Medium-Density Mixed Housing: sustainable design and construction of South African Social Housing

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Abstract

Medium-density mixed housing (MDMH), social housing (SH) being one component of that, is perceived to have the capacity to contribute to the transformation of fragmented South African cities more than the massive roll-out of government-subsidised "one-house-per-plot typology". It is also perceived that higher densities are more economically and environmentally sustainable. If these perceptions lead to large numbers of MDMH projects being built in the near future, these will have a felt impact environmentally, socially and economically.

Against this background, this paper presents the outcomes of a CSIR multi-year research project titled 'Medium Density Mixed Housing (2007-09)'. The study as carried out by Landman *et al* lists some critical success factors for MDMH as well as a spatial analysis tool (SAT) to gauge the performance aspects with regard to integration, accessibility, efficiency, image and aesthetics, surveillance, ownership and target hardening.

With particular reference to SH, it is suggested that this tool for assessment be expanded to include adaptability and changeability to accommodate future unforeseen needs – thus ensuring market viability – and also assessing the capacity of a building and/or building components to be adapted to changing circumstances of the inhabitants or needs of the owners. Concepts of building adaptability rely heavily on 4D-design theories such as Habraken's Supports, Open Building levels as well as different approaches to material/component re-use.

Currently, SH is conceived as a static representation of current needs. Two case studies, Brickfields and Carr Gardens, are used to demonstrate that the future building of SH developments needs to bear in mind a multitude of aspects including design for change and a decision-making process that takes into consideration good practice with regard to material/component selection and detailing.

1. Introduction to Medium-density mixed housing in South Africa

In searching for solutions to the growing backlog in South African housing demand and general unrest with regard to the government's ability to deliver in terms of quantity and quality, several measures have been undertaken in the recent past. The first acknowledgement that the government might be "getting it wrong" was the articulation of a New Comprehensive Plan for the Development of Sustainable Human Settlements – better known as Breaking New Ground (BNG) – approved by cabinet in 2004. This plan comprised of a series of business plans (seven in number ranging from upgrading of informal settlements to the revitalisation of housing markets). While building on existing housing policy, it also provides a new housing vision to redirect and enhance "responsive and effective delivery". The human settlements plan "reinforces the vision of the Department of Housing, to promote the achievement of a non-racial, integrated society through the development of sustainable human settlements and quality housing". Within

this broader vision, the Department committed to meeting specific objectives such as accelerating the delivery of housing, poverty alleviation, housing as a job creation strategy and as an instrument for the development of sustainable human settlements and spatial restructuring.

The BNG intention of supporting the entire residential market implies moving away from the understanding that government only supports housing for the very poor as housing for the poor is seen as an integral part of a functioning housing market. This is reinforced by the renaming of the Department of Housing as the Department of Human Settlements in 2009. Another key aspect of BNG is the major role identified for the private sector in assisting government to achieve its developmental aims.

Several policies and initiatives emphasise the importance of various types of mix in housing developments. The 2005 Social Contract for Rapid Housing Delivery stipulated that "every commercial development including housing developments that are not directed to those earning R1500 or less, spend a minimum of 20% of the project value on the construction of affordable housing". Affordable housing is currently defined as housing targeting households earning between R1 500 and R8 000 per month. The development of a Framework for Inclusionary Housing Policy for SA in June 2007 stated: "Inclusionary housing in SA means the harnessing of private initiatives in its pursuit of housing delivery to middle/higher income households to also provide (include) affordable housing opportunities in order to achieve a better socio-economic balance in residential developments and also contribute to the supply of affordable housing."

Part A of the National Housing Code (2009) explains the Integrated Residential Development Programme as follows: "The Comprehensive Plan for the Development of Sustainable Human Settlements approved on 1 September 2004, represents a paradigm shift for the national housing programme. Having achieved the initial housing delivery targets, government shifted its development focus towards addressing settlement inefficiencies through the development of integrated human settlements which will contribute towards more compact settlement form and provide a range of housing and socio-economic opportunities." It stated that the policy programmes had tended to focus primarily on the development of subsidised housing and thus did not allow for settlement planning and the integration of a range of housing types and price categories, together with commercial and social amenities in a project. In other words, the focus was on houses and not functioning, integrated neighbourhoods.

The programme does away with the requirement found in other policy programmes to identify subsidised housing recipients up front and provides for both subsidised, as well as finance-linked housing, social and rental housing, commercial, institutional and other land uses to be developed. Integration is achieved through the provision of both bonded and subsidised housing in a mix appropriate to the project location, which in turn lends itself to facilitating inclusionary housing development. It is thus seen that MDMH may be important as a key component of sustainable human settlements if the aims of the BNG are to be addressed.

MDMH is defined as housing that has a minimum of 50 dwelling units per hectare (du/ha) and a maximum of 125 du/ha. These various densities have different spatial and physical manifestations. This definition is also relative with regards to the locality in question as inner city contexts may require a significantly higher density. MDMH is generally characterised by ground-level entry, private external space for each dwelling unit, close proximity to secure parking and ground related – thus these developments are rarely over 3-4 stories above ground.

Housing alternatives have the power to change perceptions about housing for both people and the government. This is well-understood and articulated in the BNG and is one of the strengths of the plan. The various sections of the BNG mention "enhancing housing product"[1], "shifting from product uniformity to demand responsiveness"[2], and the Social (Medium-density) Housing Instrument[3] is seen to be aiming

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[1] Section 3.7, BNG
[2] Section 2.2 BNG

towards housing products that provide adequate shelter to households whilst simultaneously enhancing flexibility and mobility.

MDMH, SH being one component of that, is perceived to have the capacity to contribute to the transformation of fragmented South African cities more than the massive roll-out of government-subsidised "one-house-per-plot typology". It is also perceived that higher densities are more economically and environmentally sustainable. If these perceptions lead to large numbers of MDMH projects being built in the near future, these will have a felt impact environmentally, socially and economically.

With this background, the CSIR embarked on a multi-year research project titled: Medium Density Mixed Housing (2007-09). Some of the key findings of the CSIR MDMH project (2007-09) project are listed as follows:

1. MDMH may offer more opportunities with regards to de-concentrating poverty, revitalising neighbourhoods, enabling greater social mix and contributing to opportunities for improved safety.
2. Case studies indicate that people are willing to consider alternative housing typologies for the benefit of being closer to job opportunities and/or more security.
3. MDMH housing has the potential to add to the viability of a project by promoting affordable housing options and the opportunity to include low(er) cost housing in mixed developments. It is found, within certain limits, that developers may use cross-subsidisation to achieve a better social mix and a degree of integration.
4. There is a willingness from investors to spend on developments that have a mix of tenure options and income groups. This is therefore seen as a financially viable approach to housing.
5. It was also found that it is possible to use subsidies to achieve medium-density RDP developments.

In addition, it was also attempted to objectively describe and rate the characteristics of the residential built environment in an urban setting. A tool was developed that facilitates a qualitative and quantitative (mixed) approach to assessment. This may allow for better informed design decision-making based on empirical research. By assessing proposals for new developments, the gap between policy-makers, designers, developers and end-users could be closed.

2. SH as an important component of MDMH

SH is defined as medium to high-density housing with different tenure options but excluding immediate ownership. SH is rental housing or co-operative ownership for low-income households, developed by accredited institutions or in accredited projects, managed by an independent institution and receiving government subsidy although this subsidy may be topped up through external sources. Since the SH programme provides rental housing, it is guided by the Rental Housing Strategy.

Specific objectives set by the policy for social housing include promoting urban restructuring through social, physical, and economic integration of housing developments into existing areas; placing SH in well-serviced areas is important but this issue has generated much controversy. Inclusionary housing - which is not yet an approved policy - aims to achieve a mix of income groups in new developments. This has raised numerous debates due to a NIMBY (not-in-my-back-yard) attitude.

Policy describes the role of SH within Government's developmental agenda and outlines this sector's function to foster the creation of quality living environments for low-income persons. This includes promoting the use of public funds in such a manner that stimulates and/or facilitates private sector investment and participation in the sector. Growth and development is envisioned through the creation of

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[3] Section 4.2 BNG

good residential alternatives, employment and more compact urban regions as outlined in growth and development strategies.

Precedents show that some countries made substantial initial state investments and have shrunk this as the demand levelled out and the institutions became more profitable. After WWII in Europe, SH was the predominant product and had a major role to play in the re-building of cities in the post-war period. SH is believed to have a similar role to play in the re-building of the post-apartheid city.[4] SH has the potential to deliver housing at a scale and pace that other forms of housing delivery have not been able to achieve.

The SH programme is targeted at households within the R1 500 to R7 500 monthly income bracket (notice overlap and mis-match in figures for social housing and affordable housing). SH projects are called for in designated restructuring zones, which are linked to integrated development planning (IDP).[5] While it is an incredibly important model for future housing, SH may present some problems in the view of the authors. As it is becoming a typology linked to specific income categories, it may become stigmatised as such. By adopting a different approach to the design of SH, this may hopefully be avoided.

3. A model for assessing MDMH: Brickfields and Carr Gardens

A holistic conceptual model to understand and analyse MDMH developments was developed. It was then adapted to be more relevant to guide the research in South Africa (Landman et al 2007 and Du Toit and Landman 2007). The model consists of three main layers, namely:

1. In order for medium-density and mixed developments to contribute to more inclusive cities, a number of **Critical Success Factors** have been identified. A summary of the perceptions of various stakeholders, including funders, residents and developers, with regard to the stated measures of success was presented visually. The spatial environment in each case-study area was analysed by the use of a **Spatial Analysis Tool (SAT)** using a set of measures: **i**ntegration, accessibility, efficiency, image/aesthetics, surveillance, ownership and target hardening (See *Figures 3* and *4*). In this way, the SAT allows for both a qualitative and quantitative assessment of the physical environment. Each of the performance measures had three measures linked to them, allowing a score of between "1" and "3" for each of them, with "3" indicating a high level of adherence to the performance and scale measures, "2" moderate or somewhat and "1" low adherence. Percentages achieved for each of the spatial principles were then presented as bar charts (*Figures 5* and *6*). Scores may allow comparisons between the case studies (*Figure 7*).
2. The achievement of successful and sustainable projects is also dependent on a supporting and **enabling environment**, relating to the institutional environment, stakeholders, management and housing models available. Some of the qualitative aspects that became apparent in the stakeholder responses are presented in *Tables 1* and *2*.
3. Finally, the establishment of more **sustainable human settlements** was considered in terms of some related qualities which include, among other factors, acceptability, viability and stability.

The following section presents the findings of the assessments carried out for two of the seven case studies, Brickfields and Carr Gardens. These are both social housing projects located in Johannesburg. They are both subsidised rental units and have a number of shared characteristics in that they are both designed in a perimeter block form that creates enclosed shared space internally (See *Figures 1* and *2*).

When one compares the percentages for each category (based on the aggregate mean of the sum of all the responses per category), "safety and security" was considered to be important by the largest number

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[4] Jacus Pienaar in European Programme for Reconstruction and Development (ERRD). 2007. Unpublished report on a project to provide support to selected Social Housing Institutions.

[5] "In this Social Housing Policy document reference is made to the fact that capacity building and capital grants will only be available in designated restructuring zones." This is sourced from Restructuring Zones: Guidelines (Dan Smit, August 2005)

of respondents. This could be linked to the fact that the inner city of Johannesburg is generally considered unsafe. According to the scale measures, the "design and layout" of the projects adhered to most of the indicators linked to well-performing and safe environments for residents. The performance measures under "surveillance" scored particularly high in both cases, followed closely by "ownership", "image and aesthetics" and "target hardening". It is therefore evident that great attention was given to safe design and the development of a sense of place and belonging in these developments. In the qualitative feedback, many residents commented on issues of "safety and security". Some remarked on the proximity to certain facilities, such as taxi ranks, which decreased safety, while others remarked that the location of windows towards the street was problematic. Ironically, the "design and layout" in both developments adhered to most of the principles and indicators for safer design. It may therefore be that concerns about "safety and security" are related more to social issues than to the environmental (spatial) factors.

"Accessibility" at Brickfields scored the highest (100%), followed by surveillance (95.8%) and ownership (93.3%). This analysis shows that the design and layout of Brickfields incorporated the performance measures (linked to the spatial principles) to a large extent; hence the high scores. Based on these measures, it could therefore be concluded that spatially the development is performing very well. "Accessibility" also scored high – this was higher for Brickfields than for Carr Gardens. Although the developers cannot always influence the nature of the built environment outside the housing developments, for example in terms of access routes, the proximity of the site to facilities, i.e. access routes, plays a vital role in enhancing accessibility.

Although there are a few measures that could be accommodated to improve "integration" and "efficiency", these two principles achieved relatively high scores. It also showed that it is possible to accommodate a spatial and social mix of income and ethnic groups in one development, albeit within a specific income range.

Taking into account the performance measures and performance scales (indicators) linked to each of these developments, both housing developments scored high - Brickfields 90%, and Carr Gardens 88%. From this, it appears that residents are quite concerned with various factors related to the categories "design and layout" and "management and maintenance". This could indicate a specific concern with the nature of the physical environment and how it is maintained over the longer term. It could also be because this is where they feel there is room to intervene or where more assistance is required.

Carr Gardens scored the highest in terms of "target hardening" (100%), followed by "surveillance" (95%) and "image and aesthetics" (94%). This indicates that the design and layout of Carr Gardens incorporates all of the spatial principles for successful MDMH to a fairly high degree. It could therefore be considered as performing very well, based on the performance measures. When the percentages in each category are compared, "safety and security" was the category considered to be very important by the largest number of residents (85.3%). However, all of the categories were considered important by most of the respondents (more than 80% in all cases), with some of the sub-categories being more or less important. There was a general perception that mix of tenure could be problematic as it was believed that some tenants would not take care of units. There was also a concern about the mix of ethnic groups in Brickfields and negativity regarding foreigners. However, some did say that social mix might promote "integration".
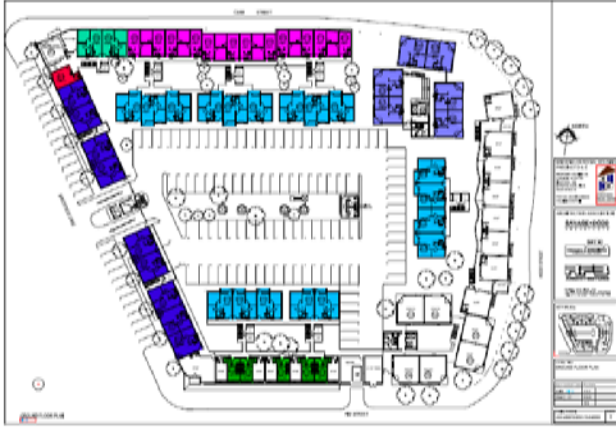
Figure 1: Site plan of Brickfields with different housing units (Source: JHC & Savage-Dodd)

Figure 2: Aerial view of Carr Gardens and its immediate physical context
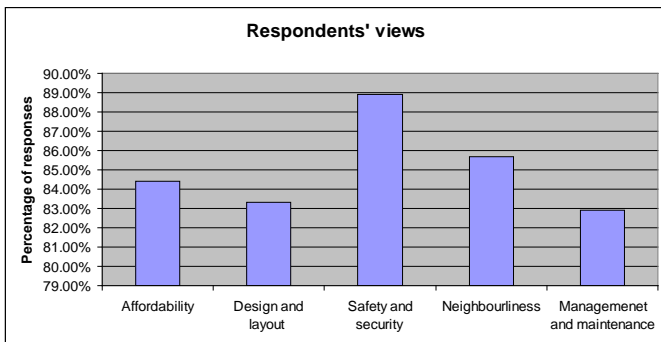

Figure 3: Comparison of "importance" of the various categories as perceived by the respondents in the Brickfields precinct
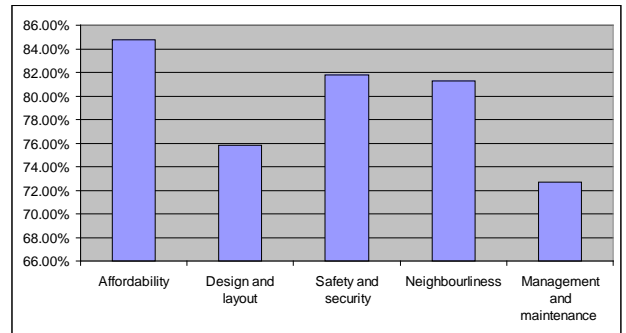

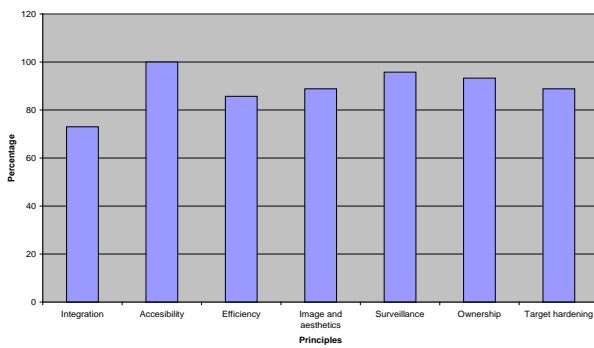**Figure 4: Comparison of the respondents' views of important success categories at Carr Gardens**

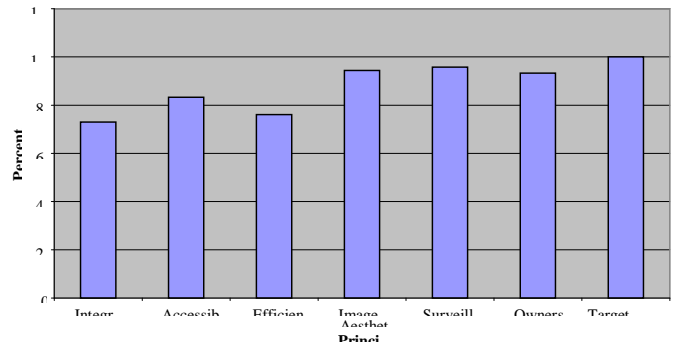**Figure 5: Comparison of the spatial performance of Brickfields, per principle**

Figure 6: Scores for each of the spatial principles at Carr Gardens

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Table 1: Key issues (sub-themes) highlighted by the respondents in the Brickfields precinct

Affordability	Design & layout	Safety & security	Neighbourliness	Management & maintenance
Affordability of units	Sufficient & secure parking space	Safe neighbourhood	Sense of community	Presence of resident association
Unit ownership	Cost of parking space	Safety and design	Sense of neighbourliness	Existence of house rules
Access to various rental options	Covered car parking / lock-up garages	Access control & safety		Consistency / flexibility of rules
	Sufficient play spaces for children	Human behaviour in common spaces		Regular maintenance
	Sufficient recreational space			Opportunity to renovate units
	Sound insulation in units			Method of payment for electricity
	Elements & finishes inside units			Screening of residents
	Size of units / rooms			

Table 2: Key issues (sub-themes) highlighted by the respondents in "open questions" in the questionnaire

| Affordability	Design & layout	Safety & security	Neighbourliness	Management & maintenance
Affordability of units	Sufficient & secure parking space	Improved security	Balance between owner and rental occupants	Participatory governance
Unit ownership	Sufficient playgrounds for children	Control of behaviour in common spaces	Mix of different cultures	Availability of information
Access to different funding options - subsidies	Sufficient recreational space		Support programmes	Consistency of rules
	Size of units / rooms			Method of payment for electricity
	Elements and finishes inside units			Maintenance and health
	*Quality of construction material			
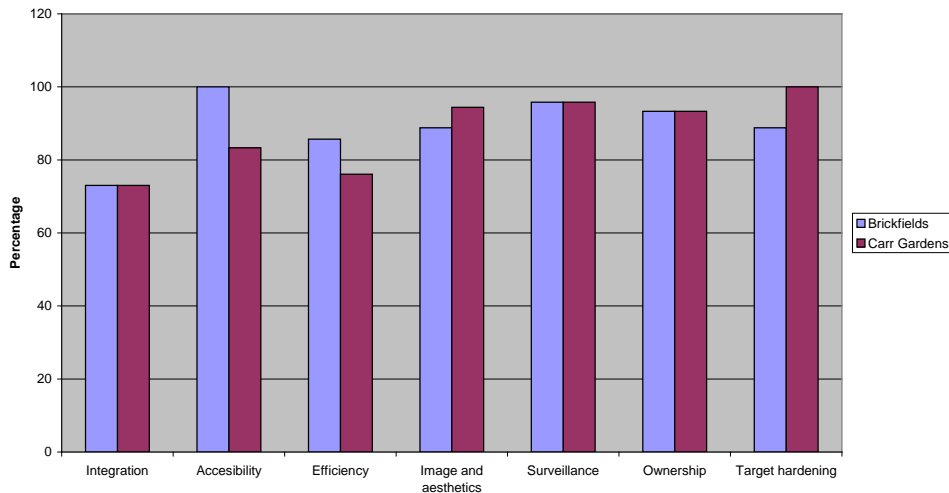
Figure 7: Comparing the "scores" of the spatial principles in Brickfields and Carr Gardens

While the above assessment methods are useful, they do have some shortcomings and will need to be developed further in the future. This paper focuses on one aspect that is considered crucial to the viability of rental housing and that is the ability to adapt and change the building stock over time. It is therefore suggested that this model be expanded to assess the ability to accommodate future unforeseen needs

ensuring market viability – and also assessing the capacity of a building and/or building components to be dismantled and deconstructed to address various sustainability principles.

While the tools used acknowledge that there needs to be a mix of unit types, finishes and sizes – with a larger mix being rated highly – it did not actually assess the potential of the buildings to adapt to future needs and market demand. Variation in forms was also assessed highly as compared to monotony of repetitive forms, which is again commendable, but does not include changing needs and taste over time. In addition "efficiency" as a parameter was limited to resource efficiency with regards to land use, material use and energy use. "Efficiency" in material use was assessed based on local availability and the embodied energy of transport. While this is an important aspect to consider, the ability to alter a construction over time according to changing conditions is not considered at all in the SAT which would imply that an approach to material selection, component design and connections would need to be assessed carefully.

4. Time-based architecture: concepts of participation, choice, variety and change

The concepts presented in this paper rely heavily on a number of theories such as Habraken's Supports, Open Building levels as well as different approaches to material/component re-use. This approach to the built environment also relates to theories relating to the way material is re-used or salvaged, based on its life-cycle analysis. Perhaps the best term to describe this approach to the built environment is time-based architecture (TBA) or 4-dimensional design (4D design) which "... refers to a design attitude to conceive 'objects' from a long-term vision, therefore integrating the fourth dimension, i.e. *time*, in the initial design phase." (Paduart et al., nd: 2). When this is achieved, time becomes a design catalyst where built environments are treated as living systems (Lukez, 2009: 5). Open Building practitioners and researchers generally refer to this as the "disentanglement" of buildings, systems and components. Disentanglement in buildings presents many benefits on site during construction as well as throughout the lifetime of the building in its operations phase. The benefits also span over to the ultimate change in use, re-use (of the building or its salvaged components).

However, unified definitions and terms for this research field are lacking and many researchers work in small enclaves and do not communicate enough with each other. For example, definitions of design for deconstruction, disassembly and dismantling seem to overlap and all use the same DfD abbreviation. "Disassembly" will be used in this paper as it is seen to combine both "deconstruction" and "dismantling" and puts more emphasis on correct detailing, procedure and the use of sub-assemblies.

The ability to adapt a building is, for the largest part, determined by two parameters: whether or not the construction can be disassembled and reconfigured or re-used; and the amount of effort that is needed to do this. Therefore, the most crucial aspect of "design for disassembly" (DfD) is the detailing of connections between a building's different components; DfD means designing buildings that can be disassembled and reassembled part per part (Durmisevic 2006), it assures that connections can be undone. "Design for compatibility" (DfC), on the other hand, ensures that elements can be connected to each other, because their measurements are all based on the same sequence.

The Hendrickx-Vanwalleghem Design Approach (HVDA) integrates both DfD and DfC into a design strategy based on process analysis and control. It presents a set of guidelines to design multiple adaptable and reusable constructional components which are compatible with each other. Thus, these components can be used to design a variety of adaptable and reusable constructional sub-assemblies. The result is a "generating system" where a limited number of basic elements and a set of combination rules allow more complex entities to be "generated". Currently, most design strategies either focus on the adaptability of a building (based on the building's life cycle) or on the ability to dismantle a building in such a way that different materials can be salvaged easily (based on the cycle of material resources). The HVDA, however, focuses on the life cycle of the components.

In assessing a building with regards to adaptability, three aspects must therefore be considered: the materials used to manufacture a building's components (included in the SAT), the components themselves, and the building as an entity (neither of which are considered in the SAT).

Several DfD design guides have been developed over the years, ranging from a few principles to several detailed guidelines (Nordby et al., 2007: 2-3). Most existing guidelines focus on the process of removing building components and materials from a built structure and the requirements for reprocessing the salvaged components and materials, in order to reintegrate them into a built structure (Sassi, 2002: 2). Since most of these guidelines specifically aim to decrease waste production, most guides focus on the environmental impact of DfD, and not necessarily on the necessity of adaptable architecture from the building user's point of view. Some guidelines include assessment methods (Durmisevic, 2006; Nordby et al., 2007; Sassi, 2002; Thormark, 2001) which focus either solely on the disassembly potential of a building component or on a combination of disassembly standards, environmental implications and guidelines that enable easy sorting, checking and reintegration of salvaged constructional components.

5. Adaptability and change in the design of subsidised rental housing in South Africa

There is an assumption that rental housing, seeing cycles of tenants over its lifetime, might not have to be adaptable. The argument is that the users are not the owners and will only inhabit the units temporarily. However, it is argued that change is important for new tenants, old tenants and for the institution that owns and manages the residential properties. This makes the building stock more viable in the long run, more able to adapt to changes in market demand and allows easier maintenance by disentangling building systems and components.

Social housing in South Africa is relatively new and thus relies heavily on European precedents. While caution needs to be taken in taking those concepts and applying them without adaptation to local needs and conditions, it is also important that lessons are not overlooked. In a study of housing on the need for adaptability, carried out in 1999 by the largest housing company at the time, a survey of users found that adaptability was the most wanted characteristic. It was also found that 25% of the housing budget is spent on renovation and another 25% on maintenance. It needs to be considered what the total savings on these costs would have been if the buildings were initially conceived of as adaptable structures (Durmisevic, 2006: 60-79).

The South African SH sector would benefit from taking these issues into consideration and perhaps avoiding the cost and difficulties that may arise in the future due to unforeseen needs. In the CSIR MDMH study by Landman et al. (2008) it was found that many residents complained about the small size of residential units which were perceived to offer little opportunity for changing family structures. The size was seen to restrict comfort and privacy and to limit the opportunities for extended families.

Residents in some cases also complained about the dull or boring colours, implying that having the opportunity to adjust these to personal taste may be advantageous. It was also clear that access issues were important for some of the age groups (e.g. stairs perceived as too dangerous for older users and small children). This also implies that there may be a need to adjust certain aspects of a unit depending on the tenant needs at a specific time.

The previous section emphasised the importance of including the "ability to change" as a parameter in the assessment of MDMH. Any proposed assessment of adaptability should be based on a set of weighted performance standards, like the CSIR's MDMH assessment tool. To keep the assessment clear, a categorisation of the performance standards is deemed necessary. This would be based on either the function of the evaluated constructional component (e.g. structure, skin, partitioning, finishing), or on the intended benefit (e.g. altering the built form, increasing user participation, reducing maintenance cost). Because it is so crucial in DfD, detailing should be a separate category.
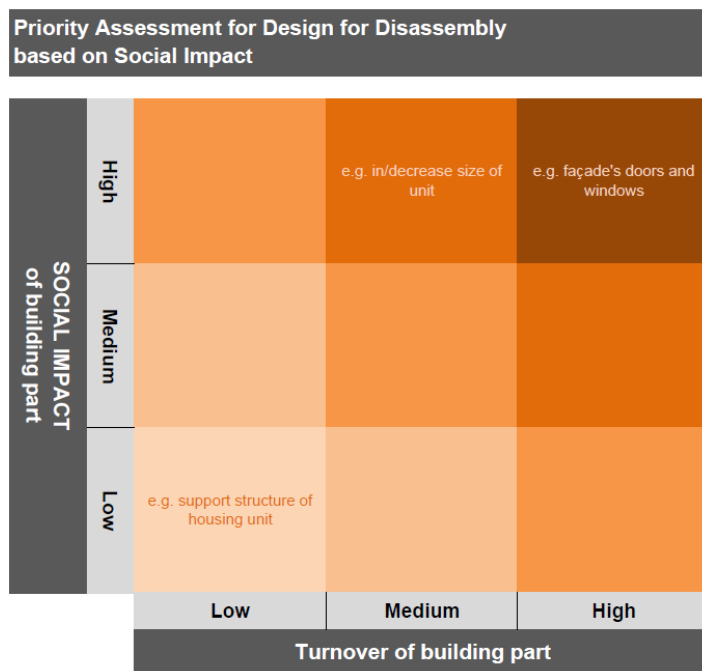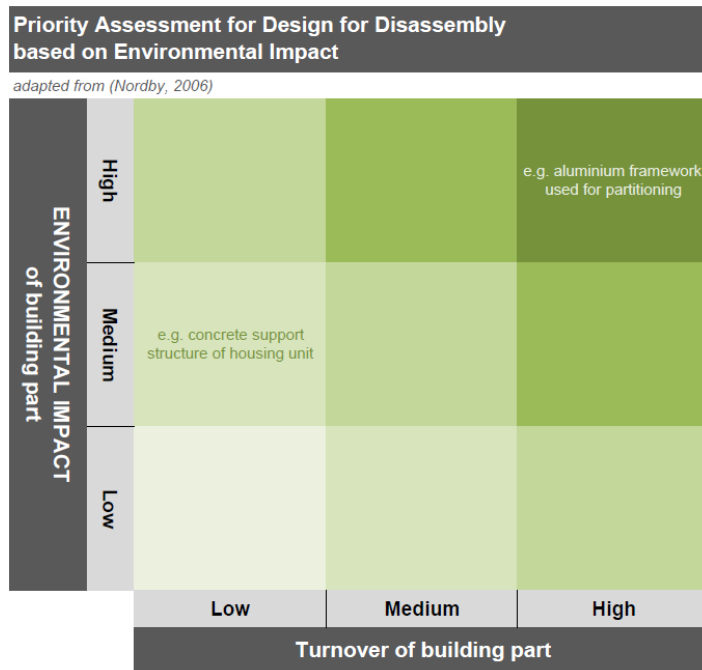
Priority Assessment for Design for Disassembly based on Environmental Impact

adapted from (Nordby, 2006)

ENVIRONMENTAL IMPACT of building part				
High			e.g. aluminium framework used for partitioning
Medium	e.g. concrete support structure of housing unit		
Low			
	Low	Medium	High
	Turnover of building part		

Priority Assessment for Design for Disassembly based on Social Impact

SOCIAL IMPACT of building part				
High		e.g. in/decrease size of unit	e.g. façade's doors and windows
Medium			
Low	e.g. support structure of housing unit		
	Low	Medium	High
	Turnover of building part		

Figure 8: The determination of priority and potential user benefit.

Two additional aspects are considered to be important when implementing the abovementioned assessment methods in MDMH and SH in South Africa: the determination of priority and the addition of potential user benefit. A possible method of attributing priority to parts of a construction is shown in Nordby et al. (2006: 7). It compares the turnover rate of a building part to its embodied environmental impact, visualising the need for DfD. For example, an interior partitioning system that uses an aluminium

frame structure has a high level of priority, because it is a system with a high turnover using components with a high embodied energy.

Prioritising has three advantages – firstly, it helps in pinpointing the parts of a construction that result in the highest cost-benefit when conceived as adaptable structures. The second advantage is that prioritising could help to keep the assessment process manageable through categorising the different components or structures based on their unique characteristics. When a component has a high disassembly priority, for example, it could be assessed using a separate method. This keeps the existing tool more streamlined and easy to use. Last but certainly not least, priority could be used to determine the weighting factor of the performance standards used in the assessment. This way, the weighting of adaptability specifications would be determined by building type and specific requirements. The impact of adaptable architecture on the user of a building could also be introduced to further influence the weighting of the performance standards.

The impact of adaptable architecture on the user of a building could also be introduced by a priority assessment as described above – it suffices to change the environmental impact to social or even socio-economic impact. This priority could then further influence the weighting of the performance standards. The ability to choose or change the size or finishes of a housing unit, for example, could be crucial to improve the sense of ownership and general living quality of the user.

6. Change as a requirement for MDMH

It is thus concluded that economics and life-cycle design are important factors that can be provided by efficient design, buildability and complete detailing, standardisation and design geometry, e.g. shape, layout, height, allowing for specification alternatives and co-ordination with structure and services etc. Whether this approach needs a major change in the way we currently build and a re-structuring of the construction industry or whether it is a simple evolution of construction methods still needs to be researched and debated. At first glance, the concept of adaptable built form might seem rather 'high-tech', but that is not necessarily the case – adaptability can be introduced by maximising the compatibility between different constructional components, thereby maximising the number of configurations that can be made. These factors, among others, will be included in the further development of the CSIR MDMH assessment tools.

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