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Title:	Policy Recommendations for Sleeping Beauties in Cities: A Framework Based on Brownfield Redevelopment Adoption Barriers and Promotional Strategies in Developing Countries
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Policy Recommendations for Sleeping Beauties in Cities: A Framework Based on Brownfield Redevelopment Adoption Barriers and Promotional Strategies in Developing Countries

Abstract
Considering brownfields as sleeping beauties of urban areas, this study addresses the critical need for implementing land reuse practices to promote sustainability in developing countries, focusing on brownfield redevelopment (BR). Despite the potential of brownfield redevelopment projects (BRPs), various barriers and strategies impact its adoption. The study aims to fill the gap by developing a research framework to quantify the impact of these barriers and strategies on BR implementation in developing countries, with a specific focus on Pakistan. Data collected from stakeholders involved in BR processes were analyzed using structural equation modeling. The findings showed that: 1)' political and legal barriers', 'financial and economics barriers', and 'technical and operational barriers' have a significant negative association with BRPs adoption; 2)' government rules and regulations', 'management and collaboration,' 'brownfield redevelopment benefits awareness and publicity' and 'subsidies and R&D funding' have a significant positive association with BRPs adoption. The results provide valuable insights for urban and environmental policymakers, assisting in developing strategies to overcome barriers to BR adoption and contributing a novel perspective to the existing body of knowledge on brownfield redevelopment. Future research can extend this inquiry by comparing barriers and strategies of BR between developed and developing economies.
Keywords: *Brownfield redevelopment; adoption; barriers; promotional strategies; policy recommendations; developing countries.*

1. Introduction

Brownfield sites are sleeping beauties in city centers, emerged from the degraded and contaminated soils where redevelopment may be complex and have an adverse environmental, social, and economic effect on the sustainable development of the communities (Hou et al., 2023). For the promotion of sustainable communities, the redevelopment of these sleeping beauties (brownfields) is necessary. Therefore, BRPs have gained significant attention all over the World and are considered an important urban policy instrument for many governments in developed countries (Ahmad et al., 2021; Hammond et al., 2023). BR is composed of all activities to remove the hazardous substances and contaminants on the brownfields and redevelop them in accordance with the principles of sustainability. For the effective and successful adoption of BRPs, it is significant to transform the brownfields into Greenfields (Líšková et al., 2022). However, BRPs are still in their early stages in developing countries.

Despite the greater significance of BRPs, many issues, including obstacles, driving forces, and measures, affect BRPs adoption. A greater understanding of all these issues (barriers and measures) is important for BRPs adoption. Therefore, numerous studies have identified the critical barriers to BRPs, and measures facilitating BRPs in different countries (Ahmad, Zhu, Shafait, et al., 2019; Ahmad et al., 2021; Fernandes et al., 2020; Glumac & Decoville, 2020). Most of these studies were conducted in developed countries, and very few studies focused on the BRPs implementation in developing countries. Despte their importance, some limitations are attached to these studies that need to be discussed to promote the successful adoption of BR in developing countries. Although, developing nations are developing BRPs agenda and long-term plans (such as Pakistan), as shown

Figure 1. Development Plans for integrating BRPs in Pakistan

in Figure 1, but it is worth mentioning that BR has not been adopted rapidly in developing countries compared to developed countries due to different barriers. Different countries have different climate conditions, customs and cultures, rules and regulations, land characteristics, BR maturity stages, environmental and socio-economic priorities, and economic development – all of which develop their ways to deal with brownfield issues (Ahmad, Zhu, et al., 2018a; Loures, 2015; Loures & Vaz, 2016). Moreover, BRPs adoption has greater potential for contributing to and achieving sustainable development. Hou et al. (2023) indicated that sustainable development is a context-based perspective, as it is necessary to address the overall society's developmental objectives to integrate social, economic, and environmental aspects (as shown in Figure 2). Considering these issues, BRPs adoption is not at the same pace throughout the world, and it is necessary to explore how BRPs can be effectively implemented within specific regions and economies for sustainable development. Analyzing BR barriers and measures is vital in understanding how to implement BR and promoting sustainable land use practices. However, studies addressing barriers and measures towards BR implementation in developing countries, especially in Pakistan, are rare as highlighted by Ahmad, Zhu, Hongli, et al. (2019); Ahmad, Zhu, Shafait, et al. (2019); Ahmad et al. (2020a). In addition, current studies focusing on barriers and measures towards BR implantation are heavenly based on descriptive and qualitative analysis, and very little knowledge exists about the quantitative impact of different barriers and measures on BRPs adoption in developing countries.

Urban policymakers, environmentalists, researchers, and stakeholders are interested in identifying barriers and measures and determining which barriers and measures are significantly associated with BR implementation. Ning (2014) proposed a framework to check the quantitative impact of barriers and drivers on network strategies adoption in sustainable construction projects and pointed out that quantitative examination of different variables affecting the successful implementation of network strategies is beneficial. Therefore, conducting a similar study in developing countries is worthwhile checking the role of barriers and measures in successful BRPs.

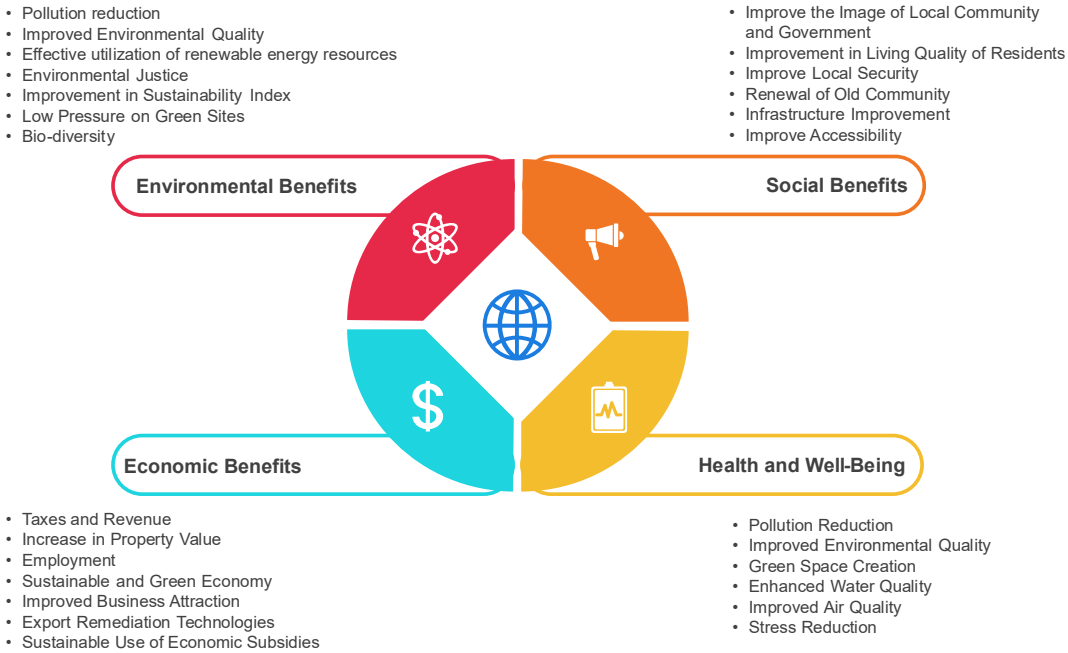

Figure 2. Benefits of Brownfield Remediation Projects

Furthermore, despite the greater importance and role of structural equation modeling (SEM) in sustainability studies, very few studies incorporated SEM in BRPs research in different countries. In developing countries, especially in Pakistan, there is no existence of such kinds of studies. The current study empirically applies SEM to propose a framework and quantitative model to check the impact of different barriers and measures on BRPs adoption. Although BRPs based studies of multilevel frameworks are crucial for both industry and academia, they are rare in developing economies. This study is a sequential part of a large-scope and multi-level PhD research work, and its objective is to promote BRPs in developing economies, especially in Pakistan. Whereas barriers and strategies of BRPs have been reported earlier by using the fuzzy Delphi Method (FDM) and structural equation modeling (SEM) (Ahmad, Zhu, Shafait, et al., 2019; Ahmad et al., 2020b). In these studies, identified barriers and strategies were filtered using FDM and later confirmed using SEM, However, these studies lack the quantitative impacts of barriers and strategies on BRPs adoption by using SEM. A structural framework based on SEM, incorporating the effect of BRPs barriers and strategies on BRPs adoption, is missing.

Therefore, given the above discussion, the objective of the current study is to investigate and model the quantitative impact of different barriers and measures on BRPs adoption in developing countries perspective, more specifically in Pakistan. This research is going to address the following research questions: (1) Do different categories of BRPs barriers (e.g. financial and economic barriers, technical and operational barriers etc.) negatively influence the BRPs adoption in Pakistani context? (2) Do BRPs promotional strategies (management and collaboration, subsidies and R & D funding

etc.) positively influence the BRPs adoption in Pakistani context?

To investigate the impact of BRPs barriers and promotional strategies on BRPs adoption, this study utilized SEM which is a powerful statistical methodology used in different disciplines to examine complex association among variables. SEM allows researchers to analyze the impact of multiple independent variables on dependent variables simultaneously by providing a comprehensive understanding of intricate causal pathways. SEM provides a multi-level model-based understanding of study variables by establishing measurement and structural models both. Therefore, it offers invaluable insights for theory development and practical applications.

Based on the above discussion, this study holds substantial theoretical and practical significance. Theoretical significance lies in understanding the role of different barriers (e.g. financial and economic barriers, technical and operational barriers etc.) and promotional strategies (management and collaboration, subsidies and R & D funding etc.) affecting BRPs adoption. Here, SEM offers a holistic understanding of BRPs adoption process. Practically, the findings of the study would be helpful in BR decision-making and foster the BR process. Further, the results on barriers and measures can support stakeholders, urban policymakers, and environmentalists in devising appropriate strategies to facilitate BRPs implementation.

2. Development of research framework and hypothesis

2.1 Proposed research framework

The research framework is beneficial to promote a new concept and develop new knowledge related to it. It is proposed on the base of theory or logic. This study developed a framework on the base of the theory. Hou et al. (2014) highlighted that earlier BR studies did not establish any research framework to analyze the BR in a specific context. As a result, developing a framework based on earlier studies, they established a framework for analyzing sustainable behavior for adopting contaminated site remediation. It is justified to do so since BR is considered a sustainable land use practice. Hou et al. (2014) framework highlights the institutional impeding forces and institutional promoting forces associated with sustainable behavior for adopting contaminated site remediation. The objective of developing a research framework was to understand the BR process better. Therefore, following the framework of Hou et al. (2014), a framework is developed to check the influence of barriers and strategies affecting BRPs adoption in the current study. The established framework would provide support to understand the brownfield issues in-depth rather than analyzing the separate effect of each issue, e.g., barriers or strategies on BRPs adoption. In the proposed framework, the barriers and strategies can be defined as:

Barriers: These are the impeding forces and problems that restrain the stakeholders from the adoption of BRPs, e.g., lack of laws and regulations and lack of remediation technology.

Strategies: Strategies represent measures and promoting forces that facilitate the adoption of BRPs, e.g., the provision of market-based incentives.

Therefore, following the study of Hou et al. (2014), barriers are considered negatively associated (−) with the BR implementation in the proposed framework, whereas strategies are considered positively associated (+). This information explains the direction of the proposed hypothesis, and it also describes that strategies work to overcome the barriers. These two issues (barriers and strategies) accumulatively affect the decision to implement BRPs; therefore, it is more appropriate to develop a framework consisting of these issues and analyze their effect on BRPs adoption simultaneously. The proposed research framework is presented in Figure 3.

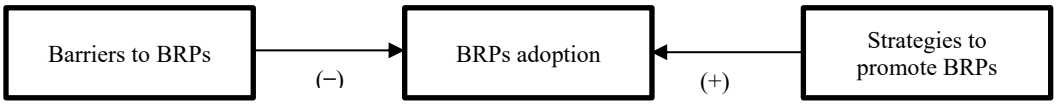

Figure 3. Proposed Research Framework for BRPs adoption in Pakistan

2.2 Development of research hypotheses

This study emphasizes the role of barriers and strategies in implementing BRPs in Pakistan. BR is considered an important policy tool to integrate sustainable development worldwide. Most of the developed countries have implemented BRPs and grabbed the multiple benefits associated with it. However, the implementation of BRPs in developing countries is still in its infancy. Therefore, a large-scale research project was proposed to promote the BRPs implementation in developing countries, especially in Pakistan. The first stage of the research project identified 26 critical barriers to BRPs adoption in the Pakistani context. It grouped these barriers into five main constructs – political and legal barriers (PLB), financial and economic barriers (FEB), technical and operational barriers (TOB), management system barriers (MSB), and environmental barriers (ENB) since a deeper and more comprehensive analysis of barriers is worthwhile to develop measures to overcome them.

In the second phase, further, Ahmad et.al (2019) identified potential strategies to promote BRPs in Pakistan and divided them into five different categories – government rules and regulations (GRR), brownfield site-related strategies (BS), management and collaboration (MC), BR benefits awareness and publicity (BRAP), subsidies and R&D funding (SRD). A list of BRPs adoption barriers and strategies adopted from the earlier studies is shown in Table 1.

Therefore, it can be said that the current study is based on the first study. However, the first study lacks the development of a measurement tool for BRPs adoption. Therefore, following Darko et al. (2018) and Lam et al. (2009), this study adapted the scale for adopting green technologies as there is no measurement scale established to measure BRPs adoption. Therefore, the scale from the studies of green technologies adoption has been adapted according to BR context as BR is one of the emerging approaches to make the environment green and provide plenty of green land for redevelopment. Therefore, this scale better suits the current study after making some modifications.

A comprehensive literature review of BR-related barriers and strategies has been performed in the first part of this study. Earlier sustainability studies indicate that barriers make it difficult to adopt sustainable and green technologies; therefore, they may negatively influence stakeholders' adoption. Therefore, the barriers to BR might have a negative impact on BR implementation. However, the strategies promote the wide adoption of BR among stakeholders, which might positively impact BRPs adoption. Therefore, based on these assumptions and the framework proposed in Figure 2, different hypotheses have been developed:

H1. Barriers have a negative impact on BRPs adoption.

H1a. Political and legal barriers have a negative impact on BRPs adoption.

H1b. Financial and economic barriers have a negative impact ozn BRPs adoption.

H1c. Technical and operational barriers have a negative impact on BRPs adoption.

H1d. Management system barriers have a negative impact on BRPs adoption.

H1e. Environmental barriers have a negative impact on BRPs adoption.

H2. Strategies have a positive impact on **BRPs adoption.**

H2a. Government rules and regulations would have a positive impact on BRPs adoption.

H2b. Brownfield site-based measures would have a positive impact on BRPs adoption.

H2c. Management and collaboration would have a positive impact on BRPs adoption.

H2d. BR benefits awareness and publicity would have a positive impact on BRPs adoption.

H2e. Subsidies and R&D funding would have a positive impact on BRPs adoption.

A model showing the research hypothesis developed above is given in Figure 4. Testing these hypotheses for BRPs adoption could contribute by increasing awareness and understanding about the impact of different barriers and strategies fostering BRPs adoption. This framework-based understanding is significant to support the urban policymakers, environmentalists, and takeholders in developing and implementing essential policies and guidelines to promote the BRPs adoption.

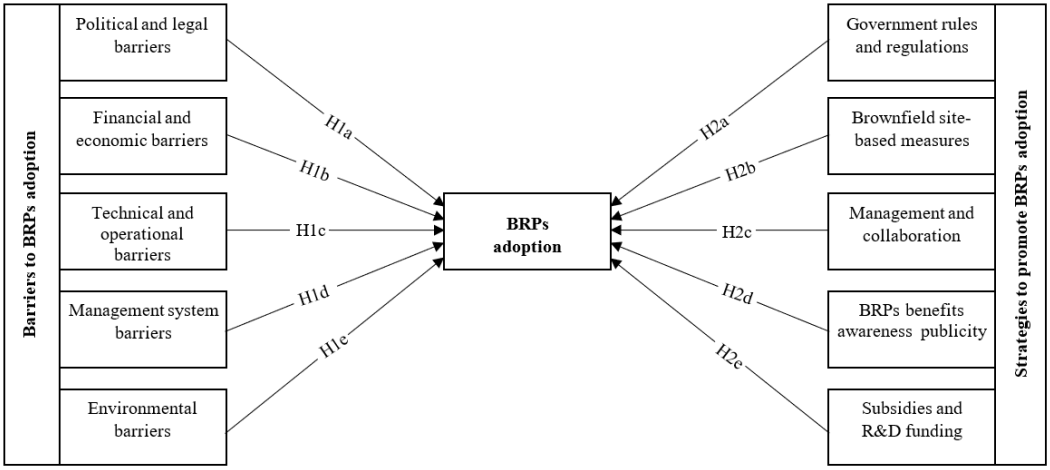

Figure 4. Hypotheses-based model of barriers and strategies impacting BRPs adoption

Table 1. Constructs (barriers/strategies) and related measurement scales from literature

Barriers constructs*[1]	Code	Measurement scale
Political and legal barriers	PLB1	Lack of brownfield-based laws and regulation
	PLB2	Insufficient Policy incentives
	PLB3	Conflict occurrence between local, provincial and federal governments
	PLB4	Ownership constraint
	PLB5	Variations in policies from different governments
	PLB6	Lack of punishment for land mafia
Financial and economic barriers	FEB1	High redevelopment cost
	FEB2	Lack of government funding and support
	FEB3	Inadequate capital investment
	FEB4	Uncertain earnings from redevelopment
	FEB5	No mechanism for Public-Private partnership
Technical and Operational barriers	TOB1	Poor remediation technology
	TOB2	Insufficient risk assessment and management techniques
	TOB3	Incapable technical staff
	TOB4	Complexity in removing hazardous substances
	TOB5	Poor infrastructure (roads, transport) in surroundings
	TOB6	Inadequate site review and studies
Management system barriers	MSB1	Lack of final approval mechanism
	MSB2	Drawbacks of land transfer
	MSB3	No lesson learned from other countries
	MSB4	Conflict between stakeholders
Environmental barriers	ENB1	Inadequate ecological information
	ENB2	No concern for environmental justice
	ENB3	Lack of public interest in environmental issues
	ENB4	Lack of awareness of environmental law
Strategies constructs*[2]	**Code**	**Measurement scale**
Government Rules and Regulations	GRR1	Integrating policies and BR process
	GRR2	Priority for BR in urban sustainability policies
	GRR3	Standardized definition, guidelines, and simplified brownfield process
Brownfield site	BS1	Comprehensive cost estimation for BR
	BS2	Matching cost efficiency with stakeholder responsiveness
	BS3	Infrastructure development in the surroundings of brownfield sites
Management and Collaboration	MC1	Creating management awareness
	MC2	Technical and strategic cooperation with developed countries

	MC3	Developing a pre-handling framework for brownfields
	MC4	e-collaboration among stakeholders
	MC5	Strategic concentration on urban sustainable development
Brownfield redevelopment benefits awareness and publicity	BRAP1	Unleash BR benefits and potential in general public
	BRAP2	Attract investors towards BR
	BRAP3	Promotion of employment opportunities
	BRAP4	Improving perception and image of brownfield redevelopment
	BRAP5	Provision of accessibility
	BRAP6	Provision of a healthy and safe environment
Subsidies and R&D funding	SRD1	Offer market-based incentive for promoting BR adoption
	SRD2	Government funding and low interest loans
	SRD3	Focus on R&D to improve remediation technology
	SRD4	Promoting public-private partnership
BRPs adoption*[3]	**Code**	**Measurement scale**
	BRA1	Relevant authorities and institutions should consider BRPs implementation
	BRA2	Current policy measures are not enough for BRPs
	BRA3	Brownfields database are not available in country
	BRA4	BRPs adoption should be forced by government.
	BRA5	BRPs adoption guidelines are not found to be in Pakistan

1. Research Methodology

3.1 Data acquisition

Following the systematic way of collecting data from the representative sample, the survey method was chosen due to its wide adaptability in sustainability and BR studies (Alberini et al., 2005; Kim & Miller, 2017; Stezar et al., 2014). Earlier research has also indicated the effectiveness of survey-based questionnaires for achieving the research objective through quantitative data (Ackroyd, 1992). Therefore, a survey-based questionnaire for achieving the research objective through quantitative data (Ackroyd, 1992). Therefore, a survey-based questionnaire was chosen to collect data from the stakeholders about the impact of barriers and strategies on BRPs adoption. The questionnaire was composed of five sections. The first section briefly described the objective and importance of BRPs adoption in the Pakistani context. Section sections collected data related to the personal information of the respondents. The third section included questions related to major barriers to BRPs, and the fourth section included questions about the strategies to promote BRPs in the Pakistani context. The last and fifth sections consisted of questions about BRPs implementation. All the questions were rated on the basis of a five-point Likert scale ranging from 1= strongly disagree to 5= Strongly Agree, as the researcher recommended a five-point Likert scale due to its wide application in social and management sciences research and its reliability to obtain un-ambiguous results (Ekanayake & Ofori, 2004).

The targeted population was composed of all stakeholders who could be involved in the BR process.

As no sampling frame existed for the current study; therefore, the sample was considered the nonprobability sample. Considering this issue, this study adopted a non-probability sampling technique to collect data from the representative sample. This technique is useful when the random sampling method cannot be practiced choosing random respondents. Therefore, a combination of sampling techniques, including convenient, purposive, and snowball sampling, was practiced (Fellows & Liu, 2015) due to different advantages: purposive sampling is useful to obtain data from a representative sample that has relevant knowledge and understanding about the research, convenient sampling technique provides a facility of convenient location, time and respondents for data collection and snowball sampling is useful because of its referral system which leads the researchers to collect data from different social networks (Ahmad, Zhu, Shafait, et al., 2018). Considering, BRPs are in its infancy in Pakistan, the data collection was performed over a period of six months—from October 2016 to March 2017—by which time a total of 800 questionnaires had been distributed among the pertinent stakeholders. Eventually, we received 380 responses, out of which only 343 were deemed as valid answers, making the rate of response 43% and the validity rate 90%. Participants included 19 Environmental Protection Agency members, 57 academicians, 25 property managers, 58 landlords, 91 community citizens, 42 municipality workers and 51 NGO members.

3.2 Data analysis

For testing the hypotheses of the study, this study decided to utilize structural equation modeling (SEM), which is the most widely used statistical technique to assess multivariate models. SEM is based on a model comprising two types of variables: 1) Observed variables and 2) latent variables. Observed variables can be measured directly (as these variables are considered measurement scales/items); however, measuring latent variables (considered as constructs of study) is not feasible directly as they are inferred from the measurement scale. SEM validates and confirms the study's hypotheses through a rigorous structural model. Therefore, it is a fact that the SEM approach is more rigorous in assessing hypotheses in comparison to traditional correlation multiple regression analysis and factor analysis (Xiong et al., 2015).

Further, SEM also provides the facility to perform confirmatory factor analysis (CFA) and path modeling by taking a single structural equation model (Eriksson et al., 2017). Generally, a structural equation model is comprised of two kinds of model: 1) measurement model (whereas this model analyzes the relationship the association between construct and measurement items); 2) structural model (which describes the association between constructs) (Hair et al., 2013). Therefore, this study adopted SEM to examine the impact of barriers and strategies on BR implementation using AMOS 21.0 software. The step-by-step study is shown in Figure 5.

4. Results

4.1 Measurement model's evaluation

The current study utilized the two-step approach recommended by Anderson and Gerbing (1988), i.e., initially, the measurement model will be analyzed; then, it will proceed to estimate the structural model. In AMOS 21.0 software, the maximum likelihood estimation model was used to analyze the measurement and structural model. Although the indicators of the data normality were not up to the standards where multivariate kurtosis=52.38 and critical ratio= 26.48, SEM can still be performed as earlier studies found that the maximum likelihood method performs well in comparison to other similar methods, e.g., generalized least square method, even the data normality is not up to the criteria (Schermelleh-Engel et al., 2003).

The measurement model for barriers is comprised of five latent variables and their related indicators,

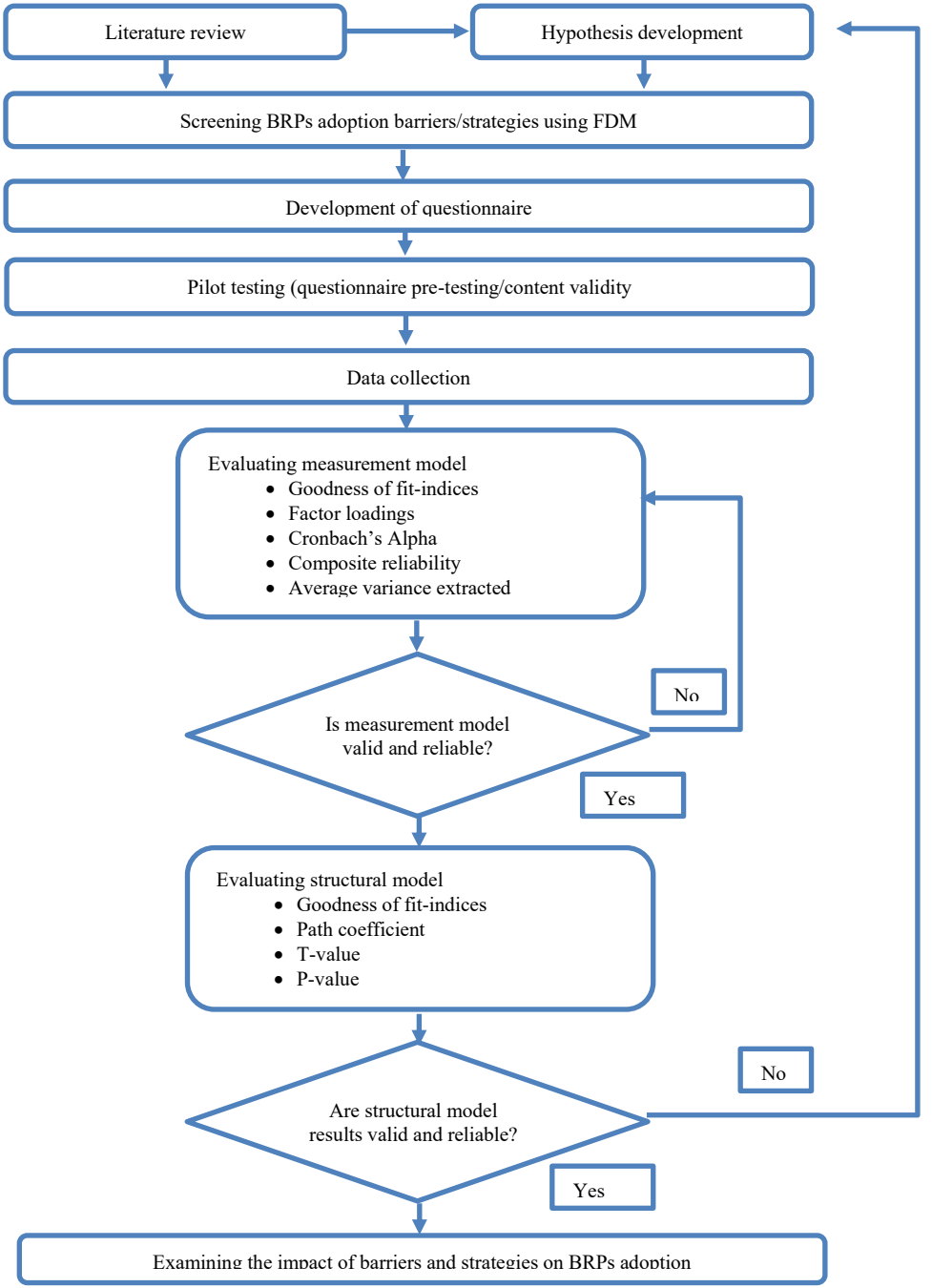

Figure 5. Step by step study scheme of study

i.e., political &legal barriers (6-indicators), financial and economic barriers (5- indicators), technical & operational barriers (6-indicators), management system barriers (4-indicators), and environmental barriers (4-indicators).

The measurement model for strategies to promote BRPs is also comprised of five latent variables and their related indicators, i.e. government rules and regulations (3-indicators), brownfield site (3-indicators), management and collaboration (5-indicators), brownfield redevelopment benefits awareness and publicity (6-indicators), subsidies and R & D funding (4-indicators).

The measurement model was evaluated by practicing the CFA techniques as recommended by Götz et al. (2010). The results of the measurement model show that the Chi-square (x2)/df is 2.863 (barriers) and 2.778 (strategies), which is significant and meets the recommended criteria of Kline (2015), as shown in Table 2. However, many researchers also recommended not focusing on the (x2)/df due to its shortcomings (Schermelleh-Engel et al., 2003). Therefore, this also relied on other measurement model fitness indicators, including RMSEA, SRMR, GFI, AGFI, NFI, and CFI, by following the guidelines of Hu and Bentler (1999). Results of all these fit indices are shown in Table 2, which shows that all the values are according to the recommended criteria and the model has good fitness and could proceed for further analysis.

After investigating the model's fitness, it is essential to evaluate the construct validity, performed by two main standards (Convergent and discriminant validity). This study evaluated convergent validity through the values of factor loadings. The results of factor loadings are significant at 0.000, and their values range between 0.55 and 0.90. Next, the average variance extracted (AVE) values are tested to prove the convergent validity. The values of AVE are between 0.53 and 0.73for both BRPs barriers and strategies respectively, which meets the cut-off criteria of 0.50 and proves sufficient convergent validity. Further, convergent validity was also judged through construct reliability (CR) values. All variables' CR values are more than the threshold of 0.70, proving the reliability of instruments and convergent validity. The results for the measurement model, including factor loadings, CR, AVE, and Cronbach's alpha, are shown in Table 3.

A comparison of AVE values was made with square of correlation estimates between two variables through a recommended approach of Fornell and Larcker (1981) to judge discriminant validity. Results of the correlation estimate between the main study constructs (barriers and strategies) brought a value of 0.32, which is below the values of AVE and evidence of excellent discriminant validity.

Table. 2 Goodness-of-model fit results for the measurement model

GOF measures	Recommended criteria	Findings for barriers	Findings for strategies
Chi-Sq./df	≤ 3.00 (Kline, 2015)	2.853	2.778
RMSEA	≤ 0.08 (Hu & Bentler, 1999)	0.0573	0.0612
SRMR	≤ 0.10 (Kline, 2015)	0.072	0.079
P-Close	P< 0.05 (Kline, 2015)	0.000	0.000
GFI	≥ 0.90 (Browne et al., 1993)	0.951	0.905
AGFI	≥ 0.85(Browne et al., 1993)	0.974	0.952
NFI	≥ 0.90 (Hoyle, 1995)	0.909	0.915
CFI	≥ 0.95 (Hoyle, 1995)	0.984	0.966

Table 3. Results for the measurement model

Construct	Measurement item code	Factor loading	Cronbach's alpha	Composite reliability	AVE
PLB	PLB1	0.759	0.841	0.872	0.551
	PLB2	0.730	–	–	–
	PLB3	0.652	–	–	–
	PLB4	0.738	–	–	–
	PLB5	0.822	–	–	–
FEB	FEB1	0.678	0.776	0.782	0.539
	FEB2	0.673	–	–	–
	FEB3	0.874	–	–	–
	FEB4	0.550	–	–	–
	FEB5	0.814	–	–	–
TOB	TOB1	0.875	0.822	0.894	0.734
	TOB2	0.783	–	–	–
	TOB3	0.604	–	–	–
	TOB4	0.739	0.744	0.771	0.569
	TOB5	0.883	–	–	–
	TOB6	0.579	–	–	–
MSB	MSB1	0.675	0.737	0.763	0.616
	MSB2	0.590	–	–	–
	MSB3	0.711	–	–	–
	MSB4	0.807	–	–	–
ENB	ENB1	0.693	0.863	0.847	0.591
	ENB2	0.669	–	–	–
	ENB3	0.781	–	–	–
	ENB4	0.868	–	–	–
GRR	GRR1	0.732	0.776	0.714	0.670
	GRR2	0.660	–	–	–
	GRR3	0.820	–	–	–
BS	BS1	0.886	0.776	0.714	0.670
	BS2	0.812	–	–	–
	BS3	0.808	–	–	–
MC	MC1	0.749	0.792	0.783	0.689
	MC2	0.693	–	–	–
	MC3	0.856	–	–	–
	MC4	0.690	–	–	–
	MC5	0.787	–	–	–
BRAP	BRAP1	0.899	0.792	0.783	0.689
	BRAP2	0.760	–	–	–
	BRAP3	0.579	–	–	–
	BRAP4	0.558	–	–	–

	BRAP5	0.901	–	–	–
	BRAP6	0.787	–	–	–
SRD	SRD1	0.659	0.671	0.684	0.728
	SRD2	0.699	–	–	–
	SRD3	0.743	–	–	–
	SRD4	0.876	–	–	–
BRA	BRA1	0.848	0.862	0.875	0.588
	BRA2	0.801	–	–	–
	BRA3	0.717	–	–	–
	BRA4	0.820	–	–	–
	BRA5	0.686	–	–	–

Later, standardized residual covariances and modification indices (MI) were evaluated to find out further issues in the model. It is recommended that a corrected model have a value of standardized residual covariances less than 2.50 and that covariances between all constructs are within the range. Therefore, no issue existed relevant to covariance. High MI indicates that model fitness could be improved by drawing a path between them. Reasonable values of MI suggest appropriate model validation.

4.2 Structural models' evaluation

4.2.1 BRPs barriers model

After evaluating the measurement model, the next step is to analyze the structural model and test the proposed hypothesis. For both BR barriers and strategies, two structural models have been developed. BRPs barriers model comprises five exogenous variables and one endogenous variable. Further, it is reminded that each exogenous variable has four to seven indicators (as described above). However, the endogenous variable BR implementation comprises one indicator, which is measured through five questions judging the situation of BRPs implementation in the Pakistani context.

The indicators used to measure the goodness-of-model fit of BRPs barriers structural model have been described in Table 4. The results indicated that all the indicators of goodness-of-model fit are according to the recommended values.

After evaluating the model fitness of the structural model, the next step is to analyze the relationship between barriers and BRPs implementation. The findings of bootstrapping for BRPs barriers models found that the path connecting political and legal barriers and BRPs implementation is significant as the t-value was 2.472 (which is greater than 1.96). The p-value was 0.081 which is less than 0.10. Therefore, it can be said that the hypothesis H1a was accepted. According to Eriksson et al. (2017), path coefficients show the relationship direction (positive or negative) of two variables and are equivalent to regression weights. The higher value of the path coefficient indicates that the impact of an independent variable on the dependent variable is strong (Hutchison & Disberry, 2015). Darko et al. (2018) described that the lower values of the path coefficient (from 0.1 to 0.3) show a weak impact, 0.3 to 0.5 shows a moderate impact, and 0.5 to 1.0 highlights a strong impact. In view of BR barriers model, only two barrier categories,' financial and economic barriers' and 'technical and operational barriers', have a strong negative effect as their path coefficients are -0.552 and -0.489 consecutively, with t-values of 5.971 and 4.885 (greater than 1.96) and p-values are also significant.

Table. 4 Goodness-of-model fit results for the structural model

GOF measures	Recommended criteria	Findings
Chi-Sq./df	≤ 3.00 (Kline, 2015)	2.857
RMSEA	≤ 0.08 (Hu & Bentler, 1999)	0.057
SRMR	≤ 0.10 (Kline, 2015)	0.060
P-Close	P< 0.05 (Kline, 2015)	0.000
GFI	≥ 0.90 (Browne et al., 1993)	0.948
AGFI	≥ 0.85(Browne et al., 1993)	0.929
NFI	≥ 0.90 (Hoyle, 1995)	0.952
CFI	≥ 0.95 (Hoyle, 1995)	0.962

In contrast, the findings for H1d and H1e show that their coefficient values had a weak impact, and their t-values were also less than 1.96 (1.048 and 0.626 consecutively); therefore, it can be said that the association of 'management system barriers' and 'environmental barriers' with BRPs adoption was not statistically significant. The structural model displaying the association between BRPs barriers and BR adoption is shown in Figure 6. The value of R^2 (coefficient of determination) for the dependent variable, BRPs adoption, was 0.573, proving that the BR barriers model accurately predicts BR implementation and shows the BR model's quality (F. Hair Jr et al., 2014). The hypothesis results for the association between BRPs barriers and BRPs adoption are presented in Table 5.

Table 5. Results of hypotheses (BRPs barriers model)

Hypo-thesis	Relationship	Path coefficient	t-value	p-value	Acceptance / rejection
H1a	PLB → BRA	- 0.375	2.472	0.081*	Acceptance
H1b	FEB → BRA	- 0.552	5.971	0.000***	Acceptance
H1c	TOB → BRA	- 0.489	4.885	0.000***	Acceptance
H1d	MSB → BRA	0.243	1.048	0.552	Rejection
H1e	ENB → BRA	- 0.199	0.626	0.328	Rejection

*** (significant at 99% CI), ** (Significance at 95% CI), * (Significant at 90% CI)

4.2.2 BRPs strategies model

For evaluating the impact of promotional strategies on BRPs adoption, a structural model was developed, comprising of five exogenous variables (government rules and regulation, brownfield site, management and collaboration, brownfield redevelopment benefits awareness and publicity, subsidies, and R&D funding) and one endogenous variable (BRPs adoption). Further, it is reminded that each exogenous variable of BR strategies structural model has three to six indicators (as described above). However, the endogenous variable BRPs

adoption comprises one indicator, which is measured through five questions judging the situation of BRPs adoption in the Pakistani context.

The indicators used to measure the goodness-of-model fit of BRPs strategies structural model have been described in Table 6. The results indicated that all the indicators of goodness-of-model fit are according to the recommended values.

After the model fitness of the strategies structural model had been proved, the next step was to evaluate the association between different BRPs promotional strategies and BRPs adoption in Pakistan. The bootstrapping results for the strategies model found four strategy categories out of five have a significant association (two strong, two moderates) with BRPs adoption. For hypothesis H1a, the results show that the path connecting government rules and regulations and BRPs adoption is positively significant as path coefficient 0.548 (greater than 0.5) shows a strong positive association, t-value is 3.420 (which is greater than the value of 1.96). The p-value is 0.000*** (significant at 99% confidence interval). In H2d, the association of brownfield redevelopment benefits awareness and publicity and BRPs adoption is also similar to H1a, where path coefficient 0.608 (greater than 0.5) shows a strong positive association, the t-value is 8.601 (which is greater than the value of 1.96), and the p-value is 0.000*** (significant at 99% confidence interval). Therefore, it can be said that these two strategy categories,' government rules and regulations and 'brownfield redevelopment benefits awareness and publicity' have the most important role in the BRPs adoption in Pakistan. The other two strategies,' management and collaboration' and 'subsidies and R&D funding are also significantly associatedion with BRPs adoption. Still, it's partial, where the values for H2c show that path coefficient is 0.399 (in between 0.3 and 0.5), t-value is 7.885 (which is greater than the value of 1.96), and p-value is 0.000*** (significant at 99% confidence interval). The results of H2e also show a partial association, and its p-value is 0.041** (significant at 95% confidence interval). Out of four hypotheses, only brownfield-related strategies have no significant association with BRPs adoption as the path coefficient of 0.221 (less than 0.3) shows a weak positive association, the t-value is 0.852 (which is less than the value of 1.96), and the p-value is 0.429 which is not significant. Therefore, the hypothesis H2b was rejected. The structural model displaying the association between strategies and BRPs adoption is shown in Figure 7. The value of R^2 (coefficient of determination) for the dependent variable, BRPs adoption, was 0.573, proving that the strategies model is accurate in predicting BRPs adoption and also shows the quality of BRPs adoption model (F. Hair Jr et al., 2014). Results for the association between BR strategies and BRPs adoption are presented in Table 7.

Table 6. Goodness-of-model fit results for structural model

GOF measures	Recommended criteria	Findings
Chi-Sq./df	≤ 3.00 (Kline, 2015)	2.691
RMSEA	≤ 0.08 (Hu & Bentler, 1999)	0.049
SRMR	≤ 0.10 (Kline, 2015)	0.058
P-Close	P< 0.05 (Kline, 2015)	0.000
GFI	≥ 0.90 (Browne et al., 1993)	0.939
AGFI	≥ 0.85(Browne et al., 1993)	0.911
NFI	≥ 0.90 (Hoyle, 1995)	0.956
CFI	≥ 0.95 (Hoyle, 1995)	0.974

Table 7. Results of hypotheses (BRPs strategies model)

Hypo-thesis	Relationship	Path coefficient	t-value	p-value	Acceptance / rejection
H2a	GRR → BRA	0.548	3.420	0.000***	Acceptance
H2b	BS → BRA	0.221	0.852	0.429	Rejection
H2c	MC → BRA	0.399	7.885	0.000***	Acceptance
H2d	BRAP → BRA	0.608	8.601	0.000***	Acceptance
H2e	SRD → BRA	0.370	3.067	0.041**	Acceptance

*** (significant at 99% CI), ** (Significance at 95% CI),

5. Discussion

5.1 BRPs adoption barriers

The results of SEM of association between barriers and BRPs adoption found that three barriers out of five significantly impact BRPs adoption. However, the financial and economic barrier category is the most critical barrier category.

The interpretation of the results shows that the higher the financial and economic barriers, the lower BRPs adoption in Pakistan. These results are also similar to the previous studies by Frantal et al. (2015), who indicated that cost and economic barriers are the most critical. Financial and economic barriers are not only critical barriers to BRPs adoption in Pakistan but in other countries as well., Lu and Xie (2015) identified that lack of government funding is one of the major barriers to BRPs adoption in China, while in Canada, De Sousa (2001) also found that heavy cost associated with BR activities is the major factor inhibiting the BRPs implementation. As a developing country, the investors have limited capital investment, and if they are not certain about future earnings, they will be afraid of investing money. Therefore, government intervention is essential to develop investors' interest.

Government BR-related policies and the introduction of incentive schemes that could be useful to BRPs adoption and convince stakeholders to show interest are currently inadequate in Pakistan. Mainly, the lack of government funding directs to the low inclination towards BRPs and improved financial mechanisms for stakeholders to bring huge capital that might be needed for effective implementation of BR, further, this high investment may also be in the form of low-interest loans, time, and provision of human resources (Liu et al., 2016; Morio et al., 2008).

Further, technical and operational barriers are the second barrier category, affecting most the BRPs adoption. BR process is a risky process involving multiple activities that require machinery and technological equipment to clean hazardous substances. It is not an easy task for any general human resource group. Therefore, a technically competent team is needed to perform all the cleanup tasks. However, currently, Pakistan lacks competent technical staff because the BR issues are in the initial stage. Lack of technical staff and repair technology leads to the poor assessment of brownfields, which could be an alarming situation and put many lives in danger. Therefore, having the professional and technical staff to deal with brownfield issues is essential. It could only be possible when Pakistan collaborates with developed countries and ask for professional training for Pakistani human resource. However, external collaboration is not enough, as it is a short-term solution. Pakistan needs to invest in R&D of BR technology and develop a great technological infrastructure that could deal with the brownfields in Pakistan. Several studies found that brownfields may differ

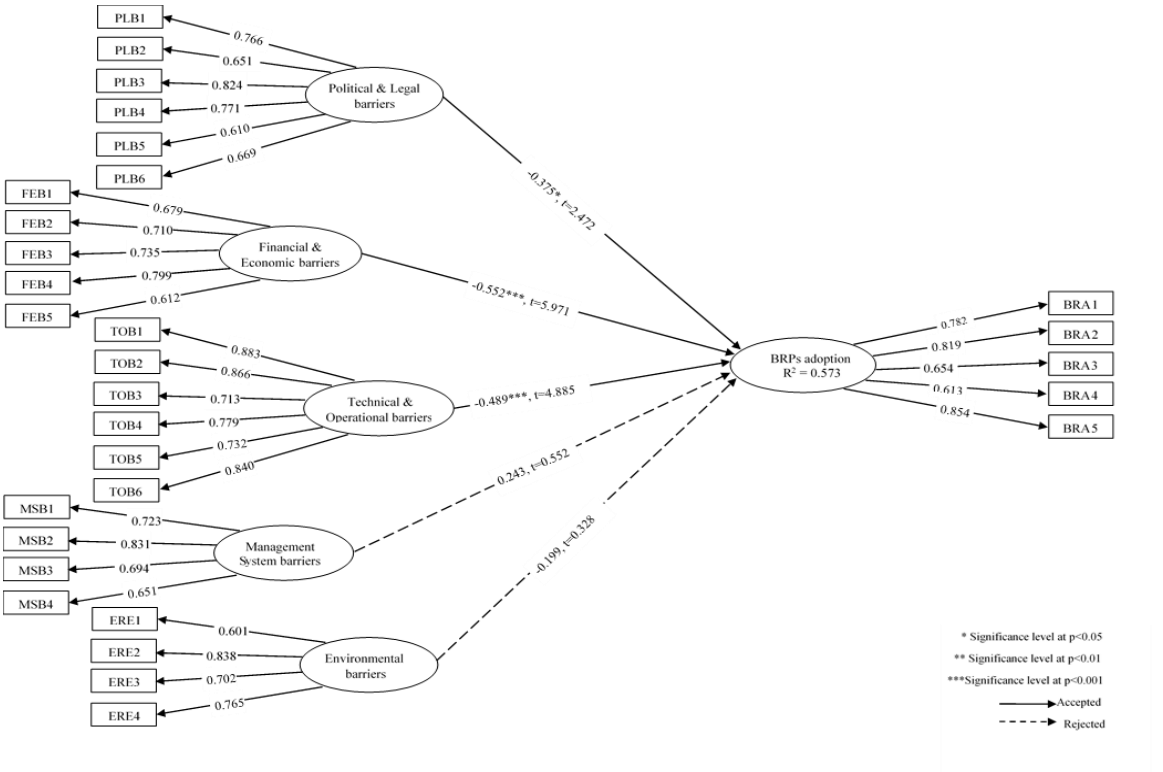

Figure 6. Structural equation model for examining the impact of BRPs barriers on BRPs adoption

from country to country, and different approaches are adopted to treat brownfield sites in different regions.

Political and legal barriers also affect the BRPs adoption. However, their effect is less severe than 'financial and economic barriers' and 'technical and operational barriers'. Politically, Pakistan is not considered a stable country, where it is not easy for a government to complete the duration of its parliament. Governments change from time to time, and every government develops its own policies. Poor incentives policy, corruption practices, and political influence on institutions place Pakistan at 136th position out of 140 nations in the World Economic Forum's competitiveness index. There are no rules and regulations for BRPs, which is a critical situation. Therefore, the government needs to develop rules and regulations and provide policy incentives with the support of all relevant institutes. Further, a major impediment is a lack of legal framework for environmental issues, especially for brownfields. Therefore, a legal framework must address all aspects of BR process and focus on all stakeholders' needs. Earlier studies Ahmad, Zhu, et al. (2018b); Ahmad, Zhu, Shafait, et al. (2019) have provided guidelines to promote BR in developing countries, which could be useful and learn from their findings. However, an independent institute dealing with BR issues may expedite the BRPs adoption in Pakistan, but it seems impossible

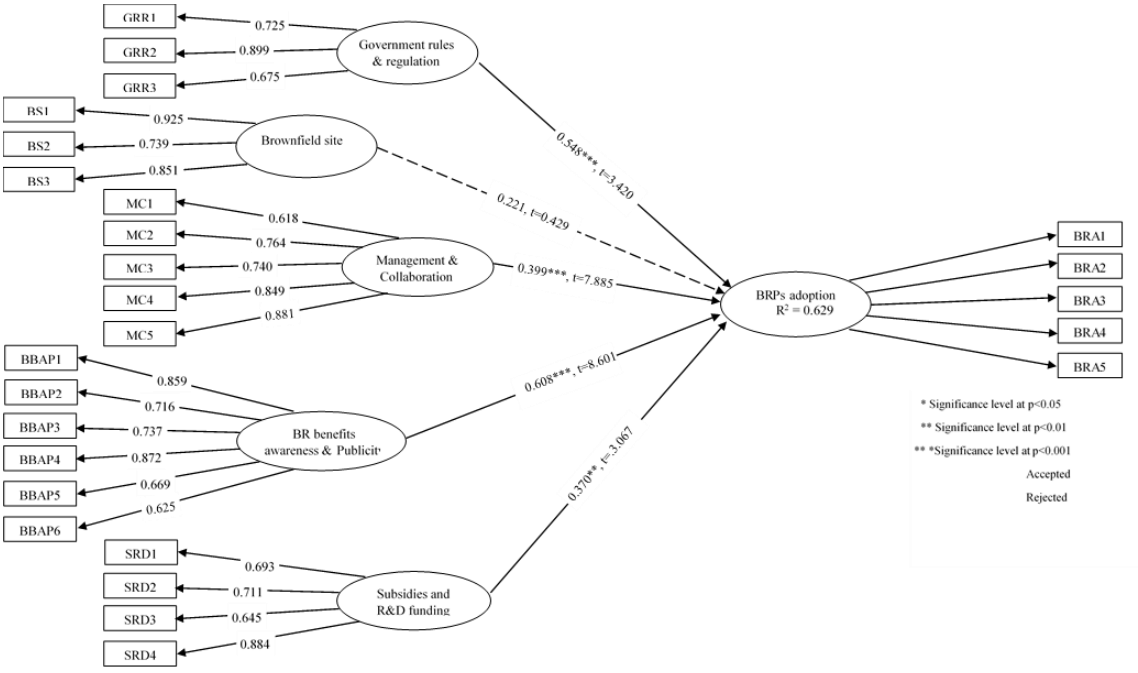

Figure 7. Structural equation model for examining the impact of BRPs strategies on BRPs adoption

without the collaboration of local municipalities and provincial and federal governments. Further, the association of 'management system barriers' and 'environmental barriers' with BRPs adoption is not strong. These results were surprising as earlier studies found that environmental barriers are critical barriers to BR implementation (Adamo et al., 2015). The reason for such findings may be due to the respondents' perception that government BR-related policies can further provide leadership support and motivation to adopt BRPs. Stakeholders are interested in the effective solution of BR implementation, which is why environmental barriers are not significantly associated, as environmental issues are concentrating most attention in this decade; however, the government should give more attention to BR issues by establishing specialized policies for it.

5.2 BRPs adoption strategies

The findings of SEM show that 'brownfield redevelopment benefits awareness and publicity' is the most important strategy category to promote the BRPs adoption in Pakistan, followed by government rules and regulations, management collaboration and strategies, and R&D funding. These results were surprisingly different from the results of the barriers model, as earlier the financial and economic barriers were the most significant. These findings imply that BRPs are unknown to the stakeholders in Pakistan. Therefore, it is not considered important for urban and environmental policy.

BR is a productive activity that is equipped with numerous benefits such as economic (employment opportunities, increased brownfield site values, increased value of properties in surroundings, affordable housing), Social (reduction in crime, social sustainability), and environmental benefits (clean-up of hazardous sites, reduced pollution and promotion of sustainable development). However, most of the stakeholders have no awareness regarding the hidden potential of BR. Therefore, publicity and awareness regarding BR emerged as an important strategy for effectively implementing BRPs in Pakistan. These findings were also supported by Ahmad, Zhu, Shafait, et al. (2018); Stezar et al. (2014), where the guidelines for the promotion of BR suggest that publicity and advertising are the important tools for BR implementation in a specific region. Publicity is a marketing tool called public relations, in which information about a product, service, or place is conveyed to the general public. This information includes the benefits of using a product that creates a good image and motivates them to have experience (Belch & Belch, 2004). Therefore, more publicity can promote BRPs adoption and enhance its adoption among stakeholders. The empirical evidence of this research suggests that effective marketing campaigns should be run on various media channels (e.g., TV, newspapers, and magazines) – can support BRPs adoption effectively in Pakistan. Further, along with the traditional media, there should be greater concentration on the innovative medium of communication, such as the internet and social media, which has large audiences and can easily convey the illuminative perspective of BR. The government can intervene in all these marketing campaigns by providing sponsorship.

The findings highlight that government rules and regulations are the second most important category for implementing BRPs in Pakistan. In earlier literature, examining the role of government rules and regulations has been given little attention (Andres & Golubchikov, 2016). However, these findings (path coefficient of 0.548) depict that government rules and regulations would have a greater impact on BRPs adoption because they would put regulatory pressure on the stakeholders for BRPs adoption. Earlier studies also considered regulatory pressure important to implement green technologies in a context (Chan et al., 2018; Darko et al., 2018). Gou et al. (2013) described that the introduction of new technologies, especially innovative and green technologies such as BRPs can only be adopted if there is some regulator pressure. They quoted this phenomenon on P.170: "If there is no legislation, people won't adopt it or interest to initiate it." If there are essential requirements, then there will be no other way except the BRPs adoption, especially for the brownfields created by industrial activities; they will be imposed with fines due to non-compliance with rules and regulations. However, the development of rules and regulations and their enforcement must be ensured with the collaboration of relevant institutes and authorities (Liu et al., 2017).

Management and collaboration emerged as a significant strategy and significantly impacted BRPs adoption. At the infancy stage of BRPs adoption, the government has a prominent role and is the central body with a leading role. Therefore, the government approaches, e.g., provision of incentives, technical support, establishing BR-related policies, and collaboration with all stakeholders, are critical for BRPs adoption. Further, management support and greater experience with BR issues in Pakistan can enhance its adoption. It's only possible when the government facilitates the top management with international training, and they could have more experience, which could be further transferred to the local employees. Top management can also motivate the low-level employees and the general public by sharing their personal experiences about BR potential.

Surprisingly, subsidies and R&D funding strategy emerged as the least important strategy but with a significant role in BRPs adoption (with path coefficient 0.370). Numerous studies concluded that providing incentives could stimulate BRPs adoption (Aktas et al., 2017; Eckerd & Heidelberg, 2015; Green, 2018). Therefore, the findings are similar to the previous research. Ozdemir (2000) explained the concept of incentive as "An action which can lead people to perform in a specific way." Mainly, two forms of incentive could facilitate BRPs adoption: 1) financial incentives (it could be in monetary terms, e.g., grant, discount, or relaxation in taxes or fees), 2) non-financial incentives (it could be in the form of the technical assistance, e.g. training and workshops). Both financial and non-financial incentives are the key policies in many developed countries (Eckerd & Heidelberg, 2015; Miller, 2014; Piccioni, 2003; Velez-Arocho et al., 2016; Waite, 2017).

Moreover, R&D funding is necessary to explore BR's benefits and improve the site risk assessment. Innovative remediation solutions can result in effective BR and can provide additional support in BR-related decision-making. Therefore, the public and private sectors should invest in the R&D of BR. The government may allocate resources for BR and land reuse practices in the budget to further establish an independent institute especially for BR issues, which could play an important role in adopting BRPs. The private sector can be involved by inviting them to invest through the channel of public-private partnership (PPP) (Medda et al., 2012; Whitman, 2006). On the other hand, the strategies related to brownfield sites were not significantly associated with BRPs adoption. It may be because of stakeholders' perception that brownfield sites-based strategies are secondary level strategies; firstly, their benefits awareness should be created by establishing relevant policies and provision of incentives.

6. Policy recommendations

The policy recommendations are that to facilitate BRPs adoption in Pakistan, the government has to take the sole responsibility for BRPs adoption at the initial stage. For example, if market-based incentives are given for BRPs implementation, the financial and economic barriers can be overcome, and the stakeholders would be interested in BRPs adoption. The lack of BRPs related policies and rules-based barriers (political and legal barriers) could be overcome if the government, along with the relevant urban, environmental, and economic institutes, develop essential BRPs policies and rules that would insert regulatory pressure on the stakeholders, especially the general public, adopt BRPs. Further, the relevant institutes should promote BRPs within both the public and private sectors because the private sector investment in PPP can facilitate BRPs in a developing country such as Pakistan. Further, the technical and operation barriers can be overcome by developing collaboration with the developed countries and importing innovative remediation technologies. Further, technical personnel from Pakistan should be sent to for training in the developed countries and learn innovative and sustainable ways to deal with BRPs issues. Therefore, management and collaboration could overcome technical and operational barriers.

The results of the current study provided empirical evidence to the policymakers as the research framework quantifying the impact of barriers and strategies provided the main 'barrier and promotional strategies' categories which affect the BRPs adoption in Pakistan. Therefore, the knowledge about significant' barrier and promotional strategies' categories could support the policy makers for better decisions. The current study framework developed BRPs body of knowledge in the developing countries and Pakistani context.

Based on the results, an implementation strategy has been proposed. The implementation strategy starts from the realization of benefits attached to BRPs, as the current study outlined multiple

economic, social and environmental benefits attached with the adoption of BRPs, as shown in Figure 7. With the realization of the benefits, barriers to BRPs have to be delineated and finally, the related strategies to overcome the barriers need to be proposed. The proposed implementation strategy for BRPs in Pakistan is shown in Figure 8.

However, for the proper implementation of this framework, it is necessary to bring all relevant authorities (as shown in Figure 9) at the same agenda. Without collaboration of these authorities, it seems a difficult task for promoting BRPs in Pakistan. However, it is also a point of attention that all these authorities in different provinces of Pakistan might have different responsibilities due to the difference in brownfield sites, types of contamination and its scale. Further, changing the political environment of the country might also bring new rules and regulations and changes in the agenda, which would also influence the landscape of BRPs. Therefore, in the context of developing nations where political environment is mostly volatile and governments are changing rapidly, it is suggested to consult with the updated authorities for collaboration.

7. Conclusion, limitations, and future research directions

BRPs adoption has been considered less documented in the developing countries, which is a surprising situation and hurdle for promoting urban sustainable development. Different obstacles and strategies impact BRPs adoption; however, none of the studies quantified the impact of barriers and strategies on BRPs adoption. Considering the lack of literature, this research empirically aimed to develop a framework modeling the impact of barriers and strategies in BR implementation. The data were collected from the stakeholders' involved in the BR process, and the survey results were evaluated using the SEM techniques. The findings show that BR barriers, including 'political and legal barriers,' 'financial and economic barriers,' and 'technical and operational barriers,' significantly negatively affect BRPs adoption. Further, the results found that strategies including 'government rules and regulations', 'management and collaboration,' 'brownfield redevelopment benefits awareness and publicity' and 'subsidies and R&D funding' have a significantly positive impact on BR implementation.

The practical implications of this study suggest that the government create an active role for BR implementation by providing incentives. In this way, the financial and economic barriers to BR implementation can be overcome, and stakeholders would be encouraged to implement BR. Further, the government rules and regulation-based barriers can be addressed by imposing a mandatory condition for BR adoption for all stakeholders; especially, the regulatory pressure can compel the local municipalities, urban and environmental policy institutes to adopt BRPs. It is necessary to promote the positive image of the BRPs in both public and private. The positive image of BR can facilitate and expedite the BRPs adoption among stakeholders.

This study provided empirical evidence by evaluating a research framework describing the quantitative impact of barriers and strategies to BRPs adoption in Pakistan. A deeper understanding and extraction of major categories of barriers and strategies could help policymakers and create a significant role in the adoption of BRPs. Therefore, urban and environmental policymakers can develop relevant strategies based on the study results. This study makes a novel contribution to the BR body of knowledge by developing quantitative models that show how various barriers and strategies can impact the successful adoption of BR in the Pakistani context.

Though the objective of the current study was achieved, some limitations and future research directions of the study are as follows: First, the sample size was more than enough to perform SEM, but a large sample size can provide more valuable results about the impact of barriers and strategies on BR implementation. Second, this study is also deficient in the sampling frame as a non-

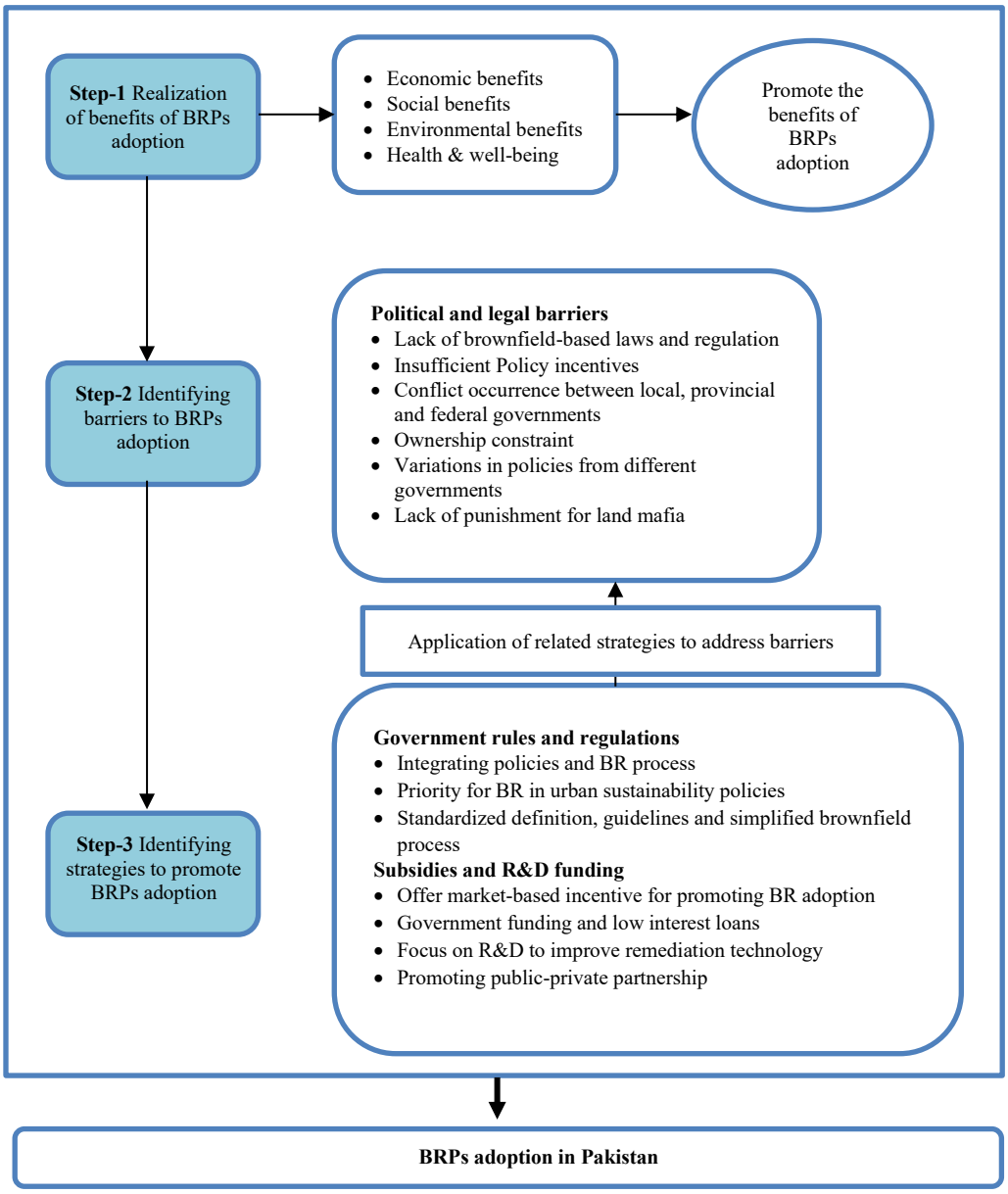

Figure 8. The adoption strategy for BRPs adoption in Pakistan

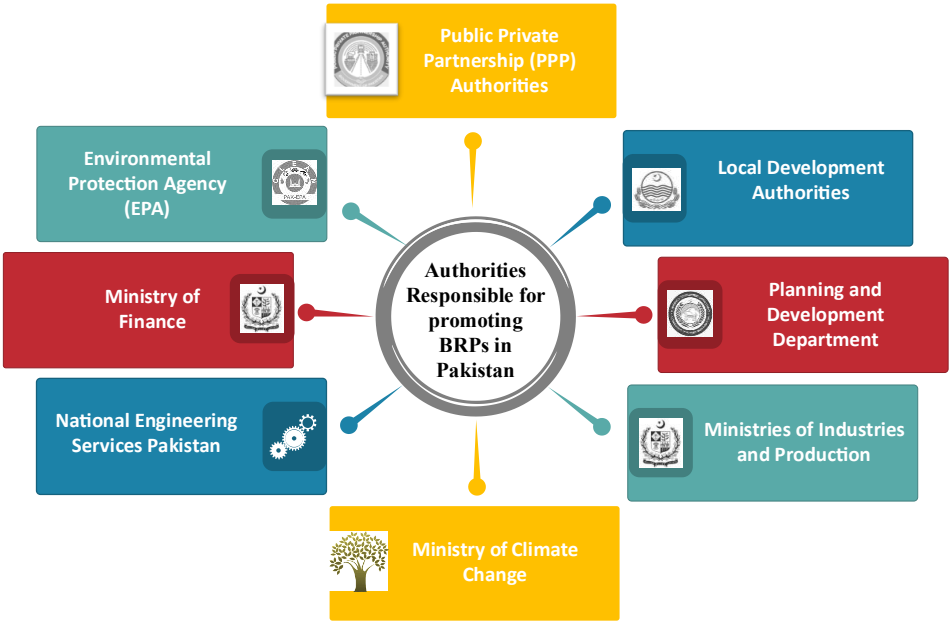

Figure 9. Relevant authorities for managing BRPs in Pakistan

probability sampling technique was adopted, which does not provide the facility of choosing respondents randomly as the respondents were selected based on their BR knowledge and willingness to be part of this research. Third, this study was based on the stakeholders' response to the BR barriers and strategies. Not all stakeholders" needs to have the same knowledge, perception, and experience about BRPs. Therefore, expert-based studies would be more useful in the future, as BR is a complex process involving multiple stakeholders and activities. Lastly, this study was a case study of a developing country, Pakistan. Therefore, it cannot be generalized to all other developing countries due to changes in brownfield characteristics, rules and regulations, etc. Therefore, more research is needed to validate this study's results or make a comparison. Further, this study could only be useful for Pakistan at the infancy stage of BRPs adoption; later, other barriers and strategies can emerge. Therefore, future similar studies should be conducted at later stages to refine the strategies.

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