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Short Communication: Optimising Bathroom Space, Design and Aesthetics

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ABSTRACT

The bathroom has become a feel-good space within the home. Also its design and planning is more influenced by technical considerations and products. Present research work tries to build an multi-objective optimization model incorporating multiple conflicting / non conflicting objectives such as: Optimizing available space; Improving accessibility and convenience; Enhancing the overall aesthetic appeal and Boost home's resale value. The problem may be solved using standard mathematical programming technique. In case of infeasible solution, Preemptive goal programming technique could be used if different priorities are to be allotted to the objectives and certain factors. In case of equal importance, Archimedean goal programming approach could be used.

Keywords: Bathroom, bathroom space, Sustainability

The bathroom's evolution from a purely functional room into a lifestyle space has seen the part played by infrastructure, layout and aesthetic factors. Bathroom space requirements vary depending on the type of housing, from single-family homes to apartments and condominiums. In single-family homes, bathrooms are typically larger and may include en-suite options in primary bedrooms. In multi-unit dwellings, space constraints often result in smaller, more compact bathrooms designed for efficiency. Adequate bathroom space is essential for functionality, comfort, and resale value. Neglecting to allocate sufficient square footage can lead to cramped and impractical spaces. When renovating a bathroom, consider both expanding existing spaces and adding additional bathrooms to meet the needs of your households. If space allows, expanding an existing bathroom can provide the opportunity to incorporate desired features and improve overall usability. In homes with multiple occupants or limited bathroom availability, adding extra bathrooms can enhance convenience and property value.

How colors and textures influence mood

The colors and textures chosen for a bathroom are powerful aspects of mood and ambience. Vibrant hues can combine energy and enthusiasm, while softer tones promote relaxation and tranquillity. Similarly, the textures of surfaces, whether sleek and polished or rustic and tactile, contribute to the overall atmosphere, creating a sensory environment that goes beyond mere aesthetics. These design choices play a critical role in shaping the emotional and psychological experience of this space.

Cool tones, such as blues and greens, are known to create a sense of calmness and serenity. When incorporated into bathroom design, these colors can create a spa-like atmosphere, promoting relaxation and stress relief. On the other hand, warm colors like yellows and oranges have a more exciting effect

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on the mind. Commonly associated with sunlight and positive energy, these tones can create a bathroom atmosphere that is visually appealing and emotionally energizing . Deep colors like charcoal or navy create shadows and highlights that emphasize the qualities of certain materials. Dark colors can bring out the intricate details and variations in texture, creating a sense of warmth and authenticity.

Texture has an incredibly large impact on the way many people see and experience a bathroom. The smoothness also conveys a sense of cleanliness and order, contributing to a visually appealing atmosphere. In addition, the texture of materials in the bathroom can influence the perceived level of luxury and class. Plush towels, soft bath mats, and other textile elements bring a touch of comfort and style.

RESEARCH QUESTIONS

1. What impact does the combined effect of colours, shapes and materials have?
2. How can daily routines be optimised?
3. How can the technical features be combined with cosy elements to achieve the optimal effect?
4. What means can be used to enhance and vary the aesthetic quality of the bathroom?
5. Are the future users interested in sustainability, wellness products or the opportunity to keep body and mind fit and healthy?
6. The bathroom – just like its samkaaleen Kitchen every time has to be in keeping with the interior style and tastes of its owners. Pre-wall systems mean that the contemporary bathroom is more and more open to design trends and fashions.

OPTIMIZATION MODEL

To maximise the utility , minimum occupancy area of bathroom .. as cities are very expensive

Various elements

1. Available space: This includes the overall dimensions of the bathroom, as well as the location and dimensions of windows, doors, and any obstacles or architectural elements such as columns or steps.

2. **Identification of essentials/needs:** Each bathroom has different needs, depending on the destination and the number of users. A toilet bowl, a washbasin, or a shower are all essential sanitary items. If space is limited, *prioritize these items* and decide which of the others are optional. Pre-emptive goal programming may be used by setting up priorities. In case, we give equal importance non Pre-emptive or Archimedean goal programming may be used.

3**. Find compact items**: As we are saying that we have minimise bathroom space, we have to look for many options for compact bathroom vanity units such as a corner toilet or a sink with a drawer underneath to save space. Showers with a corner design or sliding doors can also be a good choice for small bathrooms.

4. **Limited because of versatile furniture:** Because we are constrained to have limited space, we opt for versatile and practical furniture. For example, a cabinet as wall hanging can free up floor space. Shelves or cabinets with drawers can provide extra storage space for towels, cosmetics, and other bathroom accessories.

5.**Consideration for options for storage:** Choose bathroom fixtures with integrated storage options such as cabinets, drawers, or shelves. Open shelves can be useful for storing towels and bathroom accessories, while closed cabinets can hide less aesthetically pleasing products. This also includes Built-in Shelving [to keep toiletries organized without taking up floor space]; Under-Sink Storage [for efficient storage of essentials]; Vertical Storage [like tall cabinets and shelves, to make the most of your bathroom's height].

6. Plan circulation: Efficient circulation in the bathroom is as important as the size of the bathroom elements. Make sure there is enough space to move comfortably around the toilet, sink, and shower. Avoid overcrowding the space with unnecessary furniture and accessories.

7. **Consultation fee:** For remarkable assistance and guidance, a professional could be hired to offer advice and customized solutions for your space, so you can get the best configuration for your bathroom.

8. Space Optimization Techniques: To maximize efficiency in a full bathroom [optional for this research problem], consider space-saving design

strategies such as installing a compact bathtub or opting for a corner sink.

9. Space requirements in terms of layout and design: This includes the arrangement of fixtures and the presence of architectural features. This includes Sinks and Vanities [Placing sinks and vanities near the entrance can save space and improve accessibility. Consider wall-mounted sinks to free up floor space]; Toilets [Positioning the toilet in a more discreet area, such as behind a partial wall or in a separate alcove, can enhance privacy]; Showers and Bathtubs [Choose the right spot for showers and bathtubs to avoid interference with other fixtures and ensure adequate space for movement].

10. People with accessibility needs: For individuals with mobility challenges, additional space may be necessary to accommodate wheelchair access or specialized equipment.

11. Utilizing Vertical Space and choosing compact fixtures: Another option for optimal utilisation of space. Vertical storage solutions, such as wall-mounted cabinets and shelves, free up floor space while providing ample storage for toiletries and linens. Opting for compact fixtures, such as a pedestal sink or corner shower, can make a small bathroom feel more spacious without sacrificing functionality.

12.**Budget considerations** are crucial when planning bathroom renovations or new construction. Understanding the costs associated with materials, labor, and permits ensures a realistic project scope. Therefore it is mandatory to avoid common pitfalls when designing or renovating bathrooms to achieve optimal results and avoid costly setbacks. Failing to account for adequate space for fixtures and circulation can result in cramped and inefficient bathrooms. Neglecting to consider plumbing considerations, such as drainage and venting, can lead to costly and disruptive issues down the line.

13. Requirements: A half bathroom typically requires a minimum of 15 to 20 square feet for comfortable use. Vertical storage solutions, compact fixtures, and strategic layout designs can help maximize space in small bathrooms. A full bathroom typically requires a minimum of 36 to 40 square feet to accommodate all necessary fixtures and provide adequate maneuvering room.

In short, factors that *influence* the required area for a bathroom includes Layout, design preferences, accessibility needs, and local building codes are among the factors that influence bathroom space requirements.

Modelling: Understanding Bathroom Layout Optimization

Bathroom layout optimization involves strategically arranging fixtures and storage solutions to maximize space and improve usability. This process includes considering the placement of sinks, toilets, showers, and bathtubs, as well as storage options.

1. Multiple objectives

O1: Optimize available space

O2 : Improve accessibility and convenience

O3: Enhance the overall aesthetic appeal [P4.1.1]

O4: Boost home's resale value

Non pre-emptive goal programming

Goals and priority level with weights

The assignment of weights is based on the experts judgment for the criteria. Presently equal weights to the below mentioned four goals.

Sl. No.	Goal specification	Priority level/ weights [lj's)
1	To optimize available space P1 [0.25]	
2	To improves accessibility and convenience [people with special needs]	P2 [0.25]
3	To achieve overall aesthetic appeal	P3 [0.25]
4	To boost home resale value	P4 [0.25]

$d + kt \rightarrow$ denotes the over achievement target set for goal 'k' in year 't'

$d\text{-}kt \rightarrow$ denotes the under achievement of the target set for goal 'k' in year 't'

In a simpler version of goal programming, management sets goals and relative importance (weights) for different objectives. Then an optimal solution is defined as one that minimizes both positive and negative deviations from set goals simultaneously or minimizes the amount by which each goal can be violated. First we solve the problem using rigid constraints only and then the goals of objectives are incorporated depending upon

whether priorities or relative importance of different objectives are well defined or not.

The problem (P4.1.1) can be solved in two stages as follows:

Initial Stage of GP problem

Minimize

$$g_0(a,b,X) = b + \sum_i \sum_j \sum_t a_{ijt} + \sum_i \sum_j \sum_t b'_{ijt}$$

Where a_{ijt} and b_{ijt} are the over and under-achievement (positive & negative deviational) variables of the goals for their respective objective/constraint function of lower bound constraints and a_{ijt}', b_{ijt}' are the over and under-achievement (negative and positive deviational) variables of the goals for their respective objective/constraint function of upper bound constraints. g_0 (a, b, X) is goal objective function corresponding to rigid constraints. The choice of deviational variable in the goal objective functions which has to be minimized depends upon the following rule:

Let $f(X)$ & g be the function and its goal respectively and a_i, b_i be the over- and under-achievement (negative and positive deviational) variables.

CONCLUSION

Following paper researches on bathroom space, layout and design optimization and tries to optimize this portfolio using Standard mathematical programming problem. Non pre-emptive goal programming or Archimedean Goal programming could be used in case there obtained an infeasible solution due to restrictions which are unbounded or may be variables exceeding the capacity as per solution procedures provided by standard mathematical programming approaches using LINGO 10.

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