Ain Shams Engineering Journal 13 (2022) 101797

Contents lists available at ScienceDirect

Ain Shams Engineering Journal

journal homepage: www.sciencedirect.com

Middle-income residential compounds towards resilience through risk management: Experts' point of view

Rana Adel [a,*], Basil Kamel [b], Ahmed Amin [c], Sameh El-Feki [d], Rania Nasreldin [c]

[a] Department of Architecture, Faculty of Engineering, Modern Science and Arts University, Egypt
[b] Department of Architecture, Faculty of Engineering, AUC University, Egypt
[c] Department of Architecture, Faculty of Engineering, Cairo University, Egypt
[d] Department of Architecture, Faculty of Engineering, Modern Science and Arts University, Egypt

ARTICLE INFO

Article history:
Received 30 December 2021
Revised 14 March 2022
Accepted 31 March 2022

Keywords:
Middle-income Housing
Resilient strategy
Risk management
Indicators
Resilient Models

ABSTRACT

The middle-income sector in the Global South faces challenges in finding appropriate housing due to high dwelling costs, loans, and maintenance. This research aims to present indicators that should be met when building middle-income compounds in three aspects: middle class housing, a resilient approach, and risk management. This research relied on a three-step approach. First, it started with scanning relevant literature to identify the factors of satisfaction for the middle-income class. Building upon these factors, the second step launched a survey among 60 experts to verify the collected factors. In the third step, confirmatory factor analysis identified the critical indicators and eliminated the irrelevant ones. The main finding established a merged model consisting of urban governance, resilient cities, municipalities, and quality of life, which consisted of 12 categories and 38 indicators. The concluded remarks demonstrate that a strong relationship between the aspects improves the quality of life for middle-income compounds.

1. Introduction

The middle class in Egypt faces a challenge in finding desirable housing units that are affordable and located within an appropriate urban fabric. This problem escalated after the government started to build housing for the low-income segment only, while the private sector-built houses for the high-income segment, which left the middle class with no options in finding the appropriate shelter. Recently, the government started to adopt a new approach to include the middle-income class in their plans concerning the housing problem. However, the strategies are still not well developed and are facing some challenges in terms of payment methods, housing location, and user satisfaction. Also, the middle-income housing projects offered by the government are not capable of meeting the high demands for shelter.

Egyptian cities suffer from over-rapid growth, lack of facilities and services [1], overloading of the infrastructure utilities, and pollution [2], all of which affect middle-income housing. Moreover, most constructed housing does not meet the needs of the users in terms of design, location, services, maintenance, or even prices [3]. Finding an appropriate shelter with a reasonable price, decent design, and proper location has become very difficult for the middle class [4]. According to the demand for urban housing, the challenge of accommodating all urban residents' need for adequate housing becomes more and more difficult. On the other hand, the government is applying a new approach: constructing middle-income compounds to provide appropriate shelter at reasonable prices without considering the needs of the residents. Due to high population demands and the government's facilitation, the private sector provided the middle-income community with appropriate shelters [5]. Despite interventions, some of these compounds had succeeded, while others failed in terms of prices, services, or maintenance.

In general, this paper aims to provide a comprehensive understanding of the different indicators of resilient middle-income housing through risk management approach. The research adopts

* Corresponding author.
E-mail address: rana.adel.zaki@hotmail.com (R. Adel).
Peer review under responsibility of Ain Shams University.

Production and hosting by Elsevier

https://doi.org/10.1016/j.asej.2022.101797

both descriptive and theoretical approaches. The data collection was through a survey among representatives from the governmental and private sectors, experts, and academics who have experience in the resilient field or middle-income housing in Egypt. The research methodology, revealed in Fig. 1, shows three primary levels of research. The first level identifies the different leading indicators which fulfill users' needs. By merging four different models, indicators were chosen to cover the three main aspects: middle-income housing, resilient aspect, and risk management aspect. The second level is the survey filled by the experts and academics to ensure that the identified indicators are compatible with the Egyptian housing market, moreover to select the most significant ones. Finally, the last level applies confirmatory factor analysis, descriptive analysis, and correlation analysis to ensure the validity of data.

2. Literature review

The literature review in this research consists of four sections. The first section elaborates on the middle-income housing challenges in Egypt. The second section discusses the resilient approach and why it is essential to construct middle-income compounds. The third section covers the issue of risk management, highlighting the importance of including its indicators in the construction of resilient compounds. The final section presents the suggested model.

The selection of the references, used to conduct the literature review, was based on specific criteria. First, most of the references had to be recent studies, published after 2015; however, a few older references were included, especially for the definitions and historical backgrounds. Second, the references in the model were selected from both practical studies, which feature actual applications on cities, and theoretical studies, which were published as literature. Finally, the database varied between Elsevier, Springer, World Bank, and online websites.

2.1. The middle-income housing

Middle-income housing has been a challenging matter all over Africa. Recently, there has been rising attention towards the emerging middle class in the global South [6]. Banerjee and Duflo in 2008 defined the middle class as those living with an income of $2 to $10 a day at 1993 PPP -Purchasing Power Parity- [7]. North African countries have a higher percentage of the middle class among their population; Egypt ranks third, with a percentage of 79.7%, coming after Tunisia and Morocco [8]. According to AFDB in 2011, stated that more than half of the middle class in Egypt has become in the floating category, living on less than $4 per day [8].

In Egypt, the argument for middle-income housing started after massive government housing projects were constructed to offer appropriate housing units for middle-income communities. The core purpose of these projects was to help citizens access housing that fulfills their needs and financial capabilities and enables them to match their social and economic purpose. They targeted people who could not afford to buy the existing units offered by the private sector [9]. Egypt has been living with the housing crisis for more than 30 years. Inadequate stock, overcrowding population, and a lack of affordability have become the norm. While some government strategies tried to suggest solutions and fix problems, the housing shortage has continuously grown, and the existing housing has degraded further. For the middle- and low-income market segments, there is a massive gap between supply and demand that the government is seeking to solve [10]. The government made interventions for the rights of low-income/disadvantaged groups to find suitable shelter and affordable housing in its financial reform program, which began in the early 1990 s. This program initiated the "Mubarak Youth Housing Project" in 1996. The main aim to this project is to provide 70,000 affordable units in suitable residential environment. The target segment for this project were the youth of the middle/low-income segment [11]. Also, in the same era, the government encouraged the private sector to offer appropriate compounds, targeting the middle-income segment groups, who were seeking to live in gated communities as these compounds provide a better quality of life [12]. The government helped the private sector by offering them land with infrastructure and setting prices that should suit the middle-income residents. Most of these projects were located in Hadayk October. After this initiative, the middle-income sector was neglected for many years until the current government established other initiatives in the housing sector, targeting the upper-middle-income class by many projects, such as Sakan Masr, Dar Masr, and Ganna Project. Also, the Egyp-

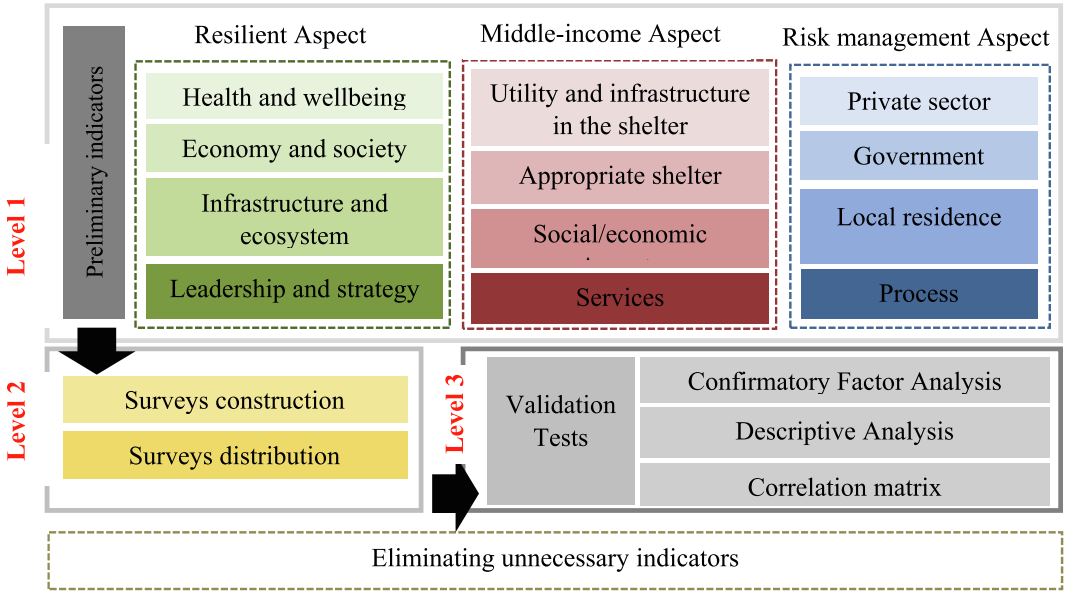


Fig. 1. Research Methodology.

tian government approved the launch of a new initiative for the middle-income segment to support the finance of their housing with EGP 50 billion. The governor of the Central Bank of Egypt, Tarek Amer, announced that the funding would be offered at an interest rate of 10%, with repayment terms of up to 20 years [13]. Despite these interventions, the existing middle-income compounds failed to comply with the needs of the users in terms of funding, designs, and locations.

2.2. Urban resilient management

According to the World Bank projects, the Covid-19 pandemic may have pushed additional 88 million to 115 million people into life-threatening poverty in 2020 [14]. The analysis indicates that these "new poor" will be more urban than chronic poor, be more engaged in informal services, and live in a congested urban setting [15], which will increase the demand for infrastructure and urban services in the developing countries. The government will face too many risks to provide the required needs, such as appropriate housing projects and adequate housing funding programs for the new poor segment.

Urban resilient management has become essential to cope with the sudden changes and risks. Urban management includes risk-based land-use planning, which identifies the safest areas to prioritize for immediate investments in urban development and infrastructure projects. Urban management for land use plans accounts for the location, type, design, quality, and timing of development of any housing project [16]. Urban resilient management is the future of planning for middle-income compounds, as many organizations have already realized the importance of resilient urban planning strategies and applied their model to their housing projects.

2.3. Risk management approach

Planning risk response is the procedure of developing options and actions to enhance opportunities and reduce threats to project objectives [17]. The plans for dealing with each risk are established according to its priority from the risk identification process. Some risks, once identified, can readily be eliminated or reduced. However, most risks are much more difficult to mitigate, particularly high-impact, low-probability risks [18].

Hubbard in 2020 considers risk management as the process of monitoring, controlling, containing, and mitigating the probability and impact of unforeseen or unfortunate events [19] The whole risk management process is defined as the impact of uncertainty on operational, managerial, financial, or strategic objectives. After exploring the risk management definitions and practices, it has become evident that risk management is the best technique to monitor the resilient strategy. According to the Fifth Edition of the PMBOK Guide, 'project risk' is an "indeterminate event that, if happens, has a constructive or damaging effect on the objectives of the project" [20]. The risk management process always starts with risk identification and a quantitative and qualitative risk assessment process. Quantitative risk analysis is one of the essential tools to evaluate risk degree, according to the experts [21]. Lock in 2007 defined quantitative analysis as a method that assigns numerical numbers to risks and their potential consequences. [22]. The objective of this process is to produce quantitative risk information to support decision-making and reduce project uncertainty [17]. Qualitative risk analysis is just as important as quantitative analysis. It is defined as the procedure of ordering risks for analysis by evaluation and combining their impact and probability of occurrence [23]. Therefore, the quantitative analysis is the chosen method for evaluating the indicators in the practical section and prioritizing them based on the feedback by the experts to high, medium, and low.

2.4. Suggested model

The practical section focuses on finding the relationships between the three main aspects: middle-income housing, resilient approach, and risk management. Four models were chosen and merged to select the most effective indicators/categories related to the Egyptian context, as shown in Table 1. The models were chosen to cover different typologies by their indexes. The first model is the Habitat Agenda Indicators, which are composed of 20 key indicators [24].

The second model is the Federation of Canadian Municipalities' Quality of Life Reporting System by John Burrett, Senior Manager,

Table 1
All indicators for the test.

Index	Key indicators	Index	Key indicators
Habitat Agenda	Overcrowding	**Index Federation of Canadian Municipalities' Quality of Life Reporting System**	Population growth
	Access to safe water		Average income
	Access to improved sanitation		Education Level
	Connection to services		Literacy levels
	Poor households		Unemployment/ employment Rates
	Literacy rates		Urban Transportation
	Urban population growth		Population Density
	Unemployment		Water consumption
			Solid waste
Index	**Key indicators**	**Index**	**Key indicators**
Urban Quality: Indicators and Assessment	Traffic accessibility	**ARUP Index the City Resilience Index**	Local business development and innovation
	Pedestrian accessibility		Inclusive Access to safe drinking water
	Availability of services and equipment		Effective sanitation
	Availability of waste container		Adequate Access to quality healthcare
	Presence of green areas		Cohesive communities
	Easy mobility services		Well-managed public finances
	Sustainable daycare and healthcare services		Comprehensive business continuity planning
	Quality of urban landscape		Diverse and affordable transport networks
	Waste management		Effective transport operation and maintenance
	Access to clean water		Appropriate codes, standards, and enforcement
			Effective co-ordination with other government bodies
			Adequate education for all
			Comprehensive hazard monitoring and risk assessment
			Consultative planning process

focusing on the residents' quality of life and supporting the role of Municipalities [25]. The third model is the ARUP city index, which is known as the City Resilience Index. The index has been developed by ARUP and supported by The Rockefeller Foundation, and it mainly focuses on the resilient indicators that can be applied to residential cities to achieve stability [26]. The last model is Urban Quality: Indicators and Assessment which is an article titled "Evaluating Urban Quality: Indicators and Assessment Tools for Smart Sustainable Cities" [27]. The models' indicators were filtered to the most effective and then chosen according to their repetition between the four models.

The chosen indicators were filtered and distributed among different groups in three aspects, as shown in Fig. 2. The first aspect is middle-income housing, which consists of four categories: utility and infrastructure in the shelter, appropriate shelter, social/economic sector, and services. The second primary aspect is the resilient aspect, consisting of four main categories: health and wellbeing, economy and society, infrastructure and ecosystem, and leadership and strategy. Finally, the third primary aspect is the risk management, consisting of four main categories: private sector, government, local residence, and process.

3. Method

The analysis relies on statistical methods to reach highly accurate results. First, survey data have been collected from experts. Then the primary data has been reviewed. Finally, indicators were encoded as shown in Table 2. Codes for the middle-income housing started with (H), followed by a letter reflecting the ascending order of categories in this aspect, and the last number in the code is the number for the indicator itself. The exact coding system was repeated for the resilient aspect, whose codes started with (R), and the risk management aspect whose codes started with (M). Afterward, the codes were logged into the AMOS software. The following procedures were applied to the results:

1. Confirmatory factor analysis: used to ensure the factorial validity of the dimensions of the measures used and eliminate the irrelevant indicator [28]
2. Descriptive analysis: used to measure the frequency, percentages, mean, and standard deviation for the indicators [29].
3. Correlation matrix: used to determine the weight of the relationship and the importance of the independent variables [30].

3.1. Research participants

The probability sampling techniques used in this research is simple random sampling, which relies on selecting a few criteria and randomly choosing members of a population. The survey was distributed among 60 respondents. All participants were experts in middle-income housing compounds, environmental approaches, or risk management. They were selected from the academic and practical fields, with a minimum of 15 years of experience. The practical field experts were included in the survey because they have good knowledge about the risks that affect the middle-income housing in construction and execution phases and the 15 years of experience in local practices reflected their knowledge about design standards and codes/regulations. On the other hand, the academics experts were included because they know the history of middle-income housing and how this sector was developed along with its codes and regulations, also they have a well knowledge about the resilient strategies used worldwide, which was reflected through their published papers that covered environmental studies, resilient approach, quality of life and middle-income housing. All respondents were asked to respond to the most important indicators with respect to the Egyptian context.

3.2. Survey design and procedure

The survey consisted of three sections, as shown in Fig. 3, and was distributed through the SurveyMonkey website. It covered different approaches in the three main aspects. The aim of the survey was to gather data about the various indicators and their effects on each residential compound from different points of view to understand all categories.

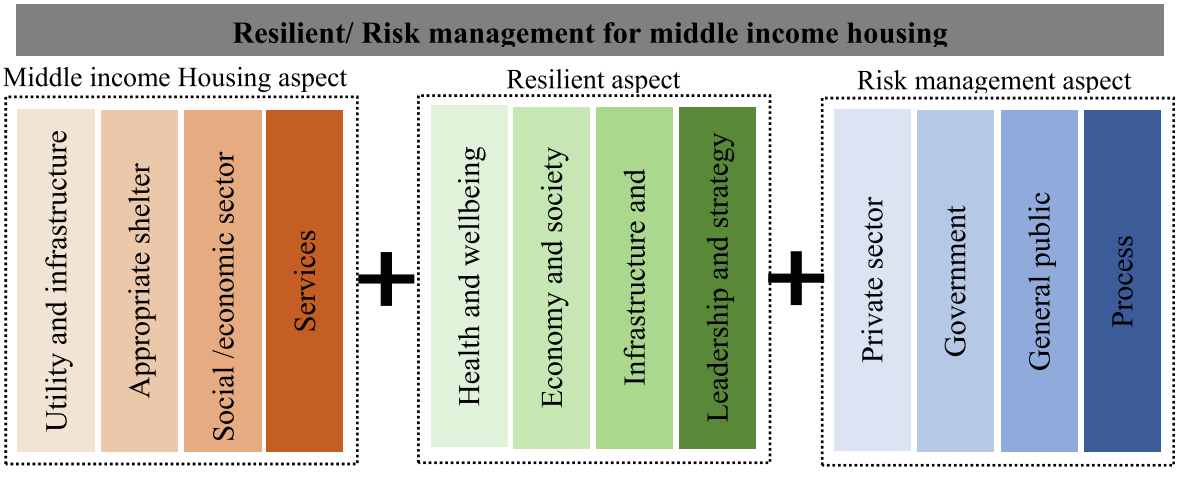


Fig. 2. Research Aspects and Categories, By authors.

Table 2
Coded selected indicators for the test.

Code	Indicator	Code	Indicator	Code	Indicator
H_A_1	Population density	M_A_1	Owner	R_A_1	Local business development and innovation
H_A_2	Access to clean water/ water loss	M_A_2	Project manager	R_A_2	Quality of urban landscape
H_A_3	Daily water consumption rate	M_A_3	contractor	R_A_3	Adequate Access to quality healthcare
H_A_4	Connection to services	M_B_1	Supervision authorities	R_B_1	Cohesive communities
H_A_5	Access to improved sanitation	M_B_2	Municipality	R_B_2	Well-managed public finances
H_A_6	Percentage of houses services by centralized sewerage	M_B_3	Engineering syndicate	R_C_1	Diverse and affordable transport networks
H_A_7	Total daily garbage collection	M_C_1	Local Residence	R_C_2	Effective transport operation and maintenance
H_B_1	Average household size	M_C_2	Owners Association	R_C_3	Percentage of Private cars
H_B_2	Housing price to income ratio	M_D_1	Planning phase	R_C_4	Traffic accessibility
H_B_3	Housing average area to number of family	M_D_2	Design quality	R_C_5	Pedestrian accessibility
H_B_4	Housing rental ratio against income	M_D_3	Execution phase	R_C_6	Appropriate codes, standards and enforcement
H_C_1	Average income	M_D_4	Close-Out Phase	R_D_1	Effective co-ordination with other government bodies
H_C_2	Unemployment rate	M_D_5	Comprehensive business continuity planning	R_D_2	Adequate education for all
H_D_1	Number of primary school children per teacher				
H_D_2	Number of kindergartens per total population number of civic.				

3.3. Research study area

The research was carried out on Dar Masr compound in Sheikh Zayed city, shown in Fig. 4. The objective of the project is to provide housing units with affordable prices, less than their equivalents that are provided by the private sector in the best locations in new cities [31]. The government launched this Project at the end of 2014, with 30,000 housing units in eight new cities.

The second case study is Montazah District Compound. The private sector established this residential project, under the theme of "youth housing projects." [11], when the government launched new initiatives to engage the private sector in middle-income housing by offering many facilities to the private sector. The project is located in Hadayk October, and it witnessed a lot of demands by the middle-income segment because of the good modern design of the housing itself and the compound's layout design. Montazah District Compound contains two types of housing: the 85 m2 apartments and townhouses, as shown in Fig. 5.

4. Results and discussion

Confirmatory Factor Analysis was employed to ascertain the scale structure by testing the three-main-aspects model inherent in the research. The study utilized AMOS software to achieve the objective of the research. Confirmatory factor analysis (CFA) can be defined as "a statistical technique used to verify the factor structure of a set of observed variables, which allows the researcher to test the hypothesis that a relationship between observed variables and their underlying latent constructs exists" [32]. It should be noted that the statistical operation of the data of the confirmatory model is based on the assumption that the relationship between each implicit and measured variable is equal to one, and irrelevant indicators will be eliminated in the analysis according to the experts' feedback.

4.1. Confirmatory factor analysis (CFA)

The CFA test results in the middle-income housing aspect came to eliminate the indicator 'Access to improved sanitation', which was coded (H_A_5); test results after the elimination came as follows in Table 3.

Quality Conformance Indicators (CFI, GFI) measure how the new model, after eliminating the unnecessary indicators, fits better than the primary model. These indicators should lie between (zero, one), where values close to one indicate a significant match, and values close to zero indicate an insignificant match. Preferably, CFI and GFI values should be greater than 80%. As in the Housing aspect, the CFI is (0.963), and GFI is (0.828), and both are greater than 80%, which indicates a strong relationship.

For the RMR indicator, values close to zero indicate a good fit, while values greater than (1.0) indicate a poor match or errors in collecting the samples. In the middle-income housing aspect, the RMR is (0.075), which means positive correspondence. For the Chi-Square standardized (CMIN/DF), the result is below (2.0), in the acceptable range, indicating a match between the actual and assumed data in the model. It has been suggested that Root Mean Square Error of Approximation (RMSEA) values less than (0.05) are good, values between (0.05) and (0.08) are acceptable, values ranging between (0.08) and (0.1) are marginal, and values greater than (0.1) are poor [33]. The RMSEA value in the housing aspect, according to CFA, is (0.076), which is below (0.08) and, therefore, is considered acceptable.

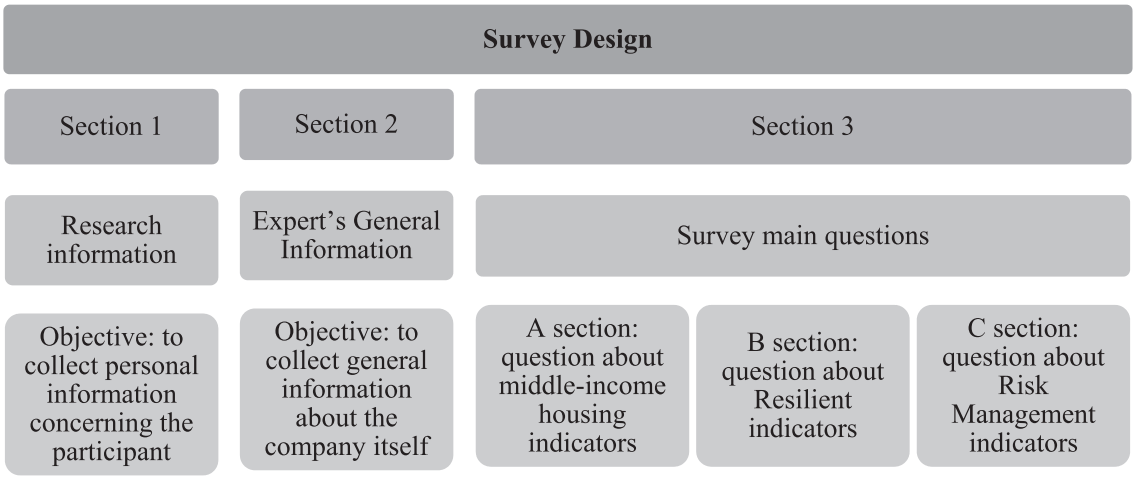


Fig. 3. Research survey's sections.

Fig. 4. Dar Masr Compound, taken by the first author.

Fig. 5. Montazah District Compound, taken by the first author.

Table 3
Confirmatory Factor Analysis for Middle-income Housing aspect.

Index	Chi-Square standardized	Goodness-of-fit-index	Comparative-of-fit-index	Root Mean Square Error of Approximation	Root mean square residual
Code	CMIN/DF	GFI	CFI	RMSEA	RMR
Value	1.314	0.828	0.963	0.076	0.075

According to experts' results, in the resilient aspect, the CFA analysis ensured that all indicators have significant relationships; thus, no indicators will be eliminated. Results came as Table 4 shows.

Table 4
Confirmatory Factor Analysis for Resilient aspect.

Code	CMIN/DF	GFI	CFI	RMSEA	RMR
Value	0.1	0.867	0.974	0.069	0.069

The measurements of the Quality Conformance Indicators (CFI, GFI) in the Resilient aspect, turned out as follows: the CFI is (0.974) and GFI is (0.867); both are greater than 80% which indicates that there is a strong relationship. The RMR indicator value in the resilience aspect is (0.069), which also indicates good correspondence. The RMSEA value is acceptable for the resilient aspect as it is (0.069). The Chi-Square standardized (CMIN/DF) value is also less than (2.0), which indicates a match between the actual results and the submissions of the model.

In the Risk Management Aspect, two indicators were eliminated by the experts' feedback through the CFA analysis; both are in the category of the project process, Close-Out Phase (M_D_4), and Comprehensive business continuity planning (M_D_5). The results are as shown in Table 5.

The measurements of the Quality Conformance Indicators (CFI, GFI) in the Risk Management Aspect, turned out as follows: the CFI is (0.985) and GFI is (0.896) and also both are greater than 80% which indicates that there is a good and strong relationship. The RMR indicator in the risk management aspect is (0.063), which also indicates good correspondence. Also, according to the CFA, the RMSEA value is acceptable; the value is (0.063), which is below (0.08). The Chi-Square standardized (CMIN/DF) for this aspect is also less than 2.

Table 5
Confirmatory Factor Analysis for Risk management aspect.

Code	CMIN/DF	GFI	CFI	RMSEA	RMR
Value	0.185	0.896	0.985	0.063	0.063

4.2. Descriptive analysis

The higher the coefficient of variation (C.V.), the greater level of dispersion around the mean. The lower the value of the coefficient of variation, the more precise the estimate [34]. The Coefficient of Variation is a ratio of the standard deviation to the mean; in the housing aspect, the C.V. ranges between 20% and 30% in the main four categories.

The results show that the highest mean indicator in the housing aspect is 'Access to clean water/ water loss' with a mean value of (4.200), which complies with Ronald McGill in 2020 discussed that water supply is an essential indicator for urban resilience. He also added the availability of sanitation and power infrastructure [35]. In addition, Prashant Kumar, Praveen Kumar Thakur, Baban K. S. Bansod, and Sanjit K. Debnath recommended having a community-based groundwater management system in their research, which also complies with the results that featured water supply as an essential indicator [36].

In the Resilient Aspect, the mean results range between (4.1) to (3.527). The highest value of mean is for 'Traffic accessibility' with (4.145), and 21% of the coefficient of variance, which means that the variance in the respondence is low. Most of the experts agree with this value, which corresponds to the study by Wael Seddik Moustafa and Ibrahim Rizk Hegazy, who discussed encouraging the middle/low-income segment to move to the 6th October City by establishing an integrated transportation system [37]. Also, Ibrahim Rizk Hegazy in 2021 stated that Al-Rehab City succeeded because it established housing accessibility [36], which complies with the importance of 'Traffic accessibility'.

The highest mean value is the Execution phase with (3.982) and C.V. 28%, which can be considered a good result, that also complies with the study by Rana Tawfik in 2013, who discussed that one of the good strategies for compounds' success is the quality of the construction which reflected the importance of the execution phase [38]. And also agree with the study by Bon-Gang Hwanga, XianboZhaoa, and Li PingToh, who discussed the importance of applying risk management strategies that directly impact the overall performance of the construction phase including (quality time and cost) of projects [39].

The ranking of the middle-income housing categories is shown in Fig. 6. The 'Utility and infrastructure in shelter' category has the highest value in this aspect with 82%, followed by the 'Appropriate shelter' with a value of 76%, then 'Social/economic' with 73%, and finally the 'Services' category with 73%. As for the resilient aspect, the ranking of the categories according to their relative importance is as follows: 'Economy and society' ranked first with 78%, followed by 'Infrastructure and ecosystem' with 76%, then 'Health and well-being' with 75%, and finally 'Leadership and strategy' with 74%, as shown in Fig. 7.

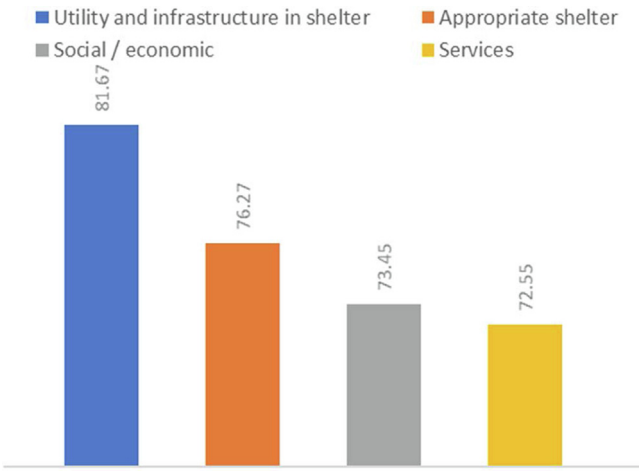


Fig. 6. Relative importance for Housing Categories.

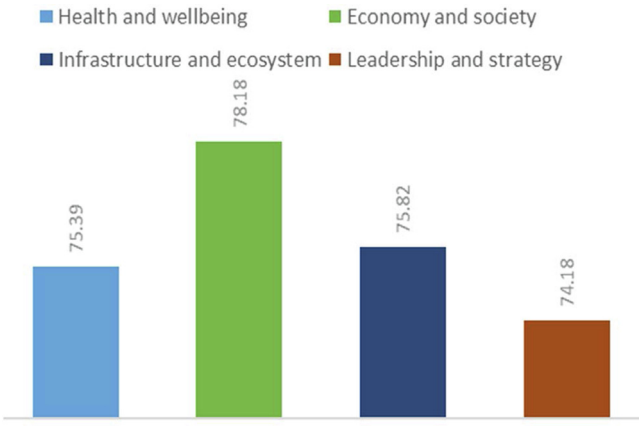


Fig. 7. Relative importance for Resilient Categories.

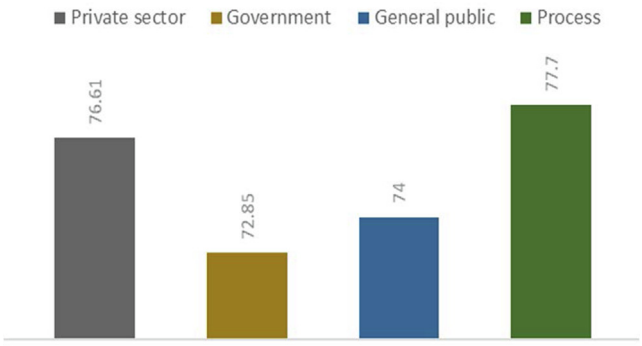


Fig. 8. Relative importance for Risk management Categories.

Fig. 8 shows the different percentages of relative importance for the categories of Risk Management. The highest percentage is the 'Risk management process' with a value of 78%. It is followed by the interventions by the 'Private sector' with 77%, then the 'General public' with 74%, and finally the 'Government' with 73%.

4.3. Correlation analysis

The objective of the correlation analysis is to find the relationship between the three main aspects, which was achieved by using SPSS software. The results of the correlation analysis are considered strong if the value of the correlation coefficient is near (1.0) value, and when the value is close to 0, it is considered a weak correlation. According to Table 6, there is a significant relationship between all aspects. The correlation coefficients between these three aspects are above (0.80), which is considered a high correlation.

Table 6
Correlation results for the three aspects.

Aspects	Housing aspect	Resilient aspect	Risk Management aspect
Housing aspect	1	0.891**	0.790**
Resilient aspect	0.891**	1	0.854**
Risk Management aspect	0.790**	0.854**	1

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

5. Conclusion

Resilient middle-income compounds are a new strategy, devised to offer appropriate housing to the middle-income segment. Thus, the research merged three essential aspects: middle-income housing, resilient approach, and risk management. Then experts identified a set of indicators across the three main categories to promote residents' satisfaction and compound adaptability through a survey. These indicators could be used as inputs to help in guiding strategic housing planning and execution when constructing middle-income compounds.

The survey analysis identified the primary indicators of the resilience of middle-income compounds through the confirmatory factor analysis and descriptive analysis. The most critical indicator in the model is 'Access to clean water/ water loss' from the middle-income housing aspect, which is related to the availability and quality of infrastructure that the government should facilitate. And in the resilient aspect, the highest indicator is (Traffic accessibility), as moving to new locations requires the availability of public transportation and accessibility of a good street network. Finally, the highest indicator in the risk management aspect is the (Execution phase). The research also proved that there is a significant relationship between the three main aspects through the correlation analysis.

One of the research limitations is the sample size, which can be increased in future research. Also, applying the indicators, identified in this research, will suit the construction of middle-income housing in Cairo only due to the differences in social and economic factors between living in the capital city and other provinces in Egypt. The indicators must be developed differently to suit other provinces in future studies. Also, future studies should include affordability as a category, with its indicators, identifying ranges of prices that the middle-income sector can afford according to their needs and approximate monthly salary, as well as the appropriate payment methods. Moreover, the design of the shelter itself must be included in the future studies, and how it changes according to the new approach—resilient middle-income compound. Overall, the government and stakeholders should be aware of the importance of applying resilient strategies in building compounds and developing urban areas. They should also consider the social, economic, infrastructural and health and wellbeing needs of the middle-income class, in order to create a resilient compound that has the ability to adapt to future changes.

Funding

This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

Institutional review board statement

The corresponding author confirm that Ain Shams University does not establish Institutional Review Board (IRB) at the moment of conducting the current study.

Informed consent statement

The 60 experts who participated in our questionnaire are anonymous. We confirm that all experts who volunteered to participate confirmed their willingness to be part in this study before filling the questionnaire. Thus, informed consent was attained from all experts included in the study.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

References

[1] Egypt | UN-Habitat, 2019. [Online]. Available: https://unhabitat.org/egypt. [Accessed 13 April 2021].
[2] Ministry of Housing, Utilities and Urban Communities. Future Vision and Strategic Directions; 2012. [Online]. Available: http://gopp.gov.eg/wp-content/uploads/2015/07/1CFV-EN.pdf. [Accessed 8 February 2020].
[3] Sims D, Abdel-Fattah H. Egypt Housing Strategy. Egypt: UN Habitat; 2020.
[4] American Chamber. New Cities on the Horizon; 2018. [Online]. Available: https://www.amcham.org.eg/publications/industry-insight/issue/12/New-Cities-on-the-Horizon. [Accessed 8 April 2020].
[5] M. Abdalla. Egypt: Providing Low Income Citizens with Affordable Housing; 2020. [Online]. Available: https://www.worldbank.org/en/news/press-release/2020/03/20/egypt-providing-low-income-citizens-with-affordable-housing. [Accessed January 2021].
[6] Ravallion M. The Developing World's Bulging (But Vulnerable) "Middle Class". Open Knowl Reposit 2010:445–54.
[7] Banerjee AV, Duflo E. What Is Middle Class about the Middle Classes around the World? Am Econ Assoc 2008;22(2):3–28.

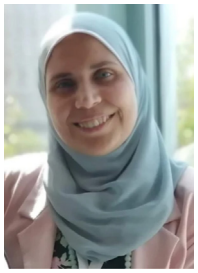
[8] Ncube M, Leyeka Lufumpa C, Kayizzi-Mugerwa S. Market Brief - The Middle of the Pyramid: Dynamics of the Middle Class in Africa; 2011. [Online]. Available: https://www.afdb.org/sites/default/files/documents/publications/the_middle_of_the_pyramid_the_middle_of_the_pyramid.pdf.
[9] Shawkat Y. Egypt's Deregulated Property Market: A Crisis of Affordability; 2015. [Online]. Available: https://www.mei.edu/publications/egypts-deregulated-property-market-crisis-affordability.
[10] Oxford Business Group. The Report: Egypt 2016. Oxford Business Group; 2016.
[11] Afify AMN. Improvement of low-cost housing conditions; policies and constraints in Egyptian context. Cairo: The Center of Planning and Architectural Studies; 2018.
[12] Hassan DK, Hewidy M, El Fayoumi MA. Productive urban landscape: Exploring urban agriculture multi-functionality practices to approach genuine quality of life in gated communities in Greater Cairo Region. Ain Shams Eng J 2022;13(3).
[13] Mubasher Egypt. Egypt launches EGP 50bn middle income mortgage funding initiative. mubasher Egypt; 5 December 2019.
[14] Freije-Rodríguez S, Woolcock M. Overview reversal of fortune- world bank group; 2020. [Online]. Available: https://openknowledge.worldbank.org/bitstream/handle/10986/34496/211602ov.pdf.
[15] Okai A. Managing Urban Risks and Building Resilience. United Nations Development Programme; 15 April 2021. [Online]. Available: https://www.undp.org/speeches/managing-urban-risks-and-building-resilience. [Accessed October 2021].
[16] Jha A, Miner T, Stanton-Geddes Z. Building Urban Resilience: Principles, Tools, and Practice. Washington: World Bank; 2013.
[17] PMI. A GUIDE TO THE PROJECT MANAGEMENT BODY OF KNOWLEDGE (PMBOK GUIDE). Newtown Square, Pennsylvania: Project Management Institute, Inc.; 2013.
[18] The Owner's Role in Project Risk Management. United States of America: National Academies Press; 2005.
[19] Hubbard DW. The Failure of Risk Management: Why It's Broken and How to Fix It. 2nd ed. John Wiley & Sons Inc; 2020.
[20] Hillson D. Managing overall project risk. PMI® Global Congress, Dubai, United Arab Emirates, 2014.
[21] Barghi B, Sikari SS. Qualitative and quantitative project risk assessment using a hybrid PMBOK model developed under uncertainty conditions. Heliyon 2020;6(1).
[22] Lock D. Project management, ninth edition. England: Aldershot, England; Burlington, Vt. : Gower Pub; 2007.
[23] Graves R. Qualitative risk assessment. PM Network 2000;10(14):61–6.
[24] UN Habitat. Urban Indicators Guildelines; 2004. [Online]. Available: https://unhabitat.org/sites/default/files/download-manager-files/Urban%20Indicators.pdf.
[25] Hoornweg D, Nuñez FR, Freire M, Palugyai N, Villaveces M, Herrera EW. City Indicators: Now to Nanjing. In: World Bank at the Third World Urban Forum, Vancouver; 2006.
[26] City Resilience Index; 2018. [Online]. Available: https://www.cityresilienceindex.org/#/.
[27] Garau C, Pavan VM. Evaluating Urban Quality: Indicators and Assessment Tools for Smart Sustainable Cities. MDPI Sustain 2018.
[28] Said H, Badru B, Shahid M. Confirmatory Factor Analysis (Cfa) for testing validity and reliability instrument in the study of education. Aust J Basic Appl Sci 2011;5(12):1098–103.
[29] Hayes A, Smith A. Descriptive Statistics; 3 August 2021. [Online]. Available: https://www.investopedia.com/terms/d/descriptive_statistics.asp.
[30] Kiernan D. Natural Resources Biometrics. New York: SUNY College of Environmental Science and Forestry; 2014.
[31] New urban communities authority. Sheikh Zayed City; 2019. [Online]. Available: http://www.newcities.gov.eg/english/aboutUs/achievments/default.aspx.
[32] Suhr DD. Exploratory or Confirmatory Factor Analysis?; 2019. [Online]. Available: https://support.sas.com/resources/papers/proceedings/proceedings/sugi31/200-31.pdf.
[33] Fabrigar L, Wegener DT, MacCallum RC, Strahan EJ. Evaluating the use of exploratory factor analysis in psychological research. American Psychological Association; 1999.
[34] Insee. Coefficient of variation/CV; 2016. [Online]. Available: https://www.insee.fr/en/metadonnees/definition/c1366.
[35] McGill R. Urban resilience – An urban management perspective. J Urban Manage – ELSEVIER 2020;9(3):372–81.
[36] Kumar Prashant et al. Groundwater: a regional resource and a regional governance. Environ Dev Sustain 2018;20:1133–51.
[37] Hegazy IR, Moustafa WS. Toward revitalization of new towns in Egypt case study. Int J Sustain Built Environ 2013;2(1):10–8.
[38] Almatarneh RT. Choices and changes in the housing market and communitypreferences: Reasons for the emergence of gated communities in Egypt. Ain Shams Eng J 2013;4:563–83.
[39] Hwang B-G, Zhao X, Toh LP. Risk management in small construction projects in Singapore: Status, barriers and impact. Int J Project Manage 2014;32(1):116–24.

Rana Adel Ibrahim, Cairo, Egypt. a Ph.D. Candidate in the Faculty of Engineering- Architecture department, Cairo University. Bachelor's and Master's degree from Cairo University in 2009 and 2016, respectively, Master's thesis titled "Factor affecting the construction of gated communities in greater Cairo Region (A Risk management assessment). Worked as a full-time teaching assistant and lecturer assistant in MSA University (2010-till now).

Basil Kamel, is a professor of architecture and urban theory in the Department of Architecture since 2011. He received his BS in 1982 and Masters of Architecture and Urban Design in 1988 from Cairo University -Cairo, Egypt, and his PhD through a joint data gathering program between the University of California at Berkeley (UCB) and Cairo University in 1995. Basil Kamel has conducted intensive research in several topics related to architectural and urban practice. His research papers cover a variety of interdisciplinary fields. Member of Committee for Inspection and Assessment of Valuable Buildings Giza Governorate (2010 & ongoing). A member of the Quality Assurance Sector, Department of Architecture, Cairo University involved in curriculum qualification for UIA program. (2008-2009). And, Board Member of Ahram Canadian University (Technical & Curriculum Support) (2006). He received many awards such as Gold Award from the INTERNATIONAL COUNCIL OF SHOPPING CENTERS (ICSC), Middle East and North Africa Shopping Center Global Awards Program 2012, for the design of Designopolis Shopping Mall, Cairo, Egypt. And, 2nd Prize (Joint) Award for the design of the Ahram Canadian University in Cairo 2011. Project Phase design was awarded to our office after Financial Negotiations in joint venture with Saleh & Hegab Consultants. Also, 2nd Prize (Joint) Award for the design of AlWatany Bank Main Building, New Cairo in 2007

Ahmed Amin, Professor of architecture and urban landscape in the department of architecture – faculty of engineering– Cairo university Since 2013, and previous director of CAEDS center of architectural and engineering design support - Department of architecture – Faculty of engineering- Cairo University 2016 -2020. Graduated from Faculty of engineering- Cairo university – 1995, Master of Science, Department of architecture – Faculty of engineering- Cairo University 1998, and Doctor of philosophy was in 2001 Member of the Organizing Committee of the First Scientific Conference of the Department of Architecture 2004, 2005, and 2006. Also, he contributed to the editing of the Arabic and English version of the research book of the 4th and 5th International Conference of the Department of Architecture - Cairo University – 2006, 2009. Finally, Editing of the Book of Urban Conservation Visions and Glimpses of the Total Production and Research of Professor Dr. Mohammed Amin Mohammed. His research interest specifically concentrated on urban landscape architecture with its diverse aspects. Professor Amin had contributed by academic researchers in scientific periodicals regionally and internationally.

Sameh El-Feki is a practicing architect who has contributed a number of public and private buildings to the Egyptian local built environment. He is also an associate professor at the Department of Architecture – MSA University. During his educational journey, he was involved in the validation process of the architectural programs from foreign bodies to Egyptian institutes, with different capacities. Sameh was awarded his PhD from Edinburgh College of Art, UK and is specialized in architectural theories and design. Through his research, he built an understanding of epistemologies that recognize the dynamic nature of both architecture and the society. In addition to being research active, supervised a number of theses and is a reviewer for a number International Journals.



Rania Nasreldin, Associated professor, faculty of engineering, Cairo University. Architect, an Associate Professor, Researcher in urban development and housing polices journals and books reviewer, view my career as a journey of research and academic education. Teaching architecture, urban design, urban planning to university students both undergrad and post grad is not only about explaining theories, it is about inspecting reality and environment very well and being able to use several creative teaching methods to trier students innovation. PhD in urban design and Community development awarded by Cairo University in 2015. MSc in Architecture awarded in 2009, area of interest is in urban design wide experience in administrative work, quality assurance and national and international accreditations, Monitoring 6 PhD. And 30 Master thesis, published more about 15 research papers.