Impact of Space Flexibility and Standardisation on Healthcare Delivery

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Abstract

Space flexibility and space standardisation can be applied in healthcare buildings to improve design, construction and service delivery in healthcare. The concepts of flexibility and standardisation have been implemented globally across different sectors and industries. However, an important question emerges relating to healthcare facilities: how do flexibility and standardisation impact healthcare staff workflow and patient care? It is appropriate to apply them simultaneously in the physical space, as they collectively improve efficiency in healthcare delivery. This paper refers to space flexibility and space standardisation (as space attributes). The synergies and tensions between both space attributes are explored. A questionnaire survey was conducted with experienced healthcare professionals that included: architects, health planners and project managers. A total of 200 questionnaires were sent out; a response rate of 35% was recorded. Semi structured interviews were conducted with the top 100 UK architectural practices. The questionnaire survey respondents felt that space flexibility can improve facility adaptability and it is more effective when applied on a long-term basis, whilst space standardisation can improve the quality of healthcare facilities and it is more effective when applied to healthcare rooms. Some of the interviewees agreed that flexibility is a component of standardisation or an area covered by standardisation.

Keywords: healthcare facility, space standardisation; space flexibility; space; staff and patient

1. Introduction

Space flexibility and space standardisation in this paper are a time referred to as *space attributes*. This paper explored the impact of hospital space flexibility and standardisation on health delivery in the views of design professionals. It also explored the combined application of space flexibility and space standardisation with emphasis on the design of the physical space. Campbell *et al*. (2002: 359) noted that information from stakeholders varies "*Healthcare professionals tend to focus on professional standards, healthcare outcomes, and efficiency. Patients often relate quality to an understanding attitude, communication skills, and clinical performance*". Perhaps, findings from healthcare facility users such as medical staff, administrative staff, other staff and patients can facilitate Stages 0 and 1 of the RIBA Plan of Work to inform the Briefing process. Flexibility helps to simplify healthcare tasks by allowing spaces to function in different ways. The National Health Service (NHS) Estates, (2004) warned that for maximum flexibility spaces for different patient requirement should be provided. The National Patient Safety Agency, (2010a:16) stated that "*Designs should aim at maximum standardisation of hospital infrastructure technology, equipment, computer systems, electrical equipment layouts, interfaces, room design, storage and navigation, systems and processes*". Pati *et al*. (2008) stated that the use of generic spaces is encouraged in the design of healthcare facilities as they allow flexibility and adaptability. Questionnaire survey and interviews were conducted to study their impact on healthcare delivery.

2. Importance and Motivation for the Research

The main aim of this research is to explore the two *space attributes*: space flexibility and space standardisation, and their impact on healthcare delivery with a focus on staff and patients. Space serves as a main connector between flexibility; standardisation, staff and patient.

The literature review findings presented in this research showed that both space flexibility and space standardisation can improve the efficiency of staff performance and quality of patient care. One of the key objectives of this research was to determine if the application of space flexibility and space standardisation can be balanced within the design of a healthcare facility. It is clear that such a balance would enhance patient care. This research addresses the following questions.

1. How does space flexibility impact staff performance and patient care?
2. How does space standardisation impact staff performance and patient care?
3. What is the impact of space on health delivery?
4. Is there a balance between space flexibility and space standardisation?

3. Research Methodology

This study was conducted to explore the impact of space flexibility and space standardisation on healthcare delivery and the tension between flexibility and standardisation in the view of design professionals. To achieve these objectives, three research methods were used; mixed method design was adopted to address different aspects of the phenomena in context. Following a literature review, a questionnaire survey and a round of interviews were conducted.

This research focuses on the use of flexibility and standardisation to inform healthcare professionals enabling pathways of executing healthcare Project Briefs. There is a rationale for the choice of the population questionnaire survey sample frame and interviewees. Facility user participation is closely related to designing the Project Briefs. Allsop and Taket, (2004) and Blyth and Worthington, (2010: xvii) agrees with Barrett and Baldry, (2003: 104), who observed that appropriate user involvement is important in the briefing stage to meet the needs of the end users. There were some procedural barriers regarding ethical data collection with healthcare patient and staffs. As a result, research findings are limited to the delivery side compared to the demand side; data was collected from experienced design professionals in the AEC industry. However findings of this research are still valid. The views of design practitioners in the AEC industry were presented. Designers have many years of experience and have some understanding of facility users' needs. Facility users have an opportunity to make inputs during the Project Briefs Stages.

The method adopted for measuring quality in this research was based on the collection and analysis of data from questionnaire survey and interviews. The information used for measuring quality indicators can be systematic or non-systematic. The non-systematic approach can be from case studies, while the systematic approach "*can be based directly on scientific evidence by combining available evidence with expert opinion, or they can be based on clinical guidelines*" (Campbell *et al*. 2002: 358). For this reason, findings from experts in the healthcare sector were backed with literature review were appropriate to support the claim that space flexibility and space standardisation has an impact on healthcare delivery.

3.1 Questionnaire Survey

Lists of healthcare practitioners collaborating with Health and Care Infrastructure Research and Innovative Centre (HaCIRIC) were collected from several of its members. A questionnaire was issued out to 200 potential respondents. A total of seventy responses were returned giving a response rate of 35%. Respondents were chosen based on their experience in healthcare facility design. Professionals included healthcare: architects; planners; and project managers. Respondents came from different parts of the world, comprising UK, Europe, North America, Africa, the Far East and the Middle East. The questionnaire survey was divided into three sections A, B and C. Section A asked the background of respondents; section B elicit information regarding the challenges and benefits of space flexibility and space standardisation; and section C of the questionnaire survey explored the relevance of flexibility at long-term and short-term basis; while standardisation was explored at different building levels. Half of the respondents (50%) had over 10 years working experience on new built hospital projects, while 41% of the respondents had over 10 years working experience on refurbished hospital projects.

The questionnaire survey respondents were asked to indicate their degree of agreement/disagreement with certain statements on a 5 point Likert scale. The questionnaire survey had no mandatory questions. The questionnaire survey was issued out to respondents via e-mail.

3.2 Interviews

Architects with vast experience in the AEC industry were contacted. The UK top 100 architectural firms based on the 2010 Building Magazine was centred on the best UK firms with the highest number of UK chartered architects. Out of the 100 invitations, ten architectural firms responded. The aim of the interview was to explore the impact of flexibility, standardisation and refurbishment in the design of a change-ready healthcare facility. Only findings centred on flexibility and standardisation are presented here. Before conducting the interview session, the interviewees were briefed the aim of the interviews. During the interviews, the participants were asked:

1. What does a flexibility process entail?
2. What does a standardisation process entail?
3. What does the combined application of flexibility and standardisation entail?
4. What are the possible tensions between space flexibility and space standardisation?

4. *Literature Review*

4.1 The Physical Space

Yanow, (1998) stated that building spaces are perceived as storytellers; they a time communicate their function or detail in building industry vocabulary through the use of building elements. The physical space is important in the different sectors of the AEC industry; it supports functional activities to take place. Allen and Henn, (2006:26) noted that "*to understand better the link between organisational structure and space, we must first understand the flow of communication and the evolution of organisational structures*". Space, social society and behaviour within an organisation are interrelated. Henn, (2003) observed that every activity has its location in social and spatial order, every building has a social dimension, every organisation has a spatial dimension; and architecture is made up of social behaviours. Space is a social product. Lefebvre, (1991:26) noted that "*space thus produced also serves as a tool of thought and of action; that in addition to being means of production it is also a means of control*". He was also of the view that space identifies knowledge, information and communication. The concept of the physical space is considered to have a triad: production and reproduction of space; presentations of space; and representation of space using symbols. Therefore, space is a social phenomenon with three key features: *conceived space* as a product of AEC professionals; *perceived space* as the analogy used to produce and reproduce space; *and lived space* which has symbolic representations. Dale and Burrell, (2008) stated that there are three key factors to consider: *space enhancement* using architectural design; *space adjustment* and the way *space is intertwined* and used by users. Allen and Henn, (2006:51) described that "*the physical space within which people work strongly affects what occurs and can occur in an organisation*" Specific space configuration can respond to future changes and requirements in a healthcare environment.

Social structure and social space interrelate with the physical space. To understand the relationship between space and society, Sailer and Penn, (2007) are of the opinion that social behaviours are related to spaces created for movement, activities and interaction. In order to organise these spaces, three key factors are identified. These are: visibility and interaction; sub-divisions; distance and proximity. Allen, (1986) stated that Space can be used to create proximity between professionals to improving working conditions. Allen and Henn, (2006:85) stated that "*space can be configured to make people more aware of that which is most important in their work, and even make a physical object of their awareness visible*" The physical space is designed to allow communication among facility users. Yanow, (2006) noted that space is organised in a sociocultural patterns and requires strategic thinking from inception to completion. Space organisation creates a social balance between social structure and social space. Space is important when communicating; it is an important factor in any institutional setup. Communication can save lives in a healthcare environment. Technological progress is also important when designing the physical space. However, it has many features that can facilitate organisation, communication, interaction, sub-divisions, simplification, and multi-tasking.

4.2 Space and its Impact on Healthcare Delivery

Space is a key feature of all building types. Healthcare space design and utilisation is important due to the rapidly changing environment due to: a growing and ageing population (changing demography); innovation and developments in medical equipment and treatment (changing technology); flexible care pathways; and modern healthcare delivery systems. Unsuitable spaces for patient use can lead to accidents. As a result, older patients can experience more falls due to the lack of hand railings (Behan *et al*., 2009).

Inadequate use of space, can easily lead to space redundancy, hindering staff services and *most important of all* affect patient care. It therefore, faces the staggering challenge of providing the required proximity between spaces, whilst being aesthetically pleasing to users. Table 1 categorises all drivers for space design. Staff performance and patient care are grouped under both "*organisational*" and "*safety and wellbeing*" categories.

Table1: Space Layout Drivers (Zhao *et al*., 2009)

Space layout planning drivers				
User satisfaction	**Safety and well being**	**Energy and environment**	**Organisational**	**Spatial configuration**
Positive distraction	Prevention of patient fall	Cost of energy	Staff productivity	Different patient accommodations
Way finding facility usability	Patient dignity	Co2 emission	Building adaptability to future changes	Proximity to nursing unit
Environment that support family members	Staff safety and well being	Energy management	Reduction in medical error	Reduced patient and staff travelled
Hygiene	Patient safety and security	sustainability	Staff confidence	Adjacency and ease of access
Acoustic	Appropriate illumination for patient	Climate change reduction		

4.3 What is a Flexible/Standardised Space?

What is a flexible space or space flexibility? This simply is a space that is able to change with time, in response to shift in function or requirements for specific purposes. These include adapting to future changes and needs of facility users. Pati *et al*. (2008) described nine key issues to consider when designing an adaptable healthcare space. These are: to categorise possible healthcare flexible spaces; increase patients visibility (distinguishability); group staff into teams to easily tackle healthcare uncertainties; to increase the closeness of patient to healthcare support at all times; zoning and accessibility of functional units; ability of units/departments to exchange functions; and to embed flexibility and expandability support systems. Flexibility is also achieved through: the concept of modularity; partial or fully interstitial spaces; and the categorisation and separation of functions.

Standardisation is attributed to specification, definition, quality and reduction of errors due to repeatability. Standardisation features such as pattern, specificity, accuracy and precision aid in establishing understanding of schemes and principles with mutual focus. It can, based on these descriptions, be applied globally in various industries to achieve a simpler standardised process or product. Egan, (1998) noted that pre-assembly of prefabricated parts of private hospitals use a sequential set of standardised rooms; he also stated that standardisation works more effectively at a room level. Standardisation is important in healthcare; specific organisations are providing specific standardised units/spaces for specific purposes in their specific organisations for their specific needs; this could be adopted elsewhere based on suitability and adaptability. Examples of healthcare standardisation stated by the National Patient Safety Agency, (2010) include: the creation of the Avanti Architect`s standardised toilet; the standardised single rooms at Pembury New Hospital; and Arup`s standardised space layout, set with space around the bed for patient movement and accommodating visitors. Building Design Partnership (BDP, 2004) stated that most hospital buildings in France are built with standard elements and systems, which are prefabricated to ease the building process.

What is a standardised space or space standardisation? It can be described as a controlled space in so much that many aspects are entirely defined. Price and Lu, (2012) described features of a standardised space as: ergonomics specifications; modular units; standardising room sizes; creating similar room patterns; and modular detailing. Reiling *et al*. (2004) noted that standardisation of workflow reduces reliance on memory, and allows people unacquainted with a specific process or product to use it in a safe and efficient manner that improves quality and productivity. Standardisation aids in making a given process more reliable, simple, preferable, desirable, appropriate and achievable.

Within a standardised room: size; shape; layout; size and orientation of windows; location of doors; direction of openings; location of toilets; and the amount of treatment space required for staff to use their medical equipment and deliver healthcare services are all a time specified.

4.4 The Impact of Space Flexibility and Space Standardisation on Healthcare Staff and Patients

Staff efficiency and patient safety are two of the key drivers for combining space flexibility and space standardisation. Pati *et al*. (2008) stated that space flexibility helps in securing the future of facilities by allowing staff to work in a flexible environment that adapts to future changes. The National Patients Safety Agency, (2010:16) stated that standardisation "*reduces costs, reduce mental workload, reduce errors and deviations from normal working easier to detect*". Standardisation also facilitates the transfer of skills between different organisations, eventually improving staff performance. Table 2 shows the impact and category of space layout drivers, while Table 3 shows impact of both *space attributes*.

Table 2: Focus of Both Space Flexibility and Space Standardisation (*Space Attributes*). Modified from Ahmad *et al*. (2011)

"Space attributes"	**Focus**	**Impact**
Space flexibility	Physical space	Growth
		Uncertainties
Space standardisation	Physical space	Staff performance
	Procedural process	Patient care

Table 3: Impact of both Space Flexibility and Space Standardisation (*Space Attributes*) on Healthcare Staff and Patients

"Space attributes"	Impact on staff	Impact on patient
Space flexibility	Gallant *et al*. (2001) stated that flexibility saves staff time by providing multi-functional rooms.	Hendrich, *et al*. (2004) stated that multi-functional spaces reduce the rate of medical errors and transportation of patients.
	Pati et *al*. (2008) described that peer line of sight, (flexible nurses) allows (nurse teaming); this increases staff confidence and stress mitigation for healthcare delivery uncertainties.	Pati *et al*. (2008) described that multi-functional spaces reduces the stress of moving patient.
	Kobus *et al*. (2008); Reiling (2007); Pati *et al.* (2008); and NHS Estates, (2005:50-55agrees that flexible spaces reduce travelling distance for staff.	Kobus *et al*. (2008); Reiling, (2007); Pati *et al*. (2008); and NHS Estates, (2005:50-55agrees that flexible spaces reduce travelling distance for patients.
	NHS Estates, (2005:50-55) flexibility enables staff to manage bed availability and some patient's needs.	NHS Estates, (2005:50-55) stated that flexibility supports the process of ward allocation to patients.
Space standardisation	Joint Commission Resources (2004) and Reiling (2007) stated that standardisation reduces staff errors.	Standards adapt to patient needs (Ahmad).
	Malone *et al*. (2007) notes that standardised workflow contribute to patient care efficiency and safety.	Reiling (2007) Standards improves the care patients receive from staff.
	Standards, guides health delivery procedures, enabling staff to easily reuse facility (Ahmad).	With standardisation, patients easily reuse facility (Ahmad).
	Reiling *et al*. (2004) states that standardisation reduces reliance on memory.	Standards, helps in organising patient's activities in healthcare facilities.
	Sexton, (2000) recommended standardisation, as it improves (safety in general) staff safety.	Sexton, (2000) recommended standardisation, as it improves (safety in general) patient safety.
	NHS Estates, (2005:40) stated standardisation allows the minimum required space for staff to conduct their services effectively.	NHS Estates, (2005:40) stated standardisation allows the minimum required space to create patient comfort.

5. Questionnaire Survey

The questionnaire survey was previously introduced. Figures 2 and 3 illustrates the geographical locations and professional roles of the questionnaire survey respondents. Semi-structured questions were presented to the respondents. Questions were centred on space flexibility and space standardisation.

Figure 1: Professional Role of Questionnaire Survey Respondents

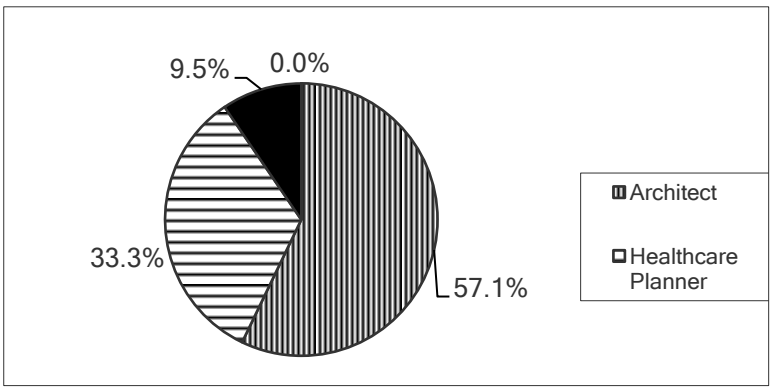
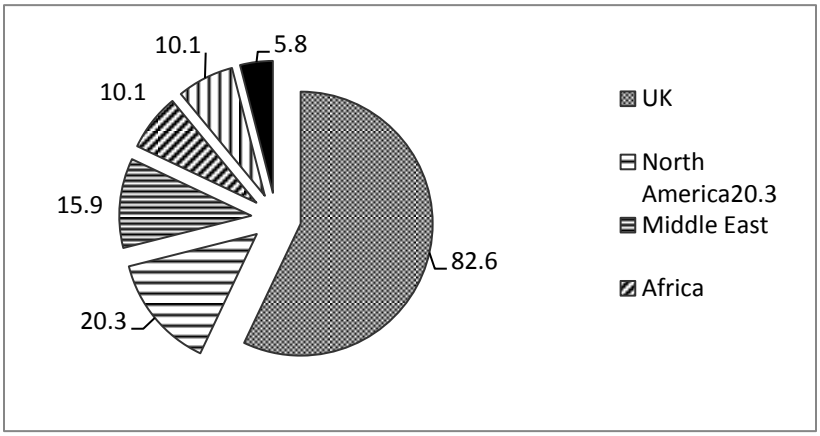


Figure 2: Geographical Location of Questionnaire Survey Respondents



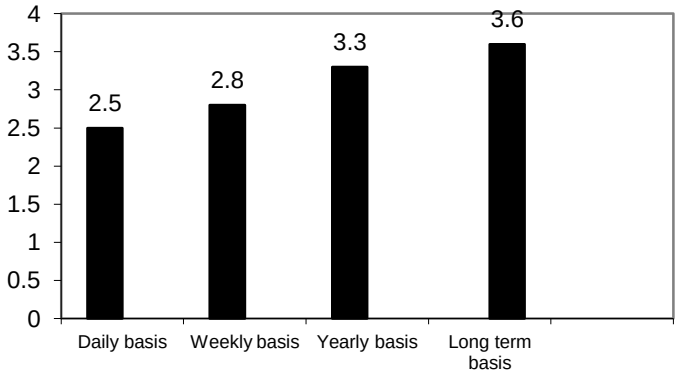
5.1 Questionnaire Survey Findings (Space Flexibility)

The questionnaire survey findings relating to space flexibility were categorised into short-term and long-term applications in healthcare facilities. The various changes occurring in healthcare facilities require different inputs to obtain desired project outcomes; some inputs may involve gradual intervention, while in other cases an immediate response may be required. Findings show effectiveness of space flexibility at different levels.

5.1.1 At what Level are there More Opportunities to implement Cost Effective Space Flexibility at Ward/Department Level in Healthcare Design?

Figure 3 illustrates the responses to the above question. Options were categorised into: daily basis; weekly basis; yearly basis and long-term basis. Finding shows that the questionnaire survey respondents were of the view that it is easier to implement cost effective space flexibility on a long-term basis within a ward/departmental level, while it is more difficult to implement it on a daily basis (short-term). This can be attributed to the rapid changing nature of healthcare facilities; Pommer *et al*. (2010:1383) noted that *"Hospitals are constantly under construction with on-going renovation and expansion to accommodate new modalities, new protocol, new technologies"*. These factors challenge the ability to implement flexibility on a short-term basis.

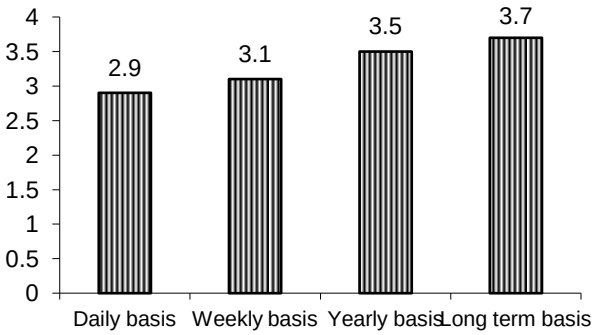
Figure 3: Questionnaire Survey Responses on Space Flexibility at Departmental/Ward Level



5.1.2. At What Level are there More Opportunities to Implement Cost Effective Flexibility at Specific Areas/Room Level in Healthcare Facility Design?

Figure 4 illustrates the responses to the above question. This question had the same options as the question before it, with opportunities on daily basis; weekly basis; yearly basis and long-term basis. Even though rooms and specific areas had fewer issues to consider compared to healthcare wards and departments, the questionnaire survey respondents were of the opinion that it is easier to implement cost effective flexibility at specific areas or room levels on a long-term basis, while it is difficult to adopt space flexibility on a short-term basis. Some respondents made extra comments that it is *possible* to implement cost effective space flexibility on a short-term basis, but it is more challenging as it allows little time to adapt to changes.

Figure 4: Questionnaire Survey Responses on Space Flexibility at Specific Area/Room Level



5.1.3 At What Levels are there More Opportunities to implement Cost Effective Space Flexibility on the Entire Building/Site Area in Healthcare Facility Design?

Figure 5 illustrates the responses to the above question. The questionnaire survey respondents indicated that space flexibility within an entire building/site level in healthcare facility design is easily achieved on a long-term basis. It is more cost effective and useful to apply space flexibility over a long period. The more the space, diversity and flexibility required, the more the cost of the project. An entire flexible site will take a longer time to construct compared to a flexible unit/building floor area.

Figure 5: Questionnaire Survey Responses on Space Flexibility at Building/Site Level

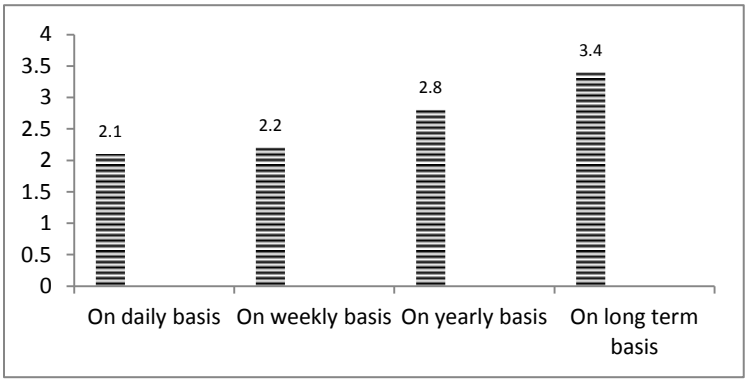
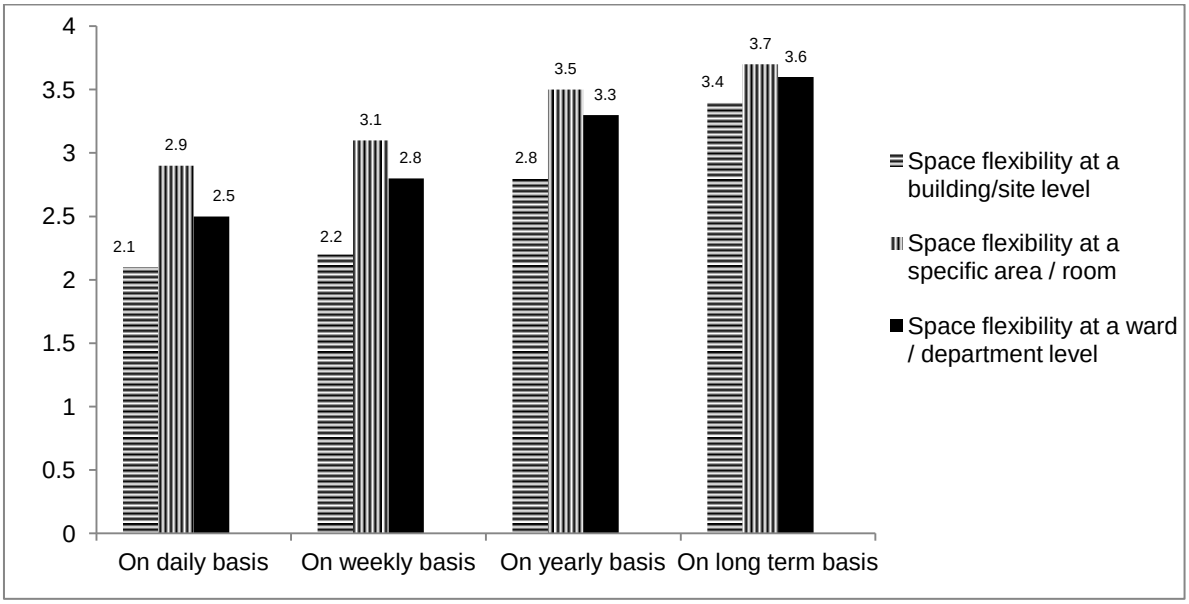


Figure 6 presents the summary of Figures 3, 4, and 5; it shows that the questionnaire survey respondents are of the opinion that space flexibility can be implemented effectively on a long-term basis with regards to the entire site, building level, departmental level, ward level, patient bedroom level or a specific area within a given healthcare facility. This can be taken into consideration when conceptualising and developing a specific design for the effective and efficient application of flexibility (Ahmad *et al*. 2011). Neufville *et al*. (2008) stated that strategic flexibility is suitable on a long-term basis; this coincides with the opinion of the questionnaire survey respondents. Figures 3, 4 and 5 show it is easier to achieve cost effective space flexibility on a long-term basis.

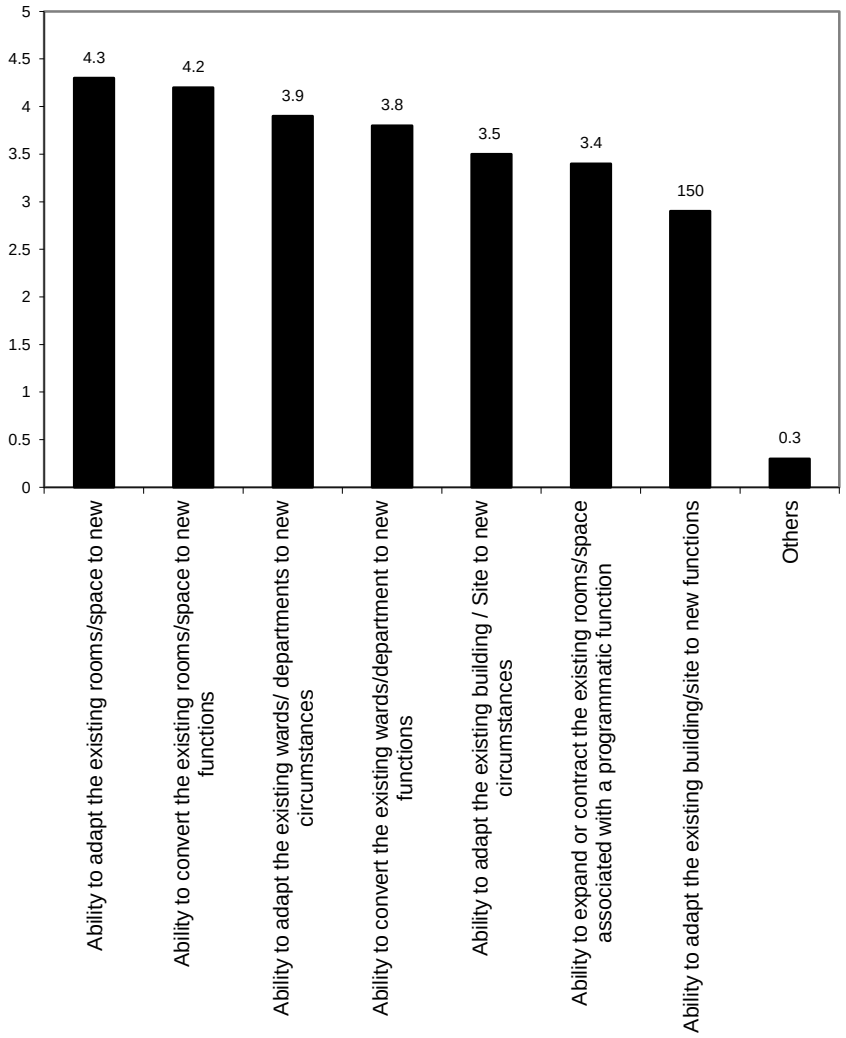
Figure 6: The Combination of Questionnaire Survey Responses (Figure 3, 4 and 5): Showing the Cost Effectiveness of Space Flexibility at Three Different Scenarios



5.1.4 What are the Most Important Types of Space Flexibility in Healthcare Facility Design?

Figure 7 illustrates the responses to the question above. The most important type of space flexibility in the opinion of the questionnaire survey respondents was the ability to adapt existing room/space to meet new needs, while the ability to adapt the existing building/site to new functions had the least rating. Creating new functions close to existing function has to be innovatively and effectively planned to achieve a good flow between the existing and new spaces.

Figure 7: Questionnaire Survey responses on the Different Types of Space Flexibility



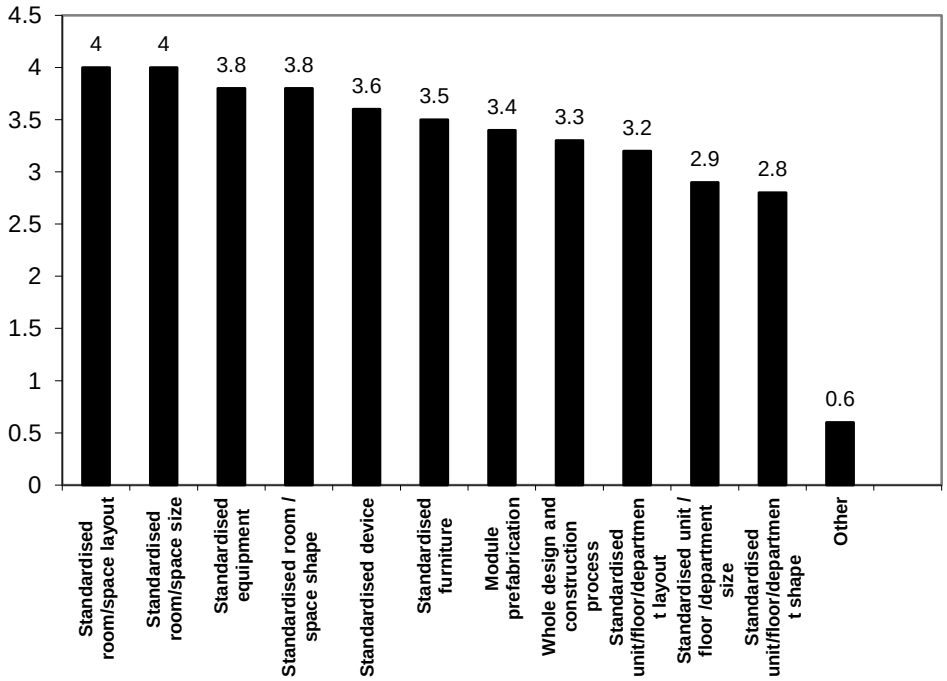
5.2 Findings (Space Standardisation)

The questionnaire survey respondents were asked to indicate their degree of agreement or disagreement relating to issues of space standardisation in the healthcare sector. Findings showed the most important type of space standardisation in the opinion of the respondents.

5.2.1 What is the Most Important Type of (Space Standardisation) in Healthcare Facility Design?

Figure 8 illustrates the responses to the question above. It was described by the questionnaire survey respondents that the most important type of standardized *space* in healthcare is standardised room/space, while standardised unit/floor/department layout was identified as the least important type of standardised space when designing healthcare spaces. Egan, (1998) noted that pre-assembly of prefabricated parts of private hospitals use a sequential set of standardised rooms. Sine and Hunt, (2009) stated that patients expect more quality in healthcare bedrooms, perhaps the features of these rooms should be standardised. Pickard, (2005:10) stated that "*total standardisation may sometimes be appropriate for small buildings, but the most common and effective application of standardisation is to room layouts and assemblies of furniture and equipment such as the NHS Estates Activity DataBase*". This coincides with the opinion of the questionnaire survey respondents to standardised single rooms for the effective application of standards in healthcare facilities. The Activity DataBase (ADB) is a healthcare briefing and design software tool used for providing healthcare data for the design and construction of healthcare facilities.

Figure 8: Questionnaire Survey Responses on the Different Types of Space Standardisation



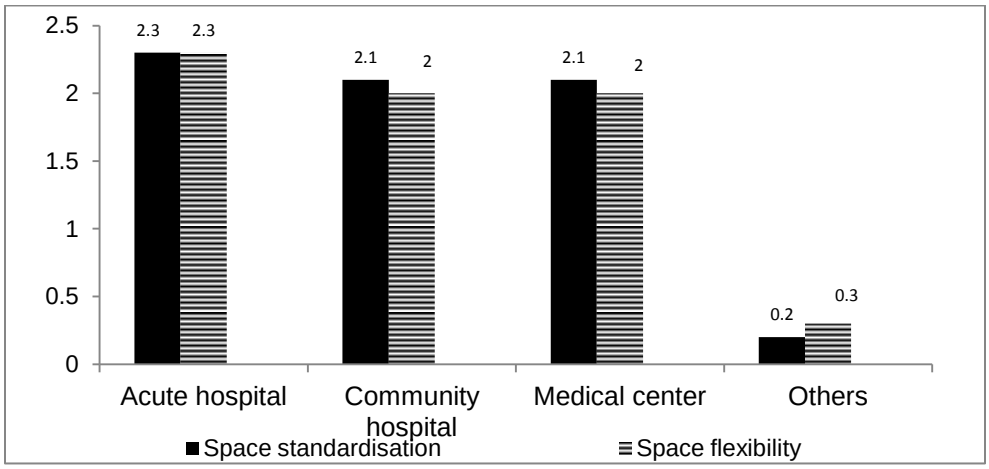
5. Relationship between Space Flexibility and Space Standardisation

This section explores the possible relationships between space flexibility and space standardisation within the questionnaire survey responses. The *space attributes* where compared to explore their relationships. Swayne *et al*. (2006) asked the question, is there a possible balance between space flexibility and space standardisation? Price and Lu, (2012) stated that there is no specific optimum ratio for the application of both *space attributes*; flexibility can complement standardisation, and when trying to find a balance between both *space attributes*, space standardisation should be implemented first, then space flexibility can be used were standardisation has lapses; space standardisation can be customised to suit user`s needs.

5.3.1 What is the Relationship between the Areas/Spaces/Units that Provide the Best Opportunity for both *Spaces Attributes*?

Figure 9 illustrates the responses to the question above. The respondents were asked to state the name of room type/area that provides the best opportunity for space flexibility? In another question; the respondents were asked to state the name of room type or area that provides the best opportunity for space standardisation? The questionnaire survey findings show that respondents are of the view that acute hospitals are healthcare spaces that provide the best opportunities for both *space attributes* to be implemented. Pickard, (2005:10) described that "*the design of Acute hospitals is different in most cases, due to their complexity and technicalities; it is advised to standardise design of part of these hospitals, which can frequently be updated in light of experience*"; he also advised "*to standardise the design of parts of hospital, or even in a few cases of whole hospital…the greatest danger is the use of a standard solution in an unimaginative or bureaucratic manner, when it is inappropriate to the needs of the project, or when it has become functionally obsolete*".

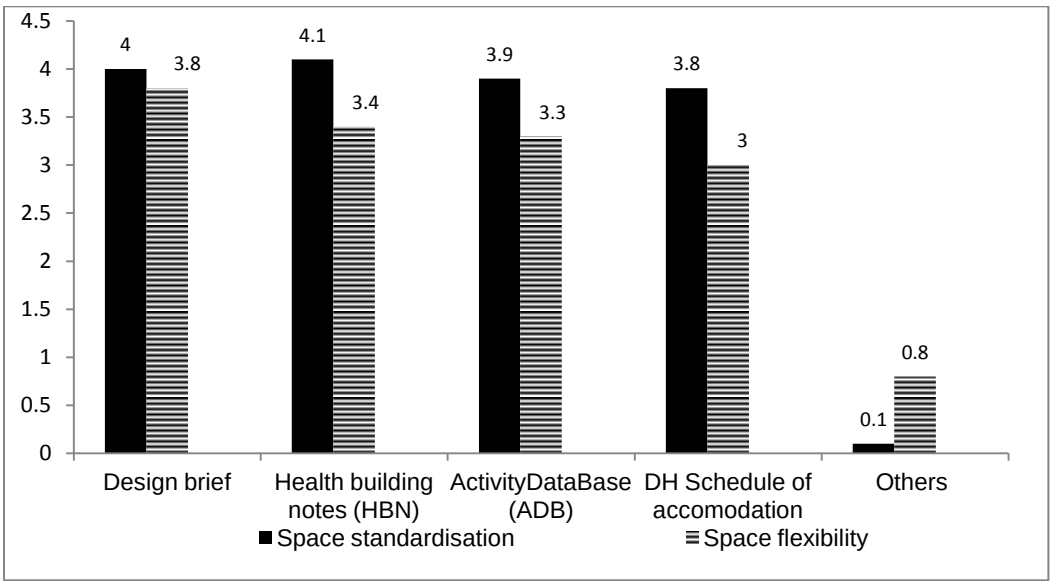
Figure 9: Questionnaire Survey Responses on the Best Opportunities for both *Spaces Attributes*



5.3.2 What is the Relationship between the Most Important Tools Used to achieving both *Space Attributes*?

Figure 10 illustrates the responses to the above question. The questionnaire survey respondents were asked: what are the most important tools used to achieve space flexibility in healthcare facilities? Another question was asked: what are the most important tools used to achieve space standardisation? The mean was tabulated for each of the *space attributes* in Figure 10; it shows that the questionnaire survey respondents are more comfortable using tools/guidance/software to achieve space standardisation rather than space flexibility.

Figure 10: Questionnaire Survey Responses on Tools/Guidance/Software Used for Both *Spaces Attributes*



From the questionnaire survey findings, four key tools have been agreed to be the most efficient tools that help in achieving both *space attributes*. These are:

- Activity DataBase (ADB);
- Health Building Notes (HBN);
- DH Schedule of Accommodation; and
- Design Brief.

Findings from the Department of Health show that there are more than 1240 different room specifications. Hignett and Lu, (2007) noted that there is a lack of confidence in the availability of information, and that there is conflict between the information focus for patient (care) and staff (efficiency) to be applied in a facility design.

5.3.3 What is the Relationship between the Degrees of Agreement/Disagreement to achieving the Drivers of both *Spaces Attributes*?

Figure 11 illustrates the responses to the question above. The questionnaire survey respondents were asked: to indicate their degree of agreement/disagreement that the following are key drivers for achieving space flexibility? The respondents were also asked: to indicate their degree of agreement/disagreement that the following are key drivers for achieving space standardisation? Findings showed that space standardisation is more efficient in dealing with clinical issues in healthcare facility design. When designing healthcare spaces, clinical areas can be fully standardised while other non-clinical areas can be partially standardised. Table 4 shows the impact of space flexibility and space standardisation drivers.

Figure 11: Questionnaire Survey Responses on Key Drivers for both *Spaces Attributes*

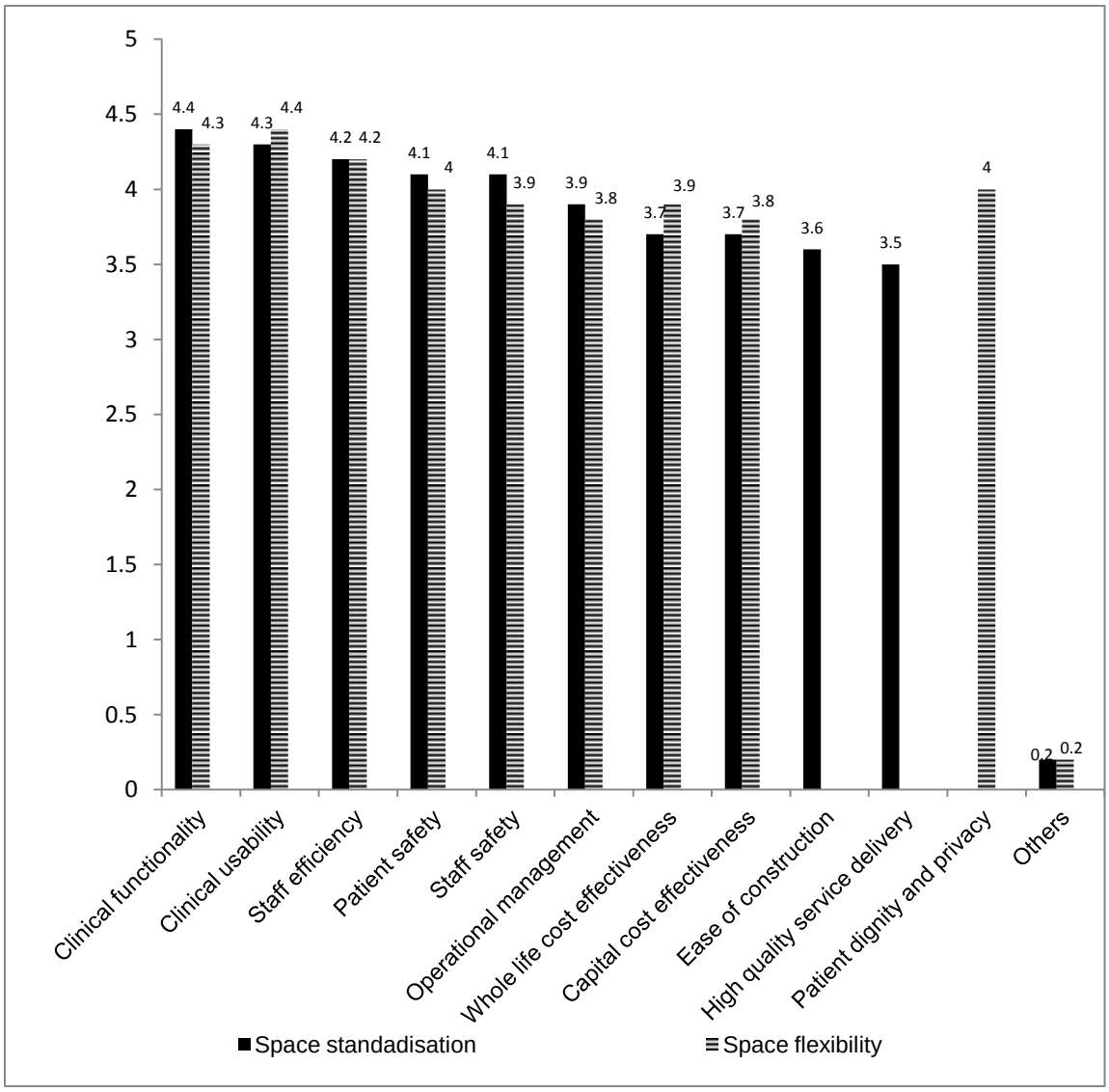


Table 4: Impact of Space Flexibility and Space Standardisation Drivers on Healthcare Facility Design and Users

Drivers	Direct (impact)	Space Flexibility Driver	Space Standardisation Driver
Staff safety	Staff	✓	✓
Patient safety	Patient	✓	✓
Staff efficiency	Staff and patient	✓	✓
Patient dignity and privacy	Patient	✓	
High quality service delivery	Patient and staff		✓
Clinical functionality	Patient and Staff	✓	✓
Operational management	Facility	✓	✓
Capital cost effectiveness	Facility	✓	✓
Whole life cost effectiveness	Facility	✓	✓
Clinical usability	Patient and staff	✓	✓
Ease of construction	Facility		✓

5.3.4 What is the Relationship between the Degrees of Agreement/Disagreement to the Different Barriers for both *Space Attributes*?

Figure 12 illustrates the responses to the above question. The respondents were asked: to indicate their degree of agreement/disagreement that the following are major barriers for achieving space flexibility? They were also asked: to indicate their degree of agreement/disagreement that the following are major barriers of space standardisation? It is noteworthy to understand that space standardisation has more conflict with space flexibility, while space flexibility has less conflicting issues with space standardisation in the opinion of the questionnaire survey respondents. Budget is more of an issue to space flexibility compared to space standardisation; embedding facility flexibility comes with a price. A financial feasibility study is required to make a business case for implementing flexibility in any given facility. Table 5 shows barriers for both *space attributes* and their impact on facility design and users.

Figure 12: Questionnaire Survey Responses on the Major Barriers to Achieving both *Spaces Attribute*

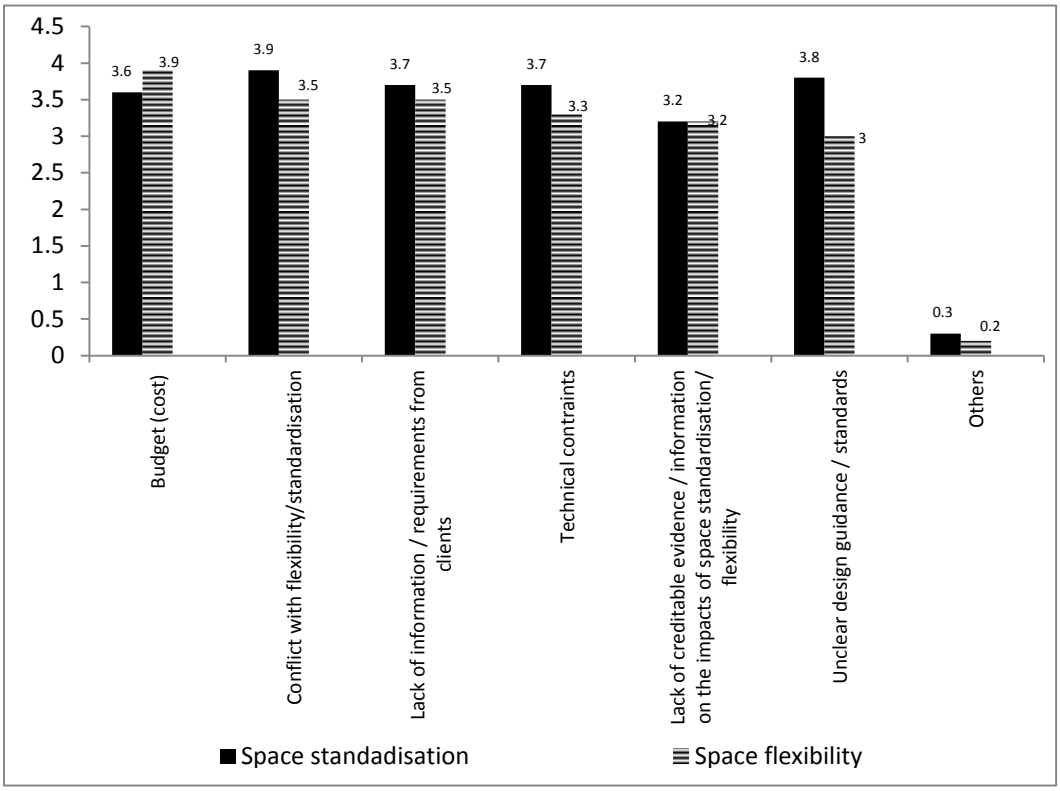


Table 5: Impact of Space Flexibility and Space Standardisation Barriers on Healthcare Facility Design and Users

Drivers	Direct (impact)	Space Flexibility Barrier	Space Standardisation Barrier
Culture	Patient and staff	✓	✓
People diversity	Patient and staff	✓	✓
Unclear design guidance	Facility design	✓	✓
Technical constraints	Facility design	✓	
Lack of credible evidence	Facility design	✓	✓
Loss of creativity	Facility design		✓
Conflict with standardisation	Facility design	✓	
Conflict with flexibility	Facility design		✓
Budget	Facility design	✓	✓

Key considerations stated by some of the respondents within the 70 participants were mostly centred on standardisation. These comments were written in the space provided "*others*" for additional information. Some of the findings coincided with Pickard (2005); he stated that standardisation is better in clinical areas and should be encouraged by stating its benefits in the Design Brief Stage. Hignet and Lu, (2007) stated that one of the barriers of standardisation is that; there is a lack of confidence in information provided for specifications, and a time these standards are rarely updated. This coincides with additional comments made by some of the questionnaire survey respondents.

6. Interview Findings

The interviews have been previously introduced; they were conducted to have an in-depth understanding of flexibility and standardisation in the design of healthcare facilities. Semi-structured interviews were conducted. The interviews lasted 30-45 minutes. Tables 6 and 7 show summary of interview responses.

Lessons learnt from the conducted interviews are presented below:

- Flexible opportunities can be achieved through the use of modular designs and reducing the number of varied spaces (Price and Lu, 2012). However, out of the ten interviewees, three interviewees were of the view that customisation of standards would be a clearer and simpler way to define the combined application of flexibility and standardisation. A standard design is altered to suit a specific context through the use of standardised alternative specifications to make designs more flexible.
- Both space flexibility and standardisation processes can influence the process of cost reduction and cost efficiency in healthcare. Their combined application can facilitate the design of a change-ready healthcare facility through the use of a standard design process (design re-use) and the use of universal healthcare spaces using generic space features such as space layout, dimension, door and window openings, door and window sizes and so on.
- Cost is a major issue relating to flexibility. It is arguably increasing the capital cost of a building and reducing the operational management cost. While some interviewees were of the view that flexibility does not necessarily increase the capital cost of a building in the long-term. With regards to standardisation, customised/flexible standards could increase costs of projects.
- There is no specific pattern of combining flexibility and standardisation from professional guidance. Therefore, all or part of flexibility parameters can be standardised. For example, flexible space layout, equipment, function can all be standardised and customised were appropriate.
- The process of applying standards involves identifying the source of information, selecting appropriate specification from bunch of available standards, categorising relevant information, reviewing existing information for possible updates and the use of specifications that can easily adapt to the proposed project business case.
- There is agreement with some of the interviewees that certain components or features with a building can be standardised to achieve flexibility; eventually improving communication, optimisation, delivery, maintenance and quality of project in context.
- Standards can facilitate flexibility whether those are flexible or inflexible. Some inflexible standards are like static modular grid layouts while a flexible standard easily specifies flexibility. Perhaps flexibility is a feature of standardisation or part covered by standardisation. Flexible standards can be updated with the availability of new insights.

Table 6: Possible Tension between Space Flexibility and Space Standardisation (Four Interviewees)

Space flexibility	**Space standardisation**
Easily focused on context	Not always focused on context
Developed in isolation mostly (reductionism)	Developed in forums mostly (Holistic)
Easier to adapt to	Harder to adapt to
Flexibility is not free	Standards are a time free
Mostly applied before standardisation (absence of interoperability)	Always standardise before applying (presence of interoperability)
Focus on specific issues	Focus on general issues
Responds to changes	Repeatability
Adjust processes	Constant and regular

Table 7: Summary of Interviews

INTERVIEW NO.	**What does a flexibility process entail?**	**What does a standardised process entail?**	**What does the combined application of flexibility and standardisation entail?**
1.	Flexibility is cost driven. Flexibility should be designed with cost in mind. Identify the different flexibility approaches. Identify possible future changes through scenario planning.	Identifying specifications required to support the business needs. HTN and guide lines can be copied and paste, monitored and manage with a BIM process.	The combined application of standardisation and flexibility can be perceived as the customisation of standards.
2.	Advice client on facility life cycle management. Focus on calculated future changes to save cost. Design long-term and short-term flexibility strategies.	Identifying the source of information. Identify information required for linking real live information to model for life cycle analysis.	Provide flexible spaces that are standardised.
3.	Define and identify flexibility requirements. Evaluate the input and output of the flexibility requirements	Use the Design Brief for design specifications.	Standardising columns, beams, windows, doors, furniture, grids. Integrate components (prefabrication) spaces involved in designing flexible spaces.
4.	Integrate user feedback into design.	Identifying the right information to achieve user needs.	Standardising elements or components of the flexible designs.
5.	Advice client on benefits of flexibility. Agree on long-term, mid-term or short-term flexibility approach. Finalise assessment of the preferable flexible design option.	Categorising relevant data. Attaching specification to design components.	Standardising parts or entire designs.

Table 7: Continued

INTERVIEW NO.	What does a flexibility process entail?	What does a standardised process entail?	What does the combined application of flexibility and standardisation entail?
6	Estimate the cost of embedding flexibility.	Identify source of information for product and processes.	This involves the use of modular grids, sizes and components; and customisation where appropriate.
7.	Identify responsible flexible design team. Organise project information within a BIM model to analyse different design options.	Review standards for possible new updates.	Attaching standards to proposed flexible spaces.
8.	Identify key flexibility components.	Standards have to be organised for planning permission application.	Combining the standardised parts into a single element. For example, a room
9.	In the conceptual stage short-term flexibility can be achieved by use of open planning, use of standard equipment and universal rooms. At the mid-term level interstitial floors and modular designs are used. Whilst long-term flexibility is achieved using open-ended corridors. Flexible foundations create space for expansion and zoning.	Identify required BIM objects with specifications for modelling different design options.	Flexibility and standardisation both tend to reduce cost and maintenance effort to improve quality Standardised components can be flexible by been interchangeable
10.	Use of multi-purposes spaces for cost and function utilisation. Flexible spaces may require flexible furniture or equipment.	Uniformity of building elements is important, although, standardisation requires design of elements in detailed relationship to the whole (compatibility).	When combining flexibility and standardisation it is important to consider standards` characteristics such as degree of specificity and simplicity

7. Discussion and Conclusions

Space flexibility for the purposes of this research focuses on the physical space/equipment/furniture only, i.e. the product resulting from design and construction. One of the questionnaire survey findings coincides with Neufville *et al*. (2008) that flexibility is more effective on a long-term basis due to the rapid changing nature of healthcare facilities. These changes are instigated by an ageing and growing population, and the changing nature of healthcare treatment (process and equipment). These factors make it difficult for healthcare spaces to adapt to changes within a short time-frame. Most of the concerns raised by the questionnaire survey respondents were centred on flexibility, standardisation and quality of information; these concerns are grouped into three categories. These are:

1- Constraints of existing spaces (four respondents)
2- The ability of a facility to be flexible (three respondents)
3- Information reliability for space specifications (three respondents)

The specifications or requirements for healthcare spaces may vary depending on facility type and use. Despite the different space requirements, healthcare spaces are a time designed with ADB standards. It was stated on the ADB website that the ADB, a healthcare briefing and design software tool is estimated to be applied in more than 90% of healthcare facilities in the UK; it provides healthcare information for the design and construction of healthcare projects and is being constantly updated for information reliability and adaptability. The question is how frequently does the software need updating to adapt to the frequent changing needs and requirements of healthcare facilities?

Understanding Space Flexibility and Space Standardisation

Flexibility has been defined in different ways; Holt *et al*. (2008:2) defined it *"as mobility, compliance, and alternatively as the reciprocal counterpart*". Pati *et al*. (2008) stated that flexibility means different things to different people. For example: "*management*" describes flexibility as the ability to manipulate higher level resources such as staffing and teaming to tackle uncertainties; "*direct caregivers*" define flexibility as the ability to multi-task and multi-skill to optimise and maximise efficiency; while "*non-nursing staff*" labels flexibility as the ability to manipulate resources to effectively manage patients' needs and appeals.

This study has acknowledged that there are some similar problems to the combined application of flexibility and standardisation. These include: budgets; dealing with diversity; and different cultures, while their similar advantages are operational efficiency, clinical usability, clinical functionality, staff and patient safety and healthcare staff efficiency. Nevertheless, the combined application of space flexibility and space standardisation is still encouraged, as their advantages outweigh their disadvantages. The advantages of both *space attributes* can be achieved using certain tools, among the different tools, the Design Brief was considered as the most common tool for designing healthcare facilities in the opinion of the questionnaire survey respondents. Another question emerged, how does this research impact the practical implementation of space flexibility and space standardisation in healthcare delivery and improves the quality of healthcare facility design? The drivers for both *space attributes* can motivate their implementation in healthcare facilities. When implementing space flexibility and space standardisation together, there is no specific (ratio) of their combined application. The strategy for combining space flexibility and space standardisation findings was to explore their relationship, this can allow the use of space standardisation where space flexibility is less effective and vice versa. However, a question arises, is the less the standards, the more the flexibility or the less the flexibility, the more the standards? Flexibility can be understood as the process of undergoing different process under varying conditions, while standardisation is attempting similar projects under similar conditions. This calls for flexible standards. Perhaps, flexibility is a component of standardisation or a part covered by standardisation.

Standardisation as an Enabler of Flexibility

Flexibility can be achieved through standardisation. One of the questionnaire survey findings on space standardisation coincides with Pickard, (2005) and Price and Lu, (2012) that standardisation is more effective when applied to healthcare rooms. For example, a single bed in a hospital is designed in so much that almost the entire room is specified. This includes the windows and door sizes, finishing materials, room size, shape, layout and more. However, facility users request for more quality and efficiency which entails the need for flexible standards. Perhaps an efficient healthcare facility that focuses on staff and patients should integrate both space flexibility and space standardisation. In some healthcare environments, local flexibility may be favoured to international standards. But it is always better to standardise where standardisation is relevant. Standardisation sometimes suggests "one size fits all". Therefore, there is a need to improvise flexibility concepts that are standardised; leading to flexible standardisation.

Flexibility has many features related to standardisation; to achieve interoperability between different standardised functions or building elements, compatible standards can be used. Standardised grid layouts allow spaces to easily expand. Flexible and inflexible standards can both facilitate flexibility. For example, some inflexible standards are like static modular grid layouts while a flexible standard easily allows flexibility to take place. For example, most windows are usually designed in a multiple of 300 millimeters (mm) standard for ease of industrial manufacturing and flexibility in their various applications. Hence, different flexible sizes in the multiple of 300 mm specification can be used such as 900 mm x 600 mm, 1200 mm x 1500 mm or 900 mm x 1200 mm. the NHS estates, (2004:20) have encouraged healthcare design professionals to increase spaces in operating theatres for maximum flexibility.

They also stated that "*a standard of 55m2 is recommended for all in-patient operating theatres*". This implies that standards can complement flexibility in some cases.

The Dynamics of Space Flexibility and Standardisation over Time

How will the dynamics of flexibility and standardisation change over time? Standards will always need updating due to client demand, Government policies, healthcare treatment needs and quality standards required or set by the NHS. While flexibility will always require changes to take place in order to adapt to user's future needs and appeals. This study concludes that due to the changing nature of demography and technology; healthcare spaces should be flexible and standardised. They can also be updated with the availability of new insights on the combined application of flexibility and standardisation. Carthey *et al*. (2009) observed that there are more challenges apart from the rapid changing nature of healthcare buildings and unforeseen conditions surrounding healthcare environments; they described that some hospitals have bad designs (existing) that do not allow further alterations, and such are Private Finance Initiative (PFI) structures; also quotes RIBA, (2005) stating that due to the rigidity and basis of PFI structures contracts, they do not allow changes to take place at a later stage. However, it is noteworthy to design and propose future flexibility on spaces that are not too rigid.

Functionality of Space Flexibility and Standardisation

Space flexibility and space standardisation can be applied in the design of the physical healthcare space to achieve optimum performance. Findings from this study can be applied in both the Concept Design and Developed Design Stages of the RIBA Plan of Work. When conceptualising the design, the application of flexibility and standardisation in healthcare can be strategically applied where they are more effective to achieve desired project outcomes. This study has identified that flexibility is more effective on a long-term basis, while standardisation is more effective when fully applied to rooms. Standardisation simplifies processes, tasks, designs, while flexibility can be used to simplify more by providing options. Standardisation also facilitates the process of re-using facilities, enhances patient safety, reduce patient error and helps in organising patients' activities. Flexibility supports nurses towards achieving staff teaming in order to increase staff confidence; it also supports bed availability management. Flexibility can improve productivity and save time by allowing different functions to take place within an intelligent multi-purpose space. The use of common spaces for multiple-purpose functions (flexibility) can reduce staff and patient travelling distance, and mitigates the pressure associated with transferring fragile patients from one functional space to the next for healthcare treatment. This study creates an opportunity to integrate both flexibility and standardization into the design process to improve the quality and efficiency of healthcare facilities. The comparison of the questionnaire survey findings showed that most of the questionnaire survey respondents were of the view that space flexibility has lesser conflicting issues with space standardisation, whilst space standardisation has more conflicting issues with space flexibility when applied together simultaneously. Therefore, space standardisation should be used where it is more effective than space flexibility and vice versa to achieve optimum healthcare delivery outcome. Individual surveys can be done to build on this research for a more harmonious and effective integration of flexibility and standardisation.

Limitations of Research

When comparing space flexibility and space standardisation, the number of people who answered and skipped some questions varied. Therefore, the comparison does not reflect equal sum of individual responses for each question. The rational is to compare the pattern of findings from each question presented in Figures 9, 10, 11 and 12; the y-axis annotates the mean of responses; a similar pattern was discovered (i.e. increasing or decreasing in the same direction).Even though findings are collected from experienced healthcare professionals; most findings are subjective perceptions. This research also focused on the supply side more closely compared to the demand side. Perhaps further research findings from both supply and demand side would enable the full exploration of the combined application of flexibility and standardisation. However, findings from the delivery side tend to share the views of experienced healthcare design professionals.

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