A New Methodology for Assessing the Minimum Need of Bedrooms Number and Size in Dwellings: A Case Study of Iraq

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A R T I C L E I N F O	A B S T R A C T
	When comparing dwellings size and percentages in most of the current housing developments in Iraq with household's size and distribution, they rarely match. That may lead to reducing the accessibility of families to satisfy their housing need. Since there is no up-to-date practical local methodology or criterion available for assessing minimum need of bedrooms number and size for dwellings and their percentages, this research established one. This research suggested a methodology to classify families of a community to subgroups by their children's number and gender, calculate their percentages and allocating the appropriate size of dwellings. The research results show that the methodology can determine the various required types and percentages of dwellings that can match minimum need of low income families. It also shows that greater diversification of dwelling units size is essential in local residential developments which differs from what is implemented in the majority of these developments. The research recommends extending studies to assess the need for other local governorates of bigger average family size and assess the future required bedrooms extension for originating and growing families to reduce their movements.

Nomenclature and Symbols

Symbol	Meaning
G	Major gender of children (male or female)
g	Minor gender of children (male or female)
B	Children **b**edroom. Numbers on the left and right of the letter represent bedrooms number and size respectively. The symbol (2**B**3) as an

	example means two bedrooms accommodating three children each.
B_m	Master bedroom
p_X	Percentage of a subgroup
n	Total number of children (male and female)
x	Number of children of the same gender
p	A case of children gender.

1. Introduction

1.1 Background of the Problem

It is observed in most of the current residential developments in both, the public and private sectors in Iraq, that dwelling types are limited to specific sizes, and lack variety. Two and three bedroom dwellings are usually offered, other sizes such as studio, single bedroom and four bedroom dwellings are usually missing. Percentages of various dwellings sizes do not often match families need. This inconsistency, as a paper hypothesis, has been inferred by investigating some local well known residential developments, presented in the research appendix.

The "National Housing Policy Report" (AECOM, 2010) referred to the role of the Iraqi government in the housing sector to analyze the demand for housing, and to develop a housing policy to increase choice and facilitate access among Iraqis to the type of decent housing. Institute for International Law & Human Rights (July 2009) defined the "Adequate Housing for Iraq as the one that must be habitable, provide individuals with adequate space, its cost at a level that allows for the attainment and the percentage of housing-related costs is in general commensurate with income levels." These two reports support the importance of finding methodologies capable to form a regulation for assessment of minimum need of bedrooms number and size in dwellings that can ensure the household need and meeting standards. Such regulations acquire increasing importance in most of the Iraqi cities due to the high average family size which exceeds significantly other countries of the world. Due to the lack of such regulations, the offered dwelling sizes and percentages are subjectively estimated, or may be determined to achieve greater revenue and not the ones that meet the actual need.

Recent researches suggest a diversity of housing sizes to meet households basic needs for improving quality of life by providing an opportunity for interaction with persons of different backgrounds (King & L. Anne 2008). Therefore, many city councils introduce regulations and codes to ensure a reasonable mix of dwelling sizes within new developments. These codes may refuse permission for a residential development that does not help to achieve a planned mix of dwelling types (Warwick District Council, 2007).

Housing is considered a commodity in the developed world. Assessing the demand there, is achieved by choosing samples of the community to estimate the current dwellings in terms of size, type, condition and tenure (County Durham, 2008). Whereas,

in Iraq, housing is a social good and a highly productive economic activity at the same time (MOCH & UN-HABITAT, 2010). The amount of housing that Iraqi households in the lowest 20 percent of incomes can afford monthly is less than the cost of one square meter (MOCH & UN-HABITAT, 2006). Those households need to be supported by the government to accommodate them in a decent housing of a minimum need that they can afford. Therefore, this research adopt the task to derive a methodology to assess the minimum need of bedrooms number and size. This methodology is depending on the demographical attributes of families and their income level regardless to the demand factors.

It is worthy to notify that the developed world, in general, don't need such assessment due to their low averages of family size and higher income as their occupation rate (family size divided by number of habitable rooms) equals one or less (Jennifer A. Rode, 2005) & (P. Huiginn, 1959), compared to the accepted overcrowding in Iraq of three according to the UN standard for developing countries (MOPDC, COSIT, 2009).

1.2   Research Objectives and Importance

This Research aims to assess the minimum need of bedrooms number and size for dwellings and their percentages in residential developments. The research importance is:
- To ensure households stability when possessing dwellings matching their need.
- To provide an academic evident base and methodologies supporting the design process.

Other important reasons are as stated in the housing market assessment manual of New Zealand (DTZ New Zealand, 2009) are completely coinciding with the Iraqi requirements, as follows:

"Housing market assessments can provide valuable insight into the housing market and assist policy development, strategic planning, decision making and resource allocation processes by:
- Ensuring the most appropriate and cost effective use of public funds.
- Enabling local and regional government to develop long term strategic views of housing need and demand to inform spatial strategies and regional housing strategies.
- Providing evidence to inform polices about the level of affordable housing required, including the need for different sizes of affordable housing."

1.3   Discussion of Previous Works

Two studies were achieved locally before the year (2003) for composing housing standards and methodologies. They are "Urban Housing Basics and Standards" by the Ministry of Planning in (MOP,BRP,1977) and the "Housing Technical Standard and Code of Practice for Iraq" (Pole Service & MOHC, 1982). Both studies had not indicated a clear methodology to assess dwellings size and percentages for the various family sizes.

"Pole-Service Standards" abbreviated the demographic and economic diversities of Iraqi families into a single case of the whole nation average. On that basis they proposed two Tables comprising limited types of dwellings for all over Iraq. As an example for the diversities in Iraqi families: the average family size in Erbil governorate is 4.8 while it is 8.2 in Al-Muthanna (MOPDC,GBS, 2009). Even in the same governorates, this average varies depending on the city (MOP,KRSO, 2007), (MOPDC,COSIT, 2008). As for the economic situation of people, there is also a great diversity among governorates ,while a poverty line in Erbil is 3%, it is 49% in Muthanna, (MOPDC,COSIT, 2009) and even in the same governorates, it varies between its cities (WFP/VAM-MPDC/CSP-MOH/NRI, 2004).

Table 1: Pole-Service allocation of bedrooms number and size
(Pole Service & MOHC, 1982).

Family size	1	2-4	4-6	6-8	8-10	10-12	12
Bedroom area (m^2)	12	21	27	39	51	63	75
Bedrooms number	1	1,2	2	3	4	5	6

Table 1 indicates "pole-service" allocation of bedrooms number and size. It is supposed that for each family size, there should be various sizes of dwellings to satisfy the need due to the demographic and economic diversities, whereas, the suggested Table shows the reverse, each three sizes of families share equal size dwellings. In addition, it is impossible to assess the dwellings percentages, by this proposed allocation.

After the year 2003, two basic local housing studies have been completed. They are:

Iraq Housing Market Study (MOCH & UN-HABITAT, 2006), and Iraq National Housing Policy (AECOM, 2010): The first comprises a general survey for the local housing market and concluded that reducing bedrooms number and size to the accepted minimum can help solving the housing crises. The reduction in the housing cost will allow families (22% of the population) to possess housing units with the government support by lending them loans. The study suggests a methodology for assessing housing sizes depending on purely economic basis regardless to families need. The study were completed in the year (2006) when the cost of a built-up square meter was estimated by 247 000 ID (Iraqi Dinar). This cost in the year (2011) is nearly doubled compared to (2006), while the average income raised only by 23% ,(MOPDC, 2011), (MOPDC, COSIT, 2009). It is expected that some of the average income families who represent 70% of the population will require the government support too, to own their units.

The second study (Iraq National Housing Policy) dealt with the government housing policy and application, and recommended to develop new criteria capable to facilitating access to decent housing for all Iraqis and monitoring the overall production of housing of various levels of quality and cost, that can increasingly meet housing demand. The study have not specified a methodology to assess dwelling sizes and percentages for various family sizes.

2. Research Variables and Methodology:

This research defines four variables that bedrooms number and size varies according to. They are: family size, children age, children gender, and the family income level. As family size increases, there will be a need to increase bedrooms number or size or both. Bedrooms number may vary also due to children gender. As an example, allocating one bedroom of two beds for two children above 10 years old is sufficient if they are of the same gender, whereas two bedrooms should be allocated if the gender of children is opposite. Bedrooms number may vary also due to children age, as in the last example, allocating one bedroom for the two children is sufficient if they are less than ten years old. Bedrooms number may vary due to the family income, as an example, allocating one bedroom for three children for a low income family is sufficient, whereas two or three bedrooms may be allocated, if the family income is high.

To achieve settling of growing families and to reduce their movement, this research considers all children as if they are above ten years old. This action will not force growing families with children below ten to move when those children grow up.

Since bedrooms number and size varies positively to the family income level, therefore the need of low income families is the minimum bedroom requirements that can ensure decent housing. The minimum bedroom requirements do not contradict with the medium and high income families, because these requirements do not confine or restrict any higher limit of their demand. Therefore minimum need of bedrooms number and size is associated to two variables:

The first is the Family size distribution according to the demographic census of the community under study, and second to the children gender which has two qualitative values; the masculine and feminine.

The following standards of dwelling occupancy that suggested by Almuar, M. (2013) are adopted for controlling allocation of bedrooms number and size:

"1. Allocating a private bedroom for the parents. Separating the children of opposite gender and of ten years old or more so as not to sleep in the same room. Children under the age of ten of both genders can share the same room.

2. Overcrowding standard must not exceed three.

3. Number of persons occupying one room shall not exceed four."

These standards match the privacy requirement of the developed world (Housing Act, UK, 1985), and to the overcrowding rates standards of the "Habitat" for developing countries (Habitat, Iraqi Bureau, 2011) and to the local economic level and traditions.

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The adopted methodology in this research is summarized by: classifying families of equal children number to subgroups by their gender. Assessing the percentages of these subgroups by applying the binomial distribution theorem. Transforming the percentages of these subgroups to percentages of the whole distribution of the community according to the demographic census. Bedrooms number and size are allocated to the subgroups, complying to the adopted standard. Finally, summarizing the types by merging percentages of dwellings of equal bedrooms number and size.

3. Assessment and Results

By the first step, classifying families of equal children number to subgroups by gender. As an example and not restricted to, group of families having three children are classified to: families of three male or female children (3G), and families of two male children and a single female child, or two female children and a single male child (2G+g). This classification has the importance when allocating the required number and size of bedrooms. Families of three male or female children(3G) can be accommodated in a single bedroom of three persons size, whereas families of two male children and a single female child , or two female children and a single male child (2G+g) should be accommodated in two bedrooms, one of two- bed size and the other of a single- bed size. Table 2 represents the subgroups classified according to the number of children and their gender.

Table 2: Subgroups classified according to the number of children and their gender.

Number of children in families									
1	2	3	4	5	6	7	8	9	
G	2G	3G	4G	5G	6G	7G	8G	9G	classification of children by number and gender
	G+g	2G+g	3G+g	4G+g	5G+g	6G+g	7G+g	8G+g	
		2G+2g	3G+2g	4G+2g	5G+2g	6G+2g	7G+2g		
			3G+3g	4G+3g	5G+3g	6G+3g			
				4G+4g	5G+4g				

The second step, assessing the percentages of these subgroups by applying the Binomial Distribution Theorem (Robert J. Boik, 2002) in Equation 1,

$$p_X = \left(\frac{n!}{x!(n-x)}\right) p^x (1-p)^{n-x} \qquad (1),$$

The Iraqi population census indicates that the percentages of male and female are (49.9%) and (50.1%) respectively (UNDP & MOPDC, 2004). Therefore, in this research, the probability of gender (p) is binomial and at the same time equals a value of (0.5). Subsequently, Equation 1 is transformed to Equation 2 by substituting (p) by (0.5). By Equation 2, the percentages of the subgroups is calculated and presented in Table 3.

$$p_X = \left(\frac{n!}{x!(n-x)}\right) 0.5^n \qquad (2)$$

Table 3: Percentages of children distribution by number and gender.

Children number									
1	2	3	4	5	6	7	8	9	
G 100%	2G 50%	3G 25%	4G 12.5%	5G 6.2%	6G 3.1	7G 1.6%	8G 0.8%	9G 0.4%	Percentages of children distribution by number and gender.
	G+g 50%	2G+g 75%	3G+g 50%	4G+g 31.3%	5G+g 18.7%	6G+g 10.9%	7G+g 6.2%	8G+g 3.5%	
			2G+2g 37.5%	3G+2g 62.5%	4G+2g 46.9%	5G+2g 32.8%	6G+2g 21.9%	7G+2g 14.1%	
					3G+3g 31.3%	4G+3g 54.7%	5G+3g 43.7%	6G+3g 32.8%	
							4G+4g 27.4%	5G+4g 49.2%	

The third step, assessing the percentages of the subgroups to the whole distribution of the community by depending on the distribution of family size. For this research, Erbil governorate of Kurdistan region is considered as a case study and its family size distribution for the year 2007 census shown in Table 4 (MOP, KRSO, 2007) is adopted for calculation. Percentages of the subgroups to the whole distribution of the community are calculated, and the results are presented in Table 5.

Table 4: Distribution of family size in Erbil governorate of 2007 census. (MOP, KRSO, 2007).

Family size	1	2	3	4	5	6	7	8	9	10	11+	Total
% of families	8.1	17.7	12.7	14.1	13.6	11.1	8.4	6.1	3.9	2.3	2	100

Table 5: Percentages of children distribution by number and gender in Erbil governorate.

Children number									
1	2	3	4	5	6	7	8	9+	
G 12.7%	2G 7.1%	3G 3.4%	4G 1.4%	5G 0.5%	6G 0.2%	7G 0.1%	8G 0.02%	9G 0.01%	Percentages of children distribution by number and gender in Erbil governorate.
	G+g 7%	2G+g 10.2%	3G+g 5.5%	4G+g 2.6%	5G+g 1.1%	6G+g 0.4%	7G+g 0.2%	8G+g 0.1%	
			2G+2g 4.2%	3G+2g 5.3%	4G+2g 2.9%	5G+2g 1.3%	6G+2g 0.5%	7G+2g 0.3%	
					3G+3g 1.9%	4G+3g 2.1%	5G+3g 1%	6G+3g 0.6%	
							4G+4g 0.6%	5G+4g 1%	

In the fourth step, bedrooms are allocated to the children subgroups. In a later stage the parents' bedroom will be added. Allocation is complying to the adopted standard in this research of minimum need which require reducing number of bedrooms in a dwelling to the minimum, reducing the use of single bedrooms and adopting diversity in bedrooms size in each dwelling. This standard is interpreted to recommendations and presented in Table 6 which includes examples indicating preferences. The recommendations in Table 6 are interpreted to allocation and presented in Table 7. Cells in Table 7 represent the number of children bedrooms in dwellings. Cells are distributed into new groups of different number of

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bedrooms. The cells of similar number of bedroom are distributed again into sub groups of one bed space difference and are shaded with different tones. This action is due to the procedure in the next step.

Table 6: Recommendations of bedrooms allocation for minimum needs.

	Recommendations	Examples		
		Children number	Rejected choice	Preferred choice
1	Reducing number of bedrooms in a dwelling to the minimum.	5	2**B**2+**B**1	**B**3+**B**2
2	Reducing the use of bedrooms of single bed.	3	3**B**1	**B**3
3	preference of diversity in bedrooms size in a single dwelling.	6	3**B**2	**B**4+**B**2

Table 7: Allocation of bedrooms number and size for children in low income families in Erbil governorate

Children number									
1	2	3	4	5	6	7	8	9	
B1 12.7%	**B**2 7.1%	B3 3.4%	B4 1.4%	B3 +B2 0.5%	2B3 0.2%	B4 + B3 0.1%	B4+B3 +B1 0.02%	B4+B+ B2 0.01%	Bedrooms number and size allocation for children
	2B1 7%	B2+ B1 10.2%	B3 + B1 5.5%	B4 + B1 2.6%	B3 +B2 + B1 1.1%	2B3 + B1 0.4%	B4+B3 + B1 0.2%	2B4+ B1 0.1%	
			2B2 4.2%	B3 + B2 5.3%	B4 + B2 2.9%	B3 + 2B2 1.3%	2B3 + B2 0.5%	B4 +B3 + B2 0.3%	
					2B3 1.9%	B4 + B3 2.1%	2B3 + B2 1%	B4 +B3 + B2 0.6%	
							B4+B3 + B1 0.6%	B4 +B3 + B2 1%	

Table 8: Finalized allocation for children of low income families in Erbil governorate

Children number									
1	2	3	4	5	6	7	8	9	
B2 19.8%		**B**4 4.8%		**B**3+**B**2 0.5%	**B**4+ **B**3 0.3%		B4+B3+B2 4.4%		Bedrooms number and size allocation for children
	B2+ **B**1 17.2%		**B**3+ **B**2 15%	**B**4+**B**3 2.6%		**B**+ 2**B**2 2.8%			
					B4+ **B**3 6.9%				

In the fifth step and in order to reduce types of dwellings to a practical limit without effecting need, a treatment has been taken to the types that have equal number of bedrooms but of one bed space less. One bed space is added to smaller bedrooms in some cases to have dwellings of equal bedrooms number and bed spaces. This procedure matches to all allocations except to the two dwelling types: (2**B**3+**B**1) and (2**B**4+**B**1) which belong to the category of families of children number of (7) and (9). These two cases comprise very low percentages, a total of 0.5% for both and therefore they are

merged with the types (**B**3+ 2**B**2) and (**B**4+**B**3+**B**2) respectively. For large developments (bigger than 1000 dwellings) a specific type for these cases can be established.

Percentages of equal size dwellings are added to get the final Table of children bedrooms allocation by number and size. Results are presented in Table 8. Finally, Table 8 is rearranged and tabulated according to bedrooms number, size and percentages. Master bedrooms are added to each allocation as presented in Table 9.

Table 9: Finalized allocation of bedrooms number and size in dwellings for low income families in Erbil governorate.

Number of bedrooms in the dwelling	Number and size of habitable rooms in the dwelling	% of dwellings size	
		Relative to size and number of habitable rooms	Relative to number of habitable rooms
1	$\mathbf{B_m}$	25.8	25.8
2	$\mathbf{B_m}$ + **B**2	19.7	24.5
	$\mathbf{B_m}$ +**B**4	4.8	
3	$\mathbf{B_m}$ + **B**2+**B**1	17.2	42.5
	$\mathbf{B_m}$ + **B**3+**B**2	15.5	
	$\mathbf{B_m}$ +**B**4+ **B**3	9.8	
4	$\mathbf{B_m}$ +**B**3+2**B**2	2.8	7.2
	$\mathbf{B_m}$ +**B**4+**B**3+**B**2	4.4	
Total		100	100

For developments of less than (100) dwellings, results can be simplified by merging types of smaller percentages of dwellings with higher ones, to reduce types without effecting the need requirements. This action will facilitate the process of design, construction and distribution. Result are approximated to the nearest integer as shown in Table 10, which can be used for housing developments and satisfying family need.

Table 10: Finalized allocation of bedrooms number and size in dwellings for low income families in Erbil governorate for small developments

Number of bedrooms in the dwelling	Number and size of habiTable rooms in the dwelling	% of dwellings size
1	$\mathbf{B_m}$	26
2	$\mathbf{B_m}$ +**B**4	25
3	$\mathbf{B_m}$ + **B**2+**B**1	17
	$\mathbf{B_m}$ +**B**4+ **B**3	25
4	$\mathbf{B_m}$ +**B**4+**B**3+**B**2	7
Total		100

4. Discussion

Research results show the capability of the methodology to assess dwelling sizes and percentages that can satisfy families minimum need. When comparing the research results of dwelling sizes for Erbil governorate -which range from one bedroom up to four- with the majority of the current developments in Iraq, one can notice the lack of the latter to variety,

sufficient bedrooms number and adequate percentages. These results support the research hypothesis.

It is worthy to mention that the range of dwelling sizes of the case study in this research, is relatively low due to low average family size of 4.6 in Erbil, compared to other local governorates of average family size of 8 or more. It is expected that for higher average family sizes, there will be more variety in dwelling sizes and different percentages which need exclusive assessment.

5. Conclusion

This paper tackles the problem of the lack of a methodology necessary to determine the minimum need of dwelling types by bedroom number and size for low income families. In This paper, the need of dwellings-and not the demand- as a dependent variable is associated to the objective independent variables; the family distribution by size, family members distribution by age and gender and the criteria in the standard of decent housing of minimum need.

The methodology proposed in this paper can ensure the coinciding of supply and need of dwellings which will increase accessibility of families. In addition, this methodology can reduce resources consumption of construction and development total cost. Although the methodology is appropriate to societies of various average family sizes, it acquires more importance when applied to societies of large average family size due to the complexity of increasing range of dwelling types. When assessing size of dwellings for medium income families, developers and designers can benefit of the methodology results as a base information for comparison and avoid allocation of smaller size dwellings than that for low income families.

This research recommends extending studies to:
• Assess the need for other local cities of higher average family size.
• Assess the future required bedrooms extension for originating and growing families to reduce movements.
• Develop mathematical methods necessary to determine demographical attributes not contained in census, such as family distribution during stages of originating, growing and dissolving.
• Achieve field researches for various types of dwellings, to detect level of "Residential Satisfaction" of families during their growth.

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7. Appendix

Table 1A: Bedroom number and size of dwellings in some housing developments in Iraq.

Housing Development	Governorate	Dwellings Type	Dwellings Number	Bedrooms Number	%	Dwelling Area (M²)	Number of Children Bed Spaces
Basmaya/Alnahrawan www.investpromo.gov.iqbasmaya/	Baghdad	Apartmt.	100 000	3 4	- -	100, 120 140	5 9
Noor Almurtada	Najaf	Apartmt.	272	2	100	80	1.5
Almenathira Housing/ www.skyscrapercity.com		Houses	134	2 3	- -	- -	- -
Bayti Housing www.myhome-iq.com		Apartmt. & Houses	370 260 610	2 3 4	21 30 49	140 170 200	4 4+3 4+4+3
Alzahrah Housing www.alzahrahousing.com		Apartmt.	- - -	1 2 3	- - -	48 61 113 120	- 1.5 2+3 3+4
Alkhalis Complex	Dialah	Apartmt.	369	2 3	33 67	- -	- -
Alaziziya Complex www.moch.gov.iq	Wasit	Apartmt.	604	2 3	15 85	- -	- -
zirbatia Complex www.moch.gov.iq		Apartmt.	544	2 3	9 91	- -	- -
Ashti City www.ashticity.com	Erbil	Houses	1200	2 4	67 33	94 145	2 7
Dashti Bahasht		Apartmt. & Houses	2376 214	2 3 3	50 50 100	91, 99 145 150, 165	2 4 4
Balad Complex www.skyscrapercity.com	Salahhiddin	Apartmt.	592	3	100	155	- -
Mtarda/ Tikrit www.moch.gov.iq		Apartmt.	512	3	100	155	- -
Alarmoshia/ Samarra www.moch.gov.iq		Apartmt.	Type A: 480 Type B: 320	3 2	60 40	137 117	- -
Tel-Afar Complex www.aknews.com	Naynawa	Apartmt.	Type A: 376 Type B: 188	3 2	67 33	127 106	- -
Haswat Alshamia	Al Anbar	Apartmt.	568	3	100	155	-
Gbail Alkharab/ Alfalloga (Alsabah Aljadid, 2343 on 24/07/2011		Apartmt.	Type A: 392 Type B: 240	3 2	62 38	150 130	- -
Ana Housing Complex		Apartmt.	Type A: 224 Type B: 300	3 2	43 57	150 112	- -

Notes:
1. number of bed spaces in bedrooms are calculated by the author depending upon the standard of area adopted in this paper.
2. Apartmt.= Apartment.
3. The sign (-) indicate not available information.

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