precedent findings by including unprecedented environmental elements particularly found in brownfield landscape.

For brownfield-related perception and preference studies, although the earlier studies have contributed to our knowledge regarding perceptions and preferences for brownfield landscapes to some extent, their findings do suffer from constraints. The implications from general perception studies tend to concentrate on providing advice related to reconsidering existing program objectives or strategies for government. Although visual preference studies seem to provide more useful guidelines for planners and designers that include influential environmental characteristic factors, the research evidence for brownfield landscapes is not very different from those from past studies conducted for other types of urban or natural landscapes, probably due to the lack of the use of suitable landscape scenes that include elements typically seen in brownfield sites. Most of the precedent studies began by producing lists of significant factors based on environmental attributes (i.e. naturalness, built-up areas, vegetation patterns and types, degree of enclosure, accessibility) and human attributes (i.e. gender, income, education, profession). For example, one study found high artificiality and both extremes of canopy closure and prospects to be important positive factors for resident's preferences (Hofmann *et al*. 2012). They then went on to develop a deeper understanding, for example by exploring how a high level of artificiality is related to a positive view of human influence in the form of maintenance. Similarly, the preference for an extreme degree of canopy closure was explained related to Gibson's prospect and refuge theory, which states that human survival requires the ability to see without being seen. Lastly, the identified environmental characteristics were discussed in terms of other influential human or context factors. For example, one study found that significant differences between stakeholders and employees emerged in alternative remediation options, where scenes containing large groups of trees may limit the visibility of industry and possibly be seen as requiring a higher cost for establishment, and were thus less preferred by stakeholders than employees (Lafortezza *et al*. 2008).

The limitations of the earlier studies have contributed to the design of this study, for example by ensuring that visual stimuli presenting exclusively brownfield site characteristics are included in the survey scenes. By doing so, this research revealed the list of unprecedented significant environmental attributes (e.g. industrial remnants, abandoned structures, degree of coverage of wild nature), as well as their relationship with the background factors (e.g. health concern, preconception of brownfields), which have not been investigated in previous studies.

5.2. Practical implications

The results of the attitude and preference research were used to develop a brownfield landscape typology and identify three major groups that would suggest a different level of challenges in reuse planning and public engagement. Along with the brownfield landscape types, participants' characteristics and backgrounds that affected their preference ratings for different types of brownfield landscapes were also identified. These findings provide baseline data in order to establish a reuse design and planning approach and engage local communities' support at an early stage.

5.2.1. Three major groups involving different levels of planning challenges

Based on factor analysis, participant preference data yielded six types of brownfield sites, which can largely be divided into three major groups. Regardless of whether pollution is present or not, designers and planners will face different levels of public support for landscapes belonging to these three groups. The first group ('historical landmarks' and 'maintained landscape and scattered structures') received easily the highest preference scores overall, regardless of participant preconception and health concern. This result implies that these types may be viewed less critically and are thus more likely to mask potential harm. They may be more easily accepted by the community for redevelopment, but this does not mean they should not be made safe, if necessary.

At the other extreme lies the third group, the industrial remnant group, which will be the most difficult to redevelop because of the stigma of pollution and health concerns. The majority of participants did not prefer the two industrial remnant types, and preconceptions and health concern factors affected the preference ratings. While the majority of participants disliked these landscapes, the participants who were more sensitive to health issues disliked them significantly more. This indicates that participants in general tend to associate industrial remnants with the type of toxic pollutants that are likely to adversely affect their family's health. Therefore, it is important that landscape architects and planners seeking to redevelop industrial remnants recognize the challenge in doing so. They may need to upgrade those sites before engaging people and reassure community residents regarding safety concerns.

There are interesting differences in preference ratings between the two industrial remnant types. 'Industrial remnant,' which consisted of scenes depicting clean and neat industrial facilities, received slightly higher rating scores than 'crumbling industrial remnants,' which included outworn facilities covered with overgrown vegetation. Participants seem to be influenced by a clean and neat landscape, even where there is clear evidence of industrial operations. In other words, an industrial site with a clean and neat appearance elicits slightly more positive perceptions, even if the site contains toxic pollutants. In contrast, the unkempt appearance of outworn industrial sites or the presence of industrial trash, such as machines and vehicles, will tend to be perceived as toxic regardless of whether they contain toxic pollutants. This suggests removing industrial junk and improving the appearance of a site would be an important part of gaining community acceptance for the redevelopment of a site if it was safe.

Lastly, the second in-between group carries some stigma, but the stigma may be overcome with good community engagement and a clear vision. The 'scruffy vegetation' and 'plain modest rundown structures' types that made up this group produced more mixed feelings among the survey participants, with a more varied and wide range of preference patterns. People's perceptions and health concerns influenced their preference for these landscapes. Participants who focused on the potential uses of these brownfield sites, such as development opportunities, natural resources, and industrial heritage, gave higher rating scores to these landscapes, while those who mostly perceived the negative influences of brownfield sites, such as toxic pollutants, dangerous structures, and places for vandalism, gave lower rating scores to these landscapes. This indicates that people were able to recognize both the positive and negative sides of these types of brownfield sites. These results seem to suggest that people may be more easily led to change their thinking about these sites and switch from negative to positive opinions. This highlights the importance of planners and landscape designers in highlighting certain aspects of the design or development process. They can influence people to focus on certain aspects

rather than others. Planners are more likely to be successful in proposing redevelopment of these types of brownfields if they demonstrate that safety concerns are met.

5.2.2. Active engagement plan for the mixed-feeling and least preferred groups

Based on the survey results, it is recommended that for sites in the in-between and third groups, reuse simulations be utilized to help people overcome stigmas and see a site's potential. It is important to help people believe that good changes can happen. For example, planners can use before and after images, or describe successful cases of similar sites that have already been completed, thus enabling people to see these sites as target areas for redevelopment.

For the in-between types (the 'scruffy vegetation' and 'plain modest rundown structures'), since people have different preferences, it is important to prepare a number of alternative designs. For instance, these designs could either utilize or remove leftover structures and vegetation. These design alternatives can stimulate debate and engage people's attention to build a consensus planning output.

5.3. Limitation and future study

The results from the visual preference survey provide baseline data for early stage engagement that will help alleviate the broad stigma attached to brownfields and support the redevelopment process. However, there is a general lack of information regarding ways to develop specific engagement strategies for other later stages in the redevelopment, such as the more contentious site remediation stage. There is a clear need for differentiated engagement strategies for disseminating the results of the second phase site assessment or for making decisions about site remediation options. During these phases, designers might need guidelines for how they should communicate with people about any risks identified (e.g. contamination types, potential effect on health) without causing unnecessary fear. They should consider approaches to effectively engage people in making remediation technology decisions. Future research is needed regarding people's acceptance of different types of remediation technology and the importance they assign to different characteristics of remediation technology, such as duration, cost, and aesthetic quality.

6. Conclusion

The results of this research provide helpful insights regarding brownfields reuse planning, design, and the public engagement process, such as a revision of definition of brownfield, provision of multiple site assessment criteria, active engagement plan for mixed-feeling and least preferred groups, engagement strategy during site remediation phase, and for different stakeholder groups. The research results also provide baseline data that can be used to enhance policy makers' and design professionals' understanding of people's attitude and preference for different brownfield types. Many cities suffering from economic decline and population loss are urgently seeking better management of abandoned areas to improve the quality of life for people who still live there. The results of this study will assist in solving these urgent urban problems in these cities.

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