
بسم الله الرحمن الرحيم

مجلة العمارة والتخطيط، م ٣٦ (٤)، ص ص ٤٠٥ - ٥٠٩ بالإنجليزية، الرياض (٢٠٢٤م/ ١٤٤٦هـ)

مجلة العمارة والتخطيط

(دورية علمية محكمة)

تصدر عن:

جامعة الملك سعود

المجلد السادس والثلاثون (٤)

ديسمبر (٢٠٢٤م)
جمادي الاول (١٤٤٦هـ)

دار جامعة الملك سعود للنشر
KING SAUD UNIVERSITY PRESS
ص.ب ٦٨٩٥٣ - الرياض ١١٥٣٧ المملكة العربية السعودية

دار جامعة الملك سعود للنشر
KING SAUD UNIVERSITY PRESS

مجلة العمارة والتخطيط

مجلة (دورية – علمية – محكمة) تعنى بنشر البحوث في مجالات العمارة وعلوم البناء، والعمارة البيئية، والتصميم الحضري، والتخطيط العمراني، والموضوعات ذات العلاقة بالعمران بصور عامة. وتصدر اربع مرات في السنة في (مارس ويونيو وسبتمبر وديسمبر) عن جامعة الملك سعود، وقد صدر العدد الأول منها في عام ١٤٠٩هـ/ ١٩٨٩م.

الرؤية:

أن تكون مجلة رائدة في نشر البحوث المحكمة في مجالات العمارة والعمران، باللغتين العربية والإنجليزية.

الرسالة:

نشر بحوث في مجالات العمارة والعمران تتميز بالأصالة والإبداع والجودة العالية، وفق المعايير المهنية العالمية.

الأهداف:

١- إيجاد مرجعية علمية رصينة في مجالات العمارة والعمران، تعم فائدتها مجتمع البحث العلمي.

٢- زيادة فرص نشر الأبحاث التي تربط بين النظرية والتطبيق في مجالات العمارة والعمران.

٣- تشجيع الباحثين على المساهمة بأفكارهم ومعارفهم وجهودهم لإنتاج بحوث تتميز بالأصالة لنشرها باللغتين العربية والإنجليزية.

المراسلة

مجلة العمارة والتخطيط

المملكة العربية السعودية

جامعة الملك سعود

كلية العمارة والتخطيط

ص.ب: ٥٧٤٤٨

الرياض: ١١٥٧٤

الهاتف/ الفاكس: ٠٠٩٦٦١١٤٦٩٦٨٤٤

البريد الإلكتروني: jap@ksu.edu.sa

الموقع: http://jap.ksu.edu.sa

الاشتراك والتبادل:

دار جامعة الملك سعود للنشر، جامعة الملك سعود ، ص. ب. ٦٨٩٥٣، الرياض ١١٥٣٧، المملكة العربية السعودية.

سعر النسخة الواحدة: ١٥ ريالاً سعودياً، أو ما يعادله بالعملة الأجنبية، يضاف إليها أجور البريد.

طبيعة المواد المنشورة:

تهدف المجلة إلى إتاحة الفرصة للباحثين لنشر إنتاجهم العلمي، وتقوم المجلة بنشر المواد التالية:

١- بحث: يشتمل على عمل المؤلف في مجال تخصصه، ويجب أن يحتوي على إضافة إلى المعرفة في مجاله.

٢- مقالة استعراضية: تتضمن عرضا نقدياً يلخص الحالة الراهنة لموضوع محدد من المنشورات السابقة.

٣- مراجعة كتاب: استعراض وتلخيص نقدي لكتاب.

٤- مقالة مختصرة.

تعليمات عامة:

- تقديم المواد: يقدم أصل البحث مخرجًا في صورته النهائية شـــاملاً الجداول والأشكال في أماكنها داخل المتن، ومطبوعًا على هيئة صفحات مرقمة ترقيماً متسلســـلًا، باستخدام برنامج MS Word، ويُرسَل نسخةً رقمية مع نموذج تقديم البحث بالبريد الإلكتروني للمجلة (jap@ksu.edu.sa)، وسـُيعتَذر عن عدم قبول أي بحث لا يلتزم مؤلفه بهذه التعليمات.
- لا يتجاوز عـــدد صفحات البحث (٢٥) صفحة (A4) متضمنة الملخصـــين العربي والإنجليزي، والجداول، والأشكال، والصور، والمراجع.
- تكتب بيانات البحث باللغتين العربية والإنجليزية، وتحتوي على: (عنوان البحث، واسم الباحث أو الباحثين والتعريف به أو بهم، وبيانات التواصل معه أو معهم).
- لا يتجاوز عدد كلمات المســـتخلص (٢٠٠) كلمة، ويتضمن العناصر التاليـــة: (موضوع البحث، وأهدافه، ومنهجه، وأهـــم النتائج، وأهم التوصيات) مع العناية بتحريرها بشـــكل دقيـــق، ويكتب على عمود واحد بعرض كتابة ١٣ سم.
- يُتبع كل مســـتخلص (عربي/ إنجليزي) بالكلمات المفتاحية (Keywords) المعبرة بدقة عن موضوع البحث، والقضايا الرئيسة التي تناولها، بحيث لا يتجاوز عددها (١٠) كلمات.
- هوامش الصفحة تكون (٥ , ٢ سم) من (الأعلى، والأسفل، واليمين، واليسار)، ويكون تباعد الأسطر مفرداً.
- يســـتخدم خط (Simplified Arabic) للغة العربية بحجم (١٦) للمتن، وبالخط الأسود (**Bold**) للعناوين، وبحجم (١٢) للحاشية والمستخلص، وبحجم (١٠) للجداول والأشكال، وبحجم (١٢) وبالخط الأسود (**Bold**) لرأس الجداول والتعليق.
- يســـتخدم خـــط (Times New Roman) للغة الإنجليزيـــة بحجم (١٢) للمتن، وبالخط الأســـود (**Bold**) للعناوين، وبحجم (٩) للحاشـــية والمستخلص، وبحجم (٨) للجداول والأشكال، وبالخط الأسود (**Bold**) لرأس الجداول والتعليق.
- الجداول والمواد التوضيحية يجب أن تكون مناســـبة لمســـاحة الصف في المجلة (١٦× ٢٣ سم بالحواشي وعلى عمودين عرض كل عمود ٦٥ , ٧ سم) مع كتابة عنوان لكل جدول، وتعليق لكل شكل وصورة، والإشارة إلى مصدر المادة إن كانت مقتبســـة. على أن يتم إرســـال (**أصول**) جميع الصور والاشـــكال وبدقة لا تقل عن (٣٠٠ dpi) للصور والاشـــكال بالاسود والأبيض و(٦٠٠ dpi) للصور والاشكال الملونة، وكملف بصيغة صورة (jpg،tiff.....) منفصل لكل صورة أو شكل. والتأكد من ان كل المعلومات فيها واضحة ومقروءة.

(بالإضافة إلى وجودها في أماكنها داخل النص).

- الاختصارات: يجب استخدام اختصارات عناوين الدوريات العلمية كما هو وارد في: The World List of Scientific Periodicals، وتستخدم الاختصارات المقننة دوليًا مثل: سم، مم، م، كم، مل، مجم، كجم .....
- المراجع: يشار إلى المراجع داخل المتن بنظام الاسم والتاريخ، وتوضع المراجع جميعها في قائمة المراجع بنهاية المادة مرتبة هجائيًا ومتبعة نظام ترتيب البيانات الببليوغرافية التالي:

أ) يشار إلى الدوريات في المتن بنظام الاسم والتاريخ بين قوسين على مستوى السطر. أما في قائمة المراجع فيبدأ المرجع بذكر الاسم الأخير للمؤلف (اسم العائلة) ثم الاسم الأول، ثم الأسماء الأخرى أو اختصاراتها بالخط الأسود. فعنوان البحث كاملاً بين شولتين " " ، فاسم الدورية مختصراً ببنط مائل، فرقم المجلد، ثم رقم العدد بين قوسين، ثم سنة النشر بين قوسين.

ب) يشار إلى الكتب في المتن داخل قوسين بالاسم والتاريخ. أما في قائمة المراجع، فيكتب الاسم الأخير للمؤلف (اسم العائلة)، ثم الاسم الأول، ثم الأسماء الأخرى أو اختصاراتها بالخط الأسود. فعنوان الكتاب ببنط مائل ثم بيان الطبعة. فمدينة النشر: ثم الناشر، ثم سنة النشر.

ج) ترجمة قائمة المراجع العربية للغة الإنجليزية، وإضافتها بعد قائمة المراجع العربية وقبل المراجع الإنجليزية (تحت عنوان Arabic References).

- الحواشي: تستخدم لتزويد القارئ بمعلومات توضيحية، ويشار إليها في المتن بأرقام مرتفعة عن السطر. وترقيم التعليقات متسلسلة داخل المتن. وفي حال الضرورة؛ يمكن الإشارة إلى مرجع داخل الحاشية عن طريق استخدام كتابة الاسم والتاريخ بين قوسين وبنفس طريقة استخدامها في المتن، وتوضع الحواشي أسفل الصفحة التي تخصها والتي ذكرت بها وتفصل بخط عن العمودين (المتن) وتكون الحواشي على سطر أو عمود واحد وليس عمودين.
- التجارب: لن يقبل أي تغيير، سواء كان بالتعديل أو الحذف أو الإضافة، في البحث في مرحلة مراجعة تجارب الطبع.
- سلامة البحث من الأخطاء اللغوية والنحوية والإملائية.
- إرسال البحث مع تعهد من الباحث/ الباحثين بأن البحث لم يسبق نشره، وأنه غير مقدم للنشر، ولن يقدم للنشر في جهة أخرى.
- في حال (قبول البحث للنشر) يتم إرسال رسالة إلى الباحث بـ (قبول البحث للنشر)، وعند رفض البحث للنشر يتم إرسال رسالة (اعتذار) إلى الباحث.
- في حال (قبول البحث للنشر) تؤول حقوق النشر كافة للمجلة، ولا يجوز نشره في أي منفذ نشر آخر ورقيًا أو إلكترونيًا، دون إذن كتابي من رئيس هيئة تحرير المجلة.
- الآراء الواردة في البحوث المنشورة تعبر عن وجهة نظر الباحثين فقط ولا تعبر بالضرورة عن رأي المجلة.
- في حال (نشر البحث) يمنح الباحث (نسختين مجانيتين) من المجلد الذي تم نشر بحثه فيه.

المحتويات

صفحة

القسم الإنجليزي

دار جـــامـــعـــة
الملك سعود للنشر
KING SAUD UNIVERSITY PRESS

قسيمة اشتراك بمجلة العمارة والتخطيط

تاريخ تعبئة القسيمة (بالتاريخ الميلادي): / / ٢٠م

اسم المشترك (رباعي): .....

اسم الجهة/الشركة (للجهات الحكومية/الشركات): .....

العنوان: ..... صندوق بريد: ..... الرمز البريدي: .....

المدينة: ..... الدولة: ..... الهاتف: ..... الفاكس: .....

البريد الإلكتروني: .....

عدد النسخ: ( )

مدة الاشتراك: ☐ سنة ☐ سنتان

نوع الاشتراك: ☐ فردي ☐ حكومي ☐ قطاع خاص

طريقة الدفع: ☐ نقداً ☐ شيك مصدق (مرفق) ☐ حوالة

تكلفة الشحن: ( )

إجمالي المبلغ:..... التوقيع: .....

قيمة الاشتراكات: الاشتراك السنوي داخل المملكة العربية السعودية (١٥) ريالاً سعودياً لكل عدد أو ما يعادله بالعملة الأجنبية يضاف إليه أجور البريد.

جميع مراسلات الاشتراك والتبادل على العنوان التالي

دار جامعة الملك سعود للنشر – جامعة الملك سعود – ص. ب. ٦٨٩٥٣ الرياض ١١٥٣٧

هاتف ١١٤٦٧٢٨٧٠(٩٦٦+) فاكس ١١٤٦٧٢٨٩٤(٩٦٦+) البريد الإلكتروني ksupress@ksu.edu.sa

موقع الدار http://ksupress.ksu.edu.sa

دار جـــامـــعـــــة
الملك سـعـود للنشـر
KING SAUD UNIVERSITY PRESS

Subscription Form for the Journal of Architecture and Planning

Date: ……/……/20

Name: ……...
Company Name (Public/Private): ……
Address: …… P.O. Box: …… Zip Code: ……...
City: …… Country: …… Tel.: …… Fax: ……..
E-mail: ……..

No. of Copies: ( )
Length of Subscription: ☐ 1 Year ☐ 2 Years
Type of Subscription: ☐ Individual ☐ Governmental ☐ Private Sector
Method of Payment: ☐ Cash ☐ Cheque ☐ Bank Transaction
Shipping Cost: ( )
Total Cost: …… Signature: ……...

Annual Subscription Rates: Within the Kingdom SAR 15.00 for each issue or its equivalent in a foreign currency (excluding postage).

All subscription and exchange correspondences should be addressed to:
King Saud University Press, King Saud University, P.O. Box 68953, Riyadh 11537, Kingdom of Saudi Arabia
Tel.: +966 11 4672870 Fax: +966 11 4672894
E-mail: ksupress@ksu.edu.sa Website: http://ksupress.ksu.edu.sa

Journal of Architecture and Planning , Vol. 36 (4) , Riyadh (2024/1446H)
doi:10.33948/JAP-KSU-36-4-5

الاندماج والتحول: معمار الرياض في الخمسينيات من القرن العشرين

نائف الغامدي[١] عبد العزيز الزهراني[٢] فهد العتيبي[٣] فيصل العصيمي[١]
علي عجلان[١] مهند الكديوي[٤] محمد النعيم[٥]

[١] *قسم العمارة وعلوم البناء، كلية العمارة والتخطيط، جامعة الملك سعود، الرياض*
[٢] *قسم العمارة، كلية الهندسة، جامعة الباحة، الباحة، المملكة العربية السعودية*
[٣] *قسم العمارة، كلية العمارة والتخطيط، جامعة القصيم، بريدة، المملكة العربية السعودية*
[٤] *وكالة الأمانة لمشاريع البنية التحتية، أمانة منطقة الرياض، الرياض*
[٥] *قسم الهندسة المعمارية، كلية الهندسة، جامعة حائل، حائل، المملكة العربية السعودية*

naag@ksu.edu.sa, Azahran@bu.edu.sa, F.alotaibi@qu.edu.sa, falosaimy@ksu.edu.sa, aajlan@ksu.edu.sa, malkiwi@alriyadh.gov.sa, Mm.alnaim@uoh.edu.sa

قدم للنشر في ١/ ١/ ١٤٤٦ هـ؛ وقبل للنشر في ١٤/ ٤/ ١٤٤٦ هـ.

ملخص البحث. يستهدف هذا البحث تحليل التحولات التي شهدها المشهد المعماري في مدينة الرياض خلال الخمسينيات من القرن العشرين، وهو عقد يُعد نقطة تحول محورية في تاريخ المملكة العربية السعودية، حيث اتسم بفترة من التحضر السريع والتكامل الثقافي. وقد أسهمت الثروة النفطية المكتشفة في تلك الفترة في دفع عجلة التغيير في البلاد، وهو ما أتاح للرياض أن تظهر كلوحة تعكس تداخل التراث الإسلامي التقليدي مع التأثيرات المعمارية الحديثة. يركز هذا البحث على تحليل الواجهات الخارجية للمباني الرئيسة والتكوينات المعمارية التي تعود إلى تلك الفترة، مع إبراز التكامل بين مواد البناء والأساليب الحديثة إلى جانب العناصر التصميمية التقليدية. من خلال إجراء تحليل متعمق لحالات دراسية مختارة، تشمل المرافق الحكومية المتميزة والمنشآت السكنية، تكشف الدراسة عن تداخل دقيق بين الأساليب الحداثية الدولية والعناصر المعمارية المحلية والإسلامية. يعكس هذا التوليف التحولات المجتمعية والثقافية التي شهدتها المملكة العربية السعودية خلال تلك الفترة، حيث كانت البلاد تسعى لتحديد هويتها في ظل التأثيرات العالمية المتزايدة. تسهم نتائج هذا البحث في تعميق الفهم للتفاعل المعقد بين التقليدية والحداثة في سياق تطور العمارة بالمملكة العربية السعودية. كما تسلط الضوء على أن الاتجاهات المعمارية في الخمسينيات من القرن العشرين في الرياض لم تكن مجرد خيارات جمالية، بل كانت مرتبطة بعمق مع الديناميكيات الاجتماعية والثقافية والاقتصادية السائدة آنذاك. تؤكد الدراسة على أهمية وضع التطورات المعمارية ضمن سياقها التاريخي والثقافي الأوسع، وتقدم رؤى حول الحوار المستمر بين الماضي والمستقبل في المشهد الحضري للمملكة العربية السعودية.

الكلمات المفتاحية: العمارة، الرمزية، التشكيل، الحداثة، التراث، الرياض، المملكة العربية السعودية.

of Saudi Arabia." Habitat international, 22(4), 571-589, (1998a).

Saleh, M. A. E., "Place identity: The visual image of Saudi Arabian cities." Habitat international, 22(2), 149-164, (1998b).

Saleh, M. A. E., "The changing image of Arriyadh city: the role of socio-cultural and religious traditions in image transformation." Cities, 18(5), 315-330, (2001a).

Saleh, M. A. E., "The evolution of planning & urban theory from the perspective of vernacular design: MOMRA initiatives in improving Saudi Arabian neighbourhoods." Land Use Policy, 18(2), 179-190, (2001b).

Shafiee, K., "Oil Industrialization in the Middle East." In Oxford Research Encyclopedia of Asian History, (2021).

Shin, S., Yoon, S.-Y., & Yoon, J.-E., "A Study on the Characteristics of Representation on'The new hierarchy'that Appear in the SANAA's Space Configuration of Museum." Korean Institute of Interior Design Journal, 22(4), 149-157, (2013).

Stake, R. E. "Qualitative case studies." The Sage handbook of qualitative research (3rd ed.). Sage Publications Ltd., (2005).

Stanek, Ł., Architecture in global socialism: Eastern Europe, West Africa, and the Middle East in the Cold war. Princeton University Press; 2020.

Thomas, G., How to do your case study. How to do your case study, 1-320, (2021).

Tournikiotis, P., The historiography of modern architecture. Mit Press; 2001.

Vitalis, R., America's kingdom: Mythmaking on the Saudi oil frontier. Verso Books; 2009.

Yin, R. K., Case study research: Design and methods (applied social research methods). Sage publications Thousand Oaks, CA; 2014.

methods approaches. Sage publications; 2017.

Doumato, L., The Contemporary Architecture of Saudi Arabia. Vance Bibliographies; 1980.

Edwards, B., Understanding architecture through drawing. Taylor & Francis; 2008.

Elsheshtawy, Y., The Evolving Arab City: Tradition, Modernity and Urban Development. Routledge; 2008.

Elsheshtawy, Y., Riyadh: transforming a desert city. Routledge; 2021.

Elwakil, M., "Modernist Indignation: Two architects on the forgotten legacy of Sayed Karim." Retrieved October 27, 2024 from https://www.madamasr.com/en/2019/02/16/feature/culture/modernist-indignation-two-architects-on-the-forgotten-legacy-of-sayed-karim/

Fabbri, R., & Al-Qassemi, S. S., Urban Modernity in the Contemporary Gulf: Obsolescence and Opportunities. Taylor & Francis; 2022.

Gharipour, M., "Tradition versus modernity: The challenge of identity in contemporary Islamic architecture." Local Identities Global Challenges, 199-205, (2011).

Giddings, B., Almehrej, M., & Cresciani, M. "The dilemma of Saudi Arabian homes in Riyadh." Space and Culture, 26(1), 4-22, (2023).

Gold, J. R., The practice of modernism: modern architects and urban transformation, 1954–1972. Routledge; 2007.

Hariri-Rifai, W., & Hariri-Rifai, M., The heritage of the Kingdom of Saudi Arabia. GDG Exhibits Trust; 1990.

Helmy, M., "Urban branding strategies and the emerging Arab cityscape: the image of the Gulf city." The British University, (2008).

Isenstadt, S., & Rizvi, K., Modernism and the Middle East: architecture and politics in the twentieth century. University of Washington press; 2008.

James-Chakraborty, K., "Beyond postcolonialism: New directions for the history of nonwestern architecture." Frontiers of Architectural Research, 3(1), 1-9, (2014).

Jobran, F., "Conventional and Contemporary Building Methods: The Transition of Traditional Saudi Arabian Architectural Designs." The International Journal of Architectonic, Spatial, and Environmental Design, 17(1), 87, (2022).

Lucas, R., & Lucas, R., Research methods for architecture. Hachette UK; 2016.

Mahgoub, Y., Architecture and the expression of cultural identity in Kuwait. The Journal of Architecture, 12(2), 165-182, (2007).

Millais, M., "A critical appraisal of the design, construction and influence of the Unité d'Habitation, Marseilles, France." Journal of Architecture and Urbanism, 39(2), 103-115, (2015).

Moscatelli, M., "Rethinking the Heritage through a Modern and Contemporary Reinterpretation of Traditional Najd Architecture, Cultural Continuity in Riyadh." Buildings, 13(6), 1471, (2023).

Nitschke, J. L., & Lorenzon, M., "Archaeology, Architecture, and the Postcolonial Critique." Postcolonialism, Heritage, and the Built Environment: New Approaches to Architecture in Archaeology, 1-11, (2020).

Patton, M. Q., "Qualitative research and evaluation methods. Thousand Oaks." Cal.: Sage Publications, 4, (2002).

Pratt, M. L., "Arts of the contact zone." In Negotiating academic literacies (pp. 171-185). Routledge, (2012).

Rabbat, N., "What is Islamic architecture anyway?" Journal of Art Historiography(6), 1, (2012).

Radford, A., Morkoç, S. B., & Srivastava, A., The elements of modern architecture: understanding contemporary buildings. Thomas and Hudson, UK; 2014.

Rojas, E., & Magalhaes, F., "The Reurbanization of the Brasilia Metropolitan Region." 42nd ISOCARP Congress, (2007).

Said, E. W., Culture and imperialism. Vintage; 2012.

Saleh, M. A. E., "The integration of tradition and modernity: A search for an urban and architectural identity in Arriyadh, the capital

public, private, and non-governmental organizations are acknowledged for their assistance and support.

8. References

Abrams, M., The art of city sketching: a field manual. Routledge; 2021.

Akkach, S., "Modernity and design in the Arab world." Design in the Borderlands, Routledge, 61-75, (2014).

Al-Farsy, F., Modernity and tradition: The Saudi equation. Routledge; 2012.

Al-Ghamrawi, A., Dr. Sayed Karim: Pioneer of city planning (Second ed.). Giza Governorate; 2015.

Al-Hathloul, S., "Riyadh architecture in one hundred years." Darat al-Funun. Amman, Jordan, (2002).

Al-Hathloul, S., "Riyadh, Saudi Arabia." In R. S. Sennott (Ed.), Encyclopedia of 20th Century Architecture (Vol. 3). Fitzroy Dearborn, (2004).

Al-Hathloul, S., "Riyadh development plans in the past fifty years (1967-2016)." Current Urban Studies, 5(01), 97, (2017).

Al-Ibrahim, M. H., "The criticism of modern architecture in Saudi Arabia." Engineering Sciences, 7(1), (1995).

Al-Naim, M., "Conservatism versus modernism: Hesitant urban identity in Saudi Arabia." The Middle East Institute, Architecture and Urbanism in the Middle East, (2008).

Al-Rasheed, M., A history of Saudi Arabia. Cambridge university press; 2010.

Aldagheiri, M., "The role of the transport road network in the economic development of Saudi Arabia." WIT Transactions on the Built Environment, 107, 275-286, (2009).

Alghamdi, N., Alnaim, M. M., Alotaibi, F., Alzahrani, A., Alosaimi, F., Ajlan, A., Alkhudhayri, Y. A., & Alshathri, A., Documenting Riyadh City's Significant Modern Heritage: A Methodological Approach. Buildings, 13(11), 2818, (2023).

Alkhabbaz, M. H., Leaping into Modernity: Architecture and Identity in Saudi Arabia, 1962-1986. Illinois Institute of Technology; 2018.

Alnaim, M. M., & Noaime, E., "Typological Transformation of Individual Housing in Hail City, Saudi Arabia: Between Functional Needs, Socio-Cultural, and Build Polices Concerns." Sustainability, 14(11), 6704, (2022).

Alshebli, A., Towards making urban planning practices more effective amid rapid urban growth in Riyadh-Saudi Arabia University of Birmingham; 2018.

Alsoliman, A., Riyadh: The process of architectural and urban development. Jadawel S.A.R.L; 2023.

Alzahrani, A., "Understanding the role of architectural identity in forming contemporary architecture in Saudi Arabia." Alexandria Engineering Journal, 61(12), 11715-11736, (2022).

Arbid, G., & Oswalt, P., Designing Modernity: Architecture in theArab World 1945-1973. De Gruyter; 2022.

Asfour, K., "Identity in the Arab Region: Architects and Projects from Egypt, Iraq, Jordan, Saudi Arabia, Kuwait and Qatar." Constructing identity in contemporary architecture: Case studies from the south, 12, 151, (2009).

Ashour, S., "Sayed Karim; Reflections on a "Revolutionary" Modernist." Failed Architecture workshop in Cairo, (2016).

Audsley, S. M. (2019). Why Study Architecture? Retrieved November 3 from https://www.masterstudies.com/articles/why-study-architecture

Avermaete, T., & Nuijsink, C. (2021). Architectural Contact Zones: Another Way to Write Global Histories of the Post-War Period? Architectural Theory Review, 25(3), 350-361.

Celedón Forster, A., Ferrari Moncada, F. A. d., Díaz Peñaloza, F. J., & Grass Puga, D. J., "Architecture as a common field of knowledge." archithese 3.2019 Chile, (2019).

Creswell, J. W., & Creswell, J. D., Research design: Qualitative, quantitative, and mixed

in the 1950s is a testament to how the city responded to changes in society and economy, integrated diverse cultures, and embraced global influences. The infusion of architecture with traditional and Islamic elements not only mirrored Saudi Arabia's societal and cultural transformations but also contributed to a distinctive architectural identity that continues to shape Riyadh's urban fabric. This research highlights the significance of considering advancements concerning their historical, cultural, and socio-economic settings. It provides perspectives on the conversation between the past and future in the urban development of Saudi Arabia.

7. Conclusion

During the 1950s, the façade typology in Saudi Arabia underwent significant changes influenced by a variety of factors. Curtain walls with large glass sections became prominent, providing uninterrupted views and blurring the line between the interior and exterior. This adoption was greatly influenced by the rise of modernist architecture, which emphasized functionality, simplicity, and a break from traditional designs. Another distinguishing feature of the building exteriors was the horizontal emphasis achieved through elongated windows and concrete lines. The nation's oil wealth fueled grand architectural ventures that blended modern and monumental styles, fueling this trend. Steel, glass, and concrete advancements catalyzed innovative designs, which can be seen prominently in modern structures and Brutalist buildings. Along with modernist tendencies, the 1950s saw an Islamic Revivalism, which blended historical Islamic architectural elements with modern designs. This decade was defined by architectural functionalism, with façades reflecting purposeful designs devoid of unnecessary embellishments. Finally, Saudi Arabia's emphasis on urban planning and public infrastructure shaped the architectural landscape, with new cities being built and existing ones being modernized to reflect the nation's progress and aspirations.

The architectural landscape of Saudi Arabia is set to evolve further, drawing on its rich history while embracing future innovations. From the 1950s, the fusion of modernist principles with traditional Islamic influences laid the groundwork for the nation's contemporary design ethos. As global architectural trends shift toward sustainable and smart designs, Saudi Arabia is expected to incorporate these elements, blending them with the country's distinct cultural and historical nuances. Material and technological advancements, combined with the nation's 2030 vision for urban development, are likely to result in architectural marvels that are both functional and environmentally conscious. Furthermore, as Saudi Arabia diversifies and modernizes, we can expect an even greater emphasis on public spaces, community-driven designs, and infrastructure promoting cultural preservation and global connectivity. In essence, Saudi Arabia's architectural narrative, rooted in the transformative 1950s, is poised to be a source of inspiration and innovation in the coming decades.

Moving forward, one critical area of investigation is the nuanced fusion of modernist principles with Islamic revivalism. Dive deeper into this intersection to learn more about the socio-cultural dynamics that influence architectural decisions in the country. Given the widespread use of steel, glass, and concrete in the 1950s, it is important to investigate how emerging materials and technologies are currently reshaping Saudi Arabia's architectural fabric. With global architectural trends emphasizing sustainability, it's critical to understand how Saudi Arabia is localizing these sustainable and smart designs, especially while retaining its unique architectural identity.

As Saudi Arabia strengthens its global ties, an intriguing area of research is determining how its architectural practices are evolving to facilitate international collaborations. Similarly, predicting the architectural philosophies guiding Saudi Arabia's future urban development provides valuable foresight. Finally, comparing Saudi Arabia's architectural trajectory to that of other rapidly urbanizing nations could provide a more comprehensive understanding of its unique journey within global trends. These research directions are critical for anyone attempting to piece together the intricate tapestry of Saudi Arabia's architectural past, present, and future.

Acknowledgments

The authors would like to acknowledge the Steering Committee of Riyadh Memory Project: Prof. Saleh Al-Hathloul, Prof. Mohammad Alissan Alghamdi, Prof. Mashary Al-Naim, and Dr. Ricardo Camacho for their constructive feedback and contributions to this research paper. All Saudi

6. Findings

Riyadh, Saudi Arabia, underwent an architectural transformation in the 1950s from traditional Najdi designs to a more modern style due to the nation's oil wealth and connections to the international community. This shift was characterized by adopting building materials like concrete and steel, replacing the traditional mud brick construction, and signaling a move towards modernization and away from conventional architectural styles.

The study found that blending Islamic elements with modern design principles resulted in a unique architectural identity in Riyadh. Buildings like the Ministry of Health, The Eastern Flower Hotel, and the National Electricity Company—each a testament to Sayed Karim's architectural vision—showcased this fusion by incorporating modern construction methods alongside traditional Islamic architectural features such as courtyards and decorative patterns, creating a distinct aesthetic that mirrored the cultural changes of that period.

Additionally, the research emphasized how foreign architects and firms shaped Riyadh's architectural landscape in the 1950s. The introduction of architectural concepts during the oil boom era contributed to bringing modernist architectural ideas to Riyadh through global exchanges and interactions. However, what truly set the style of that era apart was the city's unique ability to skillfully blend these principles with the local and Islamic architectural traditions, creating a distinctive architectural identity.

The study also highlighted the pivotal role of societal and cultural factors in shaping Riyadh's architectural development. Social norms, religious beliefs, and cultural values significantly guided architectural practices toward a harmonious fusion of modernity and tradition. This delicate balance, reflecting the community's aspiration to embrace modernization while preserving its heritage, was a prevalent theme in Riyadh's architectural story during the 1950s, underscoring the city's commitment to its cultural roots (Table 2). Furthermore, the research sheds light on Western modernity by exploring the works of Arab architects like Sayed Karim, who incorporated early modernist concepts into their designs. This perspective adds depth to the discourse on architecture by showcasing how cities outside the Western world, such as Riyadh, navigated the complexities of modernization while safeguarding their cultural roots.

In summary, Riyadh's architectural evolution

Table (2). The study main findings

Aspect	Summary of Findings
Architectural Form	The architectural form in Riyadh during the 1950s displayed a blend of modernist principles with traditional and Islamic elements. Buildings like the Ministry of Health, The Eastern Flower Hotel, and the National Electricity Company showcased modern materials and construction techniques while incorporating traditional features such as courtyards and abstract decorative motifs.
Composition	Elements. The use of horizontal windows, concrete overhangs, and flat roofing systems alongside traditional decorative patterns was prevalent.
Symbolism	Architectural symbolism during this period reflected a dialogue between the past and the future. Modern buildings incorporated Islamic and traditional motifs, serving as symbols of Saudi Arabia's cultural heritage amidst rapid modernization and urbanization.
Cultural Context	The architectural developments of the 1950s were deeply embedded in Saudi Arabia's cultural context, blending Islamic traditions with emerging modernist trends. This period reflected an architectural identity crisis and a search for a balance between preserving cultural heritage and embracing modernization.
Foreign Influence	Foreign architects and firms brought international modernist influences to Riyadh, introducing new design principles and construction techniques. However, the unique architectural identity of Riyadh from this era was shaped by the selective adaptation and integration of these foreign influences with local and Islamic architectural traditions.
Socio-Cultural	The socio-cultural dynamics of the 1950s, including religious precepts, societal norms, and the influx of oil wealth, significantly influenced architectural practices. Architects and builders navigated these dynamics by incorporating modern elements into traditional frameworks or forging new architectural vocabularies, reflecting the broader societal shifts towards modernization while retaining cultural identity.

structure. The architectural design incorporates a recurring grid pattern for the exterior, constituting a prominent element that extends vertically across the entirety of the structure. The utilization of visual rhythm in this context serves to establish a harmonious and repetitive mesh motif. Including staggered side extensions introduces an added dimension, disrupting the uniformity of the grid pattern and introducing an asymmetrical balance to the overall design.

Through observation, the study highlighted Saudi Arabia's architectural landscape in the 1950s, which changed dynamically, reflecting a mix of traditional influences and modern aspirations. Table 1 summarizes the architectural evolution, beginning with the introduction of curtain walls, which allowed for expansive glass façades, and ending with the pronounced horizontal emphasis seen in many structures. Factors such as the country's oil wealth, modernism's influence, advancements in construction materials, and a renewed interest in regional designs all played essential roles in shaping the nation's-built environment. Furthermore, the emphasis on functionalism and the commitment to urban planning and public infrastructure emphasized the country's forward-thinking vision while remaining rooted in its rich history.

Overall, the mainstream architectural and exterior façades of the Saudi Arabian 1950s were influenced by a desire for simplicity, functionality, and a connection with the natural environment. The decade saw the mainstreaming of mid-century modernism, the continued influence of the international style, and the emergence of brutalism, each with its distinct approach to exterior façades. These styles and façade typologies continue to influence architecture and design to this day, illustrating the lasting impact of the 1950s on the built environment in Saudi Arabia.

Table (1). Summary of the Saudi Arabian 1950s architectural evolution

Façade Typology	Transformation Influence
Curtain Walls: In Saudi Arabian buildings, curtain walls became a prominent façade typology that was never seen before. These were large expanses of glass held in place by a metal framework, creating a seamless transition between the interior and exterior. Curtain walls allowed for breathtaking views and a sense of openness.	Modernism Architecture: Architectural principles were widely embraced due to the high dependence on foreign architects and laborers. This international collaboration resulted in importing architectural ideas and styles from Egypt, Europe, the United States, and other parts of the world (Gold, 2007). As a result, the architect emphasized functionality and simplicity and applied conceptual ideas that were a break from historical architectural traditions. This was evident in buildings that featured clean lines, geometric shapes, and a focus on functionality.
Horizontal Emphasis: Many buildings of the 1950s, including the study cases, favored horizontal lines in their exterior façades. This was achieved through long, horizontal windows, concrete lines, flat roofs, and low, spreading forms. These designs aimed to blend the building with its natural surroundings.	Influence of Oil Wealth: The discovery and exploitation of oil reserves in Saudi Arabia during the mid-20th century led to significant economic prosperity (Shafiee, 2021). This newfound wealth allowed for ambitious architectural projects, often characterized by grandiosity and opulence. Iconic structures and modern cities began to emerge, showcasing a blend of modernist and monumental architectural styles.
Use of New Materials: Advances in materials like steel, glass, and concrete significantly shaped exterior façades in Saudi Arabia during this era. These materials allowed for more daring and innovative designs, as seen in the exposed glass façades of The Eastern Flower Hotel Modern buildings or the imposing concrete surfaces of Brutalist structures in the Ministry of Health.	Islamic Revivalism: While modernism was a dominant trend, there was also a resurgence of interest in traditional Islamic architecture during the 1950s. This revivalist movement sought to incorporate Islamic design and cultural elements into modern buildings (Rabbat, 2012). Architects looked to historical Islamic architecture for inspiration, incorporating features like arches, domes, and intricate geometric patterns into contemporary designs. This approach aimed to strike a balance between tradition and modernity.
Functionalism: The 1950s buildings in Saudi Arabia strongly emphasized functionalism in architecture, which was reflected in exterior façades. Architectural elements were designed to serve a purpose, and unnecessary ornamentation was often eschewed in favor of clean, functional lines.	Public Infrastructure and Urban Planning: Saudi Arabia invested heavily in public infrastructure during the 1950s (Aldagheiri, 2009). Urban planning and constructing modern amenities, such as highways, bridges, and public buildings, became a priority (Alshebli, 2018). This era witnessed new cities' development and existing ones' expansion and modernization. This demanded structures that expresses the country's development and needs.

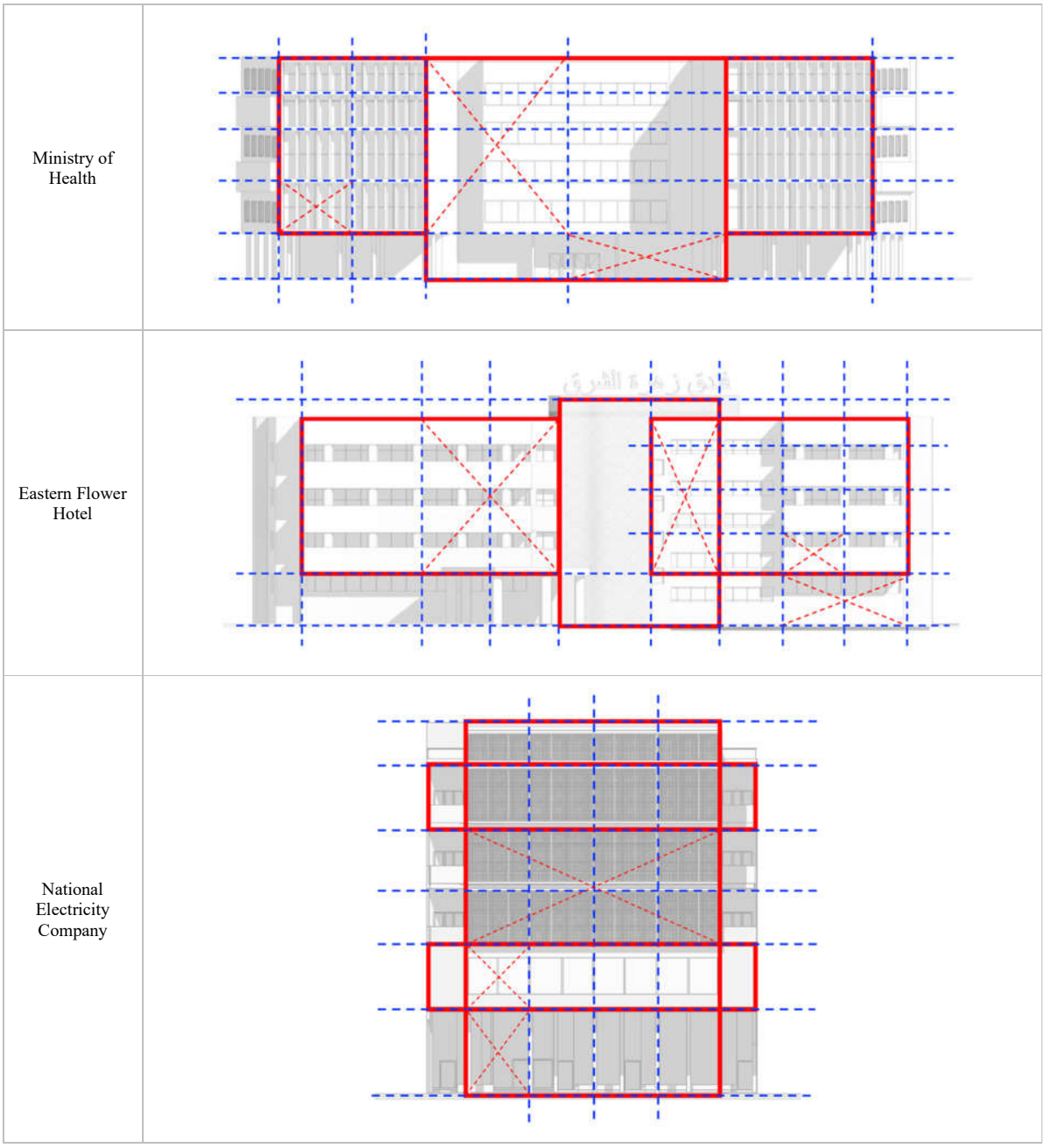


Figure (9). The geometric, compositional, and proportional aspects of 1950s façades. Source: The Authors

layered balconies introduces a sense of depth to the otherwise flat structure, forming distinct areas of shadow and light. The vertical components of the building are further divided by horizontal slabs that are evenly spaced, thereby strengthening the emphasis on the horizontal aspect.

While The National Electricity Company incorporates a balanced vertical proportion and a nearly cubical shape for its main body, it examines architectural proportion and geometric composition. The building's large rectangular openings on the ground floor serve as a visual foundation for the

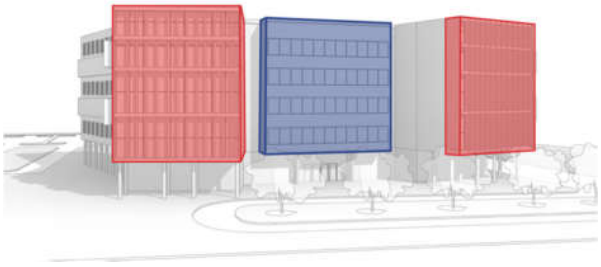
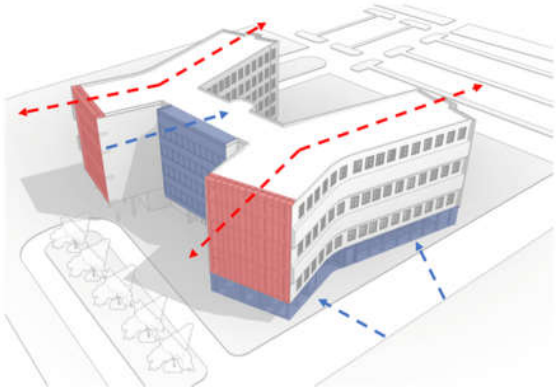
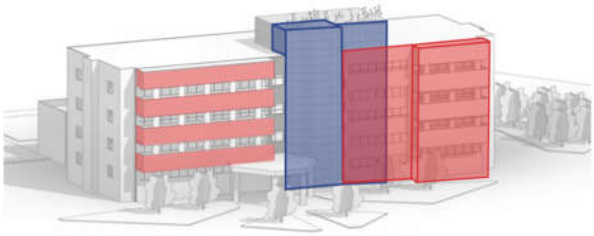
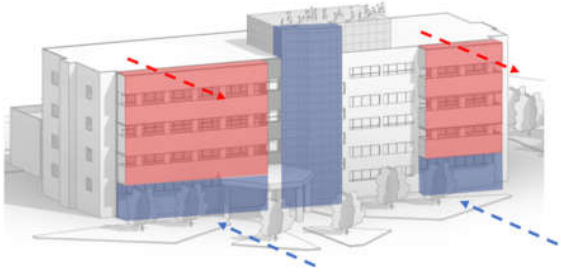
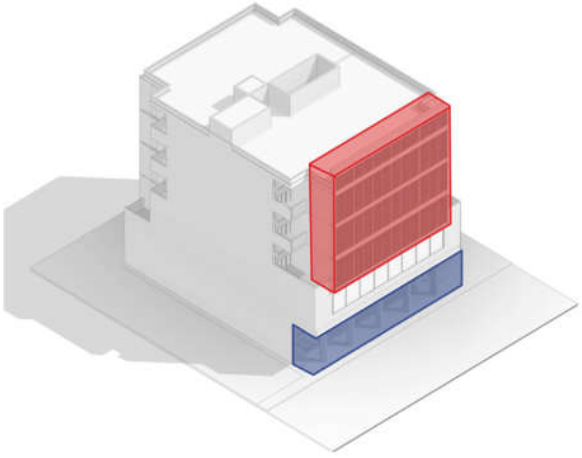
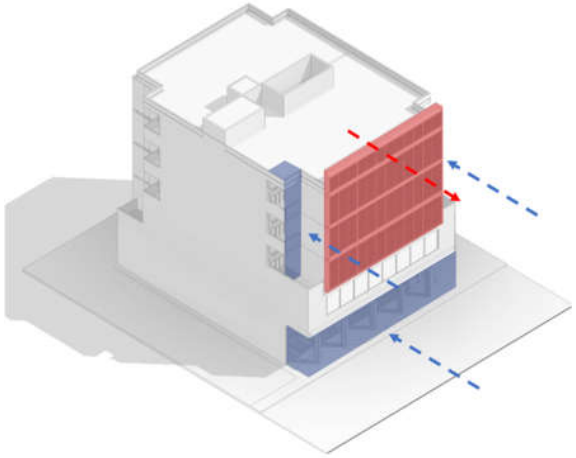
Geometry Composition	Push & Pull Geometries
Ministry of Health	
	
Eastern Flower Hotel	
	
National Electricity Company	
	

Figure (8). The geometry and characteristic aspects of 1950s façades. Source: The Authors

architects during this era (Ashour, 2016). Therefore, the architectural façades in the three cases exhibit a mid-to-late twentieth-century modernist approach, which is common in Saudi Arabia and many urban settings worldwide (Figure 8). As a result, the repetitive geometry of the façades seen in the Ministry of Health prominently features a repeated grid pattern with square and rectangular openings, a Brutalist and Modernist movement hallmark. On the other hand, the Eastern Flower Hotel balconies were elements that were not previously used in such a context, with linear railings providing semi-outdoor space for the residents. While functional, they also serve as personal expression spaces where residents can add plants, furniture, or other items. They provide brief bursts of color and variation in an otherwise monotonous façade.

The contrast between the cases expresses different approaches to architectural design. The Brutalist and Modernist movements prioritize using bold, geometric forms and minimal ornamentation, creating a sense of strength and solidity. In contrast, the Eastern Flower Hotel embraces a more organic and interactive approach, incorporating balconies as an extension of personal living spaces. This juxtaposition highlights how architecture can shape our experiences and perceptions of the built environment. Therefore, the façade's vast, unbroken surfaces and consistent use of materials create a sense of strength and permanence due to its monolithic simplicity. This monolithic appearance can evoke feelings of stability and timelessness, implying that the structure stands guard against the passage of time.

In the contrary, the grid-like structure of the metal mesh façade that covers the balconies on each floor of the National Electricity Company provides a new way of shade, privacy, and possibly passive cooling, making this building differ in its functional and decorative element. Behind this façade, each unit's balconies extend outward, providing outdoor space for the building's occupants with new approach for privacy concerns. The structure incorporates a mix of large rectangular windows and smaller square openings, with the latter providing ventilation as well as a decorative touch. Its minimalistic design leans toward minimalism, emphasizing function over form and featuring clean lines, a subdued color scheme, and a lack of ornate details. Large rectangular windows let in plenty of natural light, creating a light and airy atmosphere. Furthermore, the neutral color scheme adds a sense of sophistication and timelessness to the structure's overall aesthetic.

The three examples showcased a different approach to rhythm created by the repeated grid pattern of the windows and façade elements. This repetitive nature can be interpreted as a reflection of the consistent pace of urban life or of society's uniformity and collectivism. This created a dynamic interplay of light and shadow by creating depth in the façades, particularly in the recessed windows and protruding elements. These different rhythm approaches to shadows shift as the weather becomes harsher, providing a constantly changing interplay of light and dark. Also, add a sense of movement and vitality to the buildings, making them appear more dynamic and alive. Additionally, the interplay of light and dark can evoke different moods and emotions, enhancing the overall experience of the urban environment for both residents and passersby. In this instance, the three buildings sharply contrast with the organic forms of the surrounding landscape. This juxtaposition can be interpreted as a commentary on the relationship between nature and urban development or as a visual reminder of the coexistence of natural and built environments.

The architectural design of the Ministry of Health exhibits a combination of vertical and horizontal proportions, resulting in a visually engaging composition. The presence of horizontal elements, such as recessed rectangular windows balance the building's vertical thrust. From a geometric perspective, the architectural structure consists of solid blocks juxtaposed with voids, juxtaposed with voids, manifesting in the form of windows and semi-balconies. One notable feature is a grid-like arrangement on a particular side, which resembles the National Electricity Company design, albeit with distinct execution (Figure 9). This phenomenon offers both aesthetic appeal and potential functional utility, such as providing shade. The opposition of solid and void elements in the design engages with the notions of opacity and transparency, resulting in a distinctive visual encounter for the observer.

On the other hand, the Eastern Flower Hotel showcases a horizontal orientation and proportion, characterized by a greater emphasis on width rather than height. The geometric arrangement is characterized by sizable rectangular sections and balconies that alternate in a rhythmic pattern. The building exhibits a distinct façade pattern on one side, contributing to its visual appeal. Incorporating

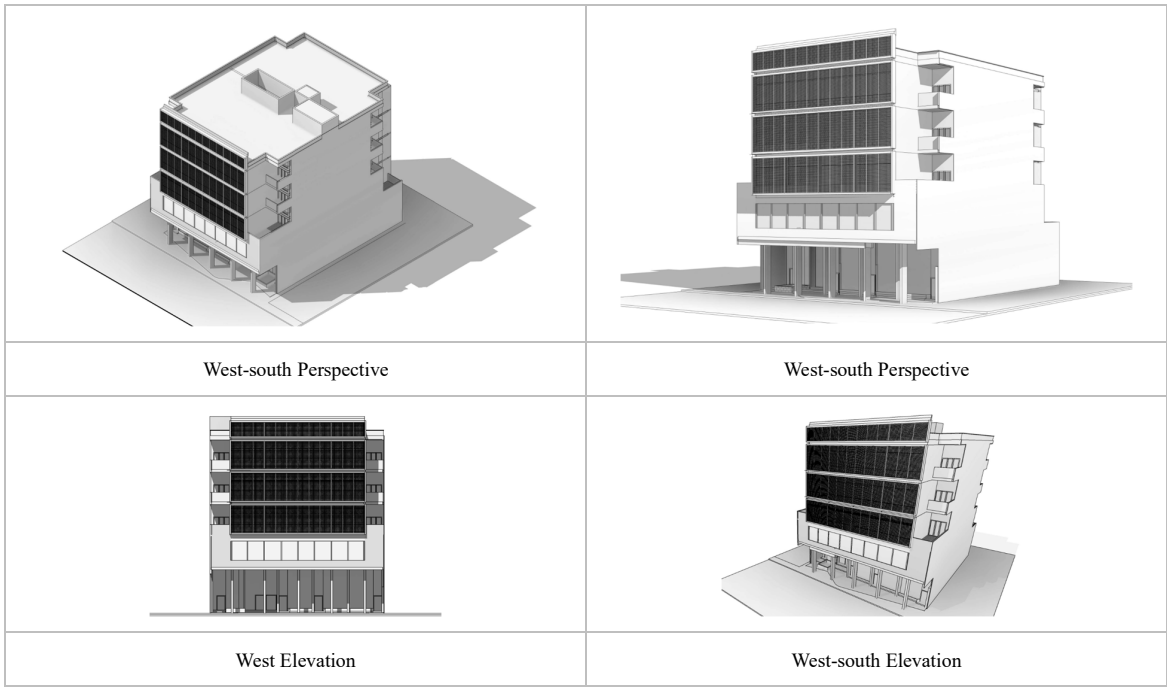


Figure (7). The National Electricity Company architectural characteristics. Source: The Authors

The building, as mentioned above, exhibits a hierarchical arrangement consisting of five levels, analogous to that of an office building. The design of the layout adhered to a rectangular shape. The core of the building housed the vertical circulation elements, such as elevators and stairs, alongside an open courtyard and other essential services (Figure 7). The primary exterior of the structure is partitioned into three distinct sections, delineated by a notable wall and linked together by a metal mashrabiya (mesh motif curtain screen), which unifies the successive levels into a cohesive whole. The ground and first levels were enveloped in stone panels featuring expansive glass apertures. Over time, the building underwent several alterations. One notable feature is the metallic cladding on the central section of the front façade, which was designed to serve as a mashrabiya, resembling those found in Hejazi architecture in the western region of the Kingdom. For example, SANAA designed the New Museum in New York, USA. It has staggered floors and a basic boxy form. Although it was built in a different era, it has a mesh façade similar to the National Electricity Company (Shin et al., 2013). Therefore, the subsequent visual representations depict the process of three-dimensional modeling applied to the National Electricity Company edifice. The architectural style of mid-century modernism is being widely adopted and integrated into mainstream design.

5. Analysis

It is notable that all the studied cases were designed by a well-known Egyptian architect, Sayed Karim (1911-2005). This is due to s being commissioned by the Saudi Government to design the majority of the Saudi ministerial buildings and some other facilities such as hotels and commercial buildings in Riyadh. When a decision was made in the late 1950s to move the capital of the country form Jeddah to Riyadh, Sayed Karim also put forth an early master plan for the city of Riyadh in 1950 (Al-Ghamrawi, 2015; Elwakil, 2019), this happened when new government buildings, housing for the government staff, and a number of royal palaces and villas were constructed in Riyadh. The Airport Road – popularly locally known as 'Ministries Street' - was known to host most ministerial buildings. In contrast, Al Malaz district houses government employees from Jeddah and elsewhere.

We could say that Sayed Karim architectural style can be described as a modern with an international touch that was common among

establishment, sports facilities for football and tennis, and event spaces. The primary architectural concept involved a central rectangular structure that housed the guest accommodation rooms (Figure 5). The guest rooms were arranged in two parallel rows, with a central corridor dividing them along the longitudinal axis of the building.

Additionally, the majority of these rooms were equipped with balconies. The vertical movement elements are prominently and precisely positioned at the central axis of the building, adjacent to the hotel's primary entrance. The primary elevation of the building is composed of horizontal elements with significant mass. A single-story hexagonal canopy covers the entrance, close to the center of the building's frontage. For example, the residential blocks of Brasilia, Brazil, were designed by Oscar Niemeyer and showcase the hotel's use of simple, geometric shapes just like the one seen in the Zahrat Al Sharq hotel. (Rojas & Magalhaes, 2007). As a result, the designer intended to incorporate curved lines amidst a collection of predominantly vertical elements, thereby introducing a sense of fluidity that was not widely embraced during that era. The subsequent visual representations illustrate the three-dimensional modeling of the hotel edifice. The architectural style of mid-century modernism is being widely adopted and integrated into mainstream design.

4.3 Case three: National Electricity Company

The third selected case study is the building of National Electricity Company. This building is known to be the first and oldest headquarter owned by the company (Figure 6). The building is located at Al Suwailim Street, Al Dirah district.

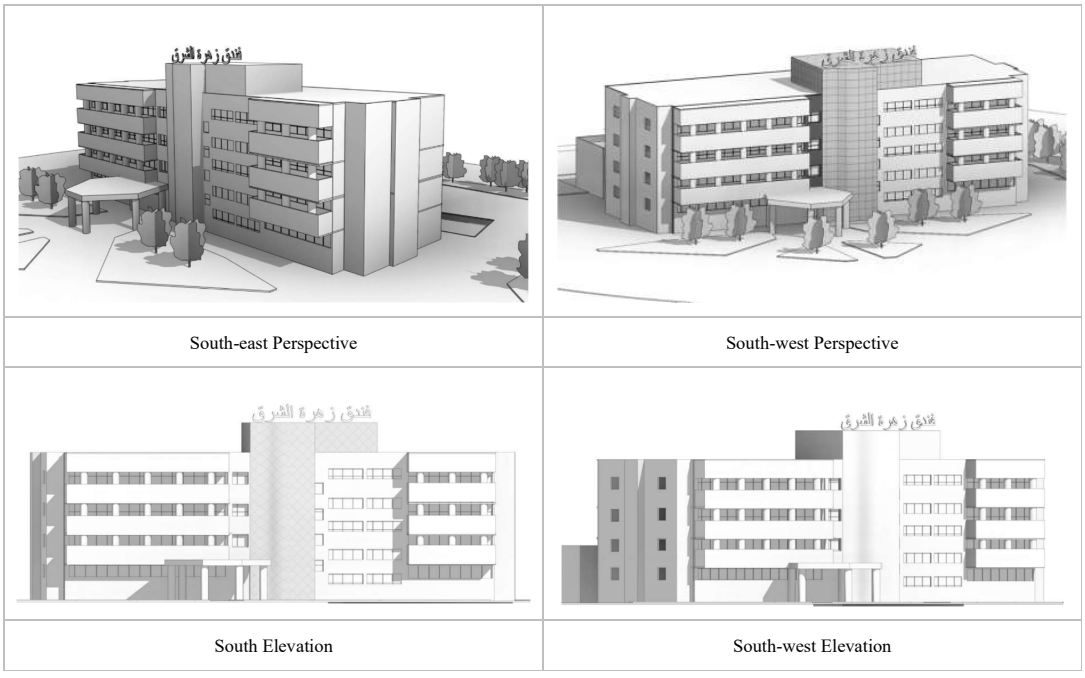
During the latter half of the 1950s, the renowned Egyptian architect Sayed Karim once again undertook the development of the National Electricity Company building. The construction of the building was undertaken by the Arab Contractors Foundation under Othman Ahmed Othman. The structure is acknowledged as the most historical, purposefully constructed central office for the electricity corporation within the Kingdom. The structure is situated on Al-Swailem Street, which is recognized as a highly trafficked thoroughfare in the capital city. The relocation of the National Electricity Company has resulted in leasing this building to a different commercial entity.

Design Date	1959	**Building Type**	Office/Commercial
Construction Date	1960	**Number of Levels**	5 Levels
Opening Date	1962	**Plot Area**	815 m^2
Designer	Sayed Karim	**Building Footprint**	593 m^2
Contractor	The Arab Contractors	**Total Floor Area**	2,965 m^2

Figure (6). The National Electricity Company architectural characteristics. Source: The Authors

Design Date	1950	**Building Type**	Housing/Hotel
Construction Date	1955	**Number of Levels**	5 Levels
Opening Date	1958	**Plot Area**	23,282 m^2
Designer	Sayed Karim	**Building Footprint**	1,304 m^2
Contractor	Mohammad Bin Laden	**Total Floor Area**	6,521 m^2

Figure (4). The Eastern Flower Hotel history and facts. Source: the Authors



South-east Perspective	South-west Perspective
South Elevation	South-west Elevation

Figure (5). The Eastern Flower Hotel architectural characteristics. Source: The Authors

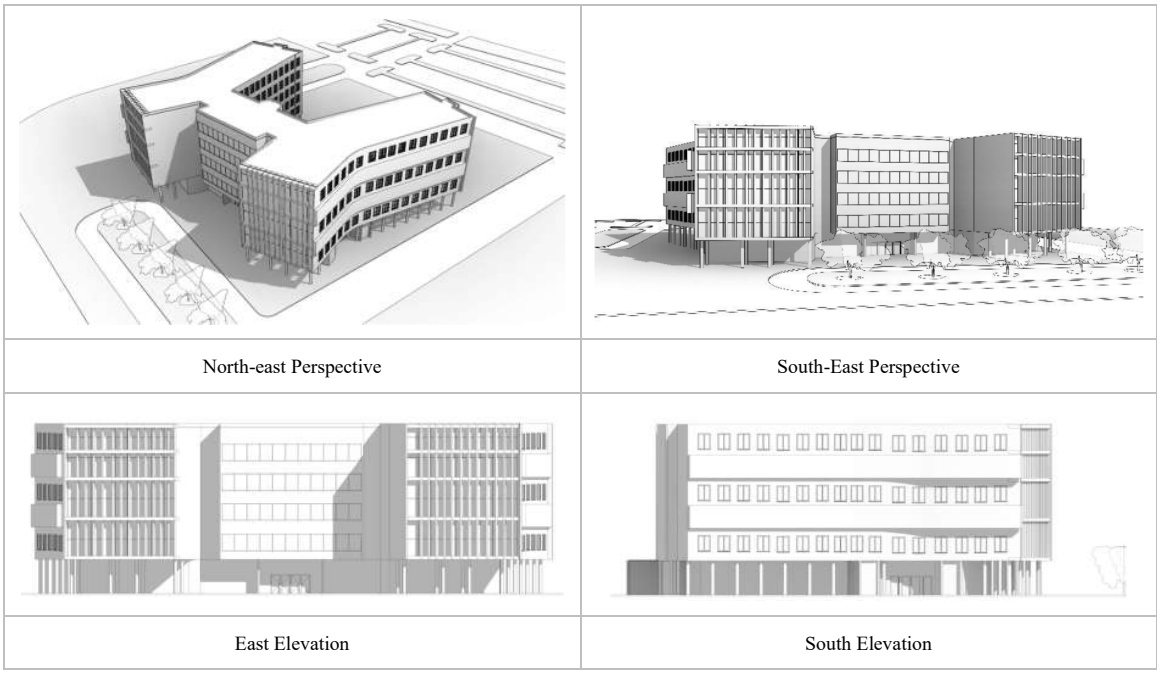


Figure (3).The Ministry of Health's architectural characteristics. Source: The Authors

exhibits contemporary architectural features, such as incorporating columns in its façades. A set of columns located in the two blocks facing one another facilitates the elevation of the first-floor slab. The construction elements employed in this project included elongated horizontal glass windows, reinforced concrete structures, flat roofing systems, and a low-profile, expansive design. The restoration of the Ministry building took place in 1999. The scope of the restoration efforts was confined to the alteration of the exterior paint's hue. The subsequent visuals depict the three-dimensional representation of the Ministry of Health edifice. The text effectively demonstrates the integration of the Mid-Century Modernist architectural style into mainstream culture.

4.2 Case Two: The Eastern Flower Hotel

The second selected case study is the building of The Eastern Flower Hotel, known in Arabic as Zahrat Al Sharq. The hotel is recognized as one of the hotels sponsored by the Saudi Government in Riyadh (Figure 4). The building is located at King Abdulaziz Road, previously known as The Airport Road, Al Malaz district.

Mohammad Bin Laden oversaw the construction, while renowned Egyptian architect Sayed Karim created the architectural design for the Zahrat Al Sharq hotel building. The structure is regarded as one of the initial hotels constructed in the 1950s under government sponsorship. Nevertheless, ownership was transferred to the contractor, Mohammad Bin Laden. The hotel is renowned for accommodating numerous guests from the Kingdom, including celebrities and prominent national and international individuals. The hotel underwent enhancements during the late 1950s and 1960s by incorporating sports facilities that met international standards. The hotel has transformed into a prestigious establishment. One prominent individual in photography is Keith Wheeler, renowned for capturing numerous photographs of Riyadh, particularly during the early 1960s. Mr. Wheeler is widely acknowledged as the preeminent photographer who extensively documented the urban landscape of Riyadh. The photographs he captured gained wide circulation and were extensively utilized in various reference books about Riyadh.

The inauguration of this building took place in 1958 under the auspices of King Saud. The structure's architectural features suggest that it can be classified as an example of contemporary design. The building amenities encompass a dining

4.1 Case One: Ministry of Health

The first selected case study is the Ministry of Health building, the first and oldest headquarters for health services in the Kingdom (Figure 2). The building is located at King Abdulaziz Road, previously known as The Airport Road, Al Murabba district.

The renowned Egyptian architect Sayed Karim oversaw the architectural design of the Ministry of Health building, and Othman Ahmed Othman led the Arab Contractors Foundation in carrying out the construction. The structure is recognized as the most historically dedicated headquarters for healthcare services in the Kingdom. During that period, most of the ministries' main offices were established along Airport Road, now referred to as King Abdulaziz Road. These offices were constructed simultaneously. The primary contractor, Arab Contractors Foundation, engaged multiple subcontractors to assist in completing the construction project for the ministry's headquarters. The headquarters location was selected to mitigate issues related to urban congestion by situating it outside the boundaries of Riyadh city. Nevertheless, the concentration of all ministry headquarters in a single location has resulted in overcrowding for both government employees and visitors to these departments.

The architectural features and design vocabulary employed in the building suggest that architect Sayed Karim drew inspiration from the modern architecture movement. The mass of the Ministry building is partitioned into three distinct zones, with the central zone serving as a connecting link between the two opposing blocks (Figure 3). The primary entrance of the edifice is situated within the central portion of the structure, establishing a formal and ceremonial point of entry. The entrance hall provides access to the Ministry's primary auditorium. The primary circulation pathway within the building is centrally positioned, facilitating accessibility to all building areas. Regarding the architectural features of the building, it is worth noting that horizontal windows are particularly prominent, particularly on the main façades. Solar breakers were employed as concrete overhangs positioned above the horizontal windows. For example, Le Corbusier's Unité d'Habitation a residential building in Marseille, France, also uses a grid façade with brutalist features similar to this study case (Millais, 2015). Therefore, the building

Design Date	1952	**Building Type**	Office/Governmental
Construction Date	1954	**Number of Levels**	5 Levels
Opening Date	1957	**Plot Area**	33,830 m^2
Designer	Sayed Karim	**Building Footprint**	5,164 m^2
Contractor	The Arab Contractors	**Total Floor Area**	20,657 m^2

Figure (2). Ministry of Health building history and facts. Source: the Authors

utilizing drawings is the ability to document and analyze real-life examples. Additionally, drawings serve as a valuable tool for evaluating the visual representation of imagined objects.

Radford et al. (2014) (Radford et al., 2014), the analysis process reveals an interpretation that subsequently provides insight into the design of a building and its architectural style. This comprehension is derived from analysis, thoughtful contemplation, and discourse surrounding the construction design and its architectural aesthetic. The significance of maintaining equilibrium in evaluating building design lies in carefully considering visual representation through drawings and the verbal articulation of concepts. Consequently, this research depends on integrating the examination of illustrations and written materials extracted from each case study. This study aims to enhance comprehension of both the logical progression of the building design and the architectural style exhibited by these structures.

3.3 Triangulation and Synthesis

Triangulation holds significant importance within the research realm as it enhances the credibility and validity of the findings. However, it aids in the mitigation of biases in the research. Triangulation in the current study indicates the incorporation of various research methods, datasets, theories, and investigations to address the research question effectively. According to Thomas (2011) (Thomas, 2021), triangulation is examining a subject matter from various perspectives and viewpoints. This approach involves conducting in-depth investigations using diverse methodologies and approaching the topic from different angles. In this study, three data-collection techniques were employed to ensure triangulation. Patton (2002) (Patton, 2002) identified three primary practices employed in the study: documentation through content analysis, observation through fieldwork analysis, and visual representation through drawings analysis. The documentation technique involved collecting and analyzing several documents pertaining to the chosen cases. The observation technique involved conducting site visits to comprehensively photograph the entirety of the building, both its interior and exterior, as well as the surrounding areas. These photographs were collected for the purpose of documentation and subsequent analysis. The visual representation involved the reproduction and analysis of building drawings through the use of annotated diagrams, which have a well-established history within the architectural profession and a substantial body of knowledge associated with them.

4. The Study Cases

The 1950s were the heyday of Mid-Century Modern architecture, emphasizing clean lines, open spaces, and a strong connection with nature. Architects like Frank Lloyd Wright, Le Corbusier, and Ludwig Mies van der Rohe, to name a few, played pivotal roles in popularizing this style (Tournikiotis, 2001). Exterior façades at that time often featured large windows, flat planes, and minimal ornamentation. Using new materials like steel and glass allowed for innovative designs, such as the iconic glass curtain wall. These buildings were characterized by integrating indoor and outdoor spaces, with features like sliding glass doors and expansive terraces. The mid-century modern style also prioritized functionality and simplicity, emphasizing open floor plans and eliminating unnecessary details.

Cultural, political, and economic changes all impacted the significant transformation of Saudi Arabian architectural styles (Al-Hathloul, 2004; Alghamdi et al., 2023). During this time, several foreign-influenced architectural trends and styles emerged or became more well-known in the area. One of the prominent architectural styles that emerged in Saudi Arabia during this era was the incorporation of traditional Islamic elements into modern designs (Al-Hathloul, 2002, 2017; Alzahrani, 2022). This fusion of old and newly created a unique aesthetic that showcased the country's rich cultural heritage while embracing contemporary influences. Additionally, the rapid urbanization and economic growth in Saudi Arabia led to the rise of futuristic and avant-garde architectural designs, reflecting the nation's aspirations for modernity and progress.

Therefore, to reach the study objective, three prominent case studies were examined to explore the architectural trend that emerged in the 1950s. The intent is to understand how these cases laid the foundation for the diverse and innovative architectural developments that have continued to shape the Saudi Arabian built environment in subsequent decades.

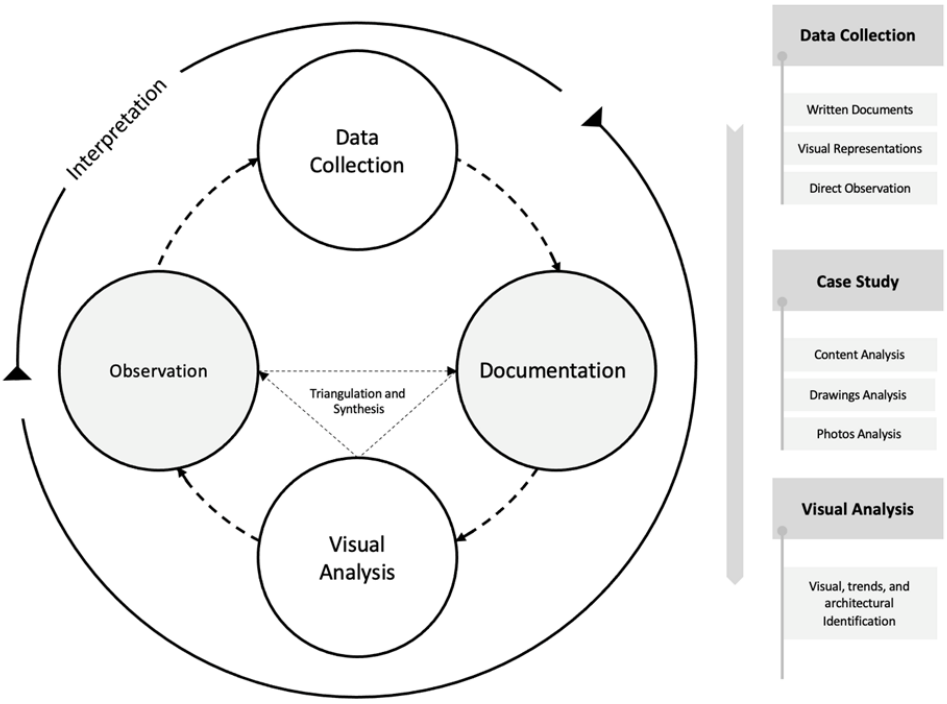


Figure (1). The study research design and methodology. Source: the Authors

- Availability of accurate information such as drawings, given that this study deals with seventy-year-old buildings and hence finding their drawings were vital for the analysis.
- Accessibility, given that many buildings were not accessible and hence, in many cases, photographing was not allowed.
- Building typology and characteristics, which cover a number of categories such as offices, housing, and commercial. Additionally, the buildings selected were varied in size, layout, and planning.

3.2 Content Analysis

Architecture is considered a discipline and a shared domain of knowledge (Celedón Forster et al., 2019). According to Audsley (2019) (Audsley, 2019), architecture is commonly referred to as the fusion of artistic and scientific principles in creating buildings and structures. According to Lucas (2016) (Lucas & Lucas, 2016), the field of study referred to as spatial design encompasses a continuously evolving corpus of knowledge that examines our utilization of space. This discipline explores various aspects, such as our habitation and occupation of space, the creation of significant environments, and the shaping of the surrounding world. Creating architectural drawings is considered an inherent practice within architecture, and it is particularly suited for research purposes as a means of inquiry. In architecture, scholarly investigation and dissemination can encompass various forms of expression, including written discourse and visual representation. Abrams (2021) (Abrams, 2021) states that an examination of a building can be conducted by analyzing its architectural drawings and through direct observation. The practice is commonly recognized as a visual analysis, which serves as a means to comprehend the intricate nature of contemporary architectural designs (Edwards, 2008). This implies that it is possible to visually examine a structure or a specific portion of it, such as its exterior surface, intending to analyze various aspects, such as its vertical dimension, horizontal dimension, and constituent materials. Lucas (2016) (Lucas & Lucas, 2016) highlights the significance of building drawing as a method of inquiry that proves suitable and facilitates the emergence of distinct forms of knowledge. According to Edwards (2008) (Edwards, 2008), one of the advantages of

scholarly contributions. The zones in question are characterized as social spaces where cultures intersect, conflict, and engage, frequently within contexts marked by notable power imbalances. The user provided a numerical reference (Avermaete & Nuijsink, 2021). These architectural contact zones are platforms for exchanging ideas, knowledge, and aesthetics between Western and non-Western cultures. They provide an opportunity for cultural hybridization and the emergence of new design expressions that challenge dominant Western paradigms. (Pratt, 2012). However, it is important to critically examine the power dynamics within these contact zones, as Western cultural design principles often overshadow and marginalize indigenous or local design traditions. This can perpetuate a cycle of cultural dominance and homogenization, undermining the diversity and richness of architecture.

Although the exploration of tracing modern heritage history through the work of foreign architects may need to be more widely discussed, a substantial body of literature delves into this subject matter. The Conceptualization and Development of Modernity through the book "Architecture in the Arab World 1945–1973" by Arbid and Oswalt (2022) examines the diverse forms of modern architecture across various locations in the Arab world. The authors explore the influences of modern architecture in the Arab world by analyzing the biographies of specific buildings (Arbid & Oswalt, 2022). This comprehensive analysis provides valuable insights into the impact of foreign architects on the development of modern architecture in the Arab world. By examining the biographies of specific buildings, Arbid and Oswalt shed light on how these architects shaped the architectural landscape in different Arab countries.

Additionally, their research helps foster a broader understanding and appreciation of the cultural exchange and cross-pollination between foreign architects and local communities during this period. Also, Fabbri and Al-Qassemi (2022) present a comprehensive analysis of architectural development in the Arabian Peninsula during the era of modernization. The research provides valuable insights into this timely and intriguing topic. This study presents a thorough and scholarly examination of the urban environments in the Gulf States, encompassing prominent cities like Riyadh, Dubai, Doha, and Kuwait City (Fabbri & Al-Qassemi, 2022).

3. Research Methodology

This research examines the prevailing architectural trend in Riyadh, Saudi Arabia, during the 1950s, to discern its distinctive attributes. The research paradigm employed in this study is pragmatism, as Creswell (2017) (Creswell & Creswell, 2017) recommended. This paradigm emphasizes the practical aspects of the inquiry, explicitly addressing the "what" and "how" questions to produce meaningful results. The research design, as depicted in (Figure 1), consists of three distinct stages. The selected case studies were initially examined through a comprehensive review of relevant literature, analysis of visual materials, including 2D and 3D drawings, and direct observation conducted during site visits. The subsequent phase encompassed a comprehensive analysis of these cases through content analysis, architectural drawings, and photo analysis. Ultimately, the investigation reached its culmination by integrating the discovered results and drawing conclusions that directly corresponded to the research inquiry, thereby shedding light on the unique architectural components of the examined era.

3.1 Case Studies Approach

Consequently, this research uses case studies approach so as to achieve the research objectives. Case study as 'a choice of what is to be studied' (Stake, 2005) (Stake, 2005) or as 'a method of research' (Yin, 2014) (Yin, 2014) is for these types of research questions: 'what', 'how', and 'why'. Thomas (2021) (Thomas, 2021) outlines case studies as follows: 'Case studies are analyses of persons, events, decisions, periods, projects, policies, institutions or other systems which are studied holistically by one or more methods.' Thomas believes that case study is 'a focus and the focus is on one thing, looking at in depth and from many angles.' He also adds that the purpose of case study is to understand the 'details of what is happening.' Stake (2005) (Stake, 2005) specifies some of the benefits of using case studies as an approach indicating that through case study, comprehensive information is gathered by a variety of data collection techniques over a constant period of time. In this research, three cases were selected. Reasons for selecting these cases were as follows:

seamless integration of traditional elements with contemporary design, creating a harmonious blend that embodies the spirit of a modern metropolis.

2.2 Preservation of Cultural Identity

While international architectural styles found their place in the city's evolving aesthetic, a parallel and deliberate effort was underway to preserve and harmoniously blend traditional and Islamic architectural elements. This intricate balance highlighted Riyadh's nuanced approach to architectural development. The city's architectural canvas board is the imprint of a steadfast commitment to seamlessly integrate elements that resonate with its cultural and religious identity amid the influx of global influences (Isenstadt & Rizvi, 2008).

The continuity of courtyards, an inherent hallmark of traditional Najdi architectural heritage, was a prime example of this thoughtful fusion. These courtyards were deftly interwoven into the ever-changing urban fabric, enduring relics of architectural wisdom. They created a tangible link to the city's historical essence by considering both practical considerations and climatic adaptability. (Helmy, 2008). These open spaces, rooted in functional wisdom, refer to a time when architecture was inextricably linked to its surroundings. These courtyards, masters of thermal comfort, orchestrated the movement of refreshing zephyrs, providing relief from the relentless desert sun. Nonetheless, their significance extended beyond climate control (Elsheshtawy, 2008). They stood as places of intimacy amid the bustling cityscape.

These influences resulted from a fusion of styles that combined modernist principles with local and Islamic traditions. Many of Riyadh's buildings from this era exhibit this architectural hybridity, with modernist forms and materials coexisting with traditional design elements. The Riyadh Railway Station, for example, was built in the late 1950s and combines a modern, streamlined design with traditional Islamic arches and geometric patterns. Similarly, many residential and commercial structures from this era feature modernist forms embellished with traditional Najdi decorative motifs. This stylistic fusion reflects Riyadh's broader societal and cultural transformations during this period, as the city navigated tensions between tradition and modernity, local identity, and global influences (Saleh, 2001b).

This harmonious interplay of architectural styles—where the universal met the traditional—exemplified Riyadh's architectural evolution. While embracing modern aesthetics, the city remained committed to paying homage to its past. While the city embraced the new ideas and technologies brought about by modernization, it also preserved its distinct cultural and architectural heritage, resulting in a distinctive architectural setting that still characterizes Riyadh today. As a result, Riyadh's commitment to upholding its legacy while embracing an evolving future is reflected in this story of converging influences.

2.3 The Story of Non-Western Modernity

In recent decades, there has been a scholarly investigation into an alternative dimension of modernity that diverges from a Eurocentric perspective. The studies above have been of utmost importance and have played an essential role in deepening the understanding of architectural and urbanistic practices in non-western countries (James-Chakraborty, 2014; Nitschke & Lorenzon, 2020; Stanek, 2020). This study investigates the process, considering the continuous reevaluation of modernism and the increasing scholarly attention toward the documentation of histories of non-Western cultures.

Sayed Karim's work serves as a notable exemplification of this phenomenon. By examining Sayed Karim's work, the objective is to uncover an alternative perspective on the concept of modernity as it pertains to the city of Riyadh. This inquiry explores the intersection between modern design philosophy and local context, specifically examining how local materials might offer a fresh interpretation of contemporary architectural structures inside urban environments.

Cross-cultural studies provide a useful framework for comprehending and evaluating the current architectural environment, characterized by blending Eastern and Western influences. The period under consideration has been subject to thorough examination within cultural and encounter studies. (Said, 2012). However, a recent increase in scholarly research has shed light on the impact of Western cultural design principles on regions often identified as the global south. Avermaete and Nuijsink (2022) were the first to use the term "architectural contact zones," drawing their inspiration from Mary Louise Pratt's

city's architectural trajectories (Al-Hathloul, 2004). The infusion of substantial financial resources facilitated the introduction of novel construction materials and advanced techniques, ushering in a significant departure from the previous reliance on traditional mud-brick craftsmanship (Alsoliman, 2023). This watershed moment saw the rise of modern structures made of the sturdiness of concrete and steel, signaling a departure from the previous paradigm. (Vitalis, 2009). This shift was not limited to physical materials; it reflected a broader shift in architectural philosophy, with Western influences gradually permeating the city's aesthetic and structural ethos.

Riyadh's architecture underwent a profound transformation during this time, effectively encapsulating the changing socioeconomic underpinnings. The change from mud-brick homes made to withstand the weather to tall concrete and steel buildings influenced by global design shows how oil-driven prosperity has changed the shape of cities and how architecture is made. This architectural style shift reflects the city's economic growth and symbolizes its integration into the global community. The construction of modern structures in Riyadh serves as a testament to the city's aspirations for progress and its desire to establish itself as a prominent player on the international stage.

The contours of modernist architectural paradigms began to unfold gracefully within Riyadh's urban fabric in the mid-1950s. During this time of change, there was a clear shift in architectural style. Government buildings, residential neighborhoods, and commercial buildings all took on the style of modernism, characterized by a focus on functionality, unadorned simplicity, and new materials (Hariri-Rifai & Hariri-Rifai, 1990). During this epoch, the resonating echoes of Western architectural influences reverberated with notable resonance. These influences were particularly evident in the designs of prominent architects such as Ludwig Mies van der Rohe, Le Corbusier, Oscar Niemeyer, Walter Gropius, Frank Lloyd Wright, and Jørn Utzon, who promoted the principles of modernism and played a significant role in shaping the architectural setting of the time (Doumato, 1980)Their minimalist aesthetics and emphasis on clean lines, open spaces, large horizontal windows, white or cream façades, and the use of reinforced concrete and steel became synonymous with the era, leaving a lasting impact on architectural practices worldwide.

Therefore, Arab architects have developed a distinctive modern architectural style due to the significant architectural impact they have witnessed, as notable examples like Sayed Karim demonstrate. There has been extensive scholarly discussion regarding the notion of Arab modernity, suggesting its existence as a comparable phenomenon to European modernity. (Akkach, 2014). This study aims to provide insight into the architectural endeavors of renowned Arab architects, whose professional development was influenced by their European education. Subsequently, these architects incorporated the principles of early modernism into their architectural projects in Gulf cities, with a particular emphasis on the urban landscape of Riyadh.

The influx of foreign architects and engineers hired to envision and actualize the growing city's spatial transformation was a case in point to fuel this architectural transformation, which was deeply rooted in modernist principles (Alnaim & Noaime, 2022). The modernist style's introduction, with its clean lines, practical forms, and deliberate lack of excessive embellishment, gave the city's architectural evolution a new life. The wave of Western architectural proclivities rushed through Riyadh's architectural veins, redefining its skyline and ushering in a contemporary visual narrative (Giddings et al., 2023). These foreign architects and engineers brought fresh perspectives and innovative design principles to Riyadh, blending traditional Saudi Arabian elements with modern aesthetics. The city's skyline became a testament to the fusion of cultures, as towering skyscrapers and sleek buildings coexisted harmoniously with historical landmarks.

This architectural zeitgeist represents the city's broader modernization journey, in which the structural language used reflects the intersection of cultural dynamism and progressive aspirations. This era not only etched modernist principles into Riyadh's architectural canvas but also left an indelible imprint of globalization's influence on the city's very silhouette, from government edifices that exude functional elegance to residential quarters that prioritize ergonomic living and commercial spaces characterized by aesthetic pragmatism. (Al-Ibrahim, 1995). The architectural transformation of Riyadh is a testament to the city's commitment to embracing the future while preserving its rich cultural heritage. This can be seen in the

transformation from the traditional architectural forms, which were once distinctive and deeply rooted in regional traditions (Saleh, 2001a)The introduction of modern architectural elements, fueled by the influx of global ideas, resulted in a departure from traditional aesthetics. The use of novel building materials, construction methods, and new spatial arrangements shaped this architectural transformation. As a result, it is critical to explore how these external influences intersected with or diverged from Saudi architectural identity.

Despite its significant role in shaping the modern architectural scene of Saudi Arabia, the phase of architectural evolution in Riyadh during the 1950s has not received the thorough examination it deserves. There has been limited exploration into the details of its design elements, materials used, and construction techniques. Additionally, the social, cultural, and economic factors that impacted choices during this transformative period have yet to be fully investigated. This research, therefore, is of utmost importance in filling these gaps in our understanding of Saudi Arabia's architectural history.

Hence, this study aims to delve into Riyadh's transformation during the 1950s by focusing on the exterior appearances and structural designs of key buildings from that era. The research seeks to uncover how the incorporation of building materials and techniques, alongside traditional design elements, led to a unique architectural style that mirrored the societal and cultural changes in Saudi Arabia at that time. Exploring the relationship between tradition and modernity in the history of Saudi Arabia, this research will examine select government and residential buildings to illustrate the significance of contextualizing architectural transformations within broader historical and cultural frameworks.

The present study begins by analyzing the context, significance, and background. The subsequent section entails a comprehensive examination of relevant scholarly literature. The third section outlines the methodological framework utilized in this study. The fourth section examines specific case studies, while the fifth section delves into the architectural trends observed in Riyadh during the 1950s. The concluding section of this study synthesizes the findings, offering insights into the architectural evolution of Riyadh during the specified decade.

2. Literature Review: A Historical Perspective

The 1950s oil prosperity impacted Riyadh's architectural development, resulting in a change from traditional Najdi designs to a more modern architectural style. The initial mud-brick dwellings, constructed using indigenous resources as a response to the challenging desert environment, eventually yielded contemporary edifices composed of concrete and steel. This architectural transition served as a representation of the city's swift economic expansion and its assimilation into international society. The city's new aesthetic exemplifies Western architects' influence and adherence to modernist principles, which are distinguishable by their emphasis on functionality, simplicity, and the use of cutting-edge materials. This study aims to analyze the equilibrium that Riyadh achieved in terms of modernization and cultural identity by incorporating traditional and Islamic architectural features alongside modernist designs. Emblematic buildings like the Riyadh Railway Station exemplify how modern forms and historical motifs can coexist. Furthermore, this study explores the idea of non-Western modernity while acknowledging the significant contributions made by Arab architects who drew inspiration from their European educational experiences. Architectural contact zones wherein Western and non-Western design elements intersect, emphasizing the dynamics of cultural exchange and the potential for overshadowing indigenous traditions.

2.1 Riyadh in the Era of Modern Architecture

Traditional Najdi architectural heritage significantly influenced the dominant architectural style during the early stages of the 1950s (Elsheshtawy, 2021). Notably, mud-brick homes were widespread and distinguished by their straightforward design and intricate decorative motifs (Al-Naim, 2008). These structures utilize locally sourced materials while being meticulously crafted to provide relief from the harsh desert climatic conditions. However, a watershed moment occurred in the mid-1950s, when the influx of oil wealth catalyzed a rapid transformation of the urban landscape, propelling Riyadh into an era of unprecedented expansion and evolution (Al-Rasheed, 2010).

It is crucial to acknowledge that Riyadh's growing wealth from oil significantly impacted the

1. Introduction

The mid-twentieth century marks a watershed moment in Saudi Arabia's architectural history, indicating a profound shift away from the country's entrenched traditional design ethos toward embracing contemporary influences (Jobran, 2022). The infusion of newly discovered oil wealth and intensifying interactions with the Western world hastened this evolution significantly (Alkhabbaz, 2018). This era's dominant architectural ethos found its identity in a remarkable fusion, deftly weaving the threads of traditional Islamic architectural heritage and Modernist thought. This fusion gave birth to a distinct architectural tapestry that artfully mirrored the country's intricate collaboration between embracing modernization and preserving its cultural heritage (Asfour, 2009). This harmonious amalgam is most vividly depicted through the lens of this epoch's exterior compositions, geometrical arrangements, and proportional configurations (Moscatelli, 2023) Therefore, the study intends to investigate and dissect the intricate tapestry of architectural trends that dominated Saudi Arabia in the 1950s. This investigation must delve into the dynamic interplay of Indigenous architectural heritage and the influx of global architectural paradigms. Furthermore, an in-depth examination of the implications of socio-cultural constraints on architectural endeavors is required to comprehensively understand this transformative era.

During this time, Riyadh's architectural settings remained consistent with global trends in the field, primarily influenced by the modernist movement, which emphasized the principle of 'form following function'. Nonetheless, the Saudi context added a distinct nuance, guiding this architectural trajectory towards a harmonious integration with Islamic and local architectural legacies (Saleh, 1998a). This complex interplay resulted in the emergence of a contextualized iteration of modernism, which artfully reconciled the style's pragmatic minimalism with the imperative of honoring traditional sensibilities and responding to the local environment (Gharipour, 2011). This convergence gave rise to a distinct architectural ethos in which the stark functionality of modernism blended seamlessly with the visual idioms and ecological imperatives inherent in the Saudi landscape.

The sociocultural context, in which architecture operates, accentuates the intricate relationship between local essence and global dynamics (Saleh, 1998b). Societal norms, religious precepts, and prevalent cultural values had a significant impact on architectural practices. Negotiating these constraints while pursuing innovative design expressions was the challenge. These values necessitate a look at how architects navigated these complex parameters, whether by subtly incorporating modern elements into traditional frameworks or boldly forging entirely new architectural vocabularies. (Al-Farsy, 2012).

The mid-20th century saw significant changes in the architecture and urban development of Riyadh, Saudi Arabia. It was a period when traditional Islamic architectural features blended with design concepts. This era in the 1950s saw a significant transformation in Riyadh's architectural identity due to the country's newfound oil wealth and increased connections with the Western world. The architectural landscape during this time reflected a mix of heritage and contemporary influences, showcasing the nation's effort to preserve its cultural roots amidst rapid urban growth and global influences.

As a result, Saudi Arabia's architectural evolution during the turbulent decades of the 1950s became an enthralling exploration of the interplay between entrenched tradition and progressive modernity. The influx of newly discovered oil wealth fueled rapid urbanization and extensive infrastructure expansion, ushering in foreign architects and architectural firms. (Mahgoub, 2007). Traditional Saudi edifices share space with cutting-edge modernist creations, and as a result of this convergence, they create an architectural landscape with an engaging mingling of various stylistic sensibilities. The crux of this study, in light of this dynamic context, is the meticulous examination of selected cases of convergence. Each of these examples, a microcosm of influences, was crucial in shaping the essence of architectural style during this era. The aim is to unravel the intricate weave that binds tradition and modernity by delving into these instances of synergy, illuminating the nuanced tapestry that makes the architectural landscape of this period a captivating chapter in Saudi Arabia's history.

The development of architectural trend during this period tells a narrative of adaptation and innovation. Saudi Arabia underwent a noticeable

Journal of Architecture and Planning , Vol. 36 (4) , pp. 487-509, Riyadh (2024/1446H)

doi:10.33948/JAP-KSU-36-4-5

Fusion and Transformation: The 1950s Architectural Metamorphosis of Riyadh, Saudi Arabia

Naif Alghamdi[1] Abdulaziz Alzahrani[2] Fahad Alotaibi[3] Faisal Alosaimi[1]

Ali Ajlan[1] Muhannad Alkudaywi[4] Mohammed Alnaim[5]

[1] Department of Architecture and Building Sciences, College of Architecture and Planning, King Saud University, Riyadh, Saudi Arabia.

[2] Department of Architecture, Faculty of Engineering, Al-Baha University, Al-Baha, Saudi Arabia.

[3] Department of Architecture, College of Architecture and Planning, Qassim University, Buraydah, Saudi Arabia.

[4] Assistance Agency for Infrastructure Projects, Riyadh Regional Municipality, Riyadh, Saudi Arabia.

[5] Department of Architectural Engineering, College of Engineering, University of Hail, Hail, Saudi Arabia.

naag@ksu.edu.sa, Azahran@bu.edu.sa, F.alotaibi@qu.edu.sa, falosaimy@ksu.edu.sa, aajlan@ksu.edu.sa, malkiwi@alriyadh.gov.sa, Mm.alnaim@uoh.edu.sa

(Received 7/7/2024; accepted for publication 17/10/2024.)

Abstract: This study explores the transformation of Riyadh's architectural landscape in the 1950s, a pivotal decade for Saudi Arabia marked by rapid urbanization and cultural integration. As the nation's newfound oil wealth catalyzed its metamorphosis, Riyadh emerged as a canvas displaying a unique blend of traditional Islamic heritage and modernist architectural influences. The research analyzes key buildings' exterior façades and architectural configurations from this era, highlighting the integration of new construction materials and methods alongside traditional design elements. Through in-depth analysis of selected case studies, including prominent government buildings and residential structures, the study reveals a nuanced fusion of international modernist styles with local and Islamic architectural elements. This synthesis reflects the societal and cultural shifts in Saudi Arabia during the 1950s as the country grappled with its identity amidst global influences. The findings of this research contribute to understanding the complex interplay between tradition and modernity in Saudi Arabia's architectural evolution. They illuminate how architectural trends of the 1950s in Riyadh were not merely aesthetic choices but were deeply intertwined with the socio-cultural and economic dynamics of the time. The study underscores the importance of contextualizing architectural developments within their broader historical and cultural settings. It offers insights into the ongoing dialogue between the past and future in Saudi Arabia's urban landscape

Keywords: Architecture; Typology; Geometry; Modern; Heritage; Riyadh; Saudi Arabia.

Journal of Architecture and Planning , Vol. 36 (4) , Riyadh (2024/1446H)
doi:10.33948/JAP-KSU-36-4-4

تحليل متعدد المعايير لتوزيع محطات طاقة الرياح على طول ساحل البحر الأحمر للمملكة العربية السعودية باستخدام نظم المعلومات الجغرافية (١٩٨٥-٢٠١٧)

جهان الخليف **عبير سلمان**

استاذ مساعد *استاذ مشارك*

قسم الجغرافيا، جامعة الملك سعود، الرياض، المملكة العربية السعودية.

jalkhelaif@stu.kau.edu.sa *abalsalman@kau.edu.sa*

قدم للنشر في ٧/ ٩/ ١٤٤٥ هـ؛ وقبل للنشر في ١٠/ ٤/ ١٤٤٦ هـ.

ملخص البحث. يعتبر تحديد مواقع محطات طاقة الرياح مهماً جداً في التخطيط الاقتصادي والعمراني؛ للاستفادة من طاقة الرياح بشكل فعال وكامل. يهدف هذا البحث إلى مقارنة الخصائص المكانية لسرعة الرياح في أربع مدن على ساحل البحر الأحمر في المملكة العربية السعودية؛ الوجه وينبع وجدة وجيزان، حيث تعتبر مناطق واعدة لتوليد طاقة الرياح وتتوفر فيها البيانات الأولية. تم جمع وتحليل بيانات متوسطات سرعة الرياح اليومية والفصلية من ١٩٨٥ إلى ٢٠١٧، وتم تحديد سرعة الرياح القصوى واتجاهها السائد في المحطات المناخية، ومن ثم تم توظيف تقنيات نظم المعلومات الجغرافية لاقتراح وتقييم أنسب مواقع محطات طاقة الرياح باستخدام تحليل متعدد المعايير في نظم المعلومات الجغرافية بالتكامل مع الحسابات الإحصائية للبيانات المناخية. تم بناء قاعدة بيانات جغرافية تتضمن ١٤ طبقة رقمية من ضمنها: سرعة الرياح والارتفاعات والمناطق العمرانية والأودية. وتضمنت النتائج المناطق المناسبة وغير مناسبة لمحطات طاقة الرياح في كل الطبقات. وأظهرت نتائج المقارنة أن جدة واعدة في إنتاج طاقة الرياح حيث تتمتع بأكبر مساحة مناسبة بحدود١٣٨٢٦,٨ كم٢، بينما أتت جازان بأقل مساحة مناسبة بحدود ٧٣٨,٧كم٢.

الكلمات المفتاحية: محطات طاقة الرياح، تحليل متعدد المعايير، نظم المعلومات الجغرافية، المملكة العربية السعودية، البحر الأحمر.

design optimization of an onshore wind farm layout. Energies 13 (22), http://dx.doi.org/10.3390/en13225946

Safari, B. (2011) Modeling wind speed and wind power distributions in Rwanda, Volume 15(2):925–35..

Salah, Abo-khalil and Praveen (2021) Wind speed characteristics and energy potential for selected sites in Saudi Arabia, Journal of King Saud University-Engineering Science, Vol-ume 33, Issue 2, Pages 119-128

Shaahid, Al-Hadhrami, and Rahman (2014) Potential of Establishment of Wind Farms in Western Province of Saudi Arabia, Energy Procedia, Volume 52, 2014, Pages 497-505

Shrestha, A., Mustafa, A. A., Htike, M. M., You, V., & Kakinaka, M. (2022). Evolution of energy mix in emerging countries: Modern renewable energy, traditional renewable energy, and non-renewable energy. Renewable energy, 199, 419-432.

Spielmann, V. Brey, Th. Dannheim, J. Vajhøj J. Ebojie M. Klein J. Eckardt S. (2021) Integration of sustainability, stakeholder and process approaches for sustainable offshore wind farm decommissioning, Renewable and Sustainable Energy Reviews, Volume 147.

Tahir, Z. Kanwal, A. Afzal, S. Ali, S. Hayat, N. Abdullah, M. Bin Saeed, U. (2021) Wind Energy Potential and Economic Assessment of Southeast of Pakistan. International Journal of Green Energy, 18(1).

Van Haaren R.and V. Fthenakis (2011) GIS-based wind farm site selection using spatial multi-criteria analysis (SMCA): Evaluating the case for New York State, Renewable and Sustainable Energy Reviews.

Villacreses, Geovanna; Gaona, Gabriel; Martínez-Gomez, avier; Juan Jijon, Diego (2017) Wind farms suitability location using geographical information system (GIS), based on multi-criteria decision making (MCDM) methods: The case of continental Ecuador. Re-newable Energy, pp. 275-286.

Vision 2030 (2023) UMAT AL JANDAL WIND FARM https://www.vision2030.gov.sa/en/explore-more/dumat-aljandal/

Wind Atlas (2020) Global wind atlas https://globalwindatlas.info accessed at Augest 2020

Yuksel, I. & Kaygusuz, K. (2011) Renewable energy sources for clean and sustainable en-ergy policies in Turkey. enewable and Sustainable Energy Reviews, 15(8), pp. 4132-4144.

6. References

Al-Abbadi (2005) Wind energy resource assessment for five locations in Saudi Arabia. Volume 30, pp. 1489-1499.

Al-Abbadi, N., Alawaji, S. & Eugenio, N., (1997) Wind energy resource assessment in Saudi Arabia. Austin, Wind Energy Association, pp. 533-41.

Alawaji, S. (1996) Wind energy resource assessment in Saudi Arabia-I network design and description. Volume 7(4):319–28.

Albraheem and AlAwlaqi (2023) Geospatial analysis of wind energy plant in Saudi Arabia using a GIS-AHP technique, Energy Reports, Volume 9

Ali, S. Lee, S. Jang, CH. (2017) Determination of the Most Optimal On-Shore Wind Farm Site Location Using a GIS-MCDM Methodology: Evaluating the Case of South Korea, En-ergies, 10(12), 2072; https://doi.org/10.3390/en10122072

Al-Ruwaithi (1982) Natural harbors on the western Saudi coast. Riyadh: King Abdul Azizi House Publication.

Ansari, J., Madni, I. & Bakhsh, H. (1986) Saudi Arabian wind energy atlas. pp. 1-27.

Arhens (1982) Meterology Today. San Fransisco: West publication company st. paul.

Baban and Parry (2001) Developing and applying a GIS-assisted approach to locating wind farms in the UK Renewable Energy, 24 (1) (2001), pp. 59-71

Baseer, M.A., Rehman, S., Meyer, J.P., Alam, M.M. (2017) GIS-based site suitability analysis for wind farm development in Saudi Arabia. Energy 141 (ii), 1166–1176. http://dx.doi.org/10.1016/j.energy.2017.10.016.

Bórawski, P., Bełdycka-Bórawska, A., Jankowski, K. J., Dubis, B., & Dunn, J. W. (2020). Development of wind energy market in the European Union. Renewable Energy, 161, 691-700.

Effat, H. & El-Zeiny, A. (2022) Multicriteria Decision Making methods (MCDM) combined with GIS to select a suitable site and estimate energy potentials.. The Egyptian Jour-nal of Remote Sensing and Space Science, 25(2), pp. 627-637.

Geerts, L. (1997) Climate and weather explained. London ans New York: Routledge.

GWEC (2019) Global Wind Energy Council. [Online] accessed at July 2020. Available at: https://gwec.net/global-wind-report-2019/

IRENA (2019) Renewable Capacity Statistics 2019, s.l.: International Renewable Energy Agency. accessed at July 2020, Available at: (www.windpower.org/en/articles/success.htm).

Isabel C. Gil-García, Ramos-Escudero, Molina-García, Fernández-Guillamón (2023) GIS-based MCDM dual optimization approach for territorial-scale offshore wind power plants, Journal of Cleaner Production, Volume 428.

Linacre, E. & Greets, B. (1997) Climates and Weather Explained. London: Routledge.

Marouani, Fouad and Mrad (2023) A techno-economic assessment and optimization of Dumat Al-Jandal wind farm in Kingdom of Saudi Arabia, Energy Sci. Eng. 2023;1–10.

Mohammedi, K., Alavi, O. & McGowan, J. (2017) Use of Birnbaum-Saunders distribution for estimating wind speed and. Energy Conversion and Management, Volume 143, p. 109–122.

Noorollahi, Y., Yousefi, H. & Mohammadi, M. (2016) Multi-criteria decision support system for wind farm site selection. Volume 13, p. 38–50.

Rehman S, H. T. M. M. (2003) Wind power cost assessment at twenty locations in the Kingdom of Saudi Arabia.. Volume 28:573–83..

Rehman, S., Halawani, T. & Husain, T. (1994) Weibull parameters for wind speed distribution in Saudi Arabia. Volume 53(6):473–9.

Rehman, S., Baseer, M.A., Alhems, L.M. (2020a) GIS-based multi-criteria wind farm site selection methodology. FME Trans. 48 (4), 855–867. http://dx.doi.org/10.5937/fme2004855R.

Rehman, S., Mohammed, A.B., Alhems, L. (2020b) A heuristic approach to sitting and

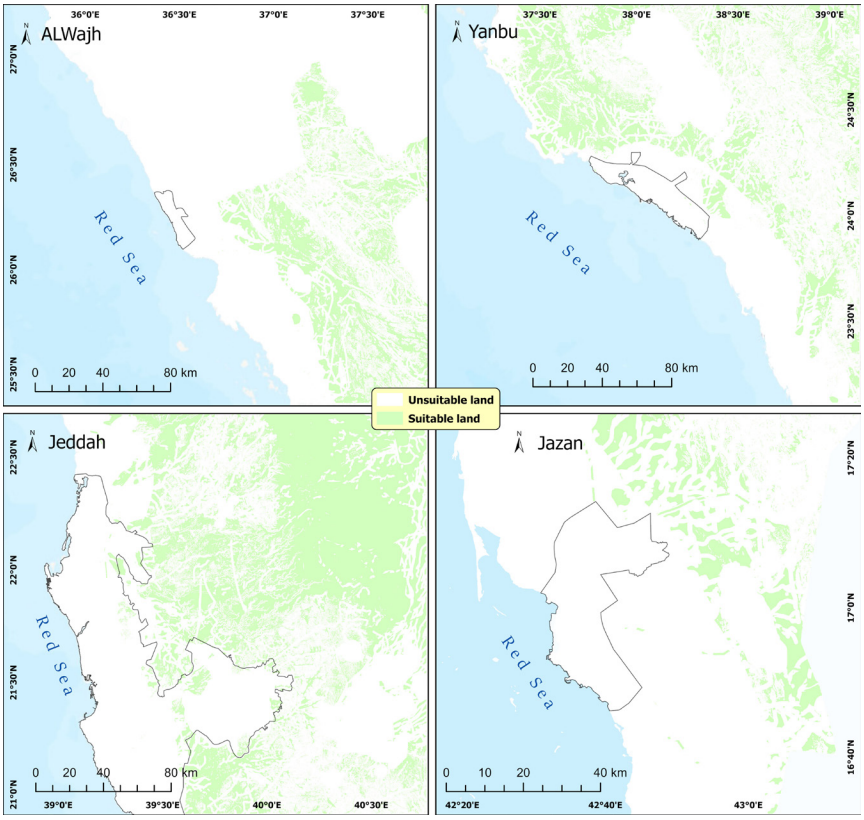


Figure (8). Suitable sites for wind power plants

In general, the four studied areas possess both natural and human resources that favour the establishment of wind power plants along large area.

The kingdom of Saudi Arabia can allocate part of its oil revenues to invest in renewable energy sources, particularly wind power, given the economic viability supported by low production costs.

However, some natural and technological challenges may impede the establishment of wind power plants. These include a lack of technical expertise, difficulties in energy storage, wind speed fluctuation, dust storms and the visual impact and noise generated by wind turbine that may cause complain of resident.

Despite these challenges, wind fan turbine generators remain economically viable owing to their low production costs and their suitability for generating electric power in certain locations. Consequently, they hold promising potential for future investment along the Red Sea coast..

5. Conclusions

Many districts in Saudi Arabia hold potential for renewable energy production. Most characteristics needed for wind power stations are available along the Red Sea.

Geographic information system is an effective way to utilize Multi-Criteria Decision-Making methods (MCDM) to identify suitable locations for wind power stations.

The Al-Wajh station holds potential for wind energy production throughout the year, with the highest watt scores recorded in the spring and summer seasons. The largest proportion of suit-able areas for establishing wind power plants was in the Jeddah city (13826.8 km2) and the least is in the Jizan city (8.5 km2). The results of this study can be used by decision-makers as a decision-aid tool.

Acknowledgments: The authors extend their appreciation to King Saud University. In addi-tion, our sincere thanks go to the General Authority for Meteorology and Environment for provid-ing the necessary weather data.

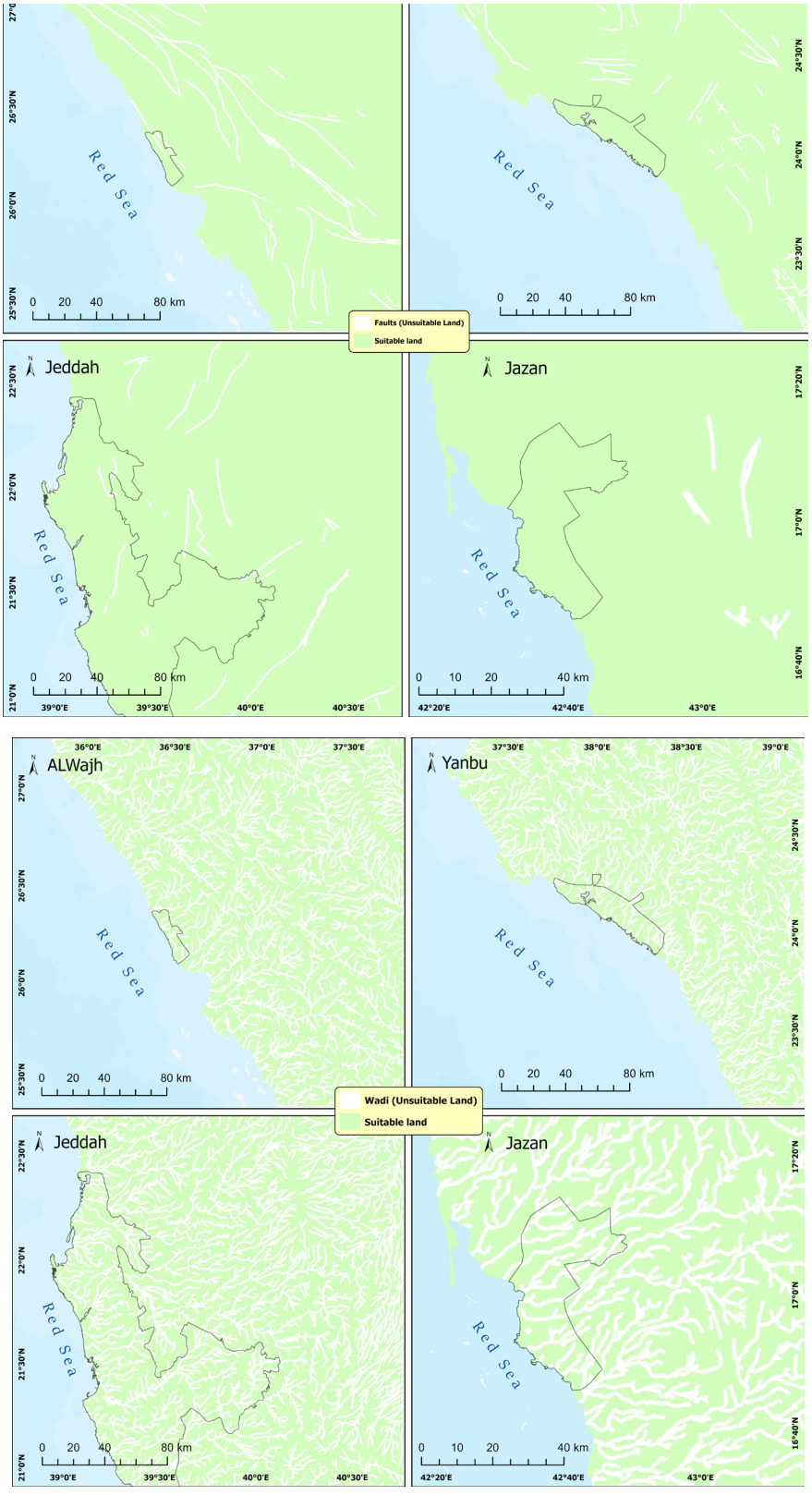
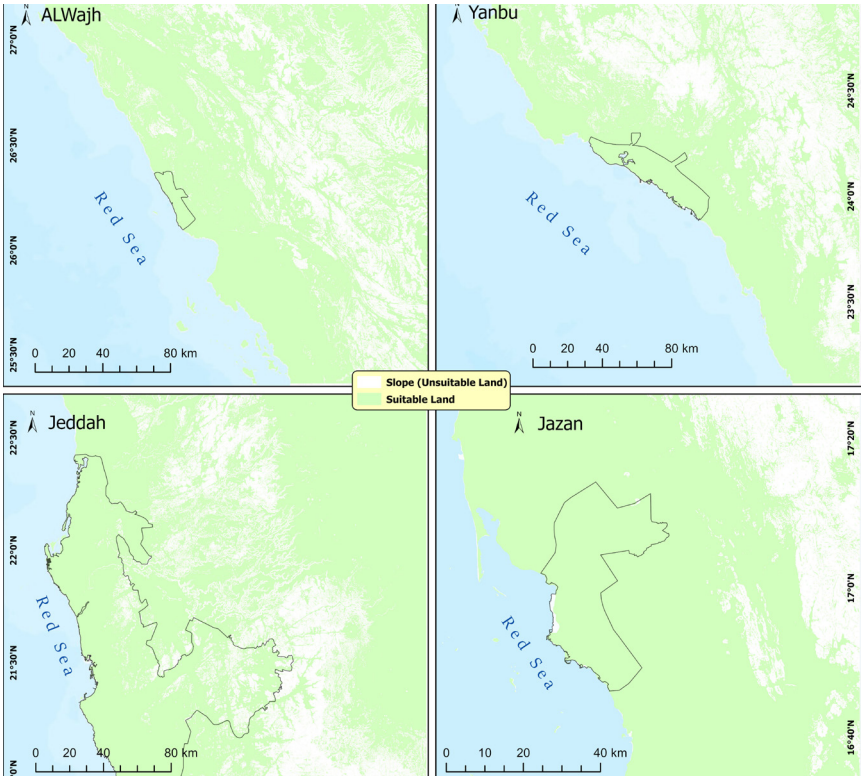
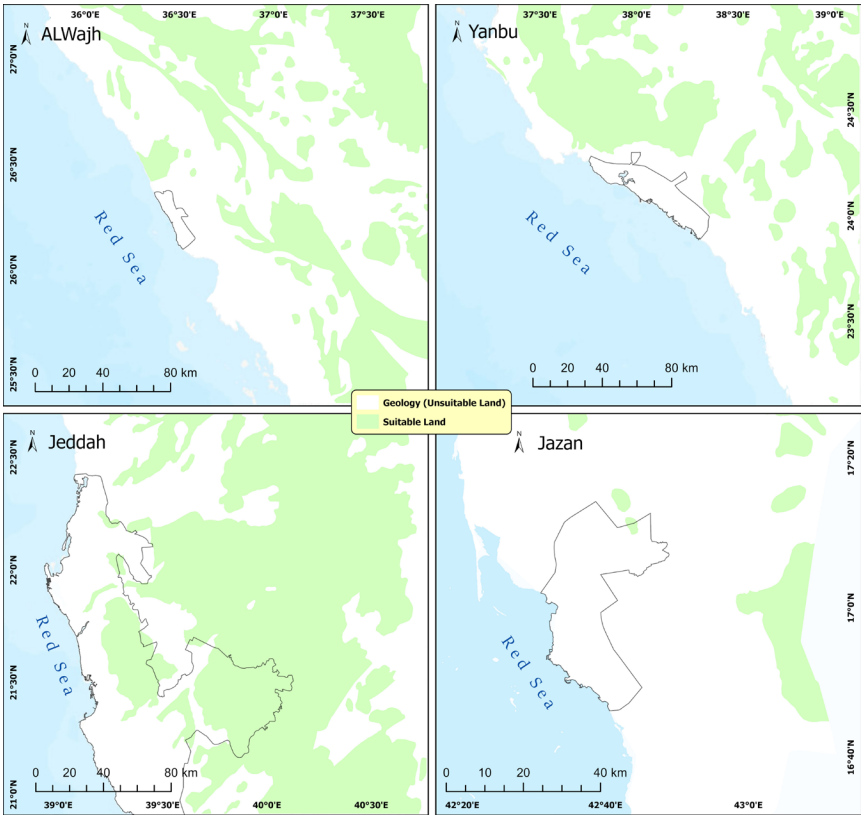


Figure (7). Suitable sites for nature criteria


ALWajh
Yanbu
Jeddah
Jazan
Red Sea
0 20 40 80 km
0 10 20 40 km
Slope (Unsuitable Land)
Suitable Land


ALWajh
Yanbu
Jeddah
Jazan
Red Sea
0 20 40 80 km
0 10 20 40 km
Geology (Unsuitable Land)
Suitable Land

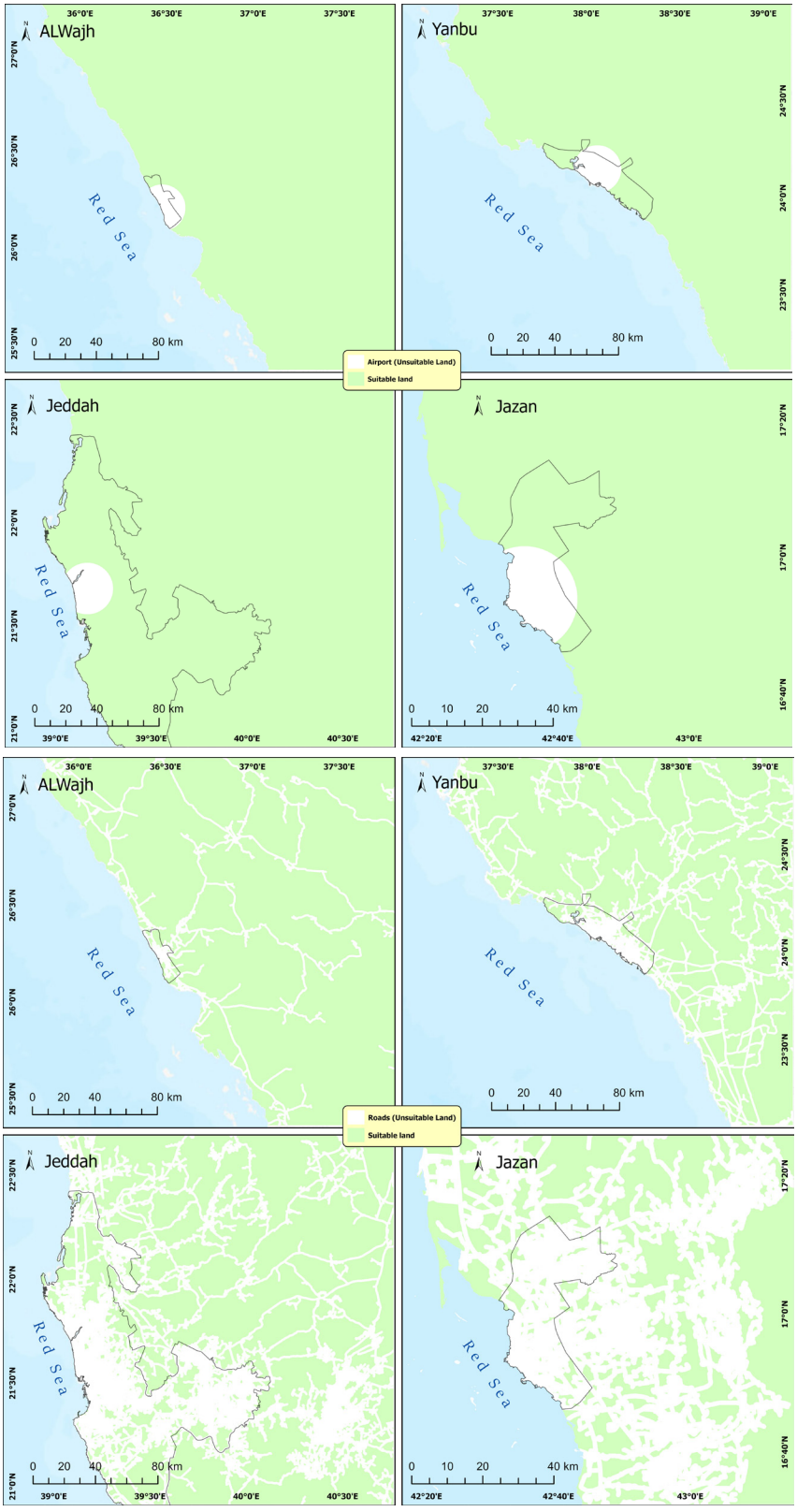
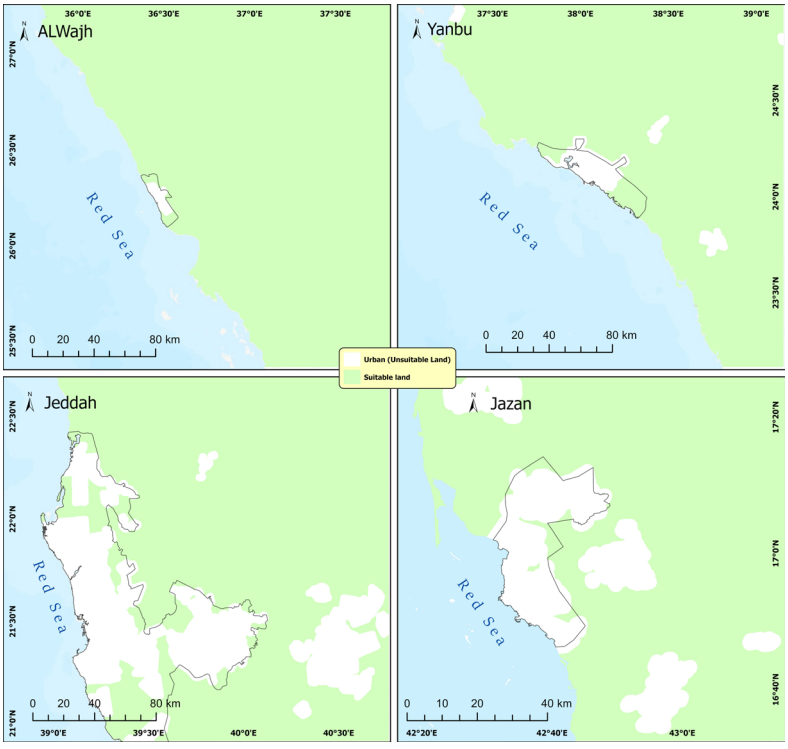


Figure (6). Suitable sites for urban criteria (Road, airport and urban area)

Table (2). Electrical-generating power by means and maximum wind speed (W) (1985–2017) per month and season

Station	Al-Wajh		Yanbu		Jeddah		Jazan	
	Mean	Max.	Mean	Max.	Mean	Max.	Mean	Max.
January	16.52	1137.2	8.12	752.99	13.17	846.24	6.54	392.63
February	23.15	1172.69	11.16	706.76	15.36	682.31	6.93	346.39
Mars	26.79	1005.43	13.96	930.15	17.57	917.8	7.1	439.95
April	25	921.62	14.4	1055.55	14.9	874.92	7.54	884.16
May	26.47	907.13	17.5	1004.95	14.47	595.48	7.38	1130.62
June	27.07	736.39	24.97	1039.89	15.81	544.76	9.1	1059.62
July	20.47	592.23	24.06	1239.99	12.23	494.79	13.64	1778.26
August	22.96	634.64	24.63	1322.93	13.47	571.05	10.89	3047.43
September	25.94	665.74	17.56	819.14	11.04	466.46	7.75	1858.06
October	17.44	841.97	9.05	651.93	6.66	491.04	6.5	1492.18
November	14.67	658.81	6.79	735.21	7.68	620.57	6.22	708.16
December	14.39	810.5	6.63	704.74	11.33	643.82	6.58	326.88
Annual Mean	21.74	840.36	14.90	913.69	12.81	645.77	8.01	1122.03
Winter	18.01	1040.13	8.63	721.5	13.29	724.12	6.68	355.3
Spring	26.08	944.73	15.28	996.89	15.65	796.06	7.34	818.24
Summer	23.50	654.42	24.55	1200.94	13.84	536.87	11.21	1961.77
Autumn	19.35	722.17	11.13	735.43	8.46	526.03	6.82	1352.8
Annual mean	21.74	840.36	14.90	913.69	12.81	645.77	8.01	1122.03



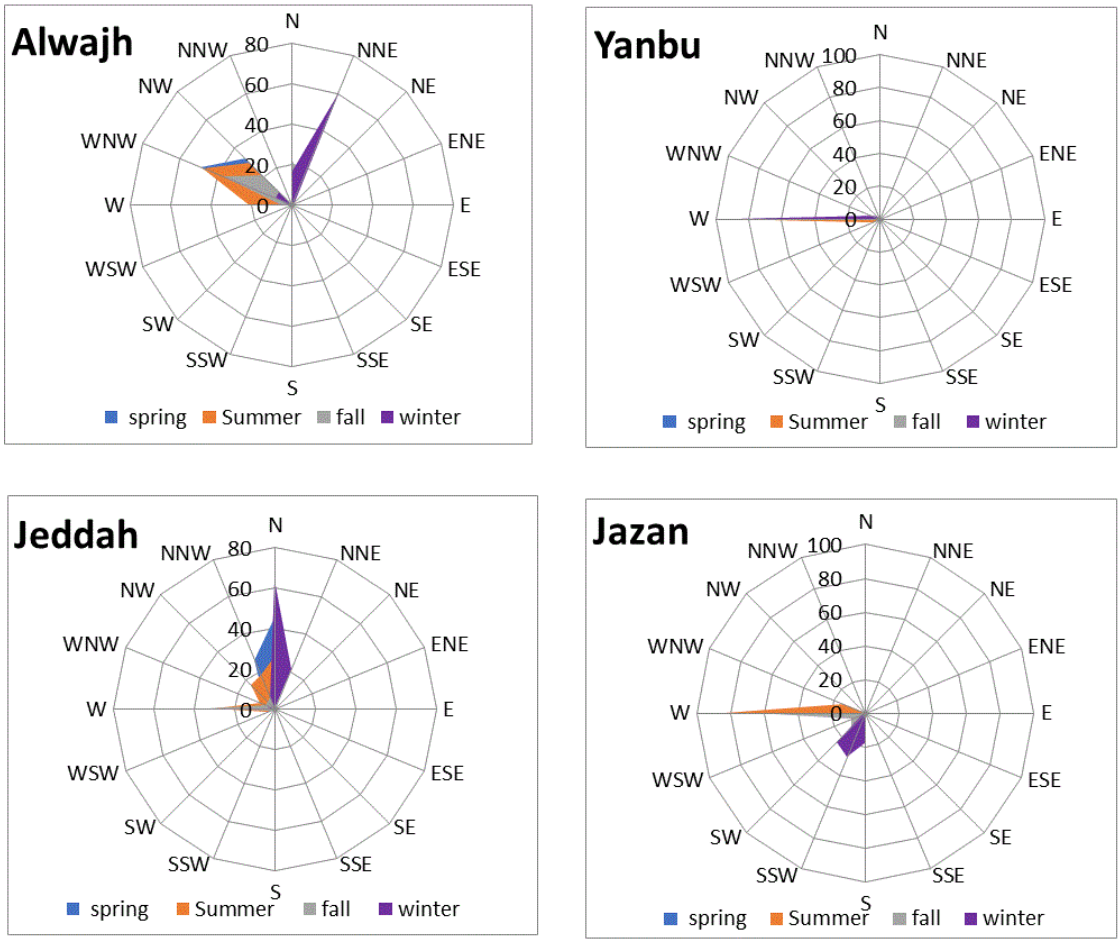


Figure (5). Wind roses (1985–2017) in the four stations.

and dropping considerably to 721.5 W in winter. Al-Wajh comes next to Yanbu, scoring peaking in winter at 1040.13 W. The Jeddah station plant records the least power production throughout the year, with approximately 536.87 W in summer and 526.03 W in autumn. This represents the lowest production of electrical energy using maximum wind speed. The annual mean is 645.77 W.

4.2 Suitability Model

The study utilised MCDA analysis methods to identify suitable locations for wind power stations, as outlined in the methodology. As shown in Figure (6, 7), the analysis outputted a raster for each criterion (nature and urban criteria) indicate areas deemed suitable or unsuitable for such installations.

The proposed model's results, illustrated in Figure 8, highlighted potential sites along the Red Sea coast after excluding unsuitable land. The model's accuracy mainly depends on the DEM's accuracy (10m) and the maps' scale. These regions possess most of the natural features and characteristics necessary for wind power stations.

Eight evaluation criteria were used to be reclassified the study area to suitable and unsuitable area. A total of 25865km2 optimal sites for wind power stations were identified by eliminating unsuitability land for each criterion, distributed across various cities within the study area. Jeddah hosts 13826.8 km2 of these, accounting for 34.8% of the total. The city of Yanbu follows with 6325 km2, representing 21.2% of the total number, followed by Al Wajh, 4974.2km2 representing 13.6%, while the smallest is Jizan, 738.7km2 with 8.5%.

Table (1). Wind mean and maximum speed during months and seasons (m/s), (1985−2017)

Month / Station	Al-Wajh		Yanbu		Jeddah		Jazan	
	Mean	Max	Mean	Max	Mean	Max	Mean	Max
January	4.01	15.88	3.17	14.09	3.71	14.68	2.92	11.18
February	4.49	16.21	3.51	14.03	3.87	13.78	2.98	11.01
March	4.72	15.65	3.79	15.42	4.09	14.84	3.01	11.97
April	4.62	15.10	3.82	15.96	3.88	14.81	3.07	14.40
May	4.68	15.26	4.07	15.74	3.85	13.20	3.06	15.34
June	4.74	14.26	4.60	16.02	3.96	12.94	3.27	15.59
July	4.32	13.26	4.57	16.65	3.63	12.44	3.74	18.53
August	4.49	13.62	4.60	17.15	3.76	13.03	3.51	20.87
September	4.66	13.75	4.09	14.79	3.49	12.22	3.1	18.64
October	4.07	14.15	3.27	13.28	2.96	12.05	2.93	16.52
November	3.77	13.28	2.95	13.84	3.09	13.14	2.87	12.08
December	3.82	14.47	2.93	13.81	3.49	13.26	2.93	10.57
Winter	4.11	15.52	3.20	13.98	3.69	13.91	2.94	10.92
Spring	4.67	15.34	3.89	15.71	3.94	14.28	3.05	13.90
Summer	4.52	13.72	4.59	16.61	3.78	12.80	3.51	18.33
Autumn	4.17	13.73	3.44	13.97	3.18	12.47	2.97	15.75
Annual Mean	4.37	14.58	3.78	15.07	3.65	13.37	3.12	14.73

The prevailing wind trends at each of the study stations vary both monthly and seasonally. The Yanbu station experiences prevailing westerly winds throughout the year, with a frequency of 375 occurrences, while the Jazan station records the same trend across all months, albeit with a lower frequency of 237 occurrences. The lowest annual frequency of westerly winds was observed at the Al-Wajh station, registering only 38 occurrences, as shown in Figure (5).

In Jeddah, the northern winds prevail are predominant throughout the year, with a frequen-cy of 173 occurrences. At the Al-Wajh station, wind trends not only vary from month to month but also differ significantly from other stations. The winds primarily come from the west–northwest during spring, summer and autumn.

The differences in the prevailing wind trends amongst the stations in the study area can be attributed to their unique geographical locations and the various wind sources impacting them.

The potential for electrical energy production was calculated considering both the mean and maximum wind speeds, as shown in Table (2). It appears that the wind-electro density is remarkably available at most study stations, especially during the summer and spring seasons.

The Al-Wajh station appears promising for wind energy production throughout the year, with the highest wattage recorded in the spring and summer seasons at 26.08 W and 23.50 W, respectively. Yanbu follows Al-Wajh closely, peaking in the summer at 24.55 W and dropping significantly during the winter months to 8.63 W. The Jazan station plant scores the least annual power production, around 11.21 W in summer and 6.68 W in winter. However, when considering maximum wind speed, the Jazan station shows potential for wind energy production, particularly in the summer and autumn seasons, with wattage peaking at1961.77 W and 1352.8 W, respectively. Yanbu follows Jazan, peaking in summer at 1200.94 W

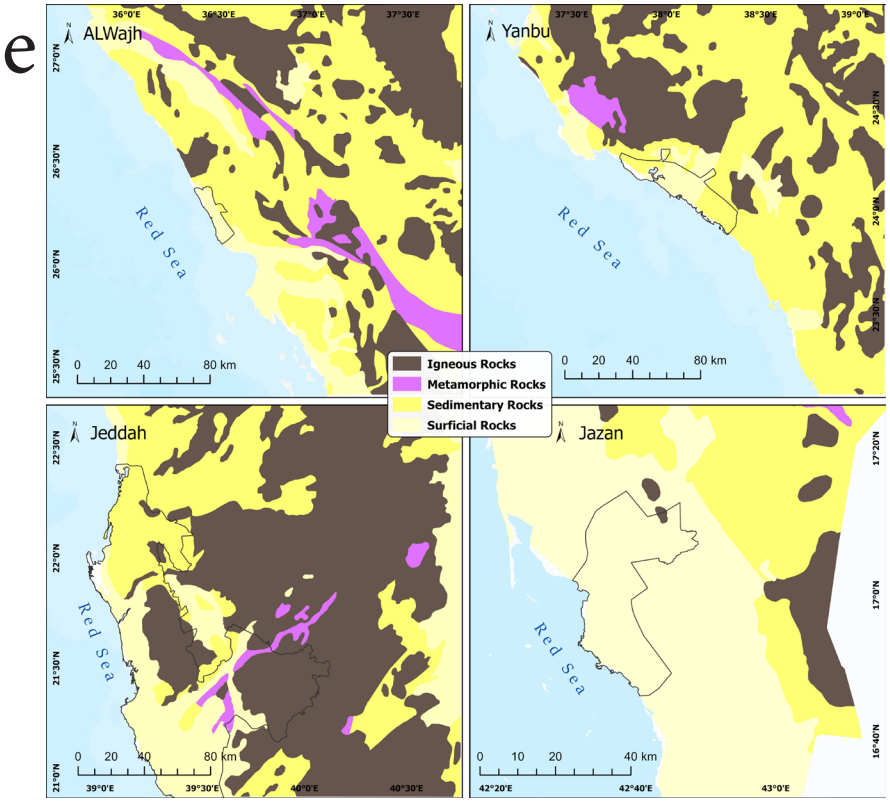


Figure (4). Criteria for site selection: (a) wadis (b) faults (c) road (d) urban area (e) geology

4. Results and Discussion

4.1 Wind speed and direction

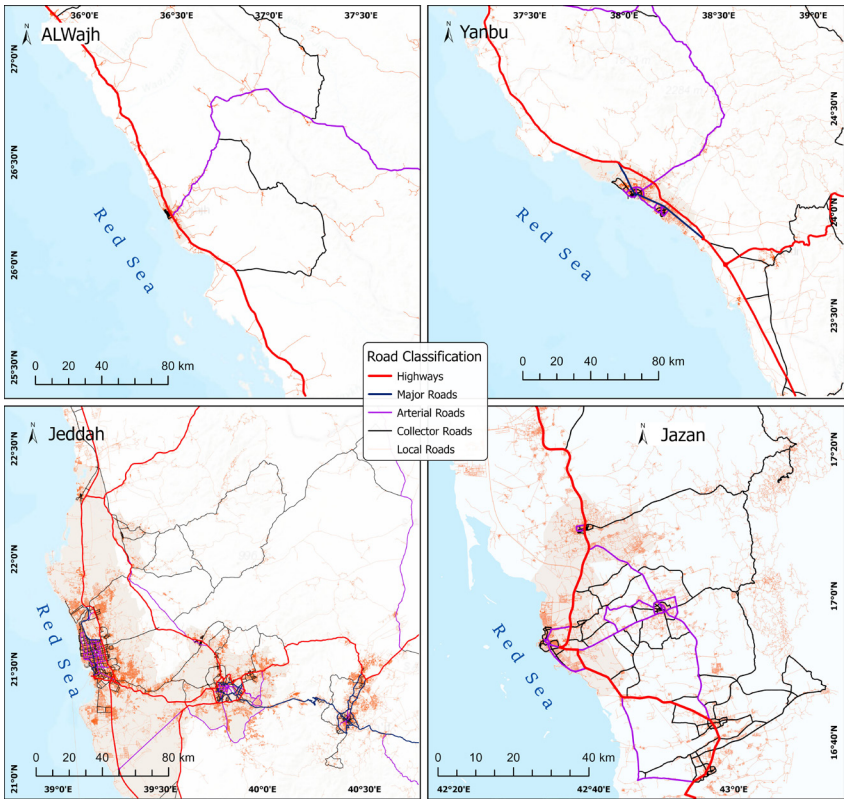
Regarding wind speed and trends, the selected stations in the area exhibit noticeable fluctua-tions in trend frequency and speed from one season to another. These variations can be attributed to seasonal shifts in temperature and atmospheric pressure values, which are influenced by various atmospheric pressure systems that affect the area. The wind speed within the study area varies be-tween winter and summer owing to geographical location and site-specific factors. Therefore, this study focuses on wind speed variations across different seasons.

The maximum wind mean speed was recorded at the Al-Wajh station, reaching 4.74 m/sec in June (refer to Table 1). Conversely, the slowest wind speed was observed at the Jazan station, dropping to 2.87 m/sec in November. In addition, the Al-Wajh station reported the maximum wind mean speed during spring at 4.67 m/sec, while the lowest speed was recorded at the Jazan station during winter, clocking in at 2.94 m/sec.

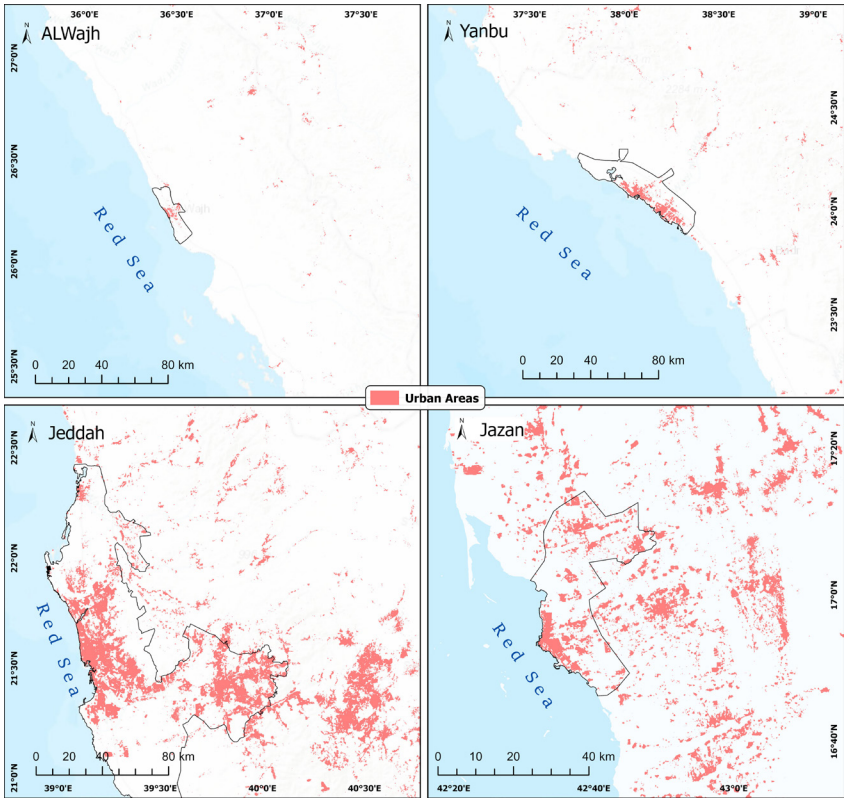
The peak wind speed was registered at the Jazan station in summer, with a notable increase from 15.59 m/sec in June to a high of 20.87 m/sec in August. The Yanbu station reported a maxi-mum wind speed of 16.61 m/sec. It is evident from the data collected across the selected stations that both absolute and average wind speeds can generate wind-powered electricity, especially dur-ing the summer months.

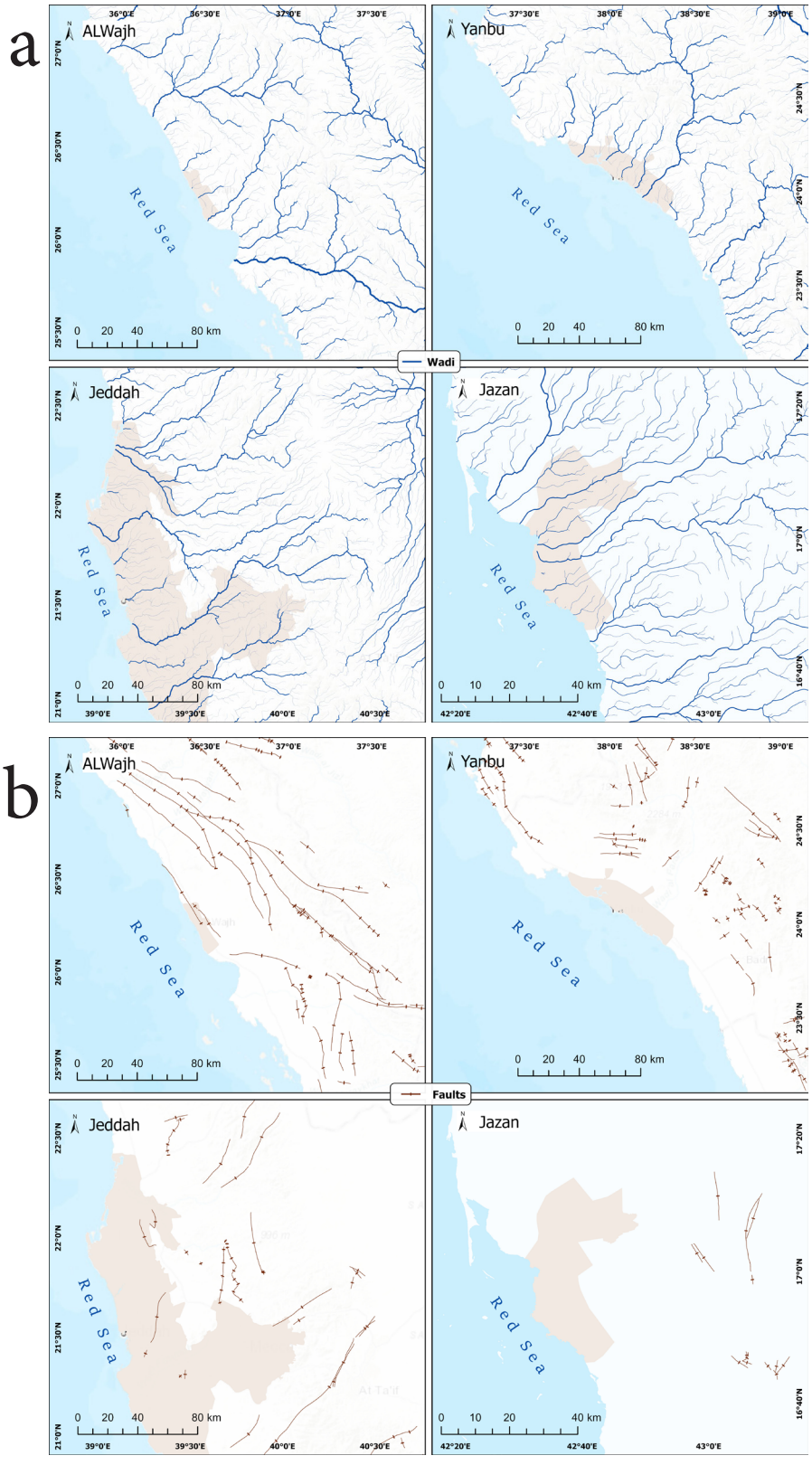
The study area displays significant seasonal variations in wind speed, trends and frequency. These variations are directly correlated with changes in seasonal temperatures and atmospheric pressure values. This pattern suggests the existence of spatial and temporal variations in wind fre-quency and trends.

c


ALWajh
Yanbu
Jeddah
Jazan
Red Sea
Road Classification
Highways
Major Roads
Arterial Roads
Collector Roads
Local Roads
0 20 40 80 km
0 10 20 40 km

d


ALWajh
Yanbu
Jeddah
Jazan
Red Sea
Urban Areas
0 20 40 80 km
0 10 20 40 km


a
ALWajh
Yanbu
Jeddah
Jazan
Red Sea
Wadi
b
ALWajh
Yanbu
Jeddah
Jazan
Red Sea
Faults

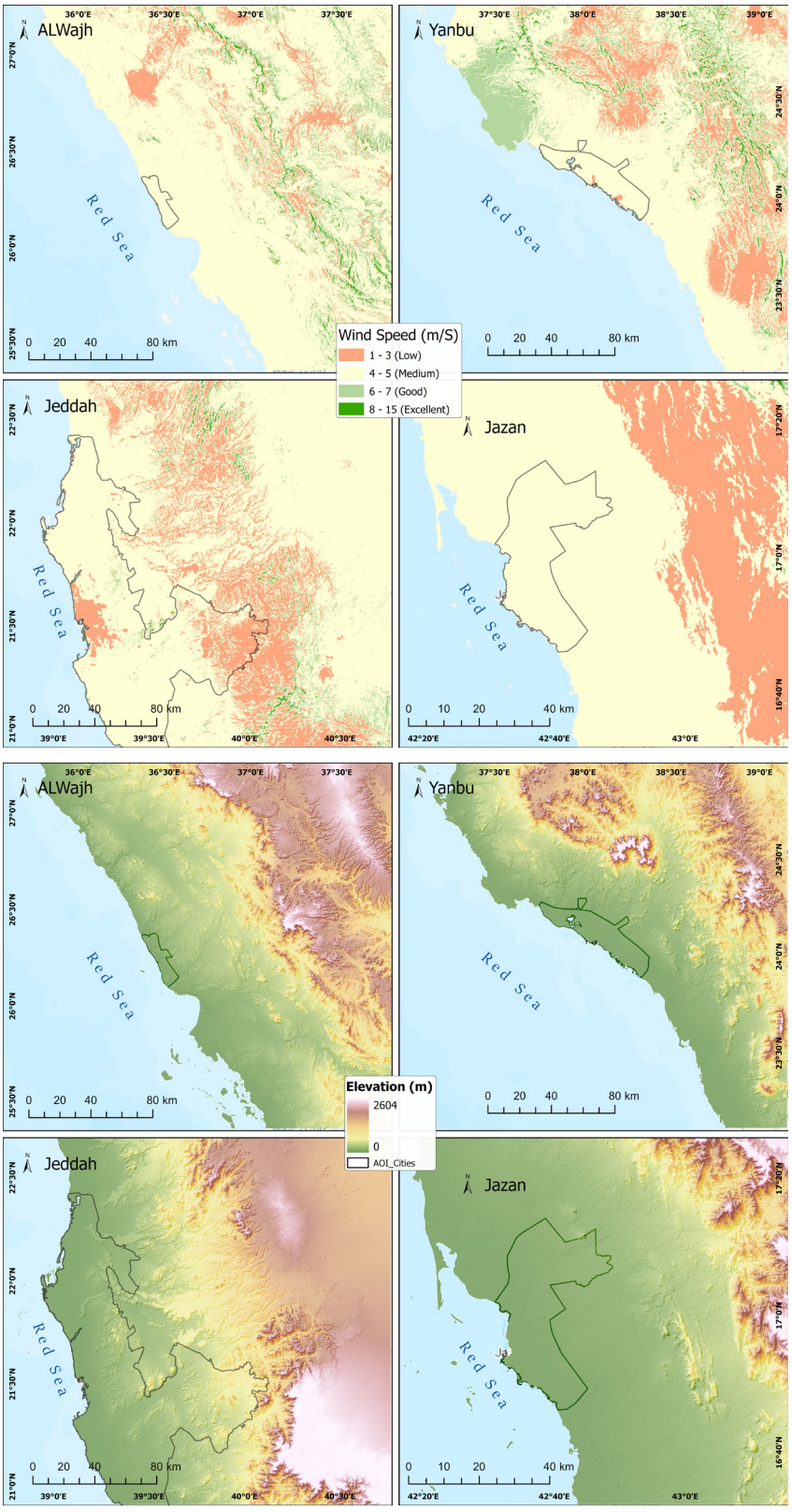


Figure (3). Digital elevation model and annual average of wind speed (m/s) (Wind Atlas 2020)

most influential layer receiving the highest value. It is critical to note that the sum of the relative weight values for all layers should not exceed 100%, as shown in Figure (2).

The wind velocity layer served as a base layer in the proposed model. Data from the Global Wind Atlas site was utilized to map wind speeds across the Kingdom of Saudi Ara-bia, as shown in Figure (3). Findings revealed that the average wind speed across the four study areas was around 10 m/s, which is highly favorable for generating electric power.

Valley streams were extracted from the digital elevation model with an accuracy of 5 m and managed using a model with an accuracy of 10 m, as shown in Figure (3). To cir-cumvent stream areas, the study excluded valley regions. These included main streams, estuaries and secondary tributaries that feed into the main streams. The road network and power lines were digitally rendered in polyline format according to data from the Saudi Electricity Company and the General Survey Authority. Preparations for urban area maps, geological maps and fault line diagrams were also undertaken, as shown in Figure (4). A noteworthy addition to the study was a layer representing the migratory paths of birds. This inclusion is aimed at preserving these routes and preventing potentially bird fatalities ow-ing to collisions with turbine blades

Subsequently, the study established appropriate rules for each layer, aiming to exclude inap-propriate areas. Utilising selects, buffer, clip and erase tools, the study identified suitable areas for establishing electric generation power stations and transitioned the data from vector to raster for-mat. This transition was crucial for setting criteria for weighted overlay. This process assigned a relative weight to each category within each layer individually, based on its importance and impact on the model. In other words, higher-ranked categories received greater relative weights.

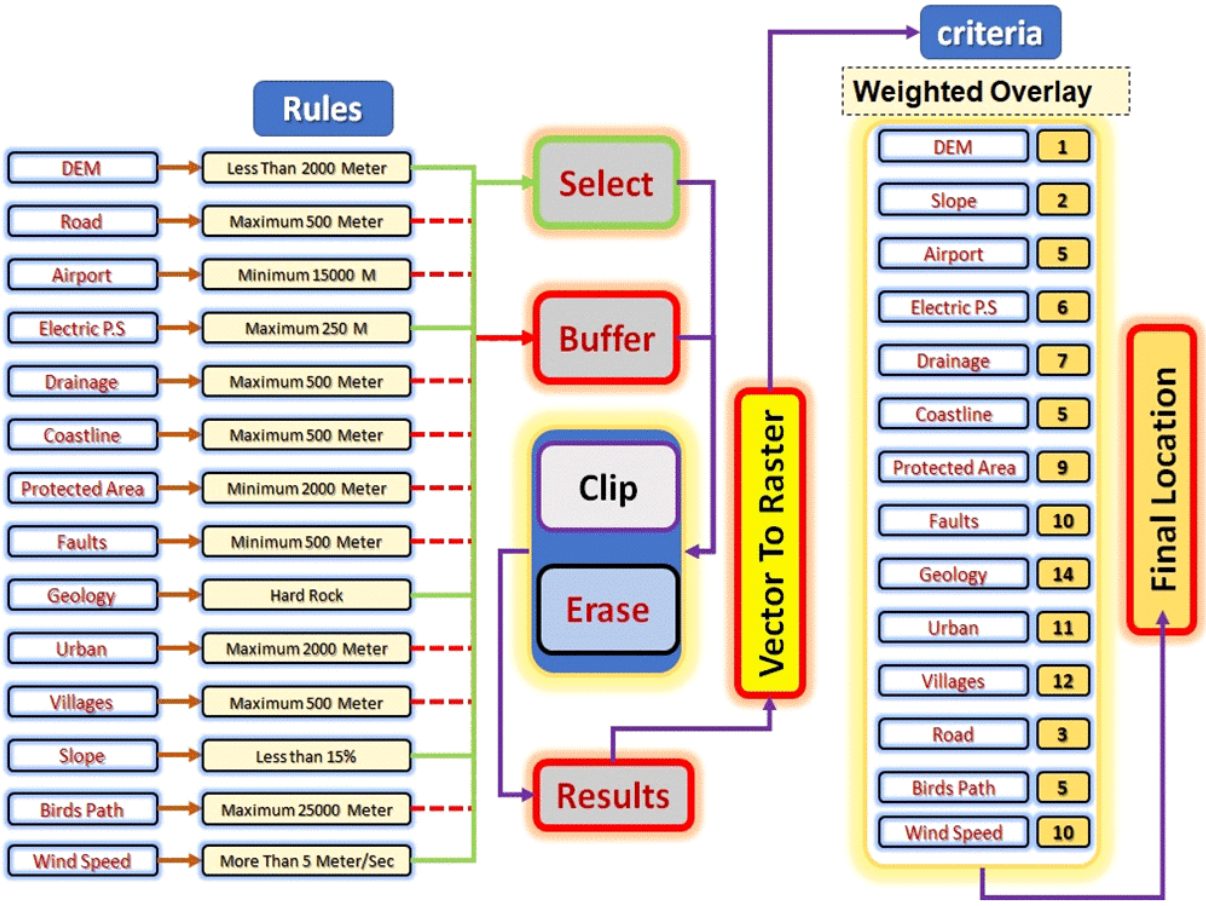


Figure (2). The conceptual model of the restrictive method (Modified after Van Haaren and Fthenakis, 2011)

This climatic diversity makes the entire coast a promising urban, economic and touristic region. Nowadays, many vital cities and urban sites are concentrations along this coast. These cities serve as important industrial, commercial, touristic and agricultural centres. Many host seaports and active airports, linking them with the internal airports of the Kingdom and the rest of the world. On the other hand, some of these cities are medium or small and function primarily as fishing seaports.

This study investigates the prevailing surface wind systems and their characteristics along the Red Sea coast of the Kingdom of Saudi Arabia. For this purpose, the study focus-es on specific sites that represent the various regions of that coast. The selected sites in-clude Al-Wajh, Yanbu, Jeddah, and Jazan, as shown in Figure (1). Each site represents a large geographical area on this coast and possesses unique physical and environmental characteristics.

The mean temperature values in the study areas decrease from south to north. The highest mean is found in Jazan in the south, while the lowest one is in Al-Wajh in the north. Rainfall, though minimal, occurs primarily in autumn and winter and varies from season to season.

3.2 Wind Energy

The evaluation of wind energy potential relies heavily on reliable data regarding wind speed and power distribution. (Safari, 2011). This study aims to compile a compre-hensive data set of wind speeds across the target areas. Our methodology involved analyz-ing climatic data from the General Authority for Meteorology and Environment at four se-lected stations over 32 years (1985–2017). The data were validated regarding complete-ness, continuity, erroneous values, etc.

Previous studies have identified key factors influencing the economic feasibility of generating electricity via wind turbines (Arhens, 1982, Geerts, 1997). These factors include the following:

- The wind speed in the area where the turbine will be installed.
- The height of the turbine axis from the ground.
- The radius of the turbine fan.

The higher the wind speed and the larger the turbine fan's height and diameter, the greater the potential for electrical energy production. Wind turbines generally start to ro-tate at a minimum speed of approximately 3 m/sec (5.8 knots), but they begin to generate electricity economically when the wind speed reaches 5 m/sec (9.7 knots). (Arhens, 1982, Linacre & Greets, 1997).

Using this wind data and information on wind turbines, we calculated the potential electricity that could be produced at each of the study stations for every month of the year. This calculation considered the average monthly wind speed and the maximum monthly speed measured at the height of 10 m above the ground. Because the base area of the wind turbine fan varies greatly between turbines, ranging from less than 1 m2 to 80 m2, we as-sumed a medium base area of 1 m2 for each turbine base. Therefore, a value assumed for the turbine area in any given month, at any of the study stations, is multiplied by the monthly values of the selected station.

The wind energy (Watt/m2) was calculated using the following equation:

$EP = C\ A\ \rho\ V3/2$ (Linacre & Greets, 1997)

where:

EP = Electrical power generated (Watt).

ρ = Air density (1.225 kg/m3).

V = Wind speed (m/sec).

C = Wind turbine coefficient (0.40).

A = the area of the turbine fan base (m2), which is assumed in this study 1 m2.

3.3 Suitability Analysis

This study incorporated a comprehensive analysis of climatic, geographic and urban data using GIS and satellite imagery. This analysis aimed to identify the most suitable lo-cations for wind power stations within the four selected sites. The process involved pro-gressively eliminating less optimal areas, refining and focusing on the most promising re-gions (Noorollahi, et al., 2016). The MCDM method is widely used in many research (Spielmann et, al 2021, Isabel et al., 2023); it provides a framework that integrates eco-nomic, social, and environmental factors to get suitability maps through spatial models (Effat & El-Zeiny, 2022). It is breaking down a complicated decision problem that helps the decision maker (Ali et, al. 2017)

A geographical database model was designed to include all relevant layers deemed crucial for accurate site selection. This database was built using the Arc GIS program and comprised 14 layers. Each layer was assigned a weighted overlay, with the

region of Saudi Arabia, using a developed (MCDM) model. Based on data record-ed over a 30-year period, a wind map was developed. Ecological, environmental, and soci-oeconomic criteria data were used. The optimal site was 22 km2 near the Al-Wajh region.

Salah et al. (2021) investigated the monthly wind energy that can be generated from a wind turbine with a 100 m diameter and 100 m hub height. The Haql, Yanbu, Dholum, Guriat, Dhahran, and Arar regions have the potential to generate wind energy of more than 1000 MWh/month, which makes them ideal for wind turbine installation. The available wind energy in the 5 sites is over 15000MWh.

Albraheem and Al-Awlaqi (2023) present a wind farm site suitability analysis based on the Analytical Hierarchy Process (AHP) and (GIS) techniques in Saudi Arabia. The final suitability map is divided into classes. The results show that the total land area of ex-tremely suitable (Class4) is 48,995 km2, where the largest land is Al Mantiqah Al Sharqi-yah within this class, and the very suitable (class 3) is 197,800 km2, where Riyadh repre-sents the largest total land.

3. Methodology

3.1 Study Area

The Kingdom of Saudi Arabia boasts a long coastline along the Red Sea shore, ex-tending approximately 1,800 km from the Jordanian border in the north to the Yemeni bor-der in the south. This coast comprises approximately 77.3% of the Kingdom's total coast-line, estimated at 2,230 km. (Al-Ruwaithi, 1982). The coastal plain consists mainly of nar-row, flat strips of sand and gravel, along with continental and marine sedimentary for-mations. Certain plain areas are covered by volcanic lava and numerous coastal lakes and bays are scattered throughout.

This long coast presents a remarkable diversity in its physical and climatic geogra-phy. The Red Sea Basin is located in hot tropical latitudes, with only a few parts north of the 30-degree latitude. The climate on the coast is very hot in summer and pleasantly warm in the winter.

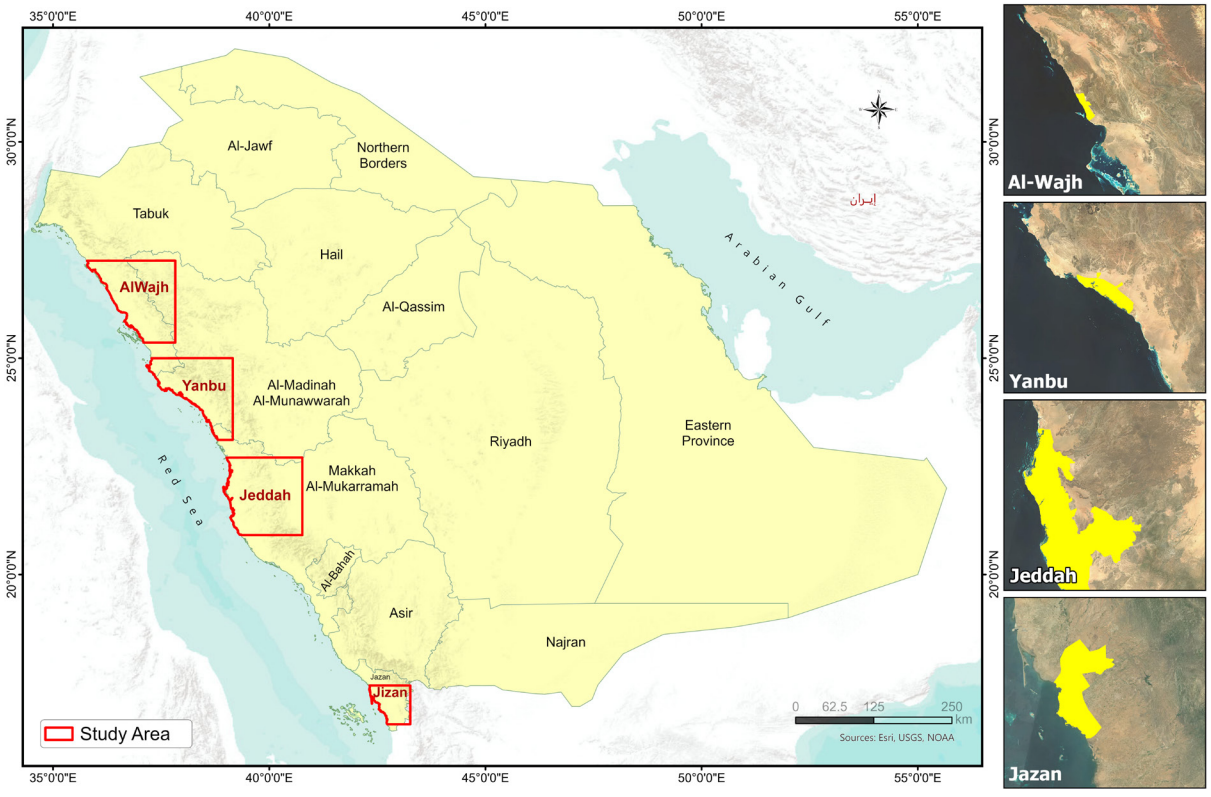


Figure (1). Study area

information systems (GIS) methods, can effectively select suitable sites and estimate energy potentials. MCDM method is widely used as decision making process, where it provides a framework for assessing land suitability for specific developments and produces suitability maps through spatial modelling (Effat & El-Zeiny, 2022).

The Kingdom of Saudi Arabia has been actively exploring renewable energy sources, such as solar and wind power, for optical use. Wind energy, in particular, has received con-siderable attention owing to its competitiveness compared to other renewable energy sources due to its abundant availability (Ansari et al., 1986; Rehman et al., 1994; Alawaji, 1996, Al-Abbadi, et al., 1997, Rehman S, 2003, Al-Abbadi, 2005). However, they are en-countering significant challenges that are impeding progress.

The western coast of Saudi Arabia, with its diverse natural reliefs and climate fea-tures, is a promising site for urban, economic, and tourist development. The constant on-shore and offshore winds significantly influence the weather, climate conditions, and so-cial and economic activities in these regions. The coastal relief's gentle slope towards the sea enhances the speed and power of coastal winds, making them ideal for generating elec-trical and mechanical energy and establishing wind power plants.

This paper aims to pinpoint the optimal location for wind power stations along the Red Sea coast in the Kingdom of Saudi Arabia. Harnessing the power of wind through the wind power stations demand significant initial investment. However, the carefully selected location of wind farm is pivotal in ensuring its economic viability. Wind energy is an al-ternative clean resource and environmentally friendly that could achieve the goal of the Saudi government to generate 50% of energy from renewable sources by 2030(Vision 2030, 2024), that may help decision maker to select an optimal site to build wind farm.

It uses GIS and the MCDM method to develop a decision support model in four ma-jor cities: Wajh, Yanbu, Jeddah and Jazan. Owing to their geographical location, enclosed between the sea in the west and elevated land in the east, these areas experience alternating onshore and offshore winds. This alternation results in varying wind trends, speeds, power, temperature, and humidity, creating diverse ecological and climatic effects. Such wind en-ergy also has a significant impact on all social and economic activities practiced by the local population where it may reduce urban migration, and it can play a role in reducing poverty in the region

2. Literature Review

Wind power stations were studied and designed to reduce the impact of greenhouse gases. Saudi Arabia generates the majority of its power from fossil fuels (oil and natural gas). However, Saudi Arabia is making rapid progress in developing renewable energy, and its goal is to reach 50% of renewable energy generated from wind energy by 2030 (Vision 2030, 2023).

Dumat Al-Jandal Wind Farm in northwest Saudi Arabia in the Al Jouf Region, is a 415 MW onshore wind farm that will become the largest wind farm in the Middle East re-gion by 2030 (Marouani et al. 2023).

Wind power stations in Saudi Arabia were discussed in many papers using different methods, such as Rehamn et al. (2003), which studied wind power potential at 20 locations in the Kingdom of Saudi Arabia. Wind duration curves were developed to calculate the cost per kWh of electricity generated from three chosen wind machines.

Shaahid et al., 2014, analysed long-term wind speed data to study the economic fea-sibility of developing a wind power plant at Taif, Western Province of the Kingdom of Saudi Arabia. The results indicated that wind electric conversion systems will not produce energy for about 46% of the year.

Baseer et al. (2017) investigated the best wind energy farm sites in Saudi Arabia us-ing GIS-based MCDM analysis based on different criteria like climatic, economic, aesthet-ic, and environmental. The most suitable sites are in the Eastern Province near Ras Tanura, Turaif in Al-Jawf region at the northern borders, and Al-Wajh in the western region.

Rehman, et al. (2020a) used a spatial interpolation technique to build an accurate wind map of Saudi Arabia, using a GIS-based multi-criteria decision-making model to se-lect suitable wind farms. The suitable sites were in the eastern region, located between Dammam and Hafr AlBatin, while the southern region had the scariest suitable area.

Rehman et al. (2020b) investigated suitable wind farm site selection in the Hijaz, the western

Journal of Architecture and Planning , Vol. 36 (4) , pp. 467-508, Riyadh (2024/1446H)

doi:10.33948/JAP-KSU-36-4-4

Multi-Criteria Analysis of Wind Power Station Distribution Along the Red Sea Coast of the Kingdom of Saudi Arabia Using GIS (1985-2017)

Jehan A. Alkhelaif — Assistant Professor

Abeer Sh. Salman — Associate Professor

Geography, King Saud University, Saudi Arabia

jalkhelaif@ksu.edu.sa — *abalsalman@ksu.edu.sa*

(Received 17/3/2024; accepted for publication 13/10/2024)

Abstract: The strategic placement of wind power stations is scientifically critical for exploiting their full capacity. This research aims to compare the spatial characteristics of wind speed across four city sites at the Red Sea coast in Saudi Arabia. These cities are Al-Wajh, Yanbu, Jeddah and Jazan, all of which have operational wind power stations that serve as our case study. Data from 1985 to 2017 were analysed, focusing on diurnal and seasonal mean values of average wind speed, maxi-mum wind speed and prevailing wind direction. These data were sourced from meteorological sta-tions located in the aforementioned cities. We employed geographical information systems tech-niques to evaluate and suggest optimal locations for potential wind power stations. These tools were integrated with statistical methods to analyse the climatic data, which further served the objectives of the study. The database for this study was built upon 14 layers, each layer determining which areas were suitable or unsuitable for wind power station placement. Amongst the examined cities, Jeddah had the largest suitable area, measuring approximately 13826.8 km^2. Conversely, Jizan had the smallest suitable area, spanning just approximately 738.7 km^2

Keywords: Wind power station; Multi-criteria Decision; GIS; Kingdom of Saudi Arabia; Red Sea.

1. Introduction

As traditional energy sources are projected to deplete in the coming decades, the world has begun to explore clean, alternative power sources (Yuksel & Kaygusuz, 2011). Renewable energy sources are not cause physical pollution where it is cleaner, efficient and ecologically friendly such as hydro, solar, and wind ((Shrestha, et al., 2022, Baban and Parry, 2001). Renewable energy technology is varied and diverse that makes it suitable for islands, villages and urban areas. Furthermore, they are abundant in nature and do not jeopardize any natural resource wind energy, known for its affordability, abundance and environmental friendliness, is emerging as a significant supplier of power both now and in the future (Mohammedi, et al., 2017). However, the fitful nature of wind power production presents a challenge (Villacreses et al, 2017).

Several countries, including China and the USA, have already turned to wind power as a primary alternative to traditional energy. These two nations accounted for more than 60% of the new wind power capacity generated in 2019 (GWEC, 2019). In addition, wind power usage has increased in the European countries (Borawski, et al., 2020) and in Asia (IRENA, 2019, Tahir, et al., 2021).

Multi-criteria decision-making methods (MCDM), when combined with geograph-ical

doi:10.33948/JAP-KSU-36-4-3

تقييم جودة البيئة الداخلية لأجنحة التمريض بمستشفى عام في جدة، المملكة العربية السعودية

حسين أسامة المنصوري **جميل فريد حجازي**

قسم العمارة، كلية العمارة والتخطيط، جامعة الملك عبد العزيز، جدة، المملكة العربية السعودية

hhussainalmansouri@stu.kau.edu.sa *jhijazi@kau.edu.sa*

قدم للنشر في ١٥/ ١١/ ١٤٤٥ هـ؛ وقبل للنشر في ١٠/ ٤/ ١٤٤٦ هـ

ملخص البحث. تعد جودة البيئة الداخلية أكثر أهمية في المستشفيات من المباني الأخرى نظراً لتأثيرها على سرعة تعافي المرضى. وهناك نقص في الضوابط التصميمية للمستشفيات في المملكة العربية السعودية من حيث التركيز على جودة البيئة الداخلية، وهو ما يجعل من الصعب تصميم الفراغات التي توفر مستويات كافية من الراحة للمستخدمين. بناءً على ذلك، تم في هذه الدراسة إجراء تقييمات موضوعية باستخدام قياسات لبعض عناصر جودة البيئة الداخلية، وتقييمات غير موضوعية عن طريق مجموعات النقاش المركزة، على أجنحة التمريض بمستشفى عام في مدينة جدة، المملكة العربية السعودية؛ بهدف تطوير ضوابط تصميمية تركز على جودة البيئة الداخلية وتوفر للمستخدمين نسبة أعلى من الراحة. استهدف التقييم الموضوعي المعايير الأربعة الرئيسة لجودة البيئة الداخلية، وهي: الراحة الحرارية، والصوتية، والبصرية، وجودة الهواء الداخلي. في المقابل، استهدف التقييم غير الموضوعي المعايير الأربعة ذاتها من خلال قياس مستوى الرضا لثلاث مجموعات من مستخدمي المستشفى: المرضى والزوار كمجموعتين مستقلتين، وطاقم التمريض والأطباء المقيمين كمجموعة واحدة. وبعد تحليل نتائج التقييمين بشكل مترابط، تم استنتاج أن الراحة الحرارية وجودة الهواء الداخلي كانت الأكثر قبولاً، بينما حازت الراحة البصرية والصوتية على نسبة رضا أقل. تم بعد ذلك تطوير ضوابط تصميمية مستهدفة مبنى المستشفى الذي تم تقييمه بناءً على المشاكل التصميمية المتعلقة بجودة البيئة الداخلية، والتي تم التوصل إليها بعد تحليل النتائج.

الكلمات المفتاحية: جودة البيئة الداخلية، الراحة الحرارية، الراحة الصوتية، الراحة البصرية، جودة الهواء الداخلي، أجنحة التمريض.

Wolkoff, Peder. "Indoor air humidity, air quality, and health – An overview". International Journal of Hygiene and Environmental Health. Vol 221(3). Pp 376–390. (2018). https://doi.org/10.1016/j.ijheh.2018.01.015

World Health Organization. WHO Guidelines for Indoor Air Quality: Dampness and Mould. Geneva: WHO. (2009). http://www.ncbi.nlm.nih.gov/books/NBK143941/

Wu, Yue & Meng, Qi & Li, Lei & Mu, Jingyi. "Interaction between Sound and Thermal Influences on Patient Comfort in the Hospitals of China's Northern Heating Region". Applied Sciences. Vol 9(24). (2019). https://doi.org/10.3390/app9245551

Zhang, Dadi & Mui, Kwok-Wai. & Wong, Ling-Tim. "Ten Questions Concerning Indoor Environmental Quality (IEQ) Models: The Development and Applications". Applied Sciences. Vol 13(5). (2023). https://doi.org/10.3390/app13053343

Zhang, Yufeng & Liu, Qianni & Meng, Qinglin. "Airflow utilization in buildings in hot and humid areas of China". Building and Environment. Vol 87. Pp 207–214. (2015). https://doi.org/10.1016/j.buildenv.2015.02.002

7_9

Pinhão, Cláudia. "Children's Hospitals - The Role of Architecture in Children's Recovery and Development". Técnico Lisboa; (2016).

Saleem, Mohd & Kausar, Mohd A. & Khatoon, Fahmida & Anwar, Sadaf & Shahid, Syed M.A. & Ginawi, Tariq, et al. "Association between Human Health and Indoor Air Pollution in Saudi Arabia: Indoor Environmental Quality Survey". Journal of Pharmaceutical Research International. Vol 32(34). Pp 57–66. (2020). https://doi.org/10.9734/jpri/2020/v32i3430965

Saudi Central Board for Accreditation of Healthcare Institutions. National Hospital Standards – Third Edition. Saudi Arabia; CBAHI. (2015).

Secchi, Simone & Setola, Nicoletta & Marzi, Luca & Amodeo, Veronica. "Analysis of the Acoustic Comfort in Hospital: The Case of Maternity Rooms". Buildings. Vol 12(8). (2022). https://doi.org/10.3390/buildings12081117

Smyth, John. Sustainable Building Services - Sustainable Ventilation in Commercial Building Environments for the 'New Normal'. UK: Chartered Institution of Building Services Engineers. (2022). https://www.cibse.org/media/pwbhcogd/cibse-kendale-award-report-2020-2022-john-smyth.pdf

STANMECH Technologies. "Sizing your Heater and Blower: The Relationship between Air Flow and Temperature". (2016). http://www.stanmech.com/1/post/2016/05/sizing-your-heater-and-blower-the-relationship-between-air-flow-and-temperature.html

Tang, Hao & Ding, Yong & Singer, Brett C. "Post-occupancy evaluation of indoor environmental quality in ten nonresidential buildings in Chongqing, China". Journal of Building Engineering. Vol 32. (2020). https://doi.org/10.1016/j.jobe.2020.101649

Toodekharman, Horre & Abravesh, Mahdieh & Heidari, Shahin. "Visual Comfort Assessment of Hospital Patient Rooms with Climate Responsive Facades". Journal of Daylighting. Vol 10(1). Pp 17–30. (2023). https://doi.org/10.15627/jd.2023.2

University of Kentucky - Department of Animal & Food Sciences. "Relationship between temperature and moisture". (2024). https://afs.ca.uky.edu/poultry/chapter-7-relationship-between-temperature-and-moisture

US Department of Veterans Affairs. Lighting Design Manual. United States: Veterans Affairs, Office of Construction and Facilities Management. (2022). https://www.cfm.va.gov/til/dManual/dmLighting.pdf

US Department of Veterans Affairs. Medical/Surgical Inpatient Units & Intensive Care Nursing Units. United States: Veterans Affairs, Office of Construction and Facilities Management. (2011). https://www.cfm.va.gov/til/dguide/dginpatientnu.pdf

US Environmental Protection Agency. "Introduction to Indoor Air Quality". (2022). https://www.epa.gov/indoor-air-quality-iaq/introduction-indoor-air-quality

Vethe, Daniel & Scott, Jan & Engstrøm, Morten, & Salvesen, Øyvind & Sand, Trond & Olsen, Alexander, et al. "The evening light environment in hospitals can be designed to produce less disruptive effects on the circadian system and improve sleep". Sleep. Vol 44(3). (2020). https://doi.org/10.1093/sleep/zsaa194

Vijaykrishna, G. & Balaji, G. "Impact of Indoor Temperature and Humidity in IAQ of Health Care Buildings". Civil Engineering and Architecture. Vol 11. Pp 1273–1279. (2023) https://doi.org/10.13189/cea.2023.110313

Vincent, Ellen & Battisto, Dina & Grimes, Larry & McCubbin, James. "The effects of nature images on pain in a simulated hospital patient room". HERD. Vol 3(3). Pp 42–55. (2010). https://doi.org/10.1177/193758671000300306

Wang, Quying & Tzortzi, Julia N. "Design guidelines for healing gardens in the general hospital". Front Public Health. Vol 11. (2023). https://doi.org/10.3389/fpubh.2023.1288586

Wisconsin Department of Health Services. "Carbon Dioxide". (2023). https://www.dhs.wisconsin.gov/chemical/carbondioxide.htm

Fausti, Patrizio & Santoni, Andrea & Secchi, Simone. "Noise control in hospitals: considerations on regulations, design and real situations". Internoise. (2019). https://iris.unife.it/bitstream/11392/2417644/2/2174.pdf

Fonseca, Ana & Abreu, Isabel & Guerreiro, Maria J. & Barros, Nelson. "Indoor Air Quality in Healthcare Units—A Systematic Literature Review Focusing Recent Research". Sustainability. Vol 14(2). (2022) https://doi.org/10.3390/su14020967

Gao, Chong & Zhang, Shanshan. "Inpatient perceptions of design characteristics related to ward environments' restorative quality". Journal of Building Engineering. Vol 41. (2021) https://doi.org/10.1016/j.jobe.2021.102410

Garnawat, Prachi & Andamon, Mary M. & Wong, James P.C. & Woo, Jin. "Assessment of indoor environmental quality in Australian healthcare facilities: a review of standards and guidelines". Healthy Buildings. (2017). https://www.isiaq.org/docs/presentation/0197.pdf

Graham, Donna & Bryan, John. "How Many Focus Groups are Enough: Focus Groups for Dissertation Research". Faculty Focus. (2022). https://www.facultyfocus.com/articles/academic-leadership/how-many-focus-groups-are-enough-focus-groups-for-dissertation-research/

Hassanain, Mohammad A. & Dehwah, Ammar H.A. & Sanni-Anibire, Muizz O. & Ahmed, Wahhaj. "Quality assessment of a campus medical facility: a users' perspective approach". International Journal of Workplace Health Management. Vol 13(6). Pp 585–599. (2020). https://doi.org/10.1108/IJWHM-01-2020-0001

Ismaeil, Esam M.H. & Sobaih, Abu Elnasr E. "Enhancing Healing Environment and Sustainable Finishing Materials in Healthcare Buildings". Buildings. Vol 12(10). (2022). https://doi.org/10.3390/buildings12101676

Katafygiotou, Martha C. & Serghides, Despina K. "Bioclimatic chart analysis in three climate zones in Cyprus". Indoor and Built Environment. Vol 24(6). Pp 746–760. (2015) https://doi.org/10.1177/1420326X14526909

Khan, Mawara & Thaheem, Muhammad J. & Khan, Musfira & Maqsoom, Ahsen & Zeeshan, Muhammad. "Thermal Comfort and Ventilation Conditions in Healthcare Facilities -Part 1: An Assessment of Indoor Environmental Quality (IEQ)". Environmental engineering and management journal. Vol 19. 917–933. (2020) https://doi.org/10.30638/eemj.2020.087

Mahmood, Fouad J. & Tayib, Abdullah Y. "Healing environment correlated with patients' psychological comfort: Post-occupancy evaluation of general hospitals". Indoor and Built Environment. Vol 30(2). Pp 180–94. (2021). https://doi.org/10.1177/1420326X19888005

Ministry of Health. "Statistical yearbook – Part 2: Health resources 2023". (2024). https://www.moh.gov.sa/en/Ministry/Statistics/book/Pages/default.aspx

Nimlyat, Pontip S. & Salihu, Bala & Wang, Grace P. "The impact of indoor environmental quality (IEQ) on patients' health and comfort in Nigeria". IJBPA. (2022). https://doi.org/10.1108/IJBPA-06-2021-0089

Nimlyat, Pontip S. & Kandar, Mohd, & Sediadi, Eka. "Empirical Investigation of Indoor Environmental Quality (IEQ) Performance in Hospital Buildings in Nigeria". Jurnal Teknologi. Vol 77(14). Pp 41-50. (2015). https://doi.org/10.11113/jt.v77.6445

Nyembwe, Jean-Paul K.B. & Ogundiran, John O. & Chenari, Behrang & Simões, Nuno A.V. & Gameiro, da Silva Manuel. "The Indoor Climate of Hospitals in Tropical Countries: A Systematic Review". Energies. Vol 16(8). (2023) https://doi.org/10.3390/en16083513

Pan American Health Organization & World Health Organization. Smart Hospitals Toolkit. Washington, D.C.: PAHO. (2017). https://cdn.who.int/media/docs/default-source/climate-change/smart-hospital-toolkit-paho.pdf

Parsons, Ken. Design of the Indoor Environment. London: Springer. Pp 157–177. (2013). https://doi.org/10.1007/978-1-4471-4781-

American National Standards Institute & American Society of Heating Refrigerating and Air-Conditioning Engineers. Thermal Environmental Conditions for Human Occupancy. United States: ASHRAE; (2023). https://ashrae.iwrapper.com/ASHRAE_PREVIEW_ONLY_STANDARDS/STD_55_2023

American National Standards Institute. "ANSI Introduction". (2023). https://www.ansi.org/about/introduction

American Society of Heating Refrigerating and Air-Conditioning Engineers. 2019 ASHRAE Handbook—HVAC Applications. United States: ASHRAE. (2019). https://www.ashrae.org/file%20library/technical%20resources/covid-19/i-p_a19_ch09_health_care_facilities.pdf

American Society of Heating Refrigerating and Air-Conditioning Engineers. "ASHRAE Regional Map" (2021). https://www.ashrae.org/file%20library/communities/regions/ashrae_2021.pdf

American Society of Heating Refrigerating and Air-Conditioning Engineers. "About ASHRAE" (n.d.). https://www.ashrae.org/about

Arens, Edward & Heinzerling, David & Paliaga, Gwelen. "Sunlight and Indoor Thermal Comfort". ASHRAE Journal. Vol 60. Pp 12–21. (2018). https://escholarship.org/uc/item/9gc4z8z6

Awada, Mohamad & Becerik-Gerber, Burcin & Hoque, Simi & O'Neill, Zheng & Pedrielli, Giulia & Wen, Jin & Wu, Teresa. "Ten questions concerning occupant health in buildings during normal operations and extreme events including the COVID-19 pandemic". Build Environ. Vol 188. (2021). https://www.ncbi.nlm.nih.gov/pmc/articles/PMC9759512/

Blume, Christine & Garbazza, Corrado & Spitschan, Manuel. "Effects of light on human circadian rhythms, sleep and mood". Somnologie (Berl). Vol 23(3). Pp 147–156. (2019). https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6751071/

Budaiwi, Ismail M. & Mohammed, Mohammed A. & Harbi, Hammad A. "Indoor environmental quality-based space categorization framework: the case of health-care facilities". Journal of Facilities Management. Vol 22(3). Pp 495-520. (2022). https://doi.org/10.1108/JFM-04-2022-0035

Carlucci, Salvatore & Causone, Francesco & De Rosa, Francesco & Pagliano, Lorenzo. "A review of indices for assessing visual comfort with a view to their use in optimization processes to support building integrated design". Renewable and Sustainable Energy Reviews. Vol 47. Pp 1016–1033. (2015). https://doi.org/10.1016/j.rser.2015.03.062

Centers for Disease Control and Prevention. Guidelines for Environmental Infection Control in Health-Care Facilities. Atlanta, Georgia: Epidemiology Program Office. (2019). https://doi.apa.org/doi/10.1037/e545922006-001

Deng, Zhixiao & Xie, Hui & Kang, Jian. "The effectiveness of acoustic treatments in general hospital wards in China". Building and Environment. Vol 244. (2023). https://doi.org/10.1016/j.buildenv.2023.110728

Department of Health. Health Building Note 00-01: General design guidance for healthcare buildings. United Kingdom: Department of Health. (2014). https://www.england.nhs.uk/wp-content/uploads/2021/05/HBN_00-01-2.pdf

DuBose, Jennifer & Davis, Robert G. & Campiglia, Gabrielle & Wilkerson, Andrea & Zimring, Craig. "Lighting the Patient Room of the Future: Evaluating Different Lighting Conditions from the Patient Perspective". HERD. Vol 15(2). Pp 79–95. (2022). https://doi.org/10.1177/19375867211063481

DuBose, Jennifer & Hadi, Khatereh. "Improving inpatient environments to support patient sleep". International Journal for Quality in Health Care. Vol 28(5). Pp 540–553. (2016). https://doi.org/10.1093/intqhc/mzw079

Facility Guidelines Institute. "2026 DRAFT FGI facility code for hospitals". (2024). https://fgiguidelines.org/public-comment-period/

5. Conclusions

This research was conducted to address the lack of focus on IEQ in Saudi Arabia's hospital design guidelines, where IEQ is not considered alongside the quality and safety of provided services. By conducting objective and subjective assessments on a relatively old hospital building's inpatient department, the research's findings show that the current level of IEQ in the inpatient wards is inconsistent between the various assessed IEQ factors, whether objectively compared with international standards or subjectively when occupant satisfaction is measured. The main goal this research set out to achieve was accomplished in the form of IEQ-focused design guidelines that can help increase the level of occupant satisfaction. Furthermore, this research can serve as a starting point for CBAHI to advance the development of local hospital design guidelines by integrating this study's results with their already existing quality and safety standards.

Finally, this research also highlights the importance of occupant comfort and its relationship with design and IEQ in hospitals and all other building types. This can ultimately encourage CBAHI, the Saudi Building Code National Committee, and the Ministry of Health to consider IEQ in their future hospital standards.

6. Future Studies

In terms of applications of this study, one way the concluded guidelines can be utilized is through implementation on part of the inpatient wards as a trial, followed by reassessment using similar methods after enough time has passed. Another way is to design a virtual model that applies these guidelines and then simulate it through software to test the guidelines' effectiveness.

As for further research, on a local scale, IEQ assessments that include varying IEQ factors, a larger number of participants and user groups, and even multiple buildings are recommended to produce design guidelines that can be standardized and applied to various hospital buildings.

7. References

Ahn, Byung-Lip & Jang, Cheol-Yong & Leigh, Seung-Bok & Jeong, Hakguen. "Analysis of the Effect of Artificial Lighting on Heating and Cooling Energy in Commercial Buildings". Energy Procedia. Vol 61. Pp 928–932. (2014). https://doi.org/10.1016/j.egypro.2014.11.997

Al Horr, Yousef & Arif, Mohammed & Katafygiotou, Martha & Mazroei, Ahmed & Kaushik, Amit & Elsarrag, Esam. "Impact of indoor environmental quality on occupant well-being and comfort: A literature review". International Journal of Sustainable Built Environment. Vol 5(1). Pp 1–11. (2016). https://doi.org/10.1016/j.ijsbe.2016.03.006

Al-Atawi, Ahmad D. & Niessen, Louis W. & Khan, Jahangir A. M. "Efficiency evaluation of public hospitals in Saudi Arabia: an application of data envelopment analysis". BMJ Open. Vol 10(1). (2020). https://doi.org/10.1136/bmjopen-2019-031924

Al-Ghamdi, Abdullah. "Experience Design Modelling of the Relationship between Patient Recovery and Hospital Design in the Kingdom of Saudi Arabia". Curtin University of Technology; (2021). https://espace.curtin.edu.au/handle/20.500.11937/84910

Aljunid, Shariffah S. & Shukri, Nurul N.H.M. & Taib, Mohd Z.M. & Samah, Zanariah A. "Determinants of Patient Satisfaction on Interior Design Quality of Public Hospitals in Malaysia". Malaysian Journal of Public Health Medicine. Vol 20(2). Pp 233–241. (2020). https://doi.org/10.37268/mjphm/vol.20/no.2/art.800

Almeida, Ricardo M.S.F. & De Freitas, Vasco P. & Delgado, João M.P.Q. School Buildings Rehabilitation: Indoor Environmental Quality and Enclosure Optimization. Cham: Springer International Publishing. Vol 83. (2015). https://doi.org/10.1007/978-3-319-15359-9

Furthermore, the targeted spaces in the assessed building received cuts in the number of staff members, which reduced the study's targeted population further, which was also explained in Section 3: Methodology.

Additionally, the objective assessment in this study measured six primary IEQ factors under the four main parameters of IEQ. In order to develop more generalized IEQ-focused design guidelines, additional, less tested IEQ factors, such as volatile organic compounds and Carbon Monoxide, should also be assessed through field measurements and compared with the standards, which requires additional time and resources.

Finally, this study assessed inpatient spaces in a single building and used the assessment data to improve the same building via developed design guidelines. However, in order to produce even more generalized IEQ-focused design guidelines that can be applied to various hospital buildings, assessments of multiple buildings are necessary, which require an extensive amount of time and resources.

4.6 Development of IEQ-Focused Design Guidelines and Recommendations

After discussing the research's findings, the guidelines and recommendations were concluded in the form of a matrix showcasing the different correlations between the measured IEQ factors and the elements included in the focus group questions (Table 7). Each correlation is given a code based on its corresponding IEQ factors and subjective elements. The type of correlation is then specified as 'Direct' or 'Inverse'. Finally, the correlation is then further explained through literature.

After understanding where exactly the correlations between the various IEQ factors lie, design guidelines and recommendations that consider these correlations can be concluded (Table 8) utilizing the same codes as Table 7.

Table (8). Concluded guidelines based on the correlation matrix (Author, 2024).

Code	IEQ- Focused Design Guidelines and Recommendations
T.1-RH I.1-SP I.1-T I.1-RH I.1-CO_2 I.2-RH I.2-CO_2 I.3-RH I.3-CO_2	1) Providing individual control over HVAC within acceptable standard limits while allowing nursing staff to monitor the controls remotely should allow users to adjust the AC unit's temperature and airflow strength without negatively affecting the indoor environment. This allows users to gain more control over their environment inside the rooms, which affects their psychological comfort and satisfaction (Mahmoud and Tayib, 2021).
A.1-SP	2) In addition to HVAC control to limit airflow noise, acoustic insulation, such as absorptive ceilings and carpets, has been proven to increase user satisfaction (Deng et al., 2023).
A.1-NL	3) In the case of rooms that lack direct sunlight, simulated daylight can be implemented to positively affect users' circadian rhythm and improve their sleep and general mood (Giménez et al., 2011, as cited in DuBose and Hadi, 2019; Vethe et al., 2020).
A.1-AL	4) Distributing artificial lighting throughout the rooms, instead of being focused above beds, can increase the satisfaction level of users (DuBose et al., 2022).
V.1-T V.1-RH	5) Implementing different types of controllable shading devices, such as louvers and curtains, can allow users to control the amount of sunlight entering their rooms (Tabasi and Banihashemi, 2022, as cited in Toodekharman et al., 2023).
V.2.T	6) Implementing dimmable artificial lighting to control the increase in temperature (Ahn et al., 2014).
V.3-AL V.3-NL	7) Utilizing a combination of guidelines 3-6, in addition to allowing users to personalize their rooms by adding furniture items such as cupboards can make users feel more at home, which improves their general mood and recovery process (De Vos, 2004, as cited in Pinhão, 2016).
V.4-NL	8) Planting gardens in single-bedroom terraces and the roofs of other buildings to create natural views (Wang and Tzortzi, 2023) or (9) Utilizing virtual images of nature as distractions for the users (Vincent et al., 2010).

Table (7). Objective and subjective assessments correlation matrix (Author, 2024).

				Objective Assessment: IEQ Field Measurements						Correlation Type (Direct/ Inverse)	Correlation
				Thermal		IAQ	Acoustic	Visual			
				Temperature	Relative Humidity	CO_2 Concentration	Sound Pressure	Natural Illuminance	Artificial Illuminance		
			Code*	T	RH	CO_2	SP	NL	AL		
Subjective Assessment: Focus Group Questions	Thermal	Temperature	T.1		T.1-RH					DIR	The capacity of air to hold moisture increases as temperature increases (University of Kentucky, 2024).
	IAQ	Airflow	I.1				I.1-SP			DIR	Increased airflow from HVAC units increases sound pressure (Fausti et al., 2019).
				I.1-T						INV	Airflow and temperature share an inverse relationship (Zhang et al, 2015; Stanmech Technologies, 2016).
					I.1-RH	I.1-CO_2				INV	Increased airflow decreases the amount of moisture and pollutants in an indoor environment (WHO, 2009).
		Air Stuffiness	I.2		I.2-RH	I.2-CO_2				DIR	Both air stuffiness and unpleasant smells are variables affected by increased RH (Wisconsin Department of Health, 2023) and CO_2 (Reinikainen et al., 1997, Reinikainen and Jaakkola, 2003, as cited in Wolkoff, 2018).
		Unpleasant Smells	I.3		I.3-RH	I.3-CO_2					
	Acoustic Comfort	Comfort in Sleep	A.1				A.1-SP			INV	Increased noise sources, such as people talking and airflow, can cause users to feel less comfortable in sleep (Dubose and Hadi, 2016).
								A.1-NL		DIR	Increased exposure to direct sunlight can allow patients to sleep more comfortably at night due to it positively affecting the circadian rhythm (Roenneberg et al., 2003, as cited in Blume et al., 2019; DuBose and Hadi, 2016).
									A.1-AL	INV	Artificial light can affect the circadian rhythm in different ways (Wright et al., 2013, as cited in Blume et al., 2019; Vethe et al., 2020).
	Visual Comfort	Natural Lighting	V.1	V.1-T						DIR	Exposure to direct sunlight increases temperature and affects thermal comfort (Arens et al., 2018).
					V.1-RH					DIR	Direct sunlight increases temperature, which in turn increases relative humidity.
		Artificial Lighting	V.2	V.2.T						DIR	Non-dimmable artificial lighting can generate indoor heat (Ahn et al., 2014).
		Interior Design	V.3					V.3-NL	V.3-AL	DIR	Using lighting when designing a hospital's environment can positively impact patients' wellbeing (Dijkstra et al., 2006, Oberlin, 2008, as cited in Aljunid et al., 2020).
		Outside Views	V.4					V.4-NL		DIR	Outside views of nature can aid patients' recovery (Ulrich, 1983, as cited in Mahmood and Tayib, 2021).

* The codes shown in gray highlights are combinations of the individual codes given to each objective and subjective assessment element found under the 'Code' row and column. For example, 'T.1-RH' is a combination of the codes 'T.1' representing 'Temperature' as a subjective assessment element, and 'RH' representing 'Relative Humidity' as an objective assessment element. The explanation of the correlation between these two elements is found in the 'Correlation' column.

User satisfaction rates (3.50<R<4.75) for the patients and visitors are directly related to the average and median. The ratings by patients are highest in double rooms(R=4.56), which is most likely due to them being well distributed inside the rooms, whereas in most single bedrooms (R=4.33) the lights are too close to the beds. On the other hand, the lights in multi-bed rooms (R=3.67) are spread out to make the wards feel darker than other rooms.

Unlike natural illuminance, there were more user complaints regarding artificial illuminance as a source of discomfort. However, most users who complained were nurses and resident doctors, who gave below-average ratings (R=2.87).

The subjective assessment of visual comfort also covered interior design and outside views, both of which received surprisingly acceptable ratings from the users, although there were some issues, such as:

- The nurses vocally complained about the interior design and decorations, stating that it requires a revamp.
- Some patients and visitors also complained about the cleanliness of the walls, floors, and curtains (in multi-bed rooms).
- Some rooms had beds facing walls instead of TVs or windows.
- Most rooms were severely lacking in interior design elements.
- Some rooms had shading devices with broken controls, meaning they were stuck and could not be opened or closed to allow or prevent daylight inside the rooms.

The different IEQ factors of visual comfort enhance the users' experience inside the building. For example, natural views from within an inpatient room can ease patients patients stay and help them discharged faster from a hospital than other patients whose rooms lack views (Ulrich, 1983, as cited in Mahmood and Tayib, 2021).

4.5 Research Limitations

Before concluding the research's findings in the form of design guidelines and recommendations, the following are the most notable restrictions that had a significant impact on the study:

The hospital's administration has a rule against leaving measurement devices unattended inside hospital spaces, meaning that devices that take measurements automatically at set time intervals could not be used in the study, as explained in Section 3: Methodology.

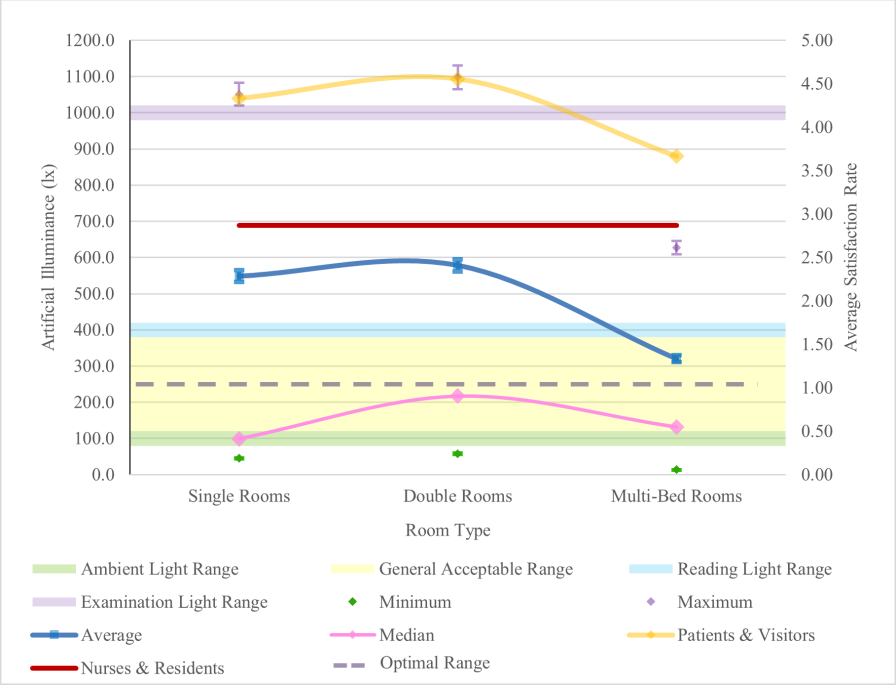


Figure (8). Artificial illuminance measurements by elevation (Author, 2024).

4.4 Visual Comfort

In the case of visual comfort's objective assessment, two IEQ factors were chosen: natural and artificial illuminance.

4.4.1 Natural Illuminance

The overall average across all four elevations for natural illuminance is 75.13±3% lx, whereas the minimum and maximum are 1.70±3% lx and 241.00±3% lx, respectively (Figure 7). The acceptable range of ambient lighting as per ANSI and Illuminating Engineering Society Standard 29-22 is 100 lx (2022, as cited in US Department of Veteran Affairs, 2022). The averages of the northwestern and southwestern elevations barely fall within the acceptable range, whereas the other two elevations have lower averages.

The satisfaction rates for natural illuminance share an inverse relationship with the median measurements and a mostly inverse relationship with the average that starts as a direct relationship in the northeastern elevation. The southwestern elevation was rated the lowest (R=2.33). Otherwise, ratings by the patients and visitors are positive (4.0<R≤4.75). Nurses and resident doctors, however, gave below-average ratings (R=2.87).

Finally, shading devices were inconsistent. Some rooms had louvers, some even had broken controls, and others had semi-transparent curtains. Despite this, user complaints about direct sunlight and sun glare were minimal.

4.4.2 Artificial Illuminance

As for artificial illuminance, the overall average across all room types for artificial illuminance is 481.98±3% lx, while the minimum and maximum are 13.40±3% lx and 1098.00±3% lx respectively (Figure 8). Although the acceptable range for ambient lighting is the same as natural illuminance, multiple acceptable ranges are depending on the task as per ANSI and Illuminating Engineering Society Standard 29-22 (2022, as cited in US Department of Veteran Affairs, 2022). The general range is between 100 and 400 lx, the recommended light for reading is 400 lx, and the examination light nurses must be around 1000 lx.

Only rooms with fully functional artificial lighting were included in this assessment, and the measurements were taken at the center of each assessed room. Artificial illuminance is much closer to the standards than natural illuminance. However, the multi-bed rooms seem to fall behind.

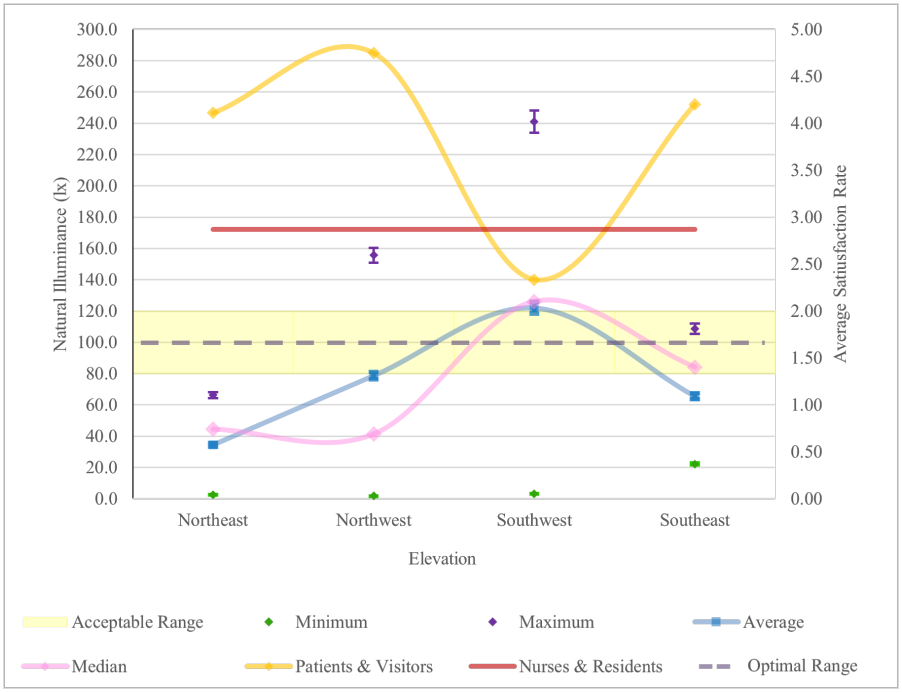


Figure (7). Natural illuminance measurements by elevation (Author, 2024).

Since this study only included vacant rooms, this discrepancy is most likely due to sharp noises occurring from outside the rooms during measurement, which may skew the average to higher levels. In this case, the median may represent the data more accurately than the average. As for user complaints, both user parties focused mainly on people talking outside the rooms as the most prevalent source of noise, followed by equipment, such as trolleys, and finally HVAC systems.

Although loud noises can affect patients' quality of rest and healing process (WHO, 1995, as cited in Secchi et al., 2022), they can also affect staff members' stress levels and work performance (Bayo et al., 1995, Montes-Gonzalez et al., 2019, as cited in Secchi et al., 2022), which may in turn affect patients as the staff members attend to them.

4.3 Indoor Air Quality

The objective assessment of IAQ focused only on CO2 concentration and is presented for each available room type (Figure 6). The average across all 3 room types is 421.83±5% ppm, whereas the minimum and maximum are 400±5% ppm and 465±5% ppm, respectively. According to the Pan American Health Association and WHO (2017), CO2 levels less than 600 ppm are acceptable. Whereas the Federation of European Heating, Ventilation, and Air Conditioning Associations list the standard as less than 550 ppm (2022, as cited in Smyth, 2022).

All measurements of CO2 fall within the range of the standards. Furthermore, the user satisfaction rates of patients and visitors ($4.0 \leq R < 4.25$) directly correlate with the average measurements, decreasing with room size. On the other hand, the median shares an irregular relationship with the satisfaction rates, where it increases with room size and then decreases to its lowest recorded point. The nurses and resident doctors gave above-average ratings (R=3.64). According to the focus groups, a few users were not satisfied with the air inside the rooms, stating that it was stuffy and held unpleasant odors.

IAQ and thermal comfort are connected based on the previously mentioned relationship between temperature, RH, bacteria, and viruses, where the bacteria and viruses can travel through the air between all hospital building users. However, increased CO2 levels in closed spaces such as inpatient rooms can cause drowsiness, headaches, and other health risks that can affect patients' recovery processes (Wisconsin Department of Health, 2023).

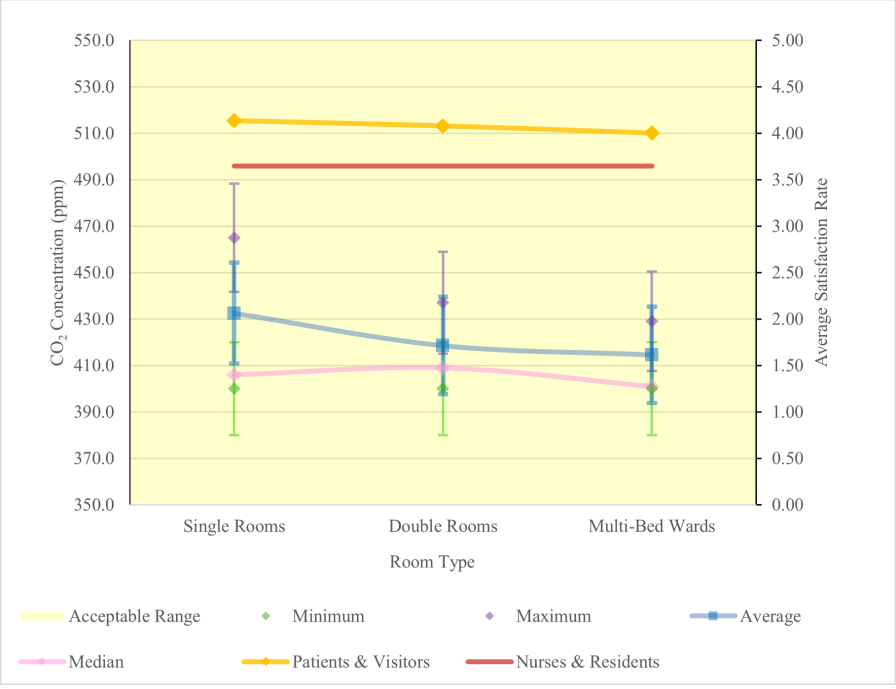


Figure (6). CO2 concentration measurements by room type (Author, 2024).

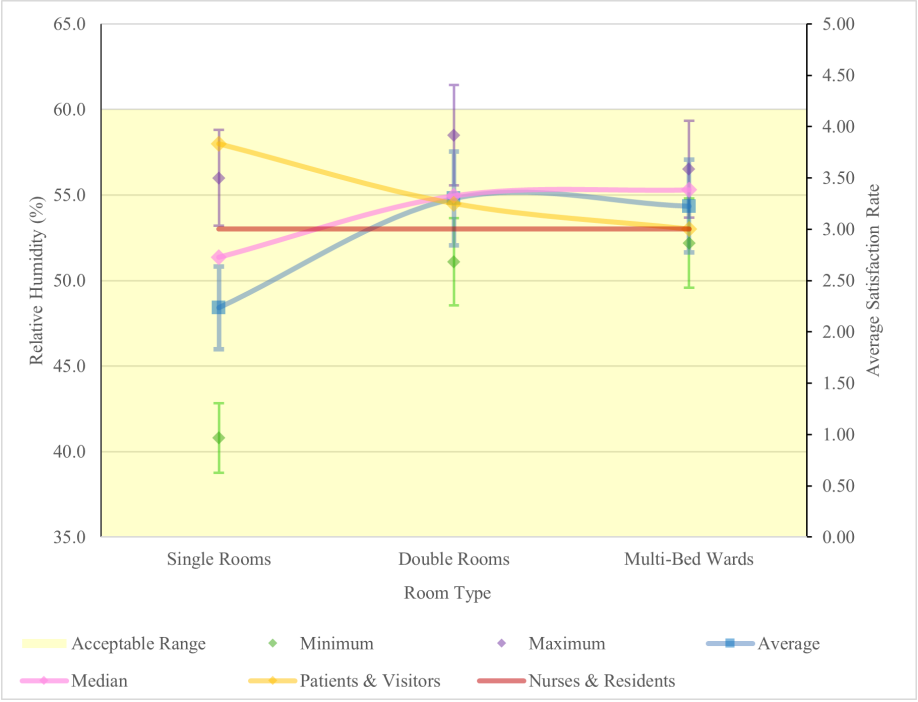


Figure (4). Relative Humidity measurements by room type (Author, 2024).

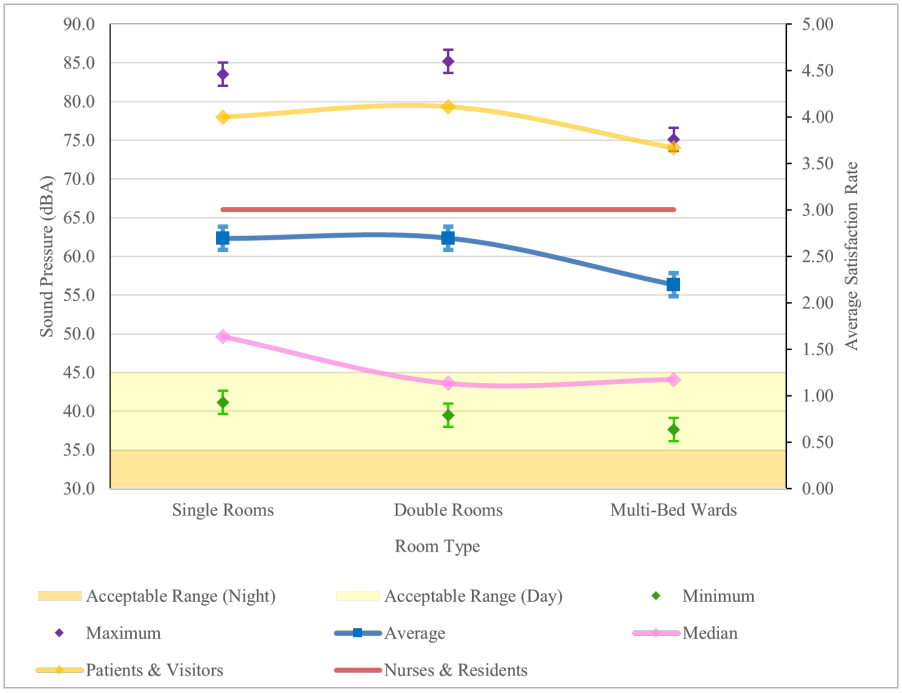


Figure (5). Sound pressure measurements by room type (Author, 2024).

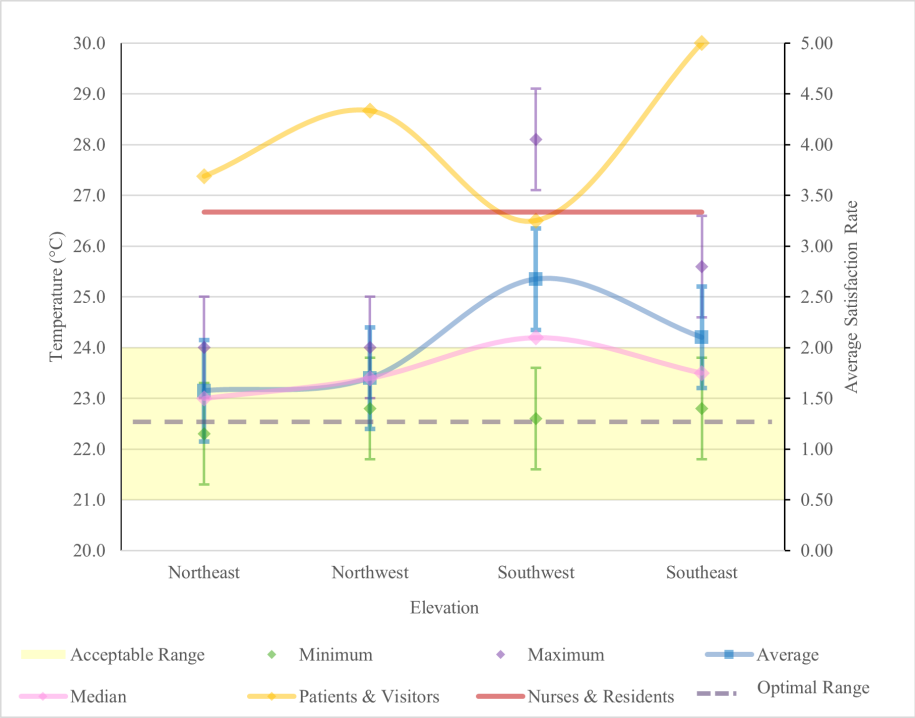


Figure (3).Temperature measurements by elevation (Author, 2024).

4.1.2 Relative Humidity

As for RH's average across all room types is 52.52±5%, whereas the minimum and maximum are 40.80±5% and 58.50±5%, respectively. The CDC (2019) Standards do not list a specific RH range for patient rooms, whereas in most other rooms it lists the acceptable range as 30 – 60%. ASHRAE Standard 170 (2019) also lists the acceptable range as having a maximum of 60% without specifying a minimum. RH levels across all room types fall within the acceptable range without including the error rate (Figure 4).

The subjective assessment of RH considers the stuffiness of air, which is also a factor of IAQ. In the subjective assessment, RH was rated slightly above average by both user parties ($3.0 \leq R < 4$). Like temperature, the users' ratings share an inverse relationship with both the median and average measurements, with smaller rooms receiving higher user ratings due to their lower RH levels.

While temperature levels affect the spreading of bacteria, RH affects the potential for germs and viruses to grow and survive. RH also affects the dryness of the skin, which itself can lead to further problems for all hospital building users (Vijaykrishna & Balaji, 2023).

4.2 Acoustic Comfort

In the case of acoustic comfort, sound pressure was the only IEQ factor assessed. According to the U.S. Environmental Protection Agency (1974, as cited in Nyembwe et al., 2023), the standard for A-weighted sound pressure differs between daytime and nighttime. The daytime maximum is 45 dBA, whereas the nighttime maximum is 35 dBA. According to the measurements, the overall average across all three-room types is 60.33±1.5 dBA, whereas the minimum and maximum are 85.20±1.5 dBA and 37.60±1.5 dBA, respectively (Figure 5).

Across all room types, the averages exceed the standards, while the medians partly fall within acceptable daytime ranges. Surprisingly, rooms with higher recorded measurements received higher ratings by patients and visitors ($3.5 < R < 4.25$), with user satisfaction and average measurement sharing a direct relationship. On the other hand, the median measurement shares an inverse relationship with the user satisfaction ratings.

a shortage of staff members recently in the inpatient department (S. Ekram, Personal Communication, November 18, 2023), with a total of 31 nurses across all three wards, which led to vacating half of the inpatient rooms to accommodate for this shortage. Judging by this, the calculations in Table 6 for occupants are halved, resulting in 78 potential occupants across all three wards.

Taking this shortage of nursing staff into account, in addition to the low probability of having all 78 beds occupied by inpatients during the assessment period, along with the recommended focus group size ranging from 3 to 12 users (Graham & Bryan, 2022), 12 people were initially planned as the targeted group size per user group, for a total of 36 users across all 3 groups. However, during the assessment, the actual group sizes were 12 patients, 9 visitors, 12 nurses, and 3 resident doctors, with the nurses and resident doctors grouped for 15 members.

As part of the focus group, the targeted users were asked to subjectively rate their satisfaction with IEQ factors such as temperature and noise. However, factors such as humidity and air freshness were omitted from the subjective assessment due to the difficulty in subjectively assessing them. The rating questions utilized 0-5 Likert-scale questions, which were used to quantify the subjective answers for comparison with the field measurements. Additionally, more qualitative questions were included to help specify sources of discomfort related to the four IEQ parameters, such as sources of noise, to minimize their impact on the users' comfort through the research.

After conducting the focus groups and collecting the required data, the next step in the subjective assessment phase was analyzing the results to identify the order in which the building users rated the four IEQ parameters from most satisfactory to least satisfactory. This ended the subjective assessment phase.

After analysing both the objective and subjective collected data individually, the next step was to find the correlation between both sets of data. Since qualitative data is not as scientifically accurate and objective as quantitative data, correlating the users' satisfaction rate from the focus groups with the physically measured IEQ factors can result in reaching unbiased judgments when developing the design guidelines this research aims for.

4. Results and Discussion

This section presents the results of each IEQ parameter's field measurements and the focus groups in correlation. Although the inpatient unit is divided into four wings (Figure 2), the results consider the different rooms' types, elevations, and time of day in some cases, rather than the wing they are located in. Key information regarding the field visit can be seen in Figure 2. In the case of patients and visitors, they are always assigned to specific rooms during their stays. Whereas nurses and resident doctors move around different rooms to check on the different patients. For this reason, nurses and resident doctors were considered one user party during the subjective data analysis, and patients and visitors were the second user party. The assessment results are as follows:

4.1 Thermal Comfort

The IEQ factors measured for thermal comfort's objective assessment are temperature and relative humidity (RH), the results of which are as follows:

4.1.1 Temperature

Across all four elevations, the average temperature is 24.03±1°C, whereas the minimum and maximum are 22.30±1°C and 28.10±1°C, respectively. According to the CDC (2019) Standards that the hospital follows, in addition to ASHRAE Standard 170 (2019), the acceptable range for temperature inside patient rooms is 21 to 24 °C. While considering the measurement tool's error rate, the temperature in the northeast and northwest elevations mainly falls within the acceptable range, whereas in the southeast and southwest elevations temperature reaches higher levels (Figure 3).

As for the subjective assessment, except for the northeast elevation, the subjective temperature ratings seem to have an inverse relationship with both the average and median field measurements, with the southwest elevation having the highest recorded measurement and the lowest user rating. Although the rating was relatively positive ($R \geq 3.25$), it was rated more positively by the patients and visitors than by the nurses and resident doctors. Furthermore, some of the users vocally complained that the room temperature was sometimes too cold.

Table (5). Occupied hospital spaces per user group (Author, 2024).

Occupied Spaces / User Groups	Inpatient Rooms	Inpatient Ward Corridors/ Nurse Stations	Nursing Staff Offices/ Break Rooms
Inpatients	✓		
Visitors	✓	✓	
Nursing Staff & Resident Doctors	✓	✓	✓

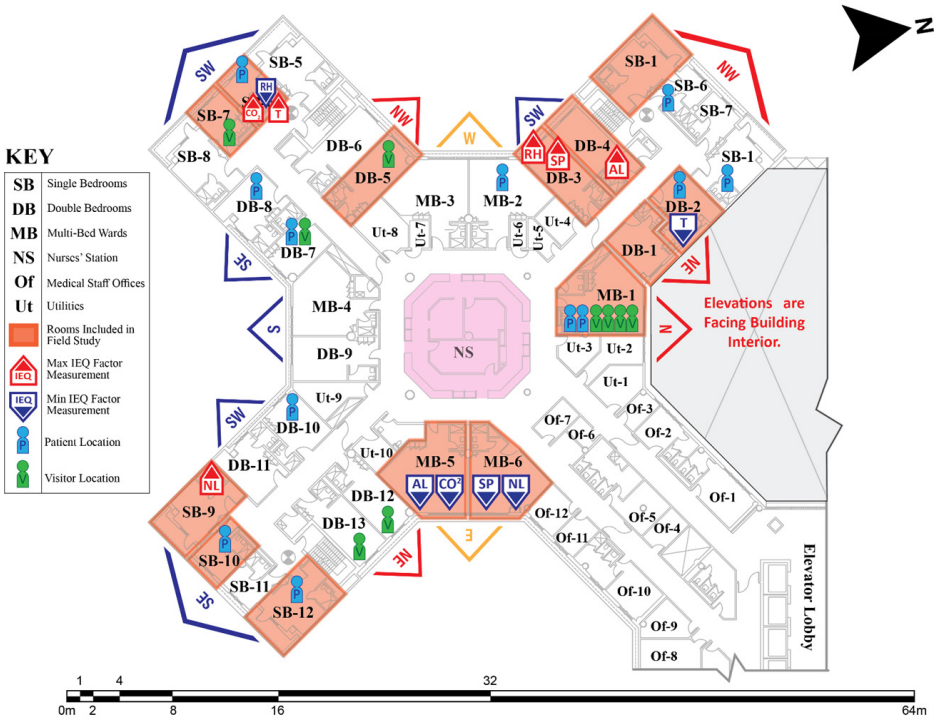


Figure (2).Typical non-intensive ward floor layout with added key information (Author, 2024).
T= Temperature; RH = Relative Humidity; SP = Sound Pressure; NL = Natural Light; AL = Artificial Light

Table (6). Maximum possible inpatient ward occupancy (Author, 2024).

	Room Type			Total per Ward	No. of Wards	Grand Total
	Single Bedroom	Double Bedroom	Multi-bed Ward			
Average Area	21.4 m^2	23.4 m^2	37.5 m^2	-		
No. of Rooms per Ward	12	13	6	31 Rooms	-	-
Public Wards						
No. of Occupants per Room Type	1	2	4	-		-
No. of Occupants Across all Rooms	12	26	24	62 Occupants	2	124 Occupants
Private Ward						
No. of Occupants per Room Type	1	1	1	-		-
No. of Occupants Across all Rooms	12	13	6	31 Occupants	1	31 Occupants

2.1 Objective Assessment

Since each of the four primary IEQ parameters has its factors, the factors most suitable for this research's objective assessment must be determined. In previous studies that share a similar setting (Nimlyat et al., 2015; Wu et al., 2019; Khan et al., 2020; Tang et al., 2020), the following IEQ factors were the most commonly measured ones:

- Temperature and relative humidity under Thermal Comfort
- Sound pressure, under Acoustic Comfort
- CO2 concentration in air, under IAQ
- Natural and artificial illuminance under Visual Comfort

The field measurements for this research targeted the hospital's inpatient wards, specifically the first three floors, since they share the same air-handling unit (H. Jalal, Personal Communication, November 16, 2023). The details of the instruments used to measure the above IEQ factors are listed in Table 3.

The measurements were taken between November 17th and 24th, 2023, at different intervals in multiple rooms between 9 AM and 9 PM, with the data grouped into four equal parts of the day (Table 4).

The short measurement period is due to the hospital's highly controlled environment, which is generally not affected by seasons since it exclusively uses mechanical ventilation. On the other hand, changes that could potentially affect the hospital's environment have been taken into account, such as the elevation a room is facing or the time of day. The measurements were also taken in vacant rooms to minimize thermal and acoustic interference from inside the rooms.

After taking the measurements, the next step was to compare their results with the CDC (2019) standards that the hospital follows, in addition to international standards, to conclude whether they fall within the acceptable range.

2.2 Subjective Assessment

After completing the objective assessment phase, the subjective assessment phase can start. The first step was deciding on the subjective assessment tool, which was chosen as focus groups since they allow for direct conversation with the targeted user groups. The second step was determining the targeted user groups, followed by the spaces covered by the assessment.

The focus groups targeted three inpatient ward user groups due to the time they spend inside the rooms: inpatients, visitors, nursing staff, and resident doctors (as one group). The assessment's targeted spaces were the inpatient rooms since they are the only spaces accessible and most frequented by all three user groups (Table 5).

The targeted number of users per group was determined by assessing the maximum possible occupancy of the inpatient wards. There are three different inpatient wards: two public wards and a private ward. According to the inpatient unit layout (Figure 2), the maximum possible occupancy across all three wards is 155 occupants (Table 6).

It is worth noting, however, that there has been

Table (3). Field measurement instrument specifications (Author, 2024).

IEQ Parameters	IEQ Factors	Measurement Instrument	Measurement Range	Measurement Accuracy
Thermal Comfort	Temperature	Nightingale Air Quality Monitor	0 to 50˚C	±1 ˚C
	Relative Humidity		0 to 99% RH	±5%
IAQ	CO_2 Concentration		400 to 5000 ppm	5% ±50 ppm
Acoustic Comfort	Sound Pressure	Mengshen Digital Sound Meter	30 to 130 dB (A-weighted)	±1.5 dBA
Visual Comfort	Natural Illuminance	Wintact Digital Illuminance Light Meter	0 to 200,000 lx	±3% (below 10,000 lx)
	Artificial Illuminance			

Table (4). Field measurement time of day details (Author, 2024).

Time of Day	Starting Hour	Ending Hour
Morning	9:00 AM	11:59 AM
Early Afternoon	12:00 PM	2:59 PM
Late Afternoon	3:00 PM	5:59 PM
Evening	6:00 PM	9:00 PM

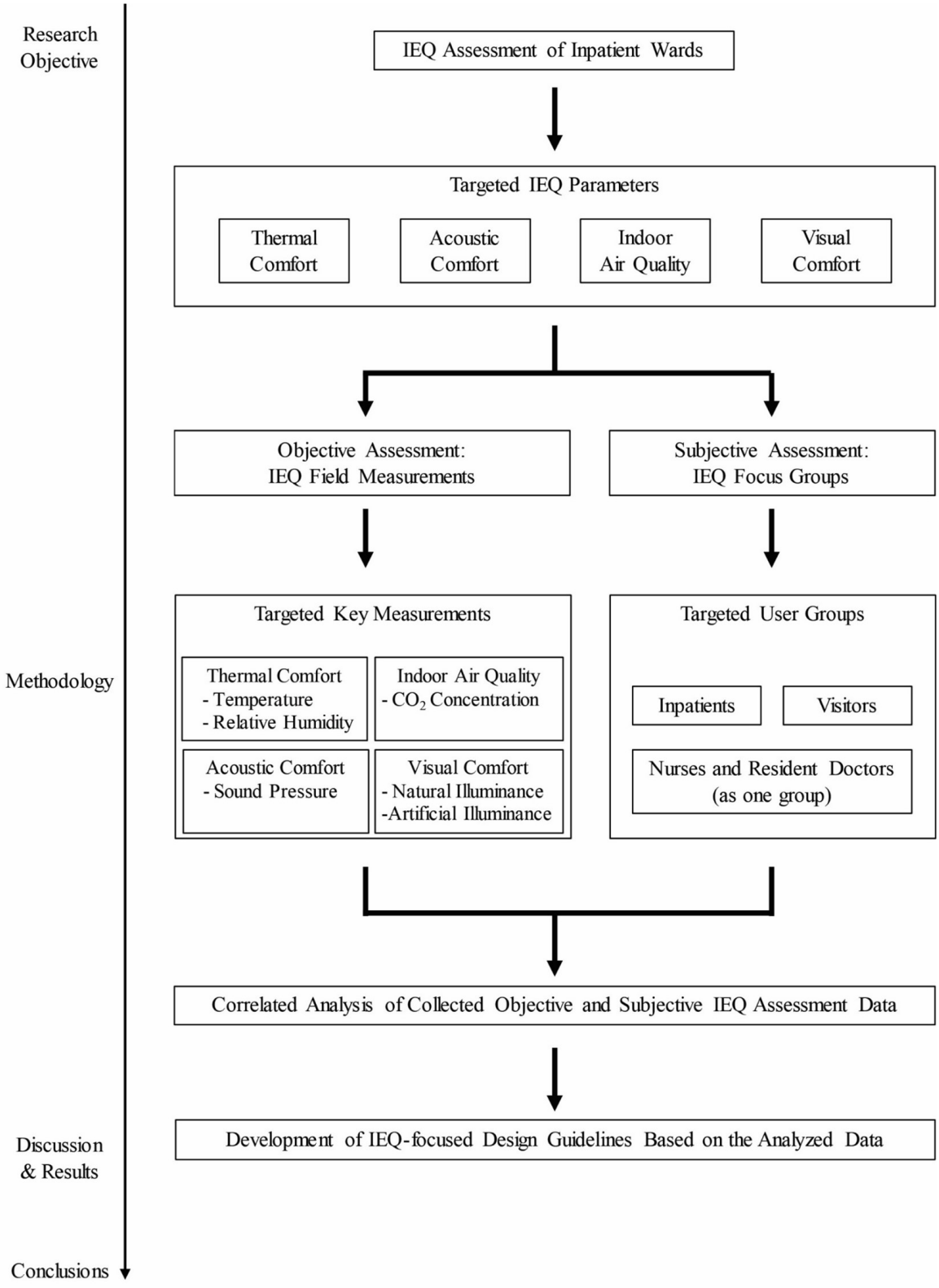


Figure (1). Summary of the research's methodology (Author, 2024).

Table (2). Literature Review (Author, 2024).

Gao and Zhang 2021	Inpatient perceptions of design characteristics related to ward environments' restorative quality	Research on hospital environments indicates that patients' mental and physical wellbeing relates to the restorative quality of inpatient ward environments, which in turn is affected by design. This study utilized surveys targeting inpatients to identify the exact design factors influencing restorative quality in inpatient ward environments.	The results indicate that the most prominent design characteristics that influence the restorative quality of ward environments include nature, artwork, furniture layout, room size, and wall color. These were categorized under four main design dimensions: object, connection, spatiality, and ambiance. Object and connection had the most significant effects on restorative quality.
Budaiwi et al. 2022	IEQ-based space categorization framework: the case of healthcare facilities	A subjective assessment was conducted through interviews and surveys targeting healthcare experts to classify healthcare space types by the importance of certain IEQ parameters in said vicinities. The interviews collected qualitative information, whereas the surveys rated the importance of each IEQ parameter in each space type.	Although the experts rated all IEQ parameters as important in all spaces, certain IEQ factors were revealed to be more significant in some spaces than others. The most critical IEQ parameter influencing healthcare facilities was revealed to be IAQ, as the participants rated it 'Highly Important'.
Nimlyat et al. 2022	The impact of IEQ on patients' health and comfort in Nigeria	Both longitudinal surveys, which target the same people over a long period, and transverse surveys, which target different people in a short period, were targeted toward patients in two hospitals to understand how IEQ affects patient health and satisfaction and to utilize this knowledge in the development of healthier hospital environments. The collected data was then analyzed using structural equation modeling, a statistical tool that analyzes the structural relationship between latent variables, such as happiness, that cannot be directly measured and measured variables. This allowed us to simultaneously investigate the parameters of IEQ and patient health and satisfaction.	The study's results revealed that patients' perceptions of their wards' IEQ affect their overall satisfaction and health outcomes, depending on the IEQ parameter. For example, the thermal and visual environments affected patient satisfaction more than health. However, all four IEQ parameters must be integrated to create a hospital environment that promotes both recovery and satisfaction.
Ismaeil and Sobaih 2022	Enhancing Healing Environment and Sustainable Finishing Materials in Healthcare Buildings	This study attempted to enhance the IEQ of an under-construction public educational hospital building while focusing on sustainability. An assessment framework based on international standards such as LEED was developed as a checklist that focuses on IEQ, energy, and interior design materials. The data for the framework was collected by interviewing green building design experts.	The assessment tool's application to the building produced positive results in all four IEQ parameters, gained high acceptance from stakeholders and decision-makers, and even promoted the building to receive a LEED Gold certification.
Zhang et al. 2023	Ten Questions Concerning Indoor Environmental Quality (IEQ) Models: The Development and Application	This study summarizes IEQ assessment methods and analysis frameworks through a review of the literature between the years 2001 and 2022. It includes 10 questions that cover the most important aspects of IEQ assessment, such as IEQ assessment models and their different applications, IEQ parameters and their relationship with satisfaction, and data collection methods.	To increase the applicability of IEQ assessment methods, a standardized database must be built covering various building types. Answering the 10 questions in this study should help promote IEQ model development and eventually lead to developing a universal IEQ model covering most building types.

3. Methodology

To achieve the research's objectives, the methodology listed below was followed (Figure 1):

This research targeted the inpatient wards of a public hospital in Jeddah, Saudi Arabia. The current hospital building was established in 1996 and houses 1067 beds across all its departments. The hospital is also one of the largest and most frequented public hospitals in Jeddah (H. Jalal, Personal Communication, November 16, 2023), hence its choice as a case study.

Table (2). Literature Review (Author, 2024).

Author/ Year	Title	Methods	Findings
Garnawat et al. 2017	Assessment of indoor environmental quality in Australian healthcare facilities: a review of standards and guidelines	A literature review was conducted on IEQ evaluation studies of healthcare and non-healthcare facilities in Australia, IEQ assessment methods in practice, and Australian guidelines and standards for managing and maintaining IEQ.	Even though Australian healthcare facility guidelines concerned with IEQ focused more on infection control over occupant satisfaction, IEQ assessments were found to include both subjective and objective data collection methods, with no universal standards for either type, as each study would develop its scale to gauge occupant satisfaction, producing different results.
Wu et al. 2019	Interaction between Sound and Thermal Influences on Patient Comfort in the Hospitals of China's Northern Heating Region	This study focuses on the sound–thermal influence on comfort in hospitals. The combined effects of the acoustic and thermal environment were objectively evaluated through field measurements of temperature, humidity, and sound pressure and then subjectively evaluated through surveys.	Both thermal and acoustic influences revealed that they are almost equally influential, meaning that a higher level of thermal comfort results in a higher level of acoustic comfort and vice versa.
Al-Atawi 2020	Efficiency evaluation of public hospitals in Saudi Arabia: an application of data envelopment analysis	A data envelopment analysis, which estimates the efficiency of comparative samples that use similar inputs to produce similar outputs, referred to as decision-making units, was utilized to gauge the technical efficiency of public hospitals in Saudi Arabia. The input used for the analysis includes the quantities of variables such as hospital beds, and full-time physicians and nurses. The output variables include yearly quantities such as outpatient visits, discharged inpatients, and surgical operations.	The study's findings indicate that 75.8% of public hospitals are considered inefficient in their performance, with small hospitals being relatively more efficient than medium-sized hospitals. The analysis also reveals that the major causes of inefficiency are the overabundance of health workers compared to the shortage of health services, indicating that a reallocation of health workers should occur to increase their efficiency.
Hassanain et al. 2020	Quality assessment of a campus medical facility: a users' perspective approach	Surveys, walkthroughs, and focus groups were conducted to assess the quality of the medical facility based on a set of quality indicators, which focused on: All four IEQ parameters, space planning and layout Building site, safety, support facilities, operation and maintenance.	The study revealed three key design issues: Accessibility from the outside and wayfinding from the inside, colder temperatures at night, and old furniture in need of renewal. The focus groups were revealed to be an effective way to enhance the quality and usability of the medical facility from a user-centric point of view.
Khan et al. 2020	Thermal Comfort and Ventilation Conditions in Healthcare Facilities - Part 1: An Assessment of IEQ	In this study, RH, temperature, and CO2 were measured using physical measurement instruments at specific hospital locations based on three parameters: Occupancy, HVAC systems, and current comfort conditions. The selected locations are emergency rooms, operation theaters, intensive care units, and medical wards	The results reveal that IEQ in naturally ventilated areas appears to be closer to standard levels during nighttime, however, it is still affected by occupancy level. On the contrary, areas with central air conditioning have the same level of controlled IEQ, and areas with split air conditioning perform better in standardizing concentrations of CO2. Thus, the authors recommend designing healthcare facilities' HVAC systems based on the maximum possible occupancy, to avoid uncomfortable conditions.
Tang et al. 2020	Post-occupancy evaluation of indoor environmental quality in ten nonresidential buildings in Chongqing, China	The study utilized surveys and physical measurements to evaluate all four IEQ parameters in four types of nonresidential buildings in the Chongqing region of China: hospitals, schools, office buildings, and shopping malls.	Glare from artificial lighting was the most repeated complaint across all building types. Furthermore, a strong relationship was identified between CO2 concentration and IAQ satisfaction. For hospitals, the findings indicate relatively higher IEQ satisfaction rates in all parameters except for acoustic comfort.
Al-Ghamdi 2021	Experience Design Modelling of the Relationship between Patient Recovery and Hospital Design in the Kingdom of Saudi Arabia	This study focused on developing a hospital design framework that promotes the safety and recovery of public hospital patients in Saudi Arabia. To achieve this goal, case studies, surveys, interviews, and building user observations were employed to collect data on local design processes, adverse incidents caused by design defects in hospitals, and how these incidents affect patient health and recovery.	The results indicate that most of the issues in local hospital design and operation occur during the early design stages, caused by the design teams' lack of experience and the lack of local data and guidelines for hospital design. The developed framework was based on principles that focus on improving local hospital design processes: prioritizing patient health and recovery through design, implementing multi-stage design processes to ensure quality, and evaluating newly built hospitals using the same framework to measure their success.

1.3 Problem Statement

As of 2023, 69.94% of healthcare facilities in Saudi Arabia are part of the public sector, 52.44% of which are accredited by CBAHI (Ministry of Health, 2024). However, CBAHI's (2015) healthcare standards lack IEQ-focused design guidelines that ensure adequate levels of IEQ. Although the Facility Guidelines Institute (2024) and National Health Service (Department of Health, 2014) provide IEQ-focused design guidelines in the US and UK, respectively, their only equivalent in Saudi Arabia is CBAHI, which provides standards for healthcare services instead of IEQ-focused design guidelines for hospital spaces, indicating that there is still a lack of focus on IEQ in healthcare facility design in Saudi Arabia.

1.4 Research Objectives and Methods

Previous data suggests that the built environment of hospitals can affect the health and recovery of patients, which is especially impactful for patients spending multiple days inside inpatient rooms (Gao and Zhang, 2021). Furthermore, in an environment as sensitive as inpatient wards, a high level of IEQ is crucial to providing users with a comfortable experience that promotes their recovery (Nimlyat et al., 2022). Therefore, thisthis study aims to develop IEQ-focused design guidelines that can be integrated with CBAHI's (2015) existing standards to create comprehensive local hospital guidelines covering both design and performance. To achieve this goal, the following objectives must first be accomplished (Table 1).

After accomplishing the above objectives, a correlated analysis of both the objective and subjective assessments was conducted, based on which the development of the IEQ-focused guidelines was made possible.

2. Literature Review

This literature review targeted cases published between 2017 and 2023, both locally and internationally, in which IEQ is assessed either objectively, subjectively, or both ways. It also covered topics that study IEQ as a concept, such as studies that developed models and assessment tools that help identify factors affecting IEQ (Table 2).

Research on the effects of the built environment on users' health dates back a few decades, and although there is an abundance of IEQ assessments in hospital buildings both locally and internationally, most of these assessments simply presented their data without building guidelines based on the results. Additionally, local literature and guidelines regarding hospital design in Saudi Arabia are still lacking, specifically in ways that ensure higher levels of IEQ. Therefore, this study aims to fill this gap by developing design guidelines focusing on increasing the level of IEQ in inpatient wards to provide the occupants with a more comfortable and satisfactory experience.

Table (1). Research objectives and their respective methods (Author, 2024).

Objective	Method
1. Objective IEQ Assessment of a public hospital's inpatient wards.	1. Field measurements of various IEQ factors via physical measurement instruments.
2. Identifying the IEQ parameters that fall short of standards.	2. Comparing measured IEQ factors with international standards.
3. Subjective IEQ Assessment of a public hospital's inpatient wards.	3. Conducting focus groups targeting three types of inpatient ward users: (a) Inpatients, (b) visitors, (c) nursing staff and resident doctors (as one group).
4. Identifying the least satisfactory IEQ parameters from the users' point of view.	4. Analysis of the focus groups' data.

1.1.1 Thermal Comfort

Thermal comfort is the thermal adaptation of building users to their surrounding environment, which depends on variables such as location, climate, and season (Quang et al., 2014, as cited in Al Horr et al., 2016). Thermal comfort is affected by environmental factors such as air temperature, relative humidity, and personal factors such as metabolic rate and clothing insulation (ASHRAE, 2010, as cited in Katafygiotou and Serghides, 2015).

1.1.2 Acoustic Comfort

Acoustic comfort refers to protecting a building's users from loud noises (Greek Legislation, 1989, as cited in Al Horr et al., 2016). Patients in spaces as sensitive as hospitals are considered more vulnerable to loud noises than healthy users such as staff members and visitors (Gabor et al., 2003; Loupa, 2020, as cited in Secchi et al., 2022).

1.1.3 Indoor Air Quality (IAQ)

The U.S. Environmental Protection Agency (2022) defines IAQ as the air quality inside and around buildings correlated with users' health and comfort. IAQ is also concerned with infection and air pollution control. Factors affecting IAQ include outdoor air, indoor occupant density, and HVAC system types and practices (Fonseca et al., 2022; U.S. Environmental Protection Agency, 2022).

1.1.4 Visual Comfort

The European standard EN 12665 (2011, as cited in Carlucci et al., 2015) defines visual comfort as "a subjective condition of visual well-being induced by the visual environment". Visual comfort is affected by several factors correlating with human needs, such as the amount of light, the uniformity of light, and the risk of glare for the building's users (Carlucci et al., 2015).

1.2 IEQ International and Local Standards

Even though some standards for health and safety in buildings are specific to certain countries, most standards are international, such as the various collaborations between ASHRAE (American Society of Heating, Refrigerating and Air-Conditioning Engineers, n.d.) and ANSI (American National Standards Institute, 2023). Even though both mentioned entities are US-based, they provide standards used globally, including Saudi Arabia (ASHRAE, 2021).

1.2.1 International Standards

These standards cover various topics but rarely provide users with architectural design guidance. For example, ANSI and ASHRAE's Standard 55 'Thermal Environmental Conditions for Human Occupancy' (2023), focuses mainly on thermal comfort and provides information such as acceptable temperature ranges for building occupants.

Some cases include detailed design guidance, such as the US Department of Veterans Affairs 'Inpatient Unit Design Guide' (2011). This guide, alongside design standards, lists important factors related to patients' physical and mental health. Most of these factors are associated with the main parameters of IEQ, such as potential stress caused by loud noises and inadequate lighting.

1.2.2 Local Standards

Local standards are limited in comparison, with local researchers resorting to international standards when conducting quality assessment studies, such as the IAQ-focused ASHRAE Standard 62-2004 (as cited in Budaiwi et al., 2022), the thermal environment-focused ISO (International Organization for Standardization) 7730 Standard (1994, as cited in Al-Sualihi et al., 2015), and the WHO (World Health Organization) Guidelines for IAQ (2010, as mentioned in Saleem et al., 2020), all of which do not provide architectural design guidelines and simply list their standards for higher levels of IEQ.

The public hospital targeted by this research utilizes both international and local standards. The international standards are the CDC (Centers for Disease Control and Prevention, 2019) 'Guidelines for Environmental Infection Control in Healthcare Facilities', which mainly focus on thermal comfort and IAQ. On the other hand, the local standards used are the CBAHI (Saudi Central Board for Accreditation of Healthcare Institutions, 2015) National Hospital Standards which focus on safety and the quality of the provided services in the hospital, much more so than IEQ from an architectural viewpoint.

Journal of Architecture and Planning , Vol. 36 (4) , pp. 445-466, Riyadh (2024/1446H)

doi:10.33948/JAP-KSU-36-4-3

Indoor Environmental Quality Assessment of Inpatient Wards, Case Study: Public Hospital in Jeddah, Saudi Arabia

Hussain Osama Al-Mansouri **Jamil Farid Hijazi**

Department of Architecture, College of Architecture and Planning, King Abdulaziz University, Jeddah, Saudi Arabia

hhussainalmansouri@stu.kau.edu.sa *jhijazi@kau.edu.sa.*

(Received 23/5/2024; accepted for publication 13/10/2024.)

Abstract: Indoor environmental quality (IEQ) is more crucial in hospitals than other building types due to its effects on the recovery of patients. In Saudi Arabia, there is a lack of hospital design guidelines prioritizing IEQ, making it difficult to design spaces that provide adequate levels of comfort. In this study, objective and subjective assessments utilizing field measurements and focus groups were conducted on inpatient wards in a public hospital in Jeddah, Saudi Arabia, to develop IEQ-focused design guidelines that provide users with more comfort and satisfaction. The objective assessment targeted the four main parameters of IEQ: thermal, acoustical, visual comfort, and indoor air quality. The subjective assessment targeted the same four parameters by gauging the satisfaction level of three hospital user groups: patients, visitors, in addition to nurses and resident doctors as one group. A correlated analysis between both assessments revealed that Thermal Comfort and Indoor Air Quality were closest to acceptability, whereas Visual and Acoustic Comfort were less satisfactory. A set of categorized IEQ-focused design guidelines was then developed based on the IEQ-related design issues concluded from the analysis

Keywords:Indoor Environmental Quality; Thermal Comfort; Acoustic Comfort; Visual Comfort; Indoor Air Quality; Inpatient Wards.

1. Introduction

It is human nature to adapt to the surrounding environment to survive. Since humans are constantly surrounded by an environment (Parsons, 2013), it is also in their nature to make the environment as safe and as comfortable as possible (Florides et al., 2002, as cited in Almeida et al., 2015). Over time, humans eventually started spending most of their time indoors, ultimately affecting their health and comfort depending on the quality of the indoor environment (Wargocki, 2009, as cited in Almeida et al., 2015).

1.1 Indoor Environmental Quality (IEQ)

Although IEQ is considered a broad concept, the National Institute for Occupational Safety and Health (2013, as cited in Awada et al., 2021) defines it as "the quality of a building's environment in relation to the health and well-being of those who occupy space within it." IEQ is affected by several factors which can be categorized under four main parameters (Franchimon et al., 2009; Alfano et al., 2010, as cited in Almeida et al., 2015), as follows:

doi:10.33948/JAP-KSU-36-4-2

تطبيق مبادئ المرونة في تصميم المساكن السعودية: مشروع تاغ فيلا في المملكة العربية السعودية

مرام المراد **محمد شينير** **سوناي آييلدز**

كلية الهندسة المعمارية والتصميم، جامعة كوجالي، كوجالي، تركيا.

Ma.almurad@gmail.com *mehmet.sener@kocaeli.edu.tr* *sonayayyildiz@gmail.com*

قدم للنشر في ١٧/ ٢/ ١٤٤٦ هـ؛ وقبل للنشر في ٢٦/ ٣/ ١٤٤٦ هـ.

ملخص البحث. تهدف هذه الدراسة إلى تقييم تطبيق التصميم المرن في مشروع تاغ فيلا (٢٠٢٢)، وهو مشروع معاصر يسعى إلى تحقيق تصميم مرن، مع الأخذ في الحسبان البنية الاجتماعية والثقافية للمجتمع السعودي. بعد أن فقدت المساكن في المملكة العربية السعودية مفهوم المرونة الذي كان موجوداً في العمارة التقليدية مع إدخال الأنماط المعمارية الأجنبية، نُفِّذت عدة مشاريع تهدف إلى استعادة هذا المفهوم. في هذه الدراسة يتم فحص ممارسات التصميم المرن المطبقة في مشروع تاغ فيلا ومستويات تحقيقها، وفقاً لتصنيف المرونة الذي وضعه المعماري السعودي رائد محمد الدخيل، مع مراعاة القيم الاجتماعية والثقافية للمملكة العربية السعودية. تركِّز الدراسة على تحديد مدى تكييف الجوانب المرنة للتصميم التقليدي للمساكن السعودية مع التصاميم السكنية المعاصرة، وتقييم الجوانب الإرشادية للقيم الاجتماعية والثقافية للمجتمع السعودي؛ لتحقيق التصميم المرن. بناءً على ذلك حُلِّلت الرسوم المعمارية لمشروع تاغ فيلا، وأُجريت مقابلة مع المهندس المعماري الذي صمم المشروع. تشير نتائج الدراسة إلى أن الأساليب التي نُفِّذت في هذا المشروع لتحقيق المرونة تحتوي على كثير من الجوانب الإرشادية التي يمكن أن تفيد دراسات أخرى تسعى لتحقيق المرونة مع مراعاة القيم الاجتماعية والثقافية.

الكلمات المفتاحية: القدرة على التكيف، المساكن المرنة، أنواع المرونة، القيم الاجتماعية والثقافية، مخطط الطابق المفتوح، مشروع تاغ فيلا.

and Satisfaction with Apartment Dwellings: A Case Study of Al-Mather Housing Project, Riyadh, Saudi Arabia." Dirasat Journal, 29 (2), 109-125. (2002).

Estaji, H. "A Review of Flexibility and Adaptability in Housing Design". International Journal of Contemporary Architecture "The New ARCH", 4(2), 37–49. (2017).

Facey, W. Back to Earth: Adobe Building in Saudi Arabia. 2nd ed. Riyadh: Al-Turath; 1997.

Feizbahr, M. and Pourzanjani, P. "The Evolution of Architectural Styles: From Modernism to Postmodernism". JRSE. Journal of Review in Science and Engineering, 2023, 1-12. (2023).

Forty, A. Words and Buildings: A Vocabulary of Modern Architecture. London: Thames & Hudson; 2000.

Gardini, A. "The Reception of Futurist Architecture after the Second World War". International Yearbook of Futurism Studies, 8, 129-149. (2018).

Giddings, B., Almehrej, M. and Cresciani, M. "The Dilemma of Saudi Arabian Homes in Riyadh". Space and Culture, 26(1), 4-22. (2020).

Gilani, Türker Ö.O. "Assessing Flexibility in Real Estate Mass Housing". Arquitetura Revista, 16(1),154-175. (2020).

Higgins, I. Spatial Strategies for Interior Design. London: Laurence King Publishing; 2015.

Kızmaz, K.C. ve Çimşit Koş, F. "Esneklik Kavraminda Kullanici Katiliminin Önemi Ve Güncel Yaklaşimlar". Beykent Üniversitesi Fen Ve Mühendislik Bilimleri Dergisi, 8(2), 111 – 142. (2015).

Lans, D.W. and Hofland, C.M. "Flexibility, How to Accommodate Unknown Future Housing Requirements." Paper presented at XXXIII IAHS World Congress on Housing Transforming Housing Environments through Design, (p.4). (2005).

M. Al-Dakheel, R. "The Role of Flexibility in Sustainable Prototype Unit Design: Riyadh Commercial Housing Developments, RCHD, Case Study". JES. Journal of Engineering Sciences, 35(2), 545-567. (2007).

Mairs, J. 2016. "First Yo! Home Scheme to Compact Houses into Small Apartments." [online] Dezeen. Available at: https://www.dezeen.com/2016/07/12/yo-home-sushi-yotel-simon-woodroffe glenn-howells-architects-manchester-england-uk/ [Accessed 12 Jun. 2023]

Oliver, P. Dwellings: The vernacular house worldwide. London: Phaidon Press; 2003.

Rapoport, A. Culture, Architecture, and Design. Chicago: Locke Science Publishing Company, Inc.; 2005.

Risselada, M. Raumplan versus Plan Libre: Adolf Loos and Le Corbusier, 1919-1930. New York: Rizzoil International Publication;1988.

Schneider, T. and Till, J. "Flexible housing: The means to the end". arq: Architectural Research Quarterly, 9, 287-296. (2005a).

Schneider, T. and Till, J. "Flexible housing: opportunities and limits". arq: Architectural Research Quarterly, 9(2), 157-166. (2005b).

Schneider, T. and Till, J. Flexible Housing. New York: Elsevier, Oxford.; 2007.

Talib, K. Shelter in Saudi Arabia. New York: Martin's Press; 1984.

Despite these limitations, TAG Villa is a notable example of the functional, structural, and cultural flexibility needed in 21st-century Saudi housing, especially compared to the ARAMCO-proposed designs. The analysis of Table 4 reveals the fact that the flexibility criteria of Al-Dakheel are achieved to a great extent in TAG villa design; however, specific criteria such as ability to separate and personalize units and extendibility couldn't be executed in the project of the building. The failure to achieve all the criteria is the differences between the demands of the users and project preparation-construction conditions of TAG villa and the specific requirements of some flexibility criteria. Considering the characteristics of architectural design and each different project's necessities accordingly, the inability to realize all flexibility criteria in one specific project may architecturally be acceptable. Another fundamental point that this study shows us is that the design components of traditional Saudi housing embody the principles of flexible design and have practically adaptable sides to contemporary housing designs aiming to achieve flexibility. So, it is also observed that the analysis of the historical background and socio-cultural values of societies that shaped their architectural production can be instructive for contemporary searches aiming to achieve flexible housing design. In this respect, TAG villa can be expressed as one positive step of providing flexibility in Saudi Arabia houses together with some of its deficiencies that can be instructive for the following studies related with flexible housing design. Future research endeavors should explore flexibility in Saudi housing across diverse regions and consider the evolving role of technology in shaping these architectural paradigms.

Acknowledgments

We would like to express our gratitude to Architect Mansour Al Farhan and his firm, ANOS Consulting Office, for their cooperation in providing the necessary information, which has greatly contributed to bolstering the credibility of our research.

8. References

Arabic references:

Bahammam, A. "An Affordable Single-family House Fits Saudis Households' Needs: A Designing Experience". Journal of Architecture and Planning, 31(2), 256-273. (2019).

Tannous, W., Mehanna, Z. and Fakoush, A. "Design Flexibility as one of The Most Important Standards for Economic Housing". Damascus University Journal of Engineering Sciences, 29 (1), 619-638. (2013).

English references:

Al-Hathloul, S. "The Arab-Muslim city: traditional, continuity and change in the physical environment." [PhD Dissertation] Massachusetts Institute of Technology. (1981).

Al-Hemaidi, W. "The metamorphosis of the urban fabric in an Arab-Muslim city: Riyadh, Saudi Arabia". Journal of Housing and Built Environment, 16, 179-201. (2001).

Almehrej, M. "A Design Guide for Contemporary Saudi Arabian Homes in Riyadh." [PhD Dissertation] Northumbria University. (2015).

Al-Said, F. A. M. "Territorial Behavior and the Built Environment: The case of Arab Muslim Towns." [PhD Dissertation] University of Glasgow-UK. (1992).

ANOS. (n.d.). "TAG Villa." [online]. Available at: https://anos.com.sa/tagvilla [Accessed 30 Sep. 2023]

Architecture, H. 2019. "Sky House - Hidden Architecture." [online] Hidden Architecture. Available at: https://hiddenarchitecture.net/sky-house/ [Accessed 12 Jun. 2023].

Babsail, M. O. and Al-Qawasmi, J. "Vernacular Architecture in Saudi Arabia: Revival of Displaced Traditions." In Vernacular Architecture: Towards a Sustainable Future. London: Taylor and Francis –Balkema. 99-104; 2015.

Bahammam, A. "Factors which influence the size of the contemporary dwelling: Riyadh, Saudi Arabia." Habitat International, 22(4), 557–570. (1998).

Bahammam, A. "Saudi Households' Experience

were employed. Structurally, the capacity to expand as families grow was prioritized. Culturally, the inward-looking shelters and commitment to societal privacy norms, alongside the use of local materials and techniques, underscore the identity and local character of these traditional dwellings. In TAG villa, several aspects demonstrate how flexibility can be achieved within the framework of Islamic culture. The reintroduction of the inward-looking facade, a feature of traditional Islamic houses, effectively enhances both interior and exterior privacy, facilitating the creation of outdoor private spaces such as courtyards and terraces for family interaction. The incorporation of solid fences on balconies ensures practical utilization by occupants rather than just decorative elements, as often seen in modern Saudi Arabian villas, where such spaces usually remain unused. The manipulation of building massing in the TAG villa provides privacy and shaded areas. Additionally, unlike the typically rectangular or square layout of ARAMCO designs, the L-shaped layout of the TAG villa promotes segregation between guest and family zones without wasting indoor or outdoor space. Accordingly, it should be stated that these flexible sides of Saudi Arabian architecture may give new points of view to modern architecture in terms of housing design while also being adaptable to contemporary architecture, as expressed in this study. Besides, this analysis on TAG villa project practically demonstrates that some aspects of vernacular Islamic architecture may overlap with the principles of contemporary modern architecture after some minor revisions that will be made during the design process.

By considering and adapting some of these aspects of flexible design that has already existed in traditional Saudi housing, Al Farhan implements an open, free layout in TAG Villa while maintaining privacy as a crucial adaptation for Saudi households. The introduced flexibility during usage, such as convertibility and versatility, enhances space efficiency, allowing users to make changes within a reasonable budget. In terms of cultural flexibility, while interior and exterior privacy are well-addressed for the benefit of the household, end-users have limited ability to personalize dwellings since the façade was completely finished. On the other hand, constraints also exist in TAG Villa, as vertical or horizontal expansion is restricted due to pre-existing spaces on the roof and front yard. Moreover, the 210m2 lot size prohibits subdividing units for rental purposes, aligning closely with the needs of Saudi families. The following table demonstrates the realized, partially realized and unrealized items of flexibility criteria (cultural, functional, and structural) of Al-Dakheel in TAG Villa project (Table 4).

Table (4). The assessment of flexibility criteria of Al-Dakheel in TAG Villa project.

Flexibility Criteria		**Assessment**	**Justifications/Reasons**
Functional Flexibility	Versatility	Partially Realized	To minimize the budget required for structural modifications.
	Convertibility	Realized	Enhancing the overall functionality and efficiency of the design without structural modifications
	Ability to separate unit into two units	Unrealized	Small lot size (210m²) restricts unit separation.
Structural Flexibility	Extendibility	Unrealized	Pre-existing roof and yard spaces prevent further expansion.
	Standardized Modularization	Realized	Alleviating structural obstacles for future modifications
	Open plan free structural system	Realized	Alleviating structural obstacles for future modifications
Cultural Flexibility	Ability to personalize unit	Partially Realized	Pre-finished facade limits user personalization opportunities.
	Ability to improve exterior privacy	Realized	Inward-looking façade enhances both interior and exterior privacy.
	Ability to improve interior privacy	Realized	Inward-looking façade enhances both interior and exterior privacy.

bedroom balconies, the architect extended the wall to a height of 2m, creating an open sky space while respecting family privacy (Figure 15).

The fence of the terrace is designed with an appropriate height, assuring privacy. In addition, to provide shading, a trellis on the roof terrace has been erected, and the sharp edge of the wall in the children's play area also serves as a shading element (Figure 16a and 16b).

Figure (15). A view of the master room balcony with 2 m high wall (Photo: by authors).

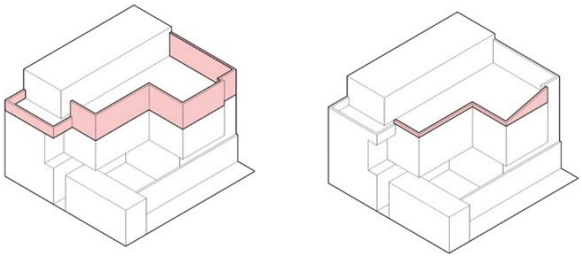


Figure (16a). Terrace fence design (ANOS, n.d.).

Figure (16b). A view of the terrace with roof trellis (Photo: by authors).

6.1.5 Ability to personalize unit

The selection of façade materials for TAG Villa prioritizes simplicity and colors that smoothly blend with the surrounding buildings, nurturing a sense of belonging and upholding the overall harmony of the street (Mansour Al Farhan, pers. comm., December 27, 2023) (Figure 17). As mentioned before, most of the buildings in Saudi Arabia are colored with the colors of local traditional materials such as sand, stone or mud. TAG Villa's exteriors incorporate a blend of paint and stone finishes, contributing to its contextual integration within the neighborhood. In terms of exterior privacy considerations, the façades of TAG Villa exhibit a deliberate minimization of openings, a departure from the more outward-looking design seen in structures influenced by ARAMCO. The architect emphasizes the potential for alterations to the façade based on individual preferences; however, such modifications are cautioned against preserving the cohesive aesthetic of the street. Thus, the user's ability to display their personal identity on the dwelling is somehow very low. However, the architect's thoughtful approach to façade design reflects an awareness of local architectural norms while providing residents with a culturally rooted and aesthetically satisfying residence.

Figure (17). Outside view of TAG Villa Unit 3 (Type D) from the street (Photo: by authors)

7. Conclusion

As partly realized in this study, the examination of traditional Saudi housing reveals the fact that its architectural design characteristics that have developed from past to present includes functional, cultural, and structural flexibility. Functionally, in many examples of vernacular Saudi houses; it is observed that multifunctional spaces, convertible space functions, and lightweight building elements

Figure (13a). Unit 3 (Type D): Roof floor plan (ANOS, n.d.).

Figure (13b). Unit 3 (Type D): First floor plan (ANOS, n.d.).

each other with minor structural modifications, involving the removal of a part of the wall, thereby achieving versatility (Figure 13b). Additionally, in the roof, the neutral room, including the bathroom, can be walled off, further illustrating versatility; by incorporating a door, a fourth bedroom with its own bathroom can be established (Figure 13a).

6.1.4 Interior and Exterior Privacy

On the ground floor, sliding doors between the family and casual zones enhance interior privacy, with separate entrances for each area if one of them is used for guests (Mansour Al Farhan, pers. comm., December 27, 2023). The kitchen, if separated, also has its own entrance from the courtyard. Additionally, the privacy of the semi-private zone (inner courtyard) is assured by adding an external entrance for the driver's room from the street (Figure 14a). Moreover, private zones such as sleeping rooms are secluded on the first floor. For exterior privacy, minimizing outward-facing windows and incorporating solid wall-parapets for balconies and terrace define the relationship with immediate neighbors. In TAG Villa, external windows and doors are crafted from reflective black glass material, ensuring occupants can see outside without being observed from the exterior. All openings are inward-oriented, preventing views into adjacent neighbors' spaces. The courtyard is overlooked by the ground floor, allowing natural light to penetrate without compromising household privacy, as well as in the roof (Figure 14b). Furthermore, instead of erecting a railing on

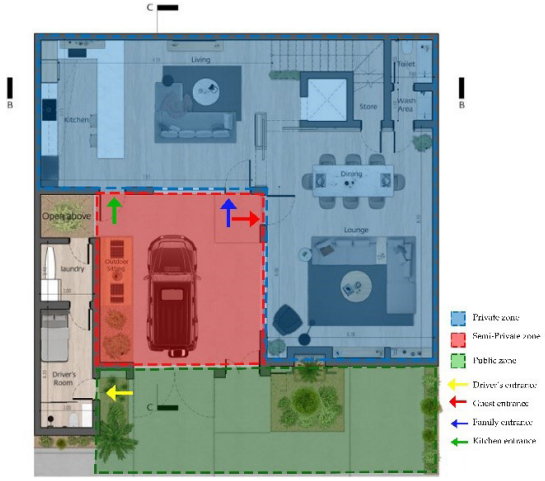


Figure (14a). The relation between zones with villa's entrances (ANOS, n.d.).

Figure (14b). Ground floor openings overlooking courtyard space (Photo: by authors).

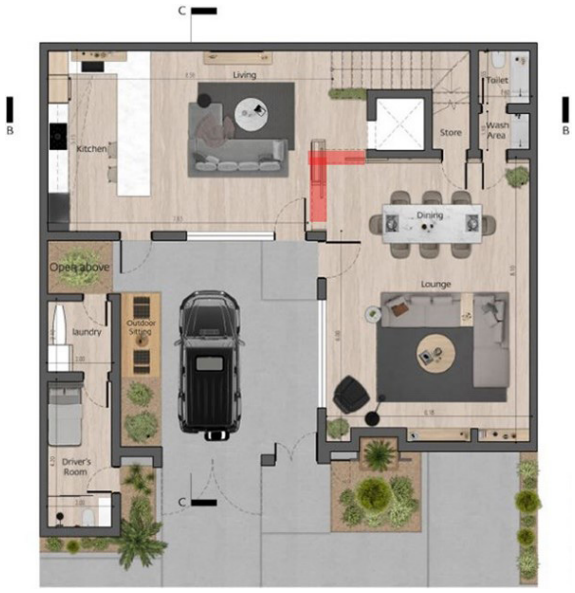


Figure (11a). Unit3 (Type D): Ground floor plan (ANOS, n.d.).

Figure (11b). Interior view of the relation between two zones provided by sliding doors (Photo: by authors).

close off the kitchen and repurpose it as a dirty kitchen. Another resident opted to position the dining room near the kitchen, enlarging the other zone for guest reception or family living area, while yet another homeowner followed the designer's recommendations" (Mansour Al Farhan, pers. comm., December 27, 2023). This high level of convertibility without structural modifications accommodates different user profiles and needs. Contrary to the regulations imposed by ARAMCO, which mandated setbacks on all sides, the developed setbacks system for detached and semi-detached villas optimizes outdoor space for the benefit of the household. Consequently, the outdoor space is designed as a courtyard instead of narrow setback areas, taking a square shape. This courtyard serves various purposes, such as an interior parking space, a family area for different activities, or a safe outdoor space for children to play (Mansour Al Farhan, pers. comm., December 27, 2023) (Figure 11a). Additionally, it includes a room for the driver (Figure 11a). For more functional use, the architect proposed pulling back the front setback by 2m due to the narrow street, with widths of 10m in the east elevation and 12m in the west elevation. This adjustment allows for parking outside the home rather than in the courtyard, facilitating car movement and enabling the multi-use of the courtyard (Figure 12).

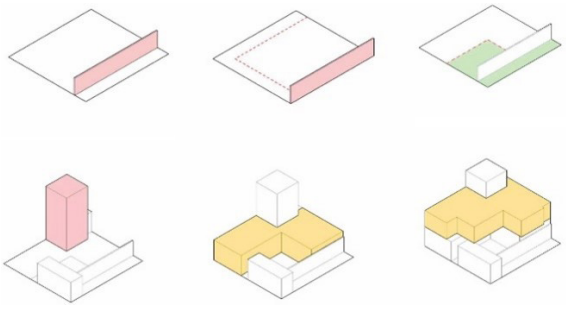


Figure (12). The design process of the setback, courtyard and ground floor (ANOS, n.d.)

According to Al-Dakheel, the convertibility measure is also defined as the ability to convert space from one function to another. Accordingly, the provision of a neutral room in the roof of TAG villa increases the design's convertibility. The roof encompasses two designated zones-one for the maid's room behind the stair and the other neutral one determined by the user, serving as a gym, office or bedroom (Figure 13a). Additionally, the rooftop floor features a multifunctional open-plan terrace, including areas for children's play, outdoor dining, BBQ, and seating as proposed by the architect (Figure 13a), establishing a multi-use space for family activities. Furthermore, bedrooms are designed as multifunctional spaces, serving not only for sleeping but also for working, dressing and sitting; two of them enclose a balcony.

6.1.3 Versatility

As noted by Mansour Al Farhan (pers. comm., December 27, 2023), on the ground floor, the kitchen can be closed off by installing an interior partition (gypsum board or glass) if desired. On the upper floor, the master room and the adjacent room (if used as a baby room) can be opened to

6.1 TAG Villa Design in Terms of Structural, Functional and Cultural Flexibility

The flexible design practices applied in TAG Villa project is examined according to Al-Dakheel's classification of flexibility in this article that are stated under five headings:

- Open plan free structural system (a structural flexibility measure)
- Convertibility (a functional flexibility measure)
- Versatility (a functional flexibility measure)
- Exterior and interior privacy (a cultural flexibility measure)
- Ability to personalize unit (a cultural flexibility measure) (Al-Dakheel, 2007)

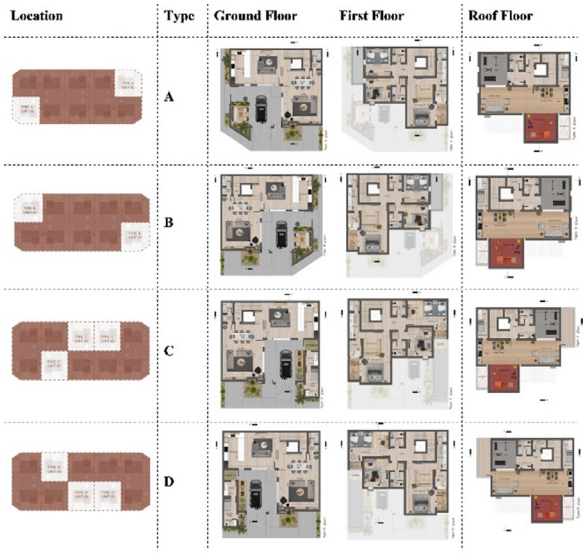


Figure (9). Four types of TAG Villa units (ANOS, n.d.)

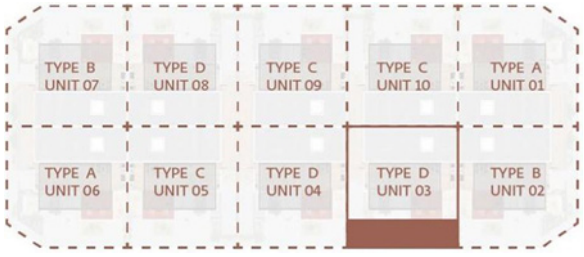


Figure (10). Master plan of TAG Villa project (ANOS, n.d.)

6.1.1 Open plan free structural system

Contemporary housing in Saudi Arabia is generally erected with concrete block infill walls within a reinforced concrete frame structure. Despite the integration of the Domino system, the open floor plan is not widely adopted in a society such as Saudi Arabia, that highly values privacy and as mentioned earlier, various factors contribute to the prevalence of large closed-floor-plans. However, in TAG Villa, the architect incorporates an open floor plan using the Domino system. This structural flexibility, coupled with the placement of services (such as staircase, bathroom, storage, and lift) in specific corner, frees up the ground floor, creating a flowing two-zone area and allowing users to customize the spaces according to their needs. Additionally, the application of modularization between building systems and standardized components facilitates minor modifications, augmenting layout versatility.

6.1.2 Convertibility

As Mansour Al Farhan (pers. comm., December 27, 2023) states, "the economic issues today make the user more concerned about the quality of spaces, which can be achieved by the multi-use of spaces, as seen in traditional Saudi housing." Due to his awareness of current user needs as a Saudi architect, he aims to address those needs adequately without requiring structural modifications or leaving any unusable spaces by easing the convertibility of spaces. On the small lot of 14x15m, the architect enhances space efficiency by dividing the ground floor into two zones, each taking a side of the L-shaped layout that are separated by sliding doors (colored in red) (Figure 11a and 11b). The functions of these zones can be altered daily or weekly based on the user's changing needs, resulting in spaces without predefined labels (Mansour Al Farhan, pers. comm., December 27, 2023). Unit 3 (Type D) in TAG Villa serves as a prototype, divided and furnished by the architect, while other units are left to the owners' discretion. The two zones are: a family zone and a casual zone. The casual zone includes the kitchen and a family sitting area. The family zone comprises a dining area and sitting area, serving both family and guests when needed (Figure 11a).

There is no dedicated space solely for guest use which was used rarely (Mansour Al Farhan, pers. comm., December 27, 2023). Additionally, the architect noted that "some owners chose to

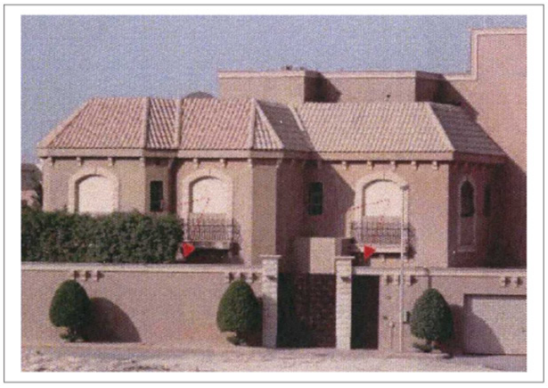


Figure (8b). Users' interventions on facade: Blocked-up windows (Almehrej 2015)

Table (3). Historical Development of Flexibility in Saudi Housing

Flexible Criteria	Accommodation Type		
	Tent	**Courtyard House**	**ARAMCO Villa Dwelling**
Functional	Multifunctional areas	Shared courtyard for multiple activities	The lack of functionality and efficiency in the internal space subdivision, each room devoted to a specific function
	Using traditional goat's hair curtains as a movable divider.	Rooms used for various purposes	
Structural	An open plan	The apility to expand horizontally or vertically	A closed-floor plan (rigid plan)
	Lightweight, portable structure.		
	Adjustable size based on family needs		
Cultural	The provision of privacy through the separation of male and female zones	The segregation between male guests and family sections	Lack of Privacy and Loss of Local Identity in Villas
	Apility to personalize the tent's exterior curtains	The courtyard allows for inward-oriented openings ensuring exterior privacy.	

villa house designs to enhance space efficiency without compromising user needs. One recent example attempting to revive flexibility, inspired by traditional housing, is TAG Villa, which will be analyzed in the following chapter.

6. Case Study: An Architectural Analysis on TAG Villa

TAG Villa buildings are situated in the central province of Saudi Arabia in Riyadh city, specifically in the Almuhammadiah district, and was designed by Saudi architect Mansour Al Farhan. Selected as a case study, TAG Villa project embodies an effort by the architect to reintroduce the concept of flexibility in contemporary Saudi housing. TAG Villa buildings are open for visitation by various stakeholders, including designers and architects within a few days after the construction was completed in October 2022. Al Farhan redefines spaces in response to users' real needs, aiming to optimize efficiency within the constraints of a 14x15m lot. Comprising ten semi-detached units classified into four types (A, B, C, and D), each with subtle design differences based on location, TAG Villa's unit lot area is 210 m2 with a built-up area of 350 m2 (Figure 9). The study focuses on Unit 03 (Type D) (Figure 10) since only this unit is accessible for visitation and suitable for an analysis of structural, functional, and cultural flexibility in TAG Villa as a case study. A general analysis on Unit 03 (Type D) building in TAG Villa project reveals the fact that its design is shaped with modernist design practices and construction techniques to a great extent while also aiming to achieve flexible design considering the socio-cultural values of Saudi Arabian society. So, an architectural examination focusing on flexible design practices implemented in this project requires an approach that evaluates modern architecture practices and socio-cultural values of societies as a whole or as complementary elements. In this framework, the flexible design principles determined by Saudi architect Raeyd M. Al-Dakheel, who searched for ways of combining modern architecture with social and cultural structure of Saudi Arabia for achieving flexible design, and put forward some standards accordingly, will be used as a guideline for our analysis on the achievement level of flexibility in this project.

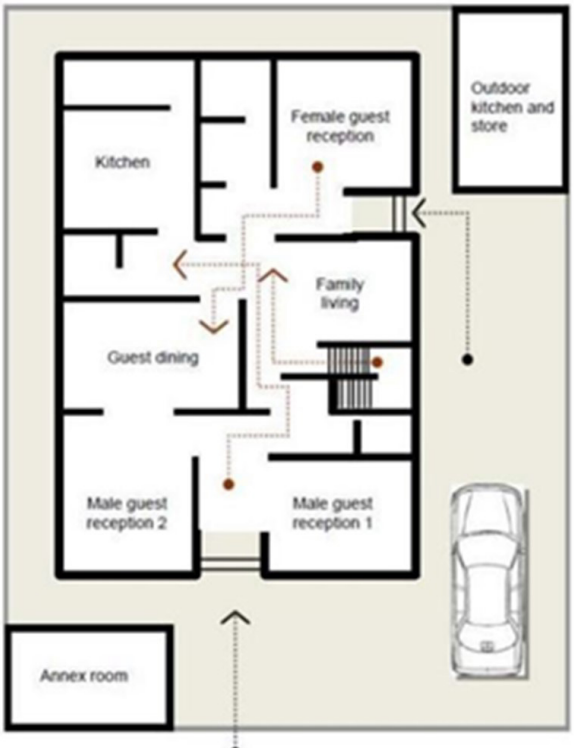


Figure (7a). Villa type dwelling: Ground floor plan (Almehrej 2015).

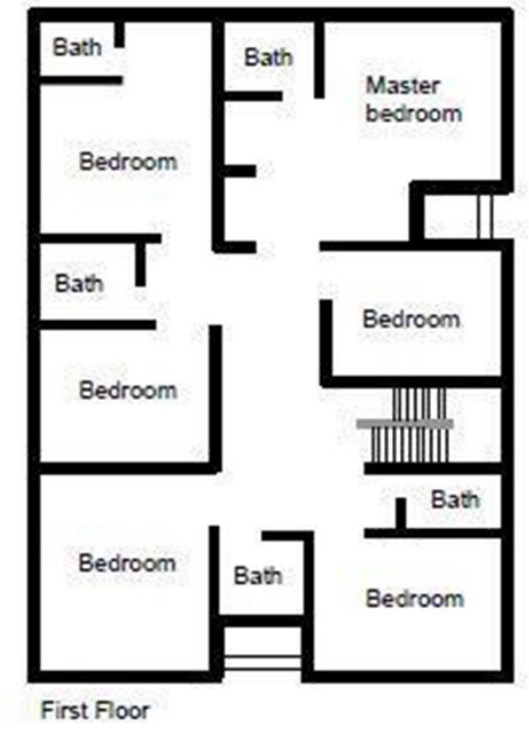


Figure (7b). Villa type dwelling: First floor plan (Almehrej 2015).

the economic boom, Bahammam (1998) points out that the large size of the dwelling unit results from a failure to determine user needs at the design stage. Moreover, in an attempt to maintain traditional customs, many spaces are duplicated, such as guest reception rooms. Also, each space is devoted to a specific function, and it's challenging to change due to heavy furniture (Bahammam, 1998). This poses a significant challenge today with the rise in land prices and population growth, leading to smaller lot sizes than the standard 25x25m size. Al-hemaidi (2001) noted, "The villa's outdoor spaces, and sometimes the indoor ones, are not used, especially not for family activities" (p. 194). According to him, setbacks surrounding the house from all sides are unusable and violate household privacy (Al-hemaidi, 2001). In contrast to courtyard houses where openings are inward-oriented, the villa house is outward-looking, disregarding the family's privacy needs (Talib, 1984; Al-Hathloul, 1981). Residents respond to this privacy violation by adding structures of corrugated plastic or steel above fences and blocking first-floor windows, altering the villa's appearance (Al-hemaidi, 2001) (Figure 8a and 8b). This leads to increased reliance on artificial light and air conditioning. Additionally, to revive the house's local identity, sand, mud, or stone colors are used in the exterior facade, imparting it a local character (Babsail and Al-Qawasmi, 2015) (Figure 8a and 8b).

As a result, it is evident that the evolution of Saudi housing from traditional to contemporary has significantly reduced the level of flexibility (Table 3). The user's needs have been overlooked, leading to ineffective and unused spaces, promoting a sense of dissatisfaction. Today, due to smaller land lots, flexible solutions are integrated into

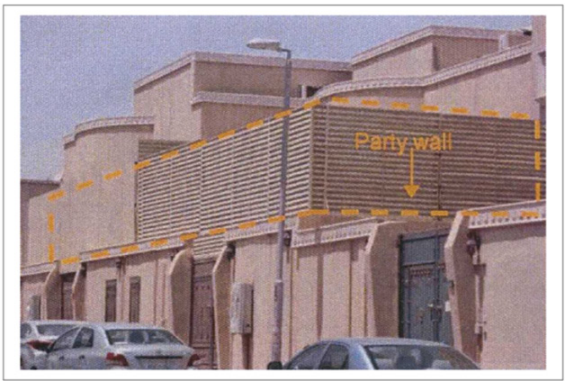


Figure (8a). Users' interventions on the facade: Fences and barriers (Almehrej 2015).

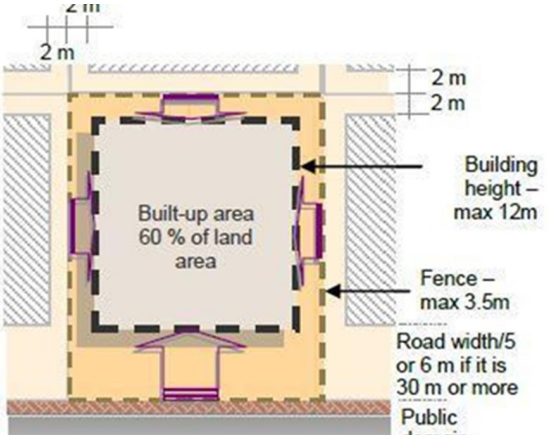


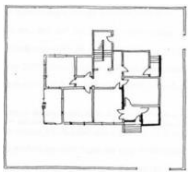
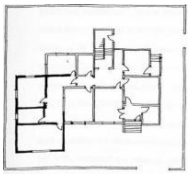
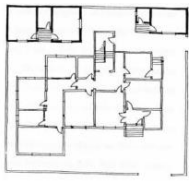
Figure (6). Applied building regulations in ARAMCO villas (Almehrej 2015).

built-up area percentage and setbacks on all sides (Figure 6).

The ARAMCO villas are two-story concrete structures situated in the center of a square lot, typically measuring 25x25m (Al-Hathloul, 1981) (Figure 6). This division of large lots was common since Saudi Arabia had witnessed a rapid economic growth with the oil discovery. Currently, in large urban centers, the villa constitutes at least 80 percent of the total number of single-family dwellings (Al-Hemaidi, 2001). However, in the 1950s, they mainly depended on ARAMCO's architects to design their villa houses due to the few numbers of Saudi architects (Al-Hathloul, 1981). According to Talib (1984), the international style imposed on villa houses in Saudi Arabia is neither suitable for the present needs of Saudi society, nor does it consider the continuity of their cultures. Consequently, the ARAMCO villa house passed through three transformation stages as shown in (Table 2).

The three stages of transformation of Al-Malaz villa confirm the inevitability of physical changes to the dwelling unit over time. The lack of functionality and efficiency in the internal space subdivision of the villa house has also been mentioned by Almehrej (2015) in his comparison between the courtyard house and the villa house. According to him, in the villa house, the arrangement of internal spaces is almost uniform throughout the city, with each room devoted to a specific function, unlike the multiple uses of rooms in the traditional courtyard house (Figure 7a and 7b). Thus, the internal layout ends up with a closed-floor plan (rigid plan) in

Table (2). The transformation stages of a typical villa in Al-Malaz (Al-Said, 1992).

Transformation Stage	Description	Plan
Villa stage	Users modified interior spaces, indicating the failure of initial arrangements and layout subdivisions. The alterations made are mostly concentrated on room functions, space subdivisions and door positions	
Villa Expansion Stage	Responds to changing user needs regarding natural, person-made and human environments. Balconies are enclosed and used as rooms, with additional structures attached to the original villa	
Villa Annex Buildings Stage	Occurred due to ever-changing user needs and municipality understanding, resulting in more relaxation of set-back regulations. Users could build an annex alongside the fence wall	

which each space within a house is designated as an independent room enclosed by walls, creating rooms with limited spatial flexibility.

As noted by Bahammam (1998), multiple spaces on the ground floor are usually allocated for the same function. There are two or more men's reception rooms—one typically furnished with Western-style furniture and another with traditional Arabic style, along with dining rooms and female reception rooms. Each space averages about 24.4 m² (Bahammam, 1998). Comparing to the courtyard house, in the villa house, the family living room takes the place of the courtyard and partially functions as a circulation space (Talib, 1984) (Figure 7a). The bedrooms are on the upper floor for internal privacy. Due to the luxury lifestyle, a room for maid(s) is added on the roof, and a driver's room in the front yard (Bahammam, 1998). According to Bahammam, the size of the villa house is much larger than the actual user needs. Besides

offers multifunctional areas; however, it maintains privacy through the separation of male and female zones (Talib, 1984). To personalize the tent, exterior curtains can be woven with colorful stripes and geometric designs chosen by the dweller (Talib, 1984). On the other hand, the urban dwellers (Sedentary (urban) people) lived in traditional mud-built courtyard houses of two or more stories. The structure system of these buildings consists of load-bearing walls constructed of sun-dried mud bricks and the external walls with a width about 80-100cm with limited small openings (Babsail and Al-Qawasmi, 2015). As Facey (1997) mentioned, any local builder with little knowledge was able to build with this flexible local building material without the need for a specialist. The internal courtyard functions as a shared space, which can be used for different purposes at the same time (Figure 5a). According to Bahammam (1998), the courtyard has played a central role in the traditional mud house because of its multiplicity of functions as an open private area; where the family can gather for different activities. In addition, rooms can be used interchangeably, and their functions may vary according to the seasons of the year (Facey, 1997). The use of simple and minimal furniture enhances the flexible use of rooms since they can be moved, rearranged or stored easily (Bahammam, 1998). Also, as Bahammam (1998) stated, the courtyard house can grow and expand horizontally or vertically as the family size increases due to marriage or birth.

In Saudi culture, the interior privacy is essential through the segregation between the male guest section and the family section. This separation

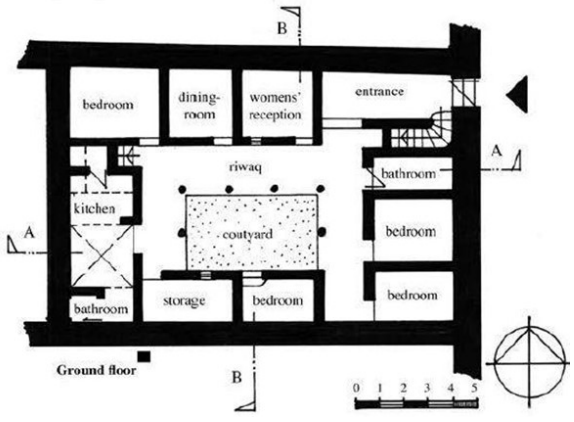


Figure (5a). Internal courtyard of the traditional mud-built courtyard house (Facey 1997)

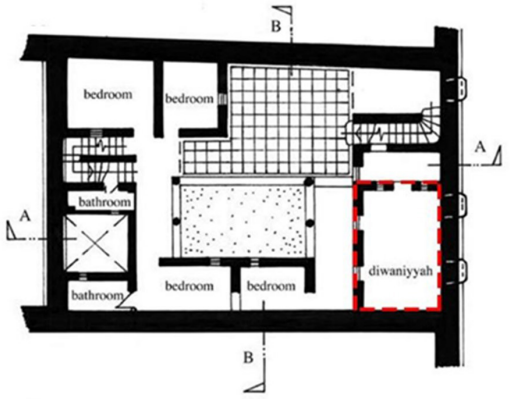


Figure (5b).Place of Diwaniyyah on the First floor (Facey 1997).

in a courtyard house is sometimes achieved by two separate entrances, two staircases and two sanitary blocks (Facey, 1997). As seen in Figure 5b, the male guest room "Diwaniyyah" is located on the upper floor, accessible via a staircase isolated from the family entrance (Figure 5b).

The courtyard allows for inward-oriented openings rather than outward-oriented ones. Consequently, small and few openings are strategically placed in well-protected locations on external walls, ensuring privacy as well (Talib, 1984). The indoor environment benefits from natural light and ventilation provided by the inner courtyard, contributing to temperature regulation.

In general, vernacular architecture in the central province addresses the social, cultural and economic needs of its inhabitants very well. However, vernacular shelters continued as the primary housing method in the central province until the 1950s when detached villas and apartments were introduced, ultimately leading to the abandonment of vernacular shelters as the main accommodation in Saudi Arabia (Babsail and Al-Qawasmi, 2015). As stated by Babsail and Al-Qawasmi (2015), these foreign types of residences were developed by ARAMCO in their Home Ownership Plans in different Saudi cities and in Al-Malaz district of Riyadh. The Al-Malaz project is a model of the contemporary neighborhood planning for all Saudi neighborhoods, also as "The New Riyadh", featuring 754 detached villas and 180 apartments (Al-Hathloul, 1981). Governed by ARAMCO's Western regulations, villa designs adhere to specifications such as building height,

with the resident's needs. This is typically achieved through enlarging the unit or space vertically on the roof and horizontally in the front or backyard, or by enclosing terraces and balconies (Al-Dakheel, 2007). Coordination of building systems can be facilitated through a standardized modularization system, or obstacles for future adjustments can be minimized with a free structural system (open-plan) (Al-Dakheel, 2007; Gilani and Türker, 2020). Importantly, structural flexibility extends beyond changes to the entire building structure; it encompasses internal physical modifications desired by users and addressed by professionals in response to their specific needs (Dittert, 1982, as cited in Lans and Hofland, 2005, p.4). Cultural flexibility, as defined by Al-Dakheel (2007), involves the capacity to personalize space or units in response to users' diverse cultural backgrounds, preferences, and tastes. Additionally, it contributes to promoting privacy in both exterior and interior spaces. Van Eldonk and Fassbinder (1990, as cited in Lans and Hofland, 2005, p.4), coined the term "character flexibility" to describe changes in architectural quality, offering an explanation for potential alterations in the facade or the identity of a house.

Table (1). List of flexibility options proposed by Al-Dakheel (Al-Dakheel, 2007).

Functional	Versatility: layout permits spatial multi-use with minor structural modifications
	Convertibility: ability to interchange spaces without any structural modification
	Ability to separate unit into two units and the ability to rejoin it at a later stage
	Pre-designed service and utility zones for plumbing and electric works.
Structural	Extendibility: the ability to add spaces vertically or horizontally through prior planning
	Standardized Modularization (to apply a holistic integrated module system that ties the unit structure with the other building systems and components)
	Open plan free structural system to alleviate structural obstacles for future modifications.
Cultural	Ability to personalize unit (to add the end-user's personal taste and to project their identity on the dwelling)
	Ability to improve exterior privacy (especially between semi-public and semi-private areas as well as the relationship with immediate neighbors)
	Ability to improve interior privacy (Through the improvement of privacy standards that are consistent with current and anticipated Saudi household needs, especially the critical boundaries between guest, family and sleeping zones).

5. Flexibility in Saudi Housing

In the central province of Saudi Arabia, domestic accommodation has historically evolved through three primary types: the tent, courtyard home, and villa home (Almehrej, 2015). The vernacular architecture of Saudi Arabia asserts the cultural values of Saudi society, which have shaped housing in accordance with Islamic rules and regulations. Islamic values prioritize family cohesion and privacy, significantly influencing house design. This influence is apparent in the construction of extendable structures to accommodate extended families and the creation of multifunctional spaces, such as courtyards, where families can engage in various activities together. Additionally, Islamic principles guide the design of inward-oriented houses and the internal separation of spaces for gender segregation. Modesty is reflected in the simplicity of exterior facades. These cultural and Islamic values have deeply influenced housing in the region, shaping its evolution over the years. In addition to the compatibility of traditional houses with Saudi culture, flexibility as a design approach was naturally integrated into them, seen in the adaptable structures of both nomadic Bedouin tents and urban mud-built courtyard houses before the 1950s, allowing for easy personalization and accommodation of varying needs. Accordingly, the flexible architectural design applied in these tents and courtyard houses is expressed below in order to see the sources that Mansour Al Farhan considered while trying to give his design a flexible character.

The tent was the dominant shelter for years emerged by the socio-cultural development of Saudi Bedouin (Desert (rural) dweller), which imposed them to live in light movable shelters where the notion of flexibility is the core of its structure (Talib, 1984). Thereby, this flexibility eases the assembly and disassembly process, as well as, controlling the size of tents as required by family size or owner status. The interior open space, divided by traditional goat's hair curtains,

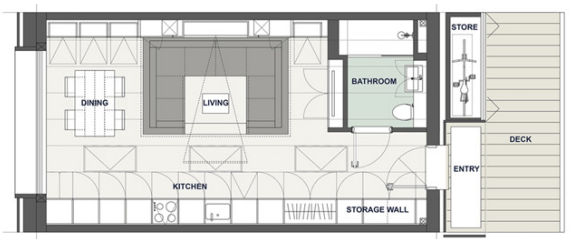


Figure (3a). Daytime floor plan of Yo Home (Mairs 2016).

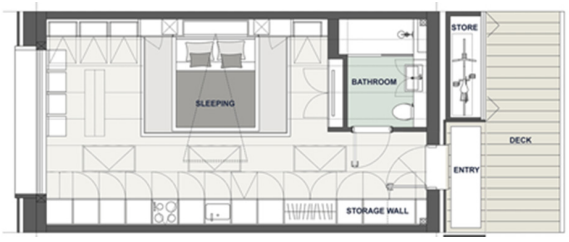


Figure (3b). Nighttime floor plan of Yo Home (Mairs 2016).

Figure (4). Versatile Plan Schemes in Sky House (Hidden Architecture 2019).

4. Flexibility Types and the Role of Culture in Housing Design

Flexible housing can be defined as housing that is designed for choice at the design stage, both in terms of social use and construction, or intended for change over its lifetime. Various types of flexibility, identified by researchers, cater to the evolving needs in a user's life-cycle. Architecturally addressing these needs in the early design stages of a house, incorporating cultural, functional, and structural flexibility, can be achieved without imposing financial burdens on users (Schneider and Till, 2005b). One of the basic parameters determinants on the achievement of flexibility in housing design is the necessity to consider the special cultural characteristics of the region where the house is located (Rapoport, 2005). The socio-cultural values of some societies, including Saudi Arabia the country where TAG Villa is constructed, are very effective on the formation of building design with all its aspects since it prohibit some factors overtly or covertly. Rapoport (2005) emphasizes that the first two of his three basic definitions of culture are directly related to housing and its environment; and he analyzes values and images, religious beliefs, family structure, social organizations, social relations between individuals and lifestyle as the cultural components that affect the housing form (Rapoport, 2005). So, it is beneficial to analyze flexibility applications in housing design by using local architectural studies made in the country that the buildings are designed since the citizens of that country are more aware of their socio-cultural values than people from other countries. In this framework, the evaluation made on flexible design in TAG villa in this study, will adhere to the criteria established by Saudi Arabian architect Raeyd M. Al-Dakheel, who has specifically focused on the concept of flexibility in the context of Saudi Arabia, ensuring its appropriateness for the local architecture. Although there are other flexibility approaches that have different frameworks and characteristics when compared with each other, Al-Dakheel's flexibility criteria are chosen for the study since he is from Saudi Arabia and determined these criteria depending on the contemporary socio-cultural and economical structure of Saudi society.

According to Al-Dakheel (2007), flexibility can mainly be classified into three categories: functional, structural, and cultural flexibility. He studied the common modifications done by Saudi households to adapt to new needs over time and, accordingly, with the cooperation of housing design experts, an appropriate list of flexibility options was proposed (Table 1). He defined functional flexibility as the capacity to interchange space functions or convert space function to another with negligible structural modifications or without any modifications (Al-Dakheel, 2007). Moreover, as noted by Gilani and Türker (2020), functional flexibility is the ability to change the function of space without structural or professional intervention while maintaining the entire structure of the dwelling. In this context, residents have full control to alter room functions or the relationship between interior spaces to meet their daily, weekly, or even monthly needs. A rectangular or square planned layout is typically preferable for functional efficiency of space, which could be designed as open space, neutral space, or multi-purpose shared space. Whereas structural flexibility requires professional intervention to be implemented in line

structure, interior, and exterior façade designs (Estaji, 2017; Higgins, 2015) (Figure 1).

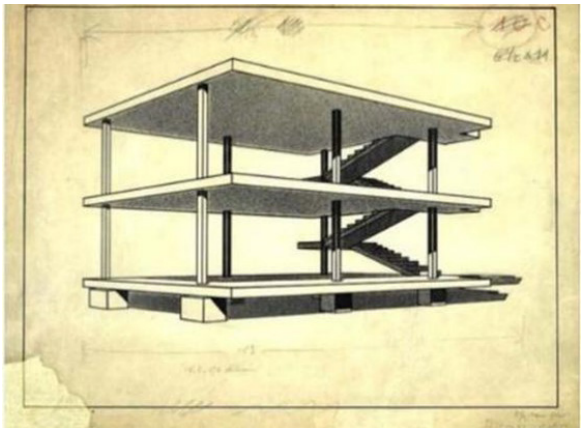


Figure (1). Le Corbusier's Domino House (1914) (Estaji 2017).

Le Corbusier referred to this spatial flexibility as "plan libre" (Risselada, 1988). In the 1920s, the Schröder House by Gerrit Rietveld embodied flexible design by utilizing movable partitions on the first floor, allowing for versatile space functions. This achieved functional flexibility with an open floor plan layout enabling diverse activities at various times of the day or night (Forty, 2000). After the post-war period, Archigram and Metabolism movements emerged in the 1960s, which also focused on the notion of flexibility (Gardini, 2018). In 1958, Kiyonori Kikutake, a pioneer of the Metabolism movement, designed the "Sky House," featuring an open square multifunctional space on the upper floor with movable service zones, offering flexibility in use according to user preferences (Figure 2a). Additionally, the ground floor that has developed over time, serves as a vertical extension to adapt to changing needs (Hidden Architecture, 2019) (Figure 2b).

Starting from the 1960s, modernism's basic approaches, such as standardization and functionality, have started to be criticized together with the emergence of the Postmodern movement (Feizbahr and Pourzanjani, 2023). Although the flexibility concept in design has arisen together with modern architecture, the following architectural styles coming to this day have also given significance to flexibility concepts and searched for ways to achieve flexibility in their designs and buildings. In this framework, the Yo

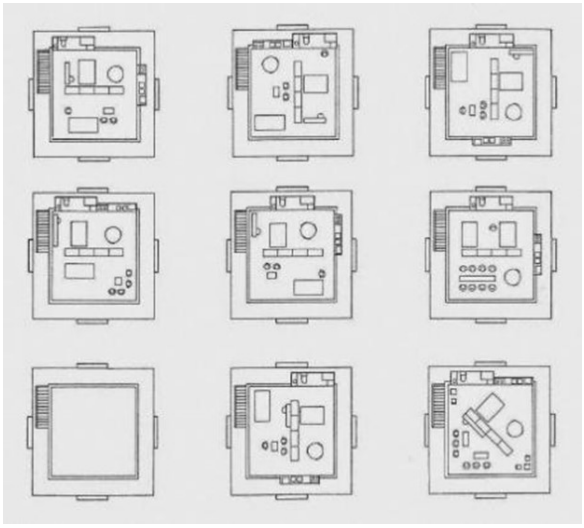


Figure (2a). Versatile Plan Schemes in Sky House (Hidden Architecture 2019).

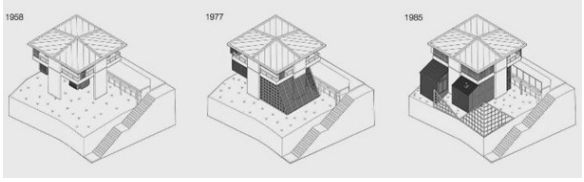


Figure (2b). The addition of ground floor in SKY House (Hidden Architecture 2019).

Home project is a contemporary example that was aimed to enhance the flexibility of small spaces through advanced technology in its design and construction process. It comprises prefabricated modular apartments designed by Simon Woodroffe in 2012 (Mairs, 2016). The internal space relies on intelligent interior design to facilitate the appearance and disappearance of spaces according to the performed activities during the day, promoting space efficiency (Figure 3a and 3b). The space is functionally flexible, enabling the user to convert the space function effortlessly by using hydraulic mechanisms and a counterweight system (Mairs, 2016) (Figure 4).

In summary, the evolution of flexible design strategies in architecture, from the open-plan concepts of Modernism to the movable partitions in the twentieth century and the advancements in technology seen in contemporary projects like the Yo Home, reflects a continual pursuit of spatial flexibility and versatility throughout architectural history.

3. Flexibility Approach in Housing Design

Firstly, understanding the term "flexibility" in general is necessary for comprehending the flexible approach in housing design. The word flexibility is defined as "the ability to change or be changed easily according to the situation" in Cambridge English Dictionary. The term "flexibility" emerged in architectural terminology in the 1950s (Forty, 2000). Various authors have defined it; however, the common expression for all these definitions of flexibility is the ability to adapt to different users' needs. In architectural design, flexibility has paved the way to create different solutions to cope with present and future changing needs and requirements. Similarly, Kızmaz and Çimşit Koş (2015) believe that the reason behind the emergence of flexible approaches in architectural design is the desire to be aware of potential scenarios and solve problems in the design even before they exist. As stated by Schneider and Till (2007), it is probably impossible to trace a chronological line of flexible housing history if we want to understand its development by cause and effect approach. Instead, its evolution can be examined within the framework of two basic approaches: the vernacular approach and the designer approach (Schneider and Till, 2007).

The solutions derived from the vernacular approach were determined mainly by local builders rather than professionals or architects due to long-term modifications to patterns of use and culture (Schneider and Till, 2007). Paul Oliver comprehensively studied the history of vernacular housing, drawing attention to the significant demands on houses in response to changing family size and structure through time (Oliver, 2003). It is notable that vernacular architecture provided some good examples of flexibility throughout the world with different strategies. For instance, rooms are not devoted to a single function or usage. Additionally, the single-room arrangement has been seen as the prototype of the open-space concept introduced in modern architecture, but with more developed internal dividers aided by advanced technology (Schneider and Till, 2007).

On the other hand, the developed flexible solutions in the twentieth century evolved in response to urgent needs. As Schneider and Till (2007) noted, this attention that has been given to flexibility was motivated by three prime factors: In the 1920s, the issue of European social housing program was revealed to provide mass housing; in the 1930s, the need for advanced solutions for mass housing by prefabrication and emerging technologies; and in the 1960s and 1970s, the need to consider user choice by focusing on participation and user involvement (Schneider and Till, 2007). Flexibility emerged as a groundbreaking solution in housing design, adopted by many architects, particularly after the First World War. The post-war period, marked by an acute housing shortage, required a substantial number of cost-effective houses. Consequently, space standards were minimized, driving the need to improve the efficiency of small spaces through flexible solutions and industrialized systems in mass housing (Schneider and Till 2007). According to Forty (2000), in the post-war period, alongside the use of movable building elements (sliding or folding elements) and multifunctional single spaces, there was a development of lightweight structures and mechanical services placed mainly on the roof to free up the layout from any obstacles. Additionally, there was an emphasis on the concept of a flexible city, where every building is demountable and transformable (Forty, 2000). As is seen, throughout the history of architecture, technological advancements have introduced flexibility in housing design through various means. Accordingly, the historical development of flexible design applications in houses across the world and Saudi Arabia is expressed generally in the following section within the context of influential architectural movements.

3.1 Flexibility in Housing Design

Modernism is widely regarded as a breaking point in architectural history, significantly contributing to the evolution of interior design. It played a crucial role by introducing the open-plan concept to buildings (Higgins, 2015). One of the pioneering architects of the modernist movement who facilitated the implementation of the open-plan concept, was Le Corbusier. In 1914, he proposed an industrialized system called the Domino system (Estaji, 2017). This system is seen as one of the first fundamental steps taken in modern architecture to achieve flexibility in the use of space. As Higgins (2015) mentioned, the Domino house played a significant role in the evolution of interior space by introducing a structural system that liberated the interior space. Comprising reinforced concrete columns and slabs allowed architects to separate

costs and enable a larger number of families to own homes by ensuring the efficient utilization of all spaces. The effective use of space in flexible housing by making it multifunctional reduces the required area, thereby lowering construction, furnishing, and maintenance costs throughout its lifespan (Tannous et al., 2013). In addition, Schneider and till defined a flexible house as "a house that can adapt to the changing needs of users" (Schneider and Till, 2005a, p. 287).

One of the observed examples of continuing research on the issues of housing design is the case of housing development in Saudi Arabia. As Saudi Arabia's Vision 2030 aims to increase the rate of homeownership among citizens by providing affordable housing. The dilemma of Saudi housing started after the abandonment of vernacular approach and the introduction of new foreign house types. One of the largest housing projects that has affected the planning of all Saudi Arabia cities is Al-Malaz project in Riyadh, which was built by ARAMCO (Arab-American Oil Company) in the 1950s. The proposed planning of the Al-Malaz district with the street grid pattern and the villa dwelling has been considered a symbol of modernity at that time (Al-Hathloul, 1989). In the beginning, society was impressed by this modern model that represents the wealth and status of households in a community (Talib, 1984). However, after a while, it started to be noticeable that Saudi people are not completely satisfied with these modern villa house types (Almehrej, 2015; Giddings et al., 2020). The failure to properly consider Saudi user's evolving needs and requirements in the villa design, concerning social, cultural, and economic factors, resulted in random modifications and changes to both the interior and exterior built environment, placing a financial burden on the family. In addition, the large-sized lots introduced by ARAMCO are no longer compatible with the affordability required for housing in Saudi Arabia today. Due to the smaller land lots, flexible solutions are integrated into villa designs to enhance space efficiency without compromising user needs.

To support Saudi Arabia's Vision 2030, Bahammam (2019) proposed an affordable single-family house design by integrating flexible solutions and encouraged Saudi architects to develop design solutions in line with this vision. In this context, the importance of flexibility in Saudi housing is highlighted in terms of rationalizing spaces, providing sufficient areas, and enhancing the needs of users.

A contemporary example of flexible design is the TAG Villa project, constructed in 2022. This project aims to incorporate flexible design aiming to optimize space efficiency within the constraints of a 14x15m lot influenced by traditional housing, respecting the sociocultural values of Saudi Arabian society. In this study, flexible design principles implemented in this project are expressed and the appropriacy of these principles to Saudi architect Raeyd M. Al-Dakheel's classification of flexibility, who made studies on determining the most suitable flexibility options for Saudi households' needs and conditions, is examined. Considering the socio-cultural values of Saudi Arabia, Al-Dakheel classifies flexibility types under three titles; functional, cultural, and structural flexibility (Al-Dakheel, 2007). So, the analysis of TAG Villa regarding its appropriateness to flexible design is made within the framework of these flexibility types determined by Al-Dakheel. The basic aim of this study is to express the flexible aspects of traditional Saudi housing design, determine how much they are practically adaptable to contemporary housing design, and observe at what rate the socio-cultural values of a society are instructive for achieving flexibility in housing design.

2. Methodology

The study relies on a qualitative research method, utilizing a semi-structured interview format to allow for both guided and open-ended responses. The interview lasted approximately 30 minutes and was conducted face-to-face with the project's architect, Mansour Al Farhan, to gain an in-depth understanding of the flexibility approach followed during the design process.

In establishing the research's theoretical framework, the concept of "flexibility" and its historical development within the context of housing design are examined. Subsequently, flexible design applications worldwide are reviewed from an architectural perspective. After identifying the suitable flexibility types for Saudi housing, as classified by Al-Dakheel, the flexible design applications of Saudi housing are analyzed about Saudi socio-cultural values. In the final chapter, the TAG Villa project will be evaluated architecturally within the framework of Al-Dakheel's flexibility classification and criteria.

Journal of Architecture and Planning , Vol. 36 (4) , pp. 427-444, Riyadh (2024/1446H)

doi:10.33948/JAP-KSU-36-4-2

Applying the Principles of Flexibility in The Design of Saudi Housing: Tag Villa Project in Saudi Arabia

Maram Almourad **Mehmet Sener** **Sonay Ayyıldız**

MSc Student *Associate professor* *Associate professor*

Faculty of Architecture and Design, Kocaeli University, Kocaeli, Turkey

Ma.almurad@gmail.com *mehmet.sener@kocaeli.edu.tr* *sonayayyildiz@gmail.com*

(Received 21/8/2024; accepted for publication 29/9/2024.)

Abstract: The housing in Saudi Arabia lost flexibility concept that had existed in vernacular Saudi housing together with the introduction of foreign building types. In this context, several projects were executed in Saudi Arabia afterwards that aimed to provide flexible design in Saudi housing. A recent project; TAG Villa (2022) is one of these contemporary projects where flexible design is aimed to be provided considering socio-cultural structure of Saudi Arabian society. In this study, the flexible design practices implemented in TAG Villa and their realization levels according to Raeyd M. Al-Dakheel's flexibility classification that he determined considering the socio-cultural values of Saudi Arabia, are examined. The main aim of this study is to express at what rate the flexible sides of traditional Saudi housing design are adaptable to contemporary housing design and evaluate the instructive aspects of the socio-cultural values of Saudi Arabian society for achieving flexible design. Accordingly, the architectural drawings of TAG Villa are analyzed and an interview with the architect of TAG Villa project is conducted. The findings of the study express that the methods implemented in this project for achieving flexibility have many instructive sides for other studies aiming to achieve flexibility considering socio-cultural values.

Keywords: Adaptability, Flexible housing, Types of Flexibility, Socio-cultural values, Open floor plan, TAG Villa project.

1. Introduction

The concept of flexibility in housing was discussed by different architects in literature over time. As it was inherently used by local people in vernacular architecture, it has been adopted by professionals as a design approach in contemporary architecture. Mainly, it has no specific chronological line for its presence and development, but it is usually introduced in conjunction with urgent situations and needs. A home is a place that grows with its residents and must be capable of adapting to changes with minimal effort. The adoption of the flexibility concept in the design of built environments could be helpful in finding effective solutions for contemporary housing design problems and changing user demands.

In contemporary times, the rise in population has increased the demand for housing, leading to higher land costs. Consequently, many architects and designers have sought solutions for designing affordable housing on small lots, while considering social, cultural, and economic aspects. According to (Tannous et all.,2013), this highlights the importance of achieving flexibility in design, as it is the best economic solution to reduce housing

doi:10.33948/JAP-KSU-36-4-1

توظيف برامج الواقع المعزز للمحافظة على المباني التاريخية وتعزيز السياحة الثقافية: دراسة حالة في متحف بيت متبولي، البلد

رفيف القرشي **الآء شطوان**

كلية الفنون والتصميم، جامعة جدة، المملكة العربية السعودية

Rafeef1alqurashi@gmail.com *ashatwan@uj.edu.sa*

قدم للنشر في ٦/ ١٠/ ١٤٤٥ هـ؛ وقبل للنشر في ٩/ ٣/ ١٤٤٦ هـ.

ملخص البحث. تعد المباني التاريخية من أهم الموروثات؛ لما لها من قيمة عمرانية وتراثية، لذلك برزت السياحة الثقافية بوصفها أحد أهم أنواع السياحة. وبما أن الدراسات السابقة تظهر ندرة استعمال التقنيات الحديثة، تسعى الورقة إلى التحقيق في دور تكنولوجيا الواقع المعزز في تلك المباني لملء الفجوة العلمية الحالية، مع التركيز بخاصة على الحفاظ على الموروث الثقافي السعودي. وقد وقع الاختيار على منزل متبولي في البلد لإجراء الدراسة؛ لما لتلك المنطقة من تاريخ ثقافي وشعبي ترويه مبانيه، بعد أن سجلت المنطقة بوصفها إحدى المناطق التراثية العالمية في تصنيف UNESCO. تسلط الدراسة الضوء على ميزات المنزل الثقافية والتصميمية الملموسة وغير الملموسة. فقد اعتمدت الدراسة على المنهجين: الوصفي التحليلي والتطبيقي، من خلال استرجاع الأدبيات السابقة وصولاً إلى تطبيق توصياتها على شكل تطبيق واقع معزز. وتوصلت الدراسة إلى أن استخدام تطبيقات الواقع المعزز مفضلة بشدة، وأنها مستقبل السياحة. كما أثبتت الدراسة أن الواقع المعزز يقدم طريقة حديثة وقابلة للتطبيق لتحسين السياحة الثقافية، من خلال سد الفجوة بين نقل التراث ومحاكاة توقعات السياح المعاصرة، كما أنه يعمل بديلاً لطرق الترميم التقليدية ويحافظ على المباني التاريخية. توصي الورقة بقيام صناع القرار في السياحة والتنمية الاقتصادية والثقافة بتطوير تطبيق الواقع المعزز وتوظيفه لجذب السياح وتحفيز النمو الاقتصادي والمساهمة في الحفاظ على التراث الثقافي السعودي.

الكلمات المفتاحية: المباني التاريخية، التراث، التقنية، الواقع المعزز، البلد، السياحة.

Reality, Archeology, and Cultural Heritage, 9(10.1145), (2001).

Weber, W., & Yannas, S. Lessons from vernacular architecture. 1st edition, London: Routledge, 2013.

Wu, H.-K., Lee, S. W.-Y., Chang, H.-Y., & Liang, J.-C. ‘’Current status, opportunities and challenges of augmented reality in education. ‘’ Computers & education, 62, (2013).

and hologram in promoting heritage tourism. '' J. Inf. Comput. Sci., 9(12), (2019).

Mazzetto, S. ''Heritage conservation and reuses to promote sustainable growth. '' Materials Today: Proceedings, 85, (2023).

mcit.gov.sa. ''Digital tourism.'' Ministry of communications and information technology (2023). https://www.mcit.gov.sa/sites/default/files/2023-09/Digital%20tourism%20Reports.pdf

Merchán, M., Merchán, P., & Pérez, E. ''Good practices in the use of augmented reality for the dissemination of architectural heritage of rural areas. '' Applied Sciences, 11(5), (2021).

Mousavi, S. S., Doratli, N., Mousavi, S. N., & Moradiahari, F. ''Defining cultural tourism. '' International Conference on Civil, Architecture and Sustainable Development, (2016).

Neuhofer, B., Buhalis, D., & Ladkin, A. ''A typology of technology-enhanced tourism experiences''. International journal of tourism research, 16(4), (2014).

Oliver, P. Ethics and the built environment. 1st edition, London: Routledge, 2012.

Olukoya, O. A. '' Framing the values of vernacular architecture for a value-based conservation: A conceptual framework''. Sustainability, 13(9), (2021).

Pan, S.-Y., Gao, M., Kim, H., Shah, K. J., Pei, S.-L., & Chiang, P.-C. ''Advances and challenges in sustainable tourism toward a green economy. '' Science of the total environment, 635, (2018).

Pardo, J. M. F. ''Challenges and Current Research Trends for Vernacular Architecture in a Global World: A Literature Review. ''Buildings, 13(1), (2023).

Park, S., Bokijonov, S., & Choi, Y. ''Review of microsoft hololens applications over the past five years. '' Applied Sciences, 11(16), (2021).

Pedersen, I., Gale, N., Mirza-Babaei, P., & Reid, S. ''More than meets the eye: The benefits of augmented reality and holographic displays for digital cultural heritage. '' Journal on Computing and Cultural Heritage (JOCCH), 10(2), (2017).

Petroman, I., Cornelia, P., Diana, M., Ramona, C., Loredana, V., & Ioana, P. ''Types of cultural tourism. '' Scientific Papers: Animal Science and Biotechnologies, 46(1), (2013).

Pratheep, P. ''Sustainable architecture and tourism management. '' Int. J. Environ. Rehabilitation Conserv., 4(2), (2013).

Quan, S., & Wang, N. ''Towards a structural model of the tourist experience: An illustration from food experiences in tourism.'' Tourism Management, 25(3), . (2004).

Richards, G. Rethinking cultural tourism. London: Edward Elgar Publishing, 2021.

Russo, M. (2021). ''AR in the Architecture Domain: State of the Art. ''Applied Sciences, 11(15), (2021).

Sacchi, L. '' A critical survey and a design proposal for Al Balad, the historic district of Jeddah, KSA. '' Digital Heritage (2), (2013).

Sarah, E. Vernacular Architecture and the 21st Century. (2011).URL: http://www. archdaily. com.

Tom Dieck, M. C., & Jung, T. H. ''Value of augmented reality at cultural heritage sites: A stakeholder approach. '' Journal of destination marketing & management, 6(2), (2017).

Tscheu, F., & Buhalis, D. ''Augmented reality at cultural heritage sites. '' Information and Communication Technologies in Tourism 2016: Proceedings of the International Conference, (2016).

Tussyadiah, I. P. ''Personal technology and tourism experience. '' ISCONTOUR. (2015).

Vision2030.gov. Quality of Life Program. (n.d.).Vision2030.gov.sa. https://www.vision2030.gov.sa/en/vision-2030/vrp/quality-of-life-program/

Vlahakis, V., Karigiannis, J., Tsotros, M., Gounaris, M., Almeida, L., Stricker, D., Gleue, T., Christou, I. T., Carlucci, R., & Ioannidis, N. ''Archeoguide: first results of an augmented reality, mobile computing system in cultural heritage sites. ''Virtual

Proceedings of the ENTER eTourism Conference, (2022).

Chen, Y., Wang, Q., Chen, H., Song, X., Tang, H., & Tian, M. ''An overview of augmented reality technology.'' Journal of Physics: Conference Series, (2019).

Chung, N., Han, H., & Joun, Y. ''Tourists' intention to visit a destination: The role of augmented reality (AR) application for a heritage site. '' Computers in Human Behavior, 50, (2015).

Çınar, K. ''Role of mobile technology for tourism development. '' The emerald handbook of ICT in tourism and hospitality (2020).

Çizel, B., & Ajanovic, E. ''Virtual reality for cultural heritage tourism. '' Proceedings of the 4th International Scientific Conference—SITCON, (2018).

Das, B. R., Maringanti, H. B., & Dash, N. S. ''Role of Artificial Intelligence in Preservation of Culture and Heritage. Digitalization of Culture Through Technology''. Proceedings of the International Online Conference On Digitalization And Revitalization Of Cultural Heritage Through Information Technology-ICDRCT-21, (2022).

Desai, N. ''Recreation of history using augmented reality.'' ACCENTS Transactions on Image Processing and Computer Vision, 4(10), (2018).

Du, D., Lew, A. A., & Ng, P. T. ''Tourism and economic growth''. Journal of travel research, 55(4). (2016).

Dwidar, S., Metwally, W., & Abbas Abdelsattar, A. ''Analytical study of heritage residential buildings in the central region of saudi arabia''. JES. Journal of Engineering Sciences, 48(1), (2020).

Faber, B., & Gaubert, C. ''Tourism and economic development: Evidence from Mexico's coastline. '' American Economic Review, 109(6), (2019).

Fan, X., Jiang, X., & Deng, N. ''Immersive technology: A meta-analysis of augmented/virtual reality applications and their impact on tourism experience.'' Tourism Management, 91, 104534. (2022).

Gattupalli, A. (2023). ''The Digital Divide: Can Technology Support Vernacular Architecture? '' Retrieved (2024), from https://www.archdaily.com/1008305/the-digital-divide-can-technology-support-vernacular-architecture

Gong, Z., Wang, R., & Xia, G. ''Augmented reality (AR) as a tool for engaging museum experience: a case study on Chinese art pieces. '' Digital, 2(1), (2022).

Gretzel, U., Reino, S., Kopera, S., & Koo, C. ''Smart tourism challenges. '' Journal of Tourism, 16(1), (2015).

Hamza, N. ''Contested legacies: vernacular architecture between sustainability and the exotic. '' Sustainable Vernacular Architecture: How the Past Can Enrich the Future, (2019).

Han, D.-I., Jung, T., & Gibson, A. ''Dublin AR: implementing augmented reality in tourism. Information and Communication Technologies in Tourism '' Proceedings of the International Conference (2013).

Han, D.-I., tom Dieck, M. C., & Jung, T. ''User experience model for augmented reality applications in urban heritage tourism. '' Journal of Heritage Tourism, 13(1), (2018).

Ibrahim, A. The Arab states' UNESCO world heritage sites: the Saudi Arabia experience. Research Gate. (2018).

Jung, T. ''Value of augmented reality to enhance the visitor experience: a case study of Manchester Jewish Museum. '' E-Review of Tourism Research, 7. (2016).

Jung, T., Chung, N., & Leue, M. C. ''The determinants of recommendations to use augmented reality technologies: The case of a Korean theme park.'' Tourism Management, 49, (2015).

Kamal, M. A. ''The morphology of traditional architecture of Jeddah: Climatic design and environmental sustainability. ''Acad J Glob Bus Econ Rev, 9(1), (2014).

Kim, S. L., Suk, H. J., Kang, J. H., Jung, J. M., Laine, T. H., & Westlin, J. ''Using Unity 3D to facilitate mobile augmented reality game development. '' IEEE (WF-IoT), (2014).

Lalitha, K., & Rajasekar, A. ''Role of technology

3. Prioritize user-centered design.
4. Update the app to showcase multimedia content, such as audio and motion graphics.
5. Include educational features to be utilized by teachers and students.
6. Maintain the long-term sustainability of the app through regular updates and support services.
7. Maintain and address ethical considerations about the data within the app and of the users.
8. To increase the app's preservation and usefulness, include educational content about traditional building methods and materials.

6. References

Arabic references

Cultural / Matbouli House is a model for Jeddah's historical houses, (2016). Retrieved from: https://www.spa.gov.sa/1446175

Economist / Minister of Tourism launches digital tourism strategy in the Kingdom (2022). Retrieved from: https://www.spa.gov.sa/2325925

Sobhey, Ibrahim. "One of the masterpieces of the military architectural heritage in the southwest of the Kingdom of Saudi Arabia is the Ottoman Castle on the island of the Knights. Yearbook of the General Union of Arab Archaeologists".Studies in the Archaeology of the Arab World 16(1). (2013). https://doi.org/10.21608/cguaa.2013.31878

Tchalabi, Sanaa. "Your guide to visiting Matbouli house in Albalad." (2023). https://ar.timeoutjeddah.com/attractions/

English references

Abbas, H. ''A tale of two rushans: Architecture through oral history.'' Islamic Heritage Architecture, 159, (87). (2016)

Aburamadan, R., Trillo, C., Udeaja, C., Moustaka, A., Awuah, K. G., & Makore, B. C. ''Heritage conservation and digital technologies in Jordan.'' Digital Applications in Archaeology and Cultural Heritage, 22, (e00197). (2021).

Alshawabkeh, Y., Baik, A., & Miky, Y. ''Integration of laser scanner and photogrammetry for heritage BIM enhancement.'' ISPRS International Journal of Geo-Information, 10(5), 316. (2021).

Alshehri, A., & Corbell, M. ''Al-Balad, The Historic Core of Jeddah: A Time Travelogue.'' Once Upon Design: New Routes for Arabian Heritage, 17-(28). (2016).

Asif, N., Utaberta, N., Sabil, A. B., & Ismail, S. ''Reflection of cultural practices on syntactical values: An introduction to the application of space syntax to vernacular Malay architecture.'' Frontiers of Architectural Research, 7(4), 521-529. (2018).

Azevedo-Salomao, E. M., & Torres-Garibay, L. A. ''Vernacular Architecture in Michoacán. Constructive Tradition as a Response to the Natural and Cultural Surroundings.''Athens Journal of Architecture, 2(4), 313-1326. (2016).

Aziz, K. A., & Siang, T. G. ''Virtual Reality and Augmented Reality combination as a holistic application for heritage preservation in the Unesco World Heritage Site of Melaka. '' International Journal of Social Science and Humanity, 4(5), 333-338. (2014).

Bagader, M. '' The Old City of Jeddah: From a walled city to a heritage site. '' WIT Transactions on the Built Environment, 143, (2014).

Bamuqabel, T., & Golkarian, S. ''Socio-economic sustainability approaches applied within the conservation strategies of the historical city of Jeddah The case study of Al-Balad". Amazonia Investiga, 12(67), (2023).

Barrile, V., Bernardo, E., Fotia, A., & Bilotta, G. ''A combined study of cultural heritage in archaeological Museums: 3D survey and mixed reality. ''Heritage, 5(3), (2022).

Bec, A., Moyle, B., Schaffer, V., & Timms, K. ''Virtual reality and mixed reality for second chance tourism. '' Tourism Management, 83, (2021).

Buhalis, D., & Karatay, N. ''Mixed reality (MR) for generation Z in cultural heritage tourism towards metaverse. Information and Communication Technologies in Tourism''.

4.2 App feasibility

The app development has proven to be a complex process. Yet, it has also proven to be doable and manageable. The challenges faced during this study can be summarized as follows:

- Rarity of specialized AR app developers in Saudi.
- Costly charges for AR app development.
- The app required countless site visits for testing and bug fixes, and given the location of the historic site, these have proven to be strenuous at times.
- Missing documents, plans, and photographs, especially for pre-renovation or old aspects of the house.

When discussing VA, not only traditional styles and materials come to mind, but also traditional construction practices. As Olukoya (2021) mentions that VA is the byproduct of individuals sharing a common heritage and creating their building methods. This point was made clear when restoring the Matbouli house, as Eng.Samir mentioned requesting the assistance of an old contractor familiar with the traditional construction methods of the Hijazi in Albalad.

As a main objective of this paper, boosting tourism is an important aspect to be discussed. The engineer delved into the importance of cultural tourism, as Han et al. (2013); Mousavi et al. (2016) validated the importance and value of culture to the tourism sector. The significance of cultural heritage is also evident through the initiatives made by the Saudi government to enhance, support and highlight this sector.

The same goes for the second objective which is the preservation of heritage, both tangible and intangible. As emphasized by Ibrahim (2018); Mazzetto (2023) regarding the importance the Saudi government has placed on preserving its cultural heritage. Eng. Samir not only validated the significance of VA as noted by Asif et al. (2018); Azevedo-Salomao and Torres-Garibay (2016), but has also stressed on the role technology plays in preserving said heritage. This was highlighted by tom Dieck and Jung (2017) and proven in this study as well.

Given that almost 85% of global tourists are interested in using AR in their visits, as documented by Han et al. (2018), it is rather important to launch apps that utilize this technology, such as the Heritage lens app developed for this study. As suggested by Eng, further developments and updates are needed to expand the app and reach a higher satisfaction rate by users and stakeholders alike. Samir; and as proven by Chung et al., 2015. Although the app proved to be costly and time consuming for the authors of this study, the study done by Merchán et al. (2021) offers the great solution of a sponsor covering the cost and assisting with experts to expedite the development and refinement process. Eng. Samir also noted this as a future step to enhance the Heritage Lens app.

5.Conclusion and recommendations

In conclusion, the integration of AR into vernacular buildings, like the Matbouli house, has been shown to have enormous potential for promoting tourism, strengthening cultural preservation, and offering tourists unforgettable experiences. This paper has demonstrated the substantial influence that technology can have on the travel and tourism sector as well as the architecture/design field through the creation of an AR app that highlights the Matbouli house's tangible and intangible cultural/design features. The study's findings have demonstrated a clear inclination towards utilizing AR apps to explore historical sites and superimpose design features and cultural elements. According to the literature review, AR apps have been well received and they have the potential to change how tourists interact with and learn about cultural heritage. Additionally, the paper's literature review revealed a gap in the literature as well as in the market for AR apps, further highlighting the area's unrealized potential for innovation and expansion. AR apps may also generate economic growth, encourage sustainable tourist practices, and help preserve cultural treasures for future generations by bridging the gap between technology and cultural heritage.

5.1 Recommendations

The study's results and conclusions have led to the following recommendations. They are proposed to maximize better the possibility of incorporating AR into vernacular buildings to improve cultural preservation and increase tourism:

1. Create, fund, and use Augmented Reality apps.
2. Advance research in technology integration into design and architecture.

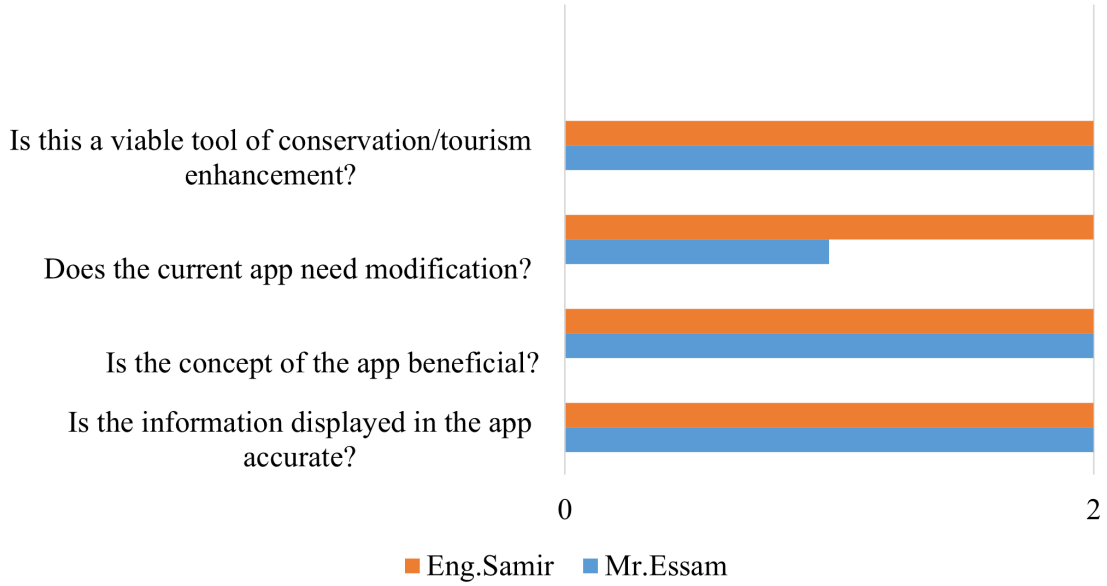


Figure (15). Interview chart. Source (author. 2024)

restoration efforts to safeguard culture and heritage.

3. To ensure authenticity, only natural materials were used in the restoration procedure of the house.
4. Completed the house restoration project without using contemporary materials like metal or cement.
5. Mentioned the use of technologies like scanning and construction software to aid the restoration process.
6. Worked in tandem using traditional Hijazi building techniques and contemporary technologies throughout restoration.

- Regarding the AR app:

1. He has always advocated for the use of new technologies, such as AR, for cultural preservation of historic buildings and tourism enhancement. As indicated in figure.15, and seeing as it is within his field of expertise, Eng. Samir provided valid feedback, including 3 important future enhancements to be considered.
2. Suggested adding audio and music to the app to engage tourists, especially the younger generations.
3. Suggested adding details on traditional building techniques and the unique design aspects of the ceilings, doors and Roshans in Hijazi vernacular buildings.
4. Suggested contacting the Ministry of Culture to enhance and grow the AR app for a more enriched and wide user experience.

They also agreed on the following points:

1. Highlighted the house's cultural and historic significance to them as a family and the historic area.
2. Emphasized how crucial it is to protect and promote the house's legacy through modern technologies.
3. Supported and praised the integration of AR into the house, precisely the concept of the current app for both tourism and preservation. As seen in figure.15, Mr. Esam praised the idea but hasn't provided feedback on suggested enhancements. Therefore, only Eng. Samir's modifications to the current app were discussed.

Both stakeholders expressed gratitude and enthusiasm for selecting the house as a case study, and were extremely helpful and generous with their expertise and feedback. Eng. Samir said: "The idea to use an AR app is excellent and praise-worthy; as it is the first app of its kind that I've seen used in a historic building to preserve it."

Figure (12). Fourth feature. Source (author. 2024)

Figure (13). Fifth feature. Source (author. 2024)

3.2.3 Trial and implementation

The trial of the app was ongoing as various site visits were needed to ensure functionality. This phase included bug fixes and updates made on the app to increase usability, ease of navigation and accuracy. The final version of the app was completed in March. A walkthrough step-by-step of the app is detailed in Figure 14.

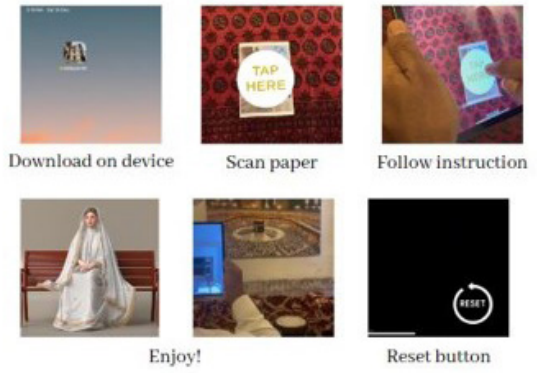


Figure (14). Steps. Source (author. 2024)

4. Results and discussion

The results of this study can be categorized under two main sections: 1. Stakeholder feedback and 2. App feasibility.

4.1 Stakeholder feedback

The semi-structured interviews with both Mr. Esam Matbouli and Eng. Samir Matbouli were of great help for the study. The core questions answered by both stakeholders are displayed in figure.15, where (0=no) and (2=yes). The results of the interviews can be summarized as follows:

Mr. Esam Matbouli's interview: Gave insightful advice about the Matbouli house museum's background, cultural and historic significance, as well as providing the author with the content displayed in the AR app including traditions and pre-renovation state of the Maqa'ad room seen in tables 4 and 5.

Eng. Samir Matbouli's interview:

- Regarding the restoration project:

1. The project took around a year to finish
2. Made valid points on the state of vernacular buildings worldwide and the need for

Figure (9). Arabic view. Source (Author, 2024)

to the app. The app has 5 main features: it includes both Arabic and English viewing options as well as a reset button to erase the displayed features and move on to others. This can be seen in Figure 9. The app also utilizes text to further explain the figures, to provide context and to enlighten tourists about the unique heritage of the house. It is important to note that studies have shown that people don't want to read a lot during their museum visits, so text should be kept to a minimum (Gong et al., 2022).

1st feature: Greeting

This feature, seen in Figure 10, includes a 3D figure of a man dressed in traditional Saudi garments welcoming tourists into the house. This feature is meant to be welcoming as well as educational as it provides key information about the house.

2nd and 3rd features: Almaqaad room

These two features, seen in Figure 11, include 3D models of the previous built elements in the room that existed before the current renovation. These elements consist of a desk for the homeowner and a wall with a crevice for an old TV which has now been completely covered and replaced with sofas. The current state can be seen in the elevation in Table 4. The wall structure, TV, and desk are

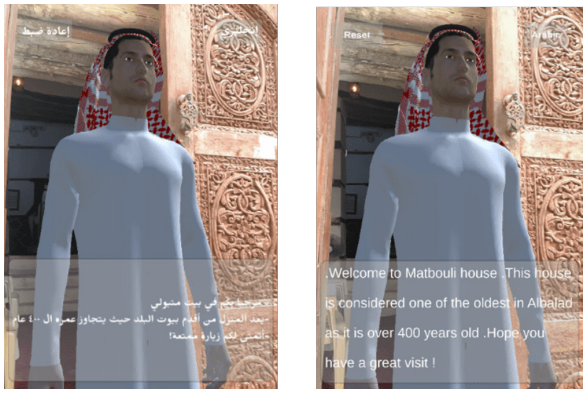


Figure (10). First feature. Source (Author, 2024)

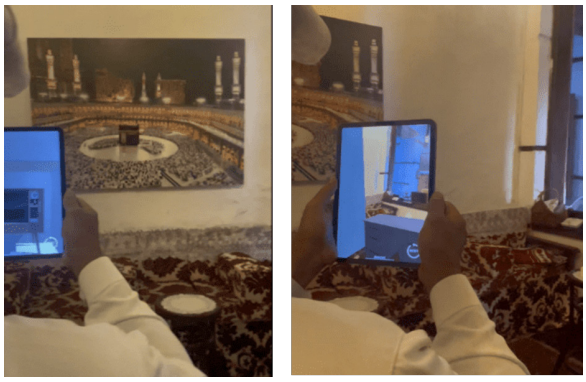


Figure (11). 2nd & 3rd features. Source (Author, 2024)

all tangible elements that give an insight into the function of the space they are in. This function has changed as time has passed and the room was renovated to accommodate these changes.

4th feature: Pilgrims

This feature, seen in Figure 12, includes 3D figures of men dressed in pilgrimage garments. Additionally, it has information on the tradition that the Matbouli family upheld for generations which is welcoming and housing pilgrims during the month of Dhul Hija. This feature, alongside the 5th, are aimed at preserving the intangible heritage of the house.

5th feature: Bride

This feature, seen in Figure 13, includes a 3D figure of a woman wearing the traditional bridal gown called "Masdah Hashimi", as well as information on the cultural tradition of the Hijaz region where weddings were held for up to 7 days in a joyful atmosphere.

3.2.2.2 Programming

During this phase, the developer and the author signed up and were verified as Apple developers to start making the app. Previous studies that have utilized AR apps were analyzed, as seen in Table 6. This gave a clear direction regarding which methods worked best and aided the programming phase. The initial model of the app took two months to program, and the main software used was Unity 3D. This software, aside from it being cost effective and easy to use, has been used to create many successful AR apps and games such as Pokémon Go. It has also been proven to improve interaction with AR content and user interface clarity (Kim et al., 2014). The app was decided to be a marker-based AR app, where an image (marker) is placed on the floor and scanned to initiate the AR features. The app was named HeritageLens, as seen in Figure 8.

Figure (8). App icon. Source (author. 2024)

HeritageLens includes the built heritage as well as cultural heritage details of the traditions that took place in the house, further conserving the culture as well as the architecture and design of the space. It allows its users to explore these features by pointing their devices (phones and iPad) toward a printed image. The app automatically scans it and superimposes the figures supposed to be in that place. Below is a breakdown of the features added

Table (6). AR apps analysis. Source (Author, 2024)

	Research paper	AR software / type	Site	App's main feature	Future recommendations related to this study
Similar implementations	"The determinants of recommendations to use augmented reality technologies: The case of a Korean theme park" (Jung et al., 2015)	Marker-based AR app and 3D book	Theme Park in Jeju Island, South Korea	Tourists can engage with superimposed characters that engage them in tales surrounding the theme park	- Marker-based apps are recommended
	"Using hologram technology in constructing virtual scenes in archaeological sites to support tourism in Egypt" (Hussein & ElDeen, 2020)	Holograms	Historic site in Egypt	Restoring and conserving the archaeological site and showcasing it in virtual scenes	- Integrating technology into design/engineering fields
	"Value of augmented reality to enhance the visitor experience: a case study of Manchester Jewish Museum" (Jung, 2016)	AR app (was yet to be developed for the study)	Manchester Jewish Museum	Preservation of history and personalized museum tours	- Implementation of an AR app to enhance the visitor experience
	"Good practices in the use of augmented reality for the dissemination of architectural heritage of rural areas" (Merchan & Perez, 2021)	Unity 3D software / Marker-based app	"La Matilla", in Spain.	Shows the archaeological remains of some Roman buildings	- Internet connectivity must always be present - The information presented in the app should be easily understood by users
Result	This paper	Unity 3D software / marker-based app	Matbouli House in Albalad, Jeddah, SA	Preservation of both tangible and intangible heritage	- Recommendations applied

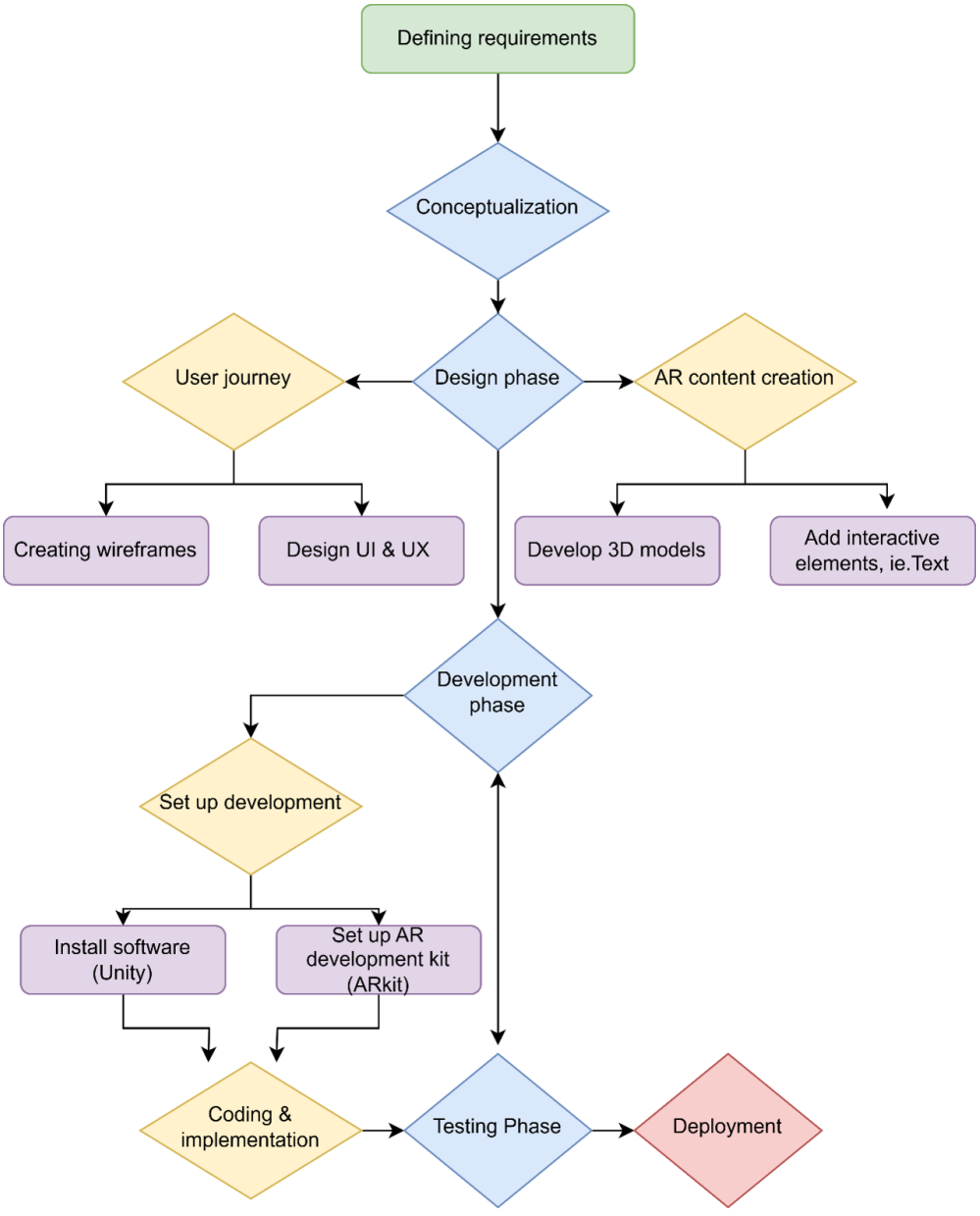


Figure (7). App development. Source (Author, 2024)

give people new approaches to perceive, identify and interact with their surroundings (Chen et al., 2019). Not only that, but as Chung et al. (2015) explained that tourists who use AR can be immersed in valuable experiences without even needing a tour guide. The app also aims to reconstruct architectural elements that have been lost. The development of the app went through a lengthy process, seen in figure.7. It can be summarized under three main phases: planning phase, programming phase, and trial/implementation phase.

3.2.2.1 Planning

This phase consisted of contacting multiple AR app developers and comparing offers. Time, cost and quality were the three main factors assessed. After several meetings, a developer was selected and given a thorough explanation of the project, objectives, and desired outcome. All the schematics, details, images and further dimensions were sent to the developer.

have potentially looked without signs of decay and erosion. This was done using the software 3dsmax, while Corona was the rendering engine. Figure 6 shows a select few of these 3D shots.

3.2.2 AR App Development

The primary research tool used in this project was an AR app development software. The software, called Unity3D, allowed for of a digital overlay that could be superimposed onto the physical environment of the Matbouli House Museum in Al-Balad. By leveraging this technology, users could interact with virtual elements that enriched their understanding of the historical and cultural significance of the building, in addition to viewing the building's past state, which has long been renovated, of some of the architectural and design elements of the house. The floorplans, elevations, and reconstructed 3D scenes laid out the groundwork for the development and implementation of the AR app. The app's main goal, as Buhalis and Karatay (2022); Lalitha and Rajasekar (2019) suggest is to offer tourists an enriched, immersive, and unique experience, all the while preserving and promoting the cultural value the households, and unique experience, all the while preserving and promoting the cultural value of the households. It is a way to

Table (4). Elevations. Source (Author, 2024)

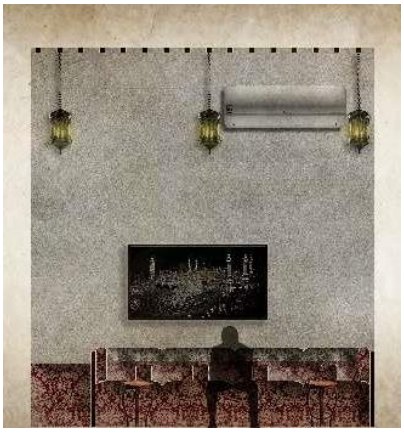
	Before renovation	After renovation
Rendered elevation		
Description	The wall had a hollow space for the TV	The space was filled out and sofas were placed, as well as an AC unit and a painting

Table (5). Elevations. Source (Author, 2024)

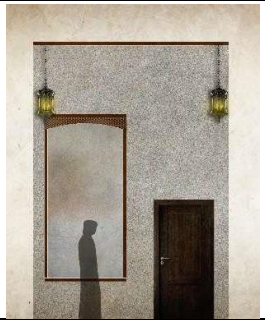
	Before renovation	After renovation
Rendered elevation		
Description	A desk used by the homeowner took up the space next to the door	The space is now adorned with a glass window overlooking the hallway

Figure (4). Site analysis. Source (Author. 2023)

the study, it was easily accessible for research and implementation purposes.

Built in Souq Al-Alawi in Harat Al-Yaman, exact location seen in Figure 4, the house stands four floors high and on an area of approximately 350 sqm. It was built more than 400 years ago by Sheikh Mahmoud Al-Matbouli. The house has two entrances, and it also has cisterns to collect rainwater. The main entrance overlooks Souq Al-Alawi, which has nearby historical landmarks such as Bayt Nassif and Ain Faraj. For centuries, the house delivered cultural significance to the area. For example, it housed pilgrims during the month of Dhul Hijja. The Matbouli family would accommodate them and provide them with all necessities to ensure their comfort throughout their stay. Additionally, weddings were hosted in the house where the bride would be for up to 7 nights in a celebratory and joyful atmosphere.

Figure (5). Matbouli house. Source (Author. 2023)

There is even a room dedicated to the sole purpose of preparing ladies for their wedding celebrations including the making of their bridal gowns and the intricate embroidery (Tchalabi, 2023). The home features intricate designs made from natural wood, concrete, and stone, as seen in Figure 5.

d. 3D regeneration

The AR app's creation required the utilization of comprehensive floorplans and schematics of the Matbouli house museum. These architectural drawings offered crucial information on the building's plan, style, and background for both the author and software developer. Unfortunately, the required architectural drawings were not readily available, therefore they were drawn by the author according to the current site.

The Matbouli house has witnessed many renovations and has housed many generations. The purpose of producing 3D visualizations was to utilize another form of technology in documenting the current state of the house digitally, as well as provide clear visualization for the software developer to work on. It is imperative to note that the developer is not a Saudi resident and was unable to conduct a physical site visit. Due to the absence of floorplans and technical drawings and the need for such drawings to communicate to the app developer the location of the features and the dimensions for each, the dimensions were documented through site visits, and the floorplan and elevations were drawn accordingly. The elevations for the room known as Almaqaad can be seen in Tables 4 and 5. The elevations show both the state of the room before the renovation and after it took place. After the floorplans and elevations were determined, 3D scenes were created to mimic how the house could

Figure (6). 3D visualization. Source (Author, 2023)

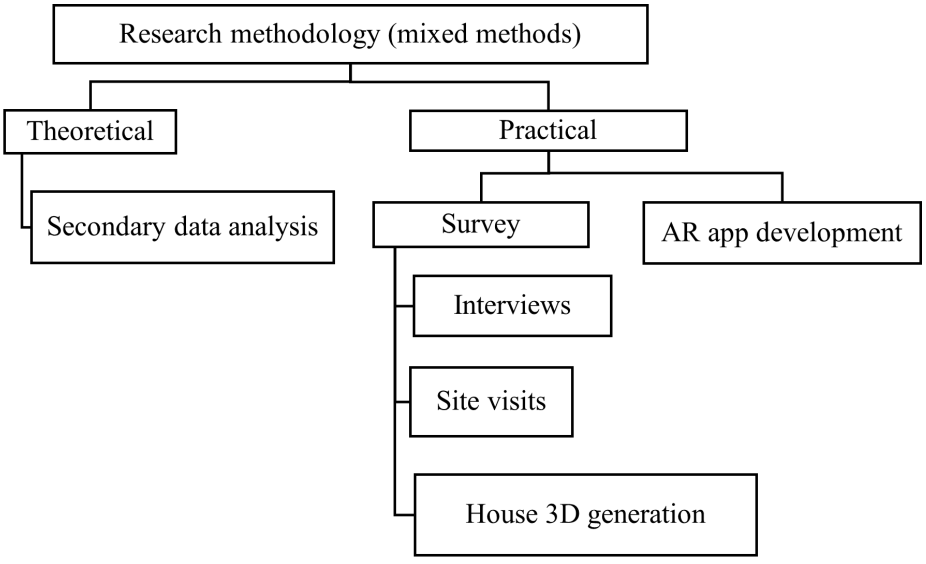


Figure (3). Methodology. Source (Author, 2023)

3.1 Theoretical methods

3.1.1 Literature review

Focused papers on vernacular architecture, tourism enhancement, AR technology, and heritage preservation were studied to obtain insights into best practices and theoretical frameworks. Additionally, the literature review aided the creation of the AR app. This theoretical underpinning drove the design and execution of the AR app, adhering to known principles and adding to the body of knowledge already available in the area.

3.2 Practical Methods

3.2.1 Survey

a. Interviews

The qualitative data was collected through semi-structured interviews with both Mr.Esam Matbouli and Eng.Samir Matbouli. To guarantee the veracity of the data provided in the AR app, newspaper articles about Matbouli House were examined. The interview was conducted with Mr. Esam and Eng. Samir was followed to further ensure the accuracy of the information. Both Interviewees were also asked their opinions on the AR app concept and their recommendations. A summary of their interviews can be seen in Table 4.

b. Site visits

Site visits were part of the observational research, and were conducted continuously throughout the study. The visits were done from October 2023 until March 2024. These visits facilitated viewing the Matbouli house museum, taking its dimensions, capturing photographs, and conducting the interview with Mr. Esam. It was therefore possible to have a thorough grasp of the traditional Matbouli home in Al-Balad, and its cultural significance.

c. Site analysis, historical and cultural significance

The study focuses on Matbouli house museum as the case study. The house is located in Albalad, Jeddah. Albalad is a UNESCO historic site; therefore, its selection adheres to the goals of the paper. Furthermore, few buildings were available and given access for research, as Albalad is undergoing significant renovations. Efforts by the Ministry of Culture are placed on doing so in the most optimum and efficient ways. Nassif House was another building selected by the author but was then written off due to the reasons mentioned beforehand. Matbouli House Museum is a prime example of vernacular buildings that have been restored and presented for tourists to display the rich culture of old Jeddah. After obtaining permission from Mr. Esam Matbouli to conduct

of them believe that VR and AR are definitely the future of tourism (Han et al., 2018). The most promising methods of the conservation of heritage sites include augmented reality apps. An AR app was developed to provide a unique experience to view the no longer accessible heritage site (La Matilla) in Spain. The app showcased the Roman building remains found in the area. These remains were buried to allow for roadwork in the area and as of late, the only evidence and visualizations of this site are presented through the AR app. After calculating the cost, time and value of conserving heritage through an AR app, the respective authorities were pleased with the potential and agreed to cover the total costs once the app was done (Merchán et al., 2021). ARCHEOGUIDE is another AR project funded by the EU designed to provide guidance and assistance to tourists of cultural heritage sites (Vlahakis et al., 2001). Other AR apps for heritage sites include Time traveler, Past View Saville, and Street Museum Londinium (Tscheu & Buhalis, 2016). Thanks to these technologies, the "passive" tourist transforms into a "active " one allowed to interact, share and view the preserved objects/sites in a novel way that ensures a memorable experience for them" (Barrile et al., 2022). Overall, proposing AR technologies as comprehensive applications for historic preservation may not only offer an innovative preservation/restoration method that is not invasive but they could also strengthen the travel experience. As a result, in the context of Melaka, which is a UNESCO World cultural site, it is a holistic approach to heritage preservation (Aziz & Siang, 2014). As fascinating as AR is and contrary to popular belief, it is still not being widely used or implemented. This could be for reasons such as the newness of it. Regardless, it is progressing slower than anticipated (Chung et al., 2015). Since some AR projects consist of using a head-mounted display, such as the one seen in Figure 2, and/or an extra backpack, this may result in issues including pain, disorientation and poor depth perception.

Figure (2). Microsoft HoloLens 2. Source (Microsoft.com)

This issue can be circumvented using more current AR systems that are portable, less intrusive and improve the sense of presence and immersion (Wu et al., 2013). In general, it can be safely said that AR is the perfect technology to present historical events and heritage without being invasive to the original architecture and compromising its integrity (Jung, 2016).

3.3.5 Potential role of AI and ML in AR

Cultural heritage around the world is facing dangers of loss and deterioration, therefore, the utilization of technologies such as Artificial Intelligence (AI), and Machine Learning (ML) for preservation has become essential (Das et al., 2022). In the VA and preservation discourse, AI can be used alongside AR to conserve cultural heritage (Aburamadan et al., 2021). As far as tourism, AI Chatbots is also becoming increasingly famous. They can assist tourists in finding answers to their questions and offer immediate customer service. AI can be used in conjunction with other technologies such as AR to elevate tourist experiences and personalize them, making them both memorable and uniquely catered to each tourist (mcit.gov.sa, 2023).

3.Research Methodology

This study utilizes a mixed-methods approach that combines descriptive research, qualitative data gathering techniques, and real-world applications including 3D modeling and AR app implementation, as seen in figure 3.

immersive experiences provide a special chance to close the knowledge gap between the past and present, improving our comprehension of architectural and cultural history. Table 3 offers a concise comparison of all three. Technologies such as AR, AR, and MR are equally interesting and all hold so much potential within the field of cultural heritage, preservation and history recreation (Buhalis & Karatay, 2022; Lalitha & Rajasekar, 2019). They create a captivating virtual universe that extends well beyond what is seen in a typical museum setting. Using technologies such as AR provides users with unique interactions with objects and information (Pedersen et al., 2017). These technologies have garnered global attention and interest, especially for tourism and preservation (Bec et al., 2021). AR is an innovative way to enhance the preservation of history, increase tourist satisfaction, gain positive feedback, and offer better learning experiences. (Tom Dieck & Jung, 2017) but it can still be said that, unfortunately, a huge gap in literature is present revolving around the use of AR for heritage preservation purposes (Aziz & Siang, 2014).

Results of a thorough study indicate that stakeholders in cultural heritage tourism view augmented reality as having many multifaceted advantages, including economic, experiential, social, epistemic, historical and artistic, and educational value. All of which encourage decision-makers and stakeholders to invest and implement this technology in settings where the preservation of history and culture is needed, such as museums (tom Dieck & Jung, 2017).

2.4.2 Impact of technology on tourism

The surge of technology in many fields has revolutionized the world, especially in the tourism sector. Tourists have new-found flexibility and options thanks to the use of phones, tablets and technology (Çınar, 2020). The recent developments made in the field of electronics and ICT (information and communication technology) have aided and boosted the successful transition to a new digital world (Pan et al., 2018). For example, some types of technology such as augmented reality or immersive virtual reality can offer a richer and more engaging tourism experience (Neuhofer et al., 2014). Tussyadiah (2015) adds that smartphones provide access to information, directions and navigation, social networks, entertainment, and other features that facilitate trip planning and improve the entire tourist experience for users. Neuhofer et al. (2014) argues that researching, comprehending, and the making of technology-enhanced experiences is severely lacking in both tourism practices and research/literature alike.

2.4.3 Uses of AR in engineering and architecture

The integration of diverse digital technologies has resulted in a shift within the architectural and construction fields (Gattupalli, 2023). The use of AR in the architectural design field can be dissected into three main categories. The first being the use of AR to address historic buildings for the purpose of conservation and knowledge and enhancement. This category is concerned with cultural heritage and tourism and VA. The second is using AR in the construction phase, and this is concerned with the design and building process, including project planning. The third is using AR for educational purposes, and this includes professional training and any transfer of knowledge regarding architecture (Russo, 2021). HoloLens was recently used in industrial engineering, where it aided in the surveillance of factory robots. Its role didn't stop there, as it was also used as a headset-based AR app that assisted people with RTA (ready-to-assemble) furniture. Users were able to visualize the spatial link between furniture pieces rapidly. Consequently, it was demonstrated that the program was successful in enhancing the user's capacity to solve spatial problems when interacting with RTA furniture that varied in terms of difficulty of assembly. HoloLens was also used to visualize 3D city models in Toronto, Canada, and different kinds of city data (Park et al., 2021).

2.4.4 AR in VA preservation and historic reconstruction

Buhalis and Karatay (2022) emphasized the importance of utilizing technologies to present culture, heritage and history to new generations such as Gen Z and to appeal to their needs. In fact, a staggering 84% of global visitors have shared enthusiasm over using technologies such as VR and AR within their travels, and no less than 42%

family in the higher levels of the house. A traditional home in Al-Balad is shown in Figure 1.

Figure (1). Albalad VA. Source (UNESCO)

2.3.2 Influence of climate and geographical location on Albalad's VA

Saudi's traditional architecture has been affected by many things, including the climate, economy, culture, and the presence of natural materials (Dwidar et al., 2020). It can be said that Saudi's VA exhibits a connection between the buildings and the climate, a byproduct of years of experience, the smart use of resources, logical analysis and the application of proper methods (Kamal, 2014). As for the climate, it can be said that the general climate is hot and dry due to the country's desert nature. Temperatures vary significantly in coastal areas, such as Jeddah, only reaching tolerable temperatures during winter (Dwidar et al., 2020).

2.3.3 Matbouli House Museum

The Matbouli House, now a museum in Historic Jeddah (Albalad), is a UNESCO World Heritage Site. (Alshawabkeh et al., 2021). The historical house is one of the oldest buildings in Albalad; where it was built more than 400 years ago. It is characterized by its vernacular style that embodies the old Hijazi architectural identity. The house was restored recently to preserve its rich cultural heritage. The restoration was led by Engineer Samir Asaad Matbouli, who supervised the entire process, which took nearly a full year to complete. Noting that UNESCO visited the house and praised its restoration upon completion (spa.gov.sa, 2016).

2.4 Impact of technology integration on architecture and cultural tourism

2.4.1 AR, VR, and MR

Technological developments, such as augmented reality (AR), virtual reality (VR) and mixed reality (MR), have completely changed how we interact with historic monuments and structures. Several case studies prove their usefulness, as

Table (3). AR,VR,MR comparison . Source (Author,2024)

Aspect	VR	AR	MR
Completely virtual environment	✓	×	×
Mixed environment	×	✓	✓
Real-world elements	×	✓	✓
Virtual elements	✓	✓	✓
Immersive	✓	✓	✓
Projection tools	Headsets	Headsets – portable devices - holograms	
User interface	Isolated	Overlaid, contextual	
Content	Fully simulated	Augmented	
Disorientation	Observed	Could be avoided depending on projection tool	
Headaches, pain			

2.2.6 Sustainable tourism

Reducing the detrimental impacts of tourism on the environment, society, and economy is the goal of sustainable tourism, which aims to create an environment that is socially and morally successful, just as much as it is economically viable (Pan et al., 2018). In the case of Al-Balad, the balance between economic gains and sustainability comes to fruition with the socio-economic strategies put in place. Achieving economic sustainability may be attained by the business growth options provided to the community, drawing in visitors, raising property values, and utilizing adaptive reuse (Bamuqabel & Golkarian, 2023). The prospects of sustainable ecotourism and digital tourism have garnered global interest. The ministry of communications and information technology in Saudi Arabia published a report commending the benefits of digital tourism and its ties to sustainability (mcit.gov.sa, 2023).

2.2.7 Saudi Initiatives in Smart tourism

Smart tourism is defined by Gretzel et al. (2015) as tourism that is backed by efforts to identify novel approaches for gathering, combining, and utilizing data from various sources. This is done in conjunction with the application of emerging technologies to convert the data into enhanced experiences, with a particular emphasis on efficiency, sustainability, and richer travel experiences. In Saudi Arabia, Mazzetto (2023) informs that the primary government organization in charge of advancing the travel and tourism industry in the Kingdom is the Saudi Commission for Tourism and National Heritage (SCTH). The Commission oversees the upkeep and conservation of Saudi cultural heritage in order to boost domestic and foreign tourism. Additionally, the current minister of tourism in Saudi Arabia, his excellence Ahmed AlKhateeb, revealed the country's plans to initiate and foster digital tourism. The strategy placed focuses on innovation and plans on inspiring other initiatives worldwide. It includes a total of 31 initiatives targeted towards digital tourism, including the use of VR and AR. The minister stressed that the Kingdom welcomes the creativity of smart and innovative minds from around the world (spa.gov.sa, 2022).

2.3 Albalad, Jeddah

Jeddah is a coastal city in the western region of Saudi Arabia, otherwise known as Hijaz. Hijaz region, has long been a cultural hub of diversity and an example of unity; it holds a special place for Muslims around the world and has been an attraction for business ventures and trade, mainly through the coastal city of Jeddah (Abbas, 2016). Since the city turned out to be the main port of Mecca, Jeddah became an important city in the Hejaz region and in the Islamic world (Bagader, 2014). Al-Balad, means 'town' in Arabic. It is the oldest part of the city of Jeddah (Kamal, 2014). Alshehri and Corbell (2016) beautifully add that while (Balad) means town, the prefix (Al) is a definite article that is added to the word Balad to make it Al-Balad, meaning 'The Town'. This simple addition implies that there is one town referred to as 'the' town. Jeddah was indeed worthy of being referred to as 'the' town. Bagader (2014) adds that Al-Balad makes up the historic part of Jeddah and has been there since the city was first built in 646 AD.

2.3.1 Albalad VA

The historic district is a unique and remarkable example of the merging of different styles and backgrounds into one spectacular architectural identity (Sacchi, 2013). As a city that was walled during the 1500s, Jeddah didn't have the capacity to ex,pand horizontally which resulted in the vertical expansion evident in its high-rise building typology (Alshehri & Corbell, 2016)The authors continue to describe the unique design elements and features of Al-Balad's buildings, ranging from the Roshans and engraved doors to the unique natural materials used in the making of the homes. Table 2 shows some of the widely used materials in Hijazi, VA, found in Al-Balad's buildings.

Kamal (2014) explains that some buildings were very high, reaching seven stories, while some were four stories high. Their design and openings allowed for cross ventilation. The layout of the houses was mostly similar; the ground floor would be strictly for welcoming guests and was typically occupied by men to offer privacy to the rest of the

Table (2). Widely used materials in Albalad . Source (Author,2024)

Name	Uses
'Mangabi' coral stones	Construction
'Nura'	Decorative plaster
'Taklilat'	Wooden beams

the Saudi initiative referred to as Vision 2030. Vision intends to support the growth of the country in many fields by improving the level of awareness of local traditions, heritage and values, all as part of a sustainable approach.

2.2.4 Tourism

Tourism is one of the fastest growing industries in the world, and is one of the most rewarding (Pratheep, 2013). Tourism comes in many types including ecotourism, wellbeing tourism, cultural tourism and rural tourism, as seen in Table 1.

Cultural tourism refers to the forms of art (culture) in the urban and rural area of a region or country, and it is defined as the movement of people to cultural attractions far from their normal place of residence, aimed at assimilating information and cultural experiences (Petroman et al., 2013). Also known as heritage tourism (Pan et al., 2018), it has become the main goal of travel for an increasing number of tourists worldwide, with the United Nations World Tourism announcing that around 40% of international tourists are seeking out cultural tourism (Richards, 2021). It is one of the fastest growing tourism sectors (Han et al., 2013). Culture is considered to be a major asset in the development of the tourism sector. As Mousavi et al. (2016) highlights, both the tangible heritage, present in museums and other attractions, and the intangible heritage that is present in festivals and events, have the power to strengthen the tourism sector.

2.2.5 Tourism and economic development

Although the service sector has been regarded and viewed as static (Faber & Gaubert, 2019), the field of tourism has increasingly developed in the last decade, reaching a staggering 266 million jobs globally supported by the growing sector. The growing demand for tourism and travel experiences has tremendously changed the economy. In fact, Du et al. (2016) declared that the global economy has grown by 9.5% (around US $7 trillion) because of tourism. This goes to show that not only has tourism made tremendous economic gains but it's proving to be the fastest growing sector worldwide. Not only that, but statistics have shown that over 47% of the economies of developing countries have been because of tourism (Pan et al., 2018). In KSA, for example, the economic impact of tourism is evident, with the official Vision 2030 page announcing that since the tourism visa was launched in 2019, over 94 million visits have been made to KSA (Vision2030.gov, n.d.).

Table (1). Types of tourism (comparison). Source (Author,2024)

Aspect	Ecotourism	Wellbeing tourism	Cultural tourism	Rural tourism
Focus	Natural environments, conservation	Personal well-being, relaxation	Cultural experiences,	Rural experiences, local lifestyle
Purpose	Sustainable travel, environmental education	Physical & mental health improvement	Understanding traditions, art, history	Enjoying countryside, local communities
Activities	Nature walks, wildlife viewing etc…	Spa treatments, meditation, yoga etc…	Museums, historical sites, festivals etc…	Farm stays, local food experiences etc…
Impact	Enhancing sustainability	Enhancing mental and physical health	Preservation of heritage – enhancing	Support for local economy, community
Accommodation	Eco-lodges, tents, sustainable resorts	Wellness resorts, spa hotels and retreats	Hotels, homestays, cultural sites	Guesthouses, farm stays, cottages
Experience	Connecting with nature, conservation	Relaxation, rejuvenation, stress relief	Immersion in local traditions and heritage	Authentic rural lifestyle, simplicity
Location	National parks, reserves, eco-destinations	Wellness retreats, spa towns	Historic cities, archaeological sites	Rural areas

insights into the benefits of utilizing technology for the conservation and promotion of Al-Balad's unique cultural heritage. As Çizel and Ajanovic (2018) asserts: "Cultural Heritage, both tangible and intangible, represents value systems, beliefs, traditions and lifestyles of one society." This study will investigate the ways in which historic buildings in Al-Balad are being preserved and showcased to the public. Moreover, the positive impacts of these efforts on tourism have been examined, all through a qualitative analysis of a case study, and a review of the relevant literature.

2.Literature Review

The literature review strives to identify the existing gap in literature concerning the integration of AR in vernacular buildings in Saudi Arabia and sets the goal of this research in realizing the importance of using such methods to boost sustainable tourism and increase the level of the heritage and historic preservation of vernacular architecture. The relevant literature is categorized under three main topics: vernacular architecture and tourism, KSA's vernacular architecture, and the impact of technology integration on architecture and cultural tourism.

2.1 Research gap analysis

Comprehensive studies examining the usage of augmented reality especially in Al Balad, historic Jeddah, are lacking. For example, about 214 results appear when searching "augmented reality in Albalad" on Google Scholar, dating back to 2014. Only a few of the papers analyze AR as an emerging tool, and none of them display the real-life application of AR on one of Albalad's vernacular buildings. Studies that already exist frequently concentrate on modern architecture or broad historical sites without exploring the potential and difficulties of vernacular building and heritage preservation through the implementation of an AR app, which this paper seeks to address.

2.2 Vernacular architecture and tourism

2.2.1 Vernacular architecture

Vernacular architecture (VA) has been defined as a construct based mainly on a society's outlooks and religious beliefs (Hamza, 2019; Oliver, 2012; Weber & Yannas, 2013). Hamza (2019) adds that with its layout of spaces and urban designs, VA represents cultural manifestations. Moreover, Olukoya (2021) defines VA as structures that are distinctive, representational, and understood within their local communities; they are buildings made by people in a specific geographical spot that are of the same ethnic background. The author explains that it's imperative to note that the contextualized cultural legacy is the result of individuals functioning within a shared heritage in a given area and time, using their own contextual processes and practices. Additionally, Sarah (2011) points out that although VA originally began at the hands of unschooled architects, this changed after the late 19th century with professional architects adopting the style to present the culture and history of a certain region, as well as the technological and environmental advancements made within a given community. Nevertheless, the previous authors agree that it is made with local and easily found materials. It is an architecture characterized by its dependence on local needs, resources, and traditions, which makes it impossible to copy without losing its essence (Merchán et al., 2021).

2.2.2 VA cultural significance

VA has a rich cultural heritage that embodies the unique traditions of a community, contributing to its wealth of heritage (Azevedo-Salomao & Torres-Garibay, 2016). The authors add that this type of construction has a noteworthy ecological quality that helps the local population as well as the surrounding natural and cultural areas. Correspondingly, it can be said that the way a space is built is correlated to the culture of the geographical region it is built in, and that the space humans occupy is filled with social information pertaining to them. In fact, the traits of a given society can be inferred from the ways that their buildings and spaces are organized (Asif et al., 2018).

2.2.3 Conservation of VA in Saudi Arabia

The MOC - Ministry Of Culture - in KSA has established 11 different commissions governed by the ministry, two of which are for architecture/ design and heritage. Ibrahim (2018) asserts that the KSA has addressed the importance of heritage and identity preservation, therefore, it has taken on many initiatives to promote conservation like the "Initiative to start Center for the National Built Heritage (CNBH)." Mazzetto (2023) emphasizes

Journal of Architecture and Planning , Vol. 36 (4) , pp. 405-425, Riyadh (2024/1446H)

doi:10.33948/JAP-KSU-36-4-1

Adopting Augmented Reality to Enhance Vernacular Building Preservation and Tourism: Case Study in Matbouli House Museum, Al-Balad

Rafeef Al-Gurashi — Master's candidate

Alaa Shatwan — Associate professor

College of Arts and Design, University of Jeddah.

Rafeef1alqurashi@gmail.com *ashatwan@uj.edu.sa*

(Received 15/4/2024; accepted for publication 12/9/2024.)

Abstract: This paper investigates the use of Augmented Reality (AR) in a vernacular building, namely the Matbouli house. The paper studies the potential of vernacular buildings as a tourism source, with a particular focus on the role of AR in preserving historic buildings. A qualitative approach is utilized, which includes a literature review, the documentation of the built and cultural heritage of Matbouli house, and designing an AR app. The app highlights the house's tangible and intangible cultural features. This study seeks to contribute to a comprehensive understanding of the challenges and opportunities associated with vernacular tourism and the integration of technology in preservation pursuits. The findings show that AR apps are becoming increasingly easy to develop and, although costly, they have the potential to reduce renovation costs in the future. Moreover, using AR applications is strongly preferred and tourists are enthusiastic about the engaging, inclusive and memorable experiences they offer. Additionally, AR technology presents a viable way to improve cultural tourism and preservation by bridging the gap between conventional heritage interpretations and modern tourist expectations. Stakeholders are recommended to leverage AR to generate creative and sustainable experiences that draw tourists, spur economic growth, and aid in preserving cultural heritage.

Keywords: Vernacular architecture; Historic Buildings; Technology; Augmented reality; Albalad; Culture; Tourism.

1. Introduction

Al-Balad is one of the kingdom's most notable heritage sites. Heritage sites reflect past traditions, art, and culture (Desai, 2018; Hamza, 2019; Pardo, 2023; Sarah, 2011). As a result of Al-Balad's increasing popularity, touristic endeavors have been made to enhance and preserve the area. There seems to be a lack of technology integration in Al-Balad, and since experience is the essence of tourism (Fan et al., 2022; Jung et al., 2015; Quan & Wang, 2004), this study seeks to address this gap by investigating ways to integrate AR (augmented reality) to maximize heritage preservation and boost tourism, while minimizing the impact of traditional historic building restoration methods. This paper aims to explore the benefits of integrating AR into Al-Balad's vernacular buildings. Although a few international applications have shown and proven AR's promising benefits within the cultural preservation and tourism enhancement pursuits, the paper seeks to investigate this potential in a real-life application in Albalad, as a first of its kind. Conducting a review of the literature for this paper on topics such as vernacular architecture, cultural tourism, and various technologies provided valuable

Journal of Architecture and Planning, Vol. 36 (4), pp. 405-509, Riyadh (2024/1446H.)

Contents

Page

English Section

- References: In general, reference citations in the text are to be in the standard (Author, Date) style. Under the "References" heading at the end of the manuscript all references are to be presented alphabetically by the author's last name in the following fashion:
  A) Periodical citations in the text are to be in the standard (Author, Date) style. Periodical references are to be presented in the following form: author's surname followed by a given name and/or initials (bold), the title of the article between quotation marks (" "), title of the periodical (in italic), volume number, issue number between brackets (if available), year of publication between brackets and pages.
  B) Book citations in the text are to be in the standard (Author, Date) style. Book references are to include the following: author's surname followed by a given name and/or initials (bold), title of the book (in italic), city of publication, publisher, year of publication between brackets and the number of pages.
- Content Note or Footnote: A content note or footnote is a note from the author to the reader providing clarifying information. A content note is indicated in the text by using a half space superscript number (e.g. … books(3) are …). Content notes are to be sequentially numbered throughout the text. A reference may be cited in a content note by the use of the standard (Author, Date) style in the same way they are used in the text. Content notes are to be presented below a solid half-line separating them from the text of the page in which the footnote is mentioned (in single column). Use the same half-space superscript number assigned in the content note(s) in the text to precede the content note itself.
- Proofs: No changes, additions or deletions will be allowed in the page proof stage.
- The paper must be revised linguistically and grammatically.
- Submitting the paper has to be attached with the researcher declaration that it has neither been previously published nor submitted to any other journal until JAP's related procedures are over.
- If the research paper is accepted for publication, a letter of acceptance will be sent to the researcher. If it is not accepted, a letter of decline will be issued.
- Once the research paper is accepted for publication, all copyrights will be reserved to JAP. Accordingly, the research paper must not be published elsewhere in any from without the written permission of JAP's editor-in-chief.
- Opinions: Conclusions and opinions included in the manuscripts submitted to the Journal are exclusively their author's own and do not in any case, represent those of the JAP or its Editorial Board.
- Two free copies of the issue containing the published manuscript will be sent to authors.

Material for Publishing:

JAP provides an opportunity for scholars to publish their original research work. The following is the manuscript type classification required by the Editorial Board:

1. Article: An account of an author's work in a particular field. It should be a new contribution to knowledge in the field in which the research is conducted.
2. Review Article: A critical synthesis summarizing the previously published literature in a particular subject.
3. Book Reviews.
4. Brief Article.

General Instructions:

- Submission of manuscripts for publication: Papers must be presented in final format; and are to include all illustrative material, such as tables and figures, in their appropriate places in the text using MS Word, and typed in pages format numbered consecutively. A soft copy combined with submittal form must be sent to the journal e-mail (jap@ksu.edu.sa) Failure to comply with these guidelines, the paper would be rejected.
- The research has to be written on A4 paper. The number of pages must not exceed 25, including English and Arabic abstracts, tables, figures, photos and references.
- Basic information about the research has to be written in both Arabic and English, and should include the following: research title; researcher's full name; affiliation; and contact details.
- Arabic and English abstracts have to include the following: research topic, objectives and methodology; most important results; and main recommendations. It must not exceed 200 words, and has to be very well written, in single column (13cm wide).
- The abstract (Arabic/English) is to be followed by a list of keywords, not more than Ten, summarizing the research fields.
- 2.5 cm page margins on all sides (top, bottom, right, and left) and single-spaced lines.
- Researches in Arabic must be typed in Simplified Arabic as follows: font 16 non-bold for text, but bold for titles; font 12, non-bold for footnotes and abstract; and font 10, non-bold for tables and figures, and font 12 bold for table headings and comments.
- Researches in English must be typed in Times New Roman as follows: font 12, non-bold for text, but bold for titles; font 9, non-bold for footnotes and abstract; and font 8, non-bold for tables and figures, but bold for table headings and comments.
- Tables and other illustrations: Tables, images and figures, should be planned to fit the Journal's text size area (16 cm x 23 cm incl. running heads), that is, in double column (7.65 cm wide each). Tables and other illustrative material must include headings or titles, and captions for figures with reference to their sources. In addition to the images and figures within the text, the original of All images and figures, with resolution not less than (300 dpi) for black and white and (600 dpi) for colored one, should be send in image file format (jpg, tiff .....) as separate file for each image or figure. All the information in the images and figures should be clear and readable.
- Abbreviations: The names of periodicals should be abbreviated in accordance with The World List of Scientific Periodicals. e.g., et al., J. of Food Sci. For weights and measurements, and where appropriate, abbreviations rather than words are to be used, e.g., cm, mm, m, km, cc, ml, g, mg, kg, min, %, etc., Fig. Latin abbreviations such as: op. cit., loc. cit., ibid., should be in italic (if they are to be used).

Journal of Architecture and Planning

The Journal of Architecture and Planning (JAP) is a refereed scientific periodical concerned with publishing research in the fields of Architecture and Building Science, Landscape Architecture, Urban Design, Urban and Regional Planning and related subjects. It is a quarterly publication (March, June, September and December) by King Saud University. The very first issue of JAP was released in 1409H/1989G.

Vision

To be a leading journal for publication of refereed research articles in architecture, urbanism and related fields, in both Arabic and English.

Mission

Publication according to international professional standards of original, innovative and high quality research in architecture and urbanism and related fields.

Goals

1. To provide a reliable scientific reference of value to the research community in architecture and urbanism.
2. To expand the opportunity to publish research articles linking theory to practice in architecture, urbanism and related fields.
3. To encourage researchers to produce original studies in architecture and urbanism, by providing a publishing outlet in both Arabic and English.

Contact Information

Journal of Architecture & Planning
Kingdom of Saudi Arabia
King Saud University
College of Architecture and Planning
P. O. Box 57448
Ryiadh 11574
Tel/Fax: +966114696844
E-mail: jap@ksu.edu.sa
Website: http://jap.ksu.edu.sa

Subscription and Exchange:

King Saud University Press, King Saud University, P. O. Box 68953, Riyadh 11537, Kingdom of Saudi Arabia.
Price for issue: 15 SAR or its equivalent in a foreign currency (excluding postage).

دار جامعة الملك سعود للنشر
KING SAUD UNIVERSITY PRESS

Journal of Architecture and Planning, Vol. 36 (4), pp. 405-509, Riyadh (2024/1446H.)

JOURNAL OF ARCHITECTURE AND PLANNING

(Refereed Scientific Periodical)

Published by:
King Saud University

Volume Thirty Six (4)

December (2024)
Jumada-1 (1446H.)

دار جامعة الملك سعود للنشر
KING SAUD UNIVERSITY PRESS
P. O. Box 68953, Riyadh 11537, Kingdom of Saudi Arabia

IN THE NAME OF ALLAH,
MOST GRACIOUS, MOST MERCIFUL