

Low-Income Housing Backlogs and Deficits “Blues” in South Africa.

What Solutions Can a Lean Construction Approach Proffer?

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ABSTRACT

This paper seeks to answer the following main question: “Does housing backlogs and deficits rhetoric constrain policy makers, decision-makers, practitioners and experts from engaging in the implementation of transformative low-income housing projects and programmes in South Africa?”. The aim and purpose of this paper are: (1) to contribute to the understanding of the concept of low-income housing backlogs and deficits “blues” in South Africa. This is achieved through suggesting how innovative lean housing construction and development approach/models can play a “catalytic” role in the quest to redress low-income housing provision and delivery requirements; and (2) to argue that applied research and development of housing innovations in practice is critical in transforming the low-income housing sustainability agenda in South Africa and by extension in developing countries. The analysis is based on a critical literature review of housing approaches of low-income housing delivery, affordable strategies, policy implementation realities and discourses, low-income housing technology options, in addition to industry experience and own observation. This paper establishes the significance of considering up scaling the implementation of lean advanced construction techniques, use of low-cost building materials and fast-construction building techniques in responding to the growing demand for low-income housing provision and services in South Africa. The need to continuously monitor, evaluate and review the housing policy and regulatory set-up relevancy in addressing low-income housing deficits and backlogs with the aid of a lean construction as necessary to improve low-income housing delivery deployment in South Africa.

1. INTRODUCTION

The Oxford dictionary defines the word “blues” as meaning “a feeling of depression or deep unhappiness, gloominess, despondency, dejection and despair”. The concept of low-income housing (LIH) and the notion of housing backlogs and deficits “blues” in South Africa is linked to a sub-optimal performing LIH sector in which slow turn-around times, slow service LIH delivery stock turnover and continued failure to reverse significantly LIH waiting list requirements persists across municipalities throughout

the country. Coupled with the challenge and threat presented by climate change (CC) induced vulnerabilities for LIH with questions marks hanging with respect to the capacity and capabilities of both state and non-state actors to provide a sustainable CC resilient and insulated LIH sector in the country, so much that perceived feelings of gloom, despondency, dejection and despair start finding expression in respect to the ability of the housing sector to guarantee settlement resilience in this new climatic and socio-economic environment. In this regard, exploring how existing initiatives such as alternative building

technologies (ABT), lean construction (LC) could be buttressed through a CC resilient human settlement oriented and friendly approach becomes an exciting space for human settlement research and development (R&D) dialogues (Smith, 2010; Howell, 2011; Goetz and Schaeffler, 2015; Bajjou and Chafi, 2019).

This paper focuses on raising questions regarding LIH debates in South Africa. The departure point of the paper is to argue that LIH debates should move beyond theorising to implementing transformative sustainable projects and programs. In the process, major roadmap research and implementation agenda are presented, which are

expected to assist in going over the rhetoric's and shortcomings of current initiatives aimed at (re)solving the LIH challenge and issues in South Africa. In any case, the full cycle, structured and systematic mass scale "application of the LC approach to the construction and deployment of affordable housing (AH), can generate benefits" much greater than the ad-hoc, incremental, disjointed and fragmented current set-up (Tissington, 2011).

While some progress towards addressing LIH has been achieved since 1996, however the pace and scale were not able to wipe out housing informalities as presented in Table 1.

Table 1. Distribution of households by type of main dwelling (*Census 1996 – Community survey 2016*).

Main dwelling	Census 1996		Census 2001		Census 2011		Community survey 2016	
	Number	(%)	Number	(%)	Number	(%)	Number	(%)
Formal dwelling	5,834,819	65.1	7,680,421	68.5	11,219,247	77.6	13,404,199	79.2
Traditional dwelling	1,644,388	18.3	1,664,787	14.8	1,139,916	7.9	1,180,745	7.0
Informal dwelling	1,453,015	16.2	1,836,231	16.4	1,962,732	13.6	2,193,968	13.0
Other	35,290	0.4	46,628	0.4	128,266	0.9	142,271	0.8
Total	8,967,512	100.0	11,218,067	100.0	14,450,161	100.0	16,921,183	100.0

Source: (Statistics South Africa, 2016).

One tenable way to tackling LIH matters in South Africa is through engaging disruptive LC and ABT in anchoring CC resilient settlements that do not perpetuate climate change apartheid and injustice in contemporary times. This is because the total application of LC methods, approaches and techniques will lead to the reduction of project site resource wastage, quick construction project completion times, improved quality of LIH life structures and increased profit margins for housing and building constructors. Following former President Jacob Zuma's proclamation in 2009 to change the "Department of Housing into the Department of Human Settlements" the conception of LIH was expanded from the provision of a housing unit to the planning, provision and management of spatially integrated, inclusive and resilient human settlements in which housing is nested and compliant to norms and standards linked to spatial settlement efficiency, justice, economy, resilience and good governance. These new housing ethos has roots and implications with respect to how spatial planning and settlements are (re)structured to promote spaces, places and cultures where it is a pleasure to work, live, recreate and pray for all citizens in South Africa (DEA, 2011; Zeiderman, 2016). However, it is debatable whether, to date, the intentions of such a bold measure have been fully executed or even attained. The importance of adaptive and resilient LIH is heightened in South Africa given the reality and advent of climate change induced

settlement vulnerabilities linked to the risks of flooding, heat waves (temperatures) as well as the rise in the sea level (Roberts and O'Donoghue, 2013). While research and innovation with respect to ABT and LC exist, however, despite these being inadequate, worse still is the paucity of studies and work that links ABT, LC and climate change (CC) in the context of human settlements especially in South Africa. This paper therefore seeks to provide a conceptual analysis projecting how ABT, LC and CC can be linked and mainstreamed in bringing about added value to the LIH construction, deployment and sustainability framework cycle.

The Comprehensive Housing Plan (CHP) was developed with the intention of furthering the need for the development of integrated and sustainable human settlements in South Africa via the breaking new ground housing policy. The breaking new ground housing policy itself seeks, among other things, to facilitate transition and migration towards the eradication of informal settlements in South Africa in the shortest pragmatic possible time (Ndaba, 2008; Smit et al., 2011). The planned targets for transforming spatial settlements (including the provision of housing) and physical planning through seeking to achieve spatially connected, integrated and socially vibrant and dynamic human settlements act as framework guidance tools (Council for Scientific and Industrial Research, 2011). The CHP is being implemented via the informal

settlement-upgrading (ISU) pilot projects across all provinces in South Africa (The Presidency, 2014). The ISU projects are implemented within the purview of a structured logic framework model in which clear milestones and timelines for LIH construction are adhered in compliance with agreed project phases, area-based housing development requirements, and emphasise community participation, social and economic development as essential components of any LIH projects (National Department of Human Settlements, 2015). Section 26 of the Republic of South Africa’s Constitution (1996) clearly “enshrines everyone’s right of access to adequate housing”. Despite

the clear constitutional mandate, and “notwithstanding the provision of 2.3 million housing units to nearly 11 million people, South Africa still has a housing crisis after 24 years of democracy, with over 2.1 million households lacking adequate housing (and millions more lacking access to basic services)” (National Department of Human Settlements, 2010). Understanding the quantity of informal dwellings provides a picture of housing shortages or requirements as illustrated in Table 2, which presents the percentage of households that live in formal, informal and traditional dwellings in provinces of South Africa.

Table 2. Share of households living in formal, informal and traditional dwellings, by province, in 2018.

Type of dwelling	Province									
	Western Cape	Eastern Cape	Northern Cape	Free State	KwaZulu Natal	North West	Gauteng	Mpumalanga	Limpopo	South Africa
Other	1.4	0.5	0.2	0.1	0.2	0.0	1.9	0.0	0.0	0.8
Informal	19.0	6.3	11.7	12.4	6.7	18.6	19.8	4.9	4.9	13.1
Traditional	0.0	20.5	0.7	2.2	12.6	0.5	0.2	2.2	2.2	5.0
Formal	79.6	72.8	87.3	85.2	80.5	80.9	78.2	93.0	93.0	81.1

Source: (Statistics South Africa, 2018).

What strikes the eye is that approximately 18% of South Africans live in dwellings that are not classified as formal. Construction and building technologies e.g. Building Information Modelling (BIM) have the capacity and capabilities to ensure the optimum selection of LIH building alternatives that are able to reduce to the bare minimum possible building and construction costs and timelines while achieving optimum Leadership in Energy and Environmental Design (LEED) materials credit points (Marzouk and Metawie, 2014). The opportunity to apply advanced LIH construction methods and technologies suggests

that there is a market for the developing, upgrading and improving the LIH sector delivery mechanisms. This further opens opportunities to capture the value addition that ABT and LC implementation within the context of implanting CC resilient settlements provides. The differentiated spatial footprint of informal dwellings resonates with the scale and magnitude of informal dwelling challenges between urban and rural areas as illustrated in Table 3, which presents the percentage of households that lived in formal, informal and traditional dwellings of metropolitan areas in 2018.

Table 3. Share of households living in formal, informal and traditional dwellings, by metropolitan areas, in 2018.

Type of dwelling	Metropolitan or City Area in South Africa							
	Nelson Mandela Bay	Mangaung (Formerly Bloemfontein)	eThekweni (Formerly Durban)	Tshwane (Formerly Pretoria)	Cape Town	Ekhuruleni	City of Johannesburg	Buffalo
Other	1.0	0.5	0.0	0.0	1.4	1.7	3.2	0.7
Informal	6.1	11.8	13.0	16.9	17.9	20.0	21.7	23.2
Traditional	0.0	0.3	2.9	0.5	0.7	0.2	0.1	3.2
Formal	92.9	87.5	84.1	82.6	80.0	78.2	75.1	72.8

Source: (Statistics South Africa, 2018).

The challenge of LIH is much more pronounced once viewed in the context of the major metropolitan

and city regions/areas of South Africa. This is because housing demand and supply is linked to the rapid

urbanisation phenomena in the country and finds expression in the growth of informal settlements. Irrespective of the fact that the South African government, through the Reconstruction and Development Programme (RDP), from 1994 has been able to deliver 3 million houses, informal housing still persist today including in the backyards of the RDP houses themselves raising serious contradictions and contestations regarding whether the RDP is making a difference or is an inadequate and incomplete solution (Shapurjee and Charlton, 2013). The challenge of informal settlements is much more acute in urban areas

as depicted from Table 2, since approximately 26% of the urban residents in South Africa live in informal settlements. This raises questions regarding the need to explore and investigate the feasibility of utilising alternative building technology lean construction (ABTLC) within the purview of implementing CC resilient settlements in addressing LIH matters in South Africa. Housing delivery is not just about access to a housing unit but the bundle of rights that are linked to socio-economic and legal issues is critical as illustrated in Table 4, which presents the percentage of dwelling units in 2018, by tenure status.

Table 4. Share of dwelling units, by tenure status, in 2018.

Occupation status	Type of dwelling			
	Formal	Traditional	Informal	Other
Occupied rent free	12.3	18.5	21.9	60.7
Owned and fully paid off	54.2	74.5	36.5	9.1
Owned but not yet paid off	8.3	0.6	0.4	0.0
Rented	25.3	6.4	41.2	30.2

Source: (Statistics South Africa, 2018).

The occupation status of housing owners is linked to security of tenure and land rights. In case occupants live in informal settlements these issues are inadequately addressed if not completely absent. This has implications on land rights and the ability of owners to develop/improve, sale or transfer rights within the property market domain.

The conceptions of housing include not only a dwelling space but entail a sense of belonging as well as start-up kit to access and engage with the wider environment and world (Ballard, 1999; Dayaratne and Kellett, 2008; Myers, 2016). The informal housing sector is complex but riddled with its own set of “wicked

problems” that requires careful unpacking to address, as depicted in Table 3. Options and housing packages mixes that are able to provide low-cost, adaptive structures via the ABTLC with full consideration of the CC vulnerabilities are worth pursuing and implementing. The structural quality of LIH is crucial as these are vulnerable groups that have low adaptive capacity in the event of a disaster affecting their structures; hence, Table 5 presents the percentage of households that were of the opinion that their Reconstruction and Development Programme (RDP) or state-subsidised houses have weak or very weak walls and/or roof.

Table 5. Share of households declaring that their ‘RDP’ or state-subsidised houses have weak or very weak walls and/or roof, by province, in 2018.

Owner/Occupier perception of RDP or subsidised unit	Province									
	Western Cape	Easter Cape	Northern Cape	Free State	KwaZulu Natal	North West	Gauteng	Mpumalanga	Limpopo	South Africa
Walls - weak or very weak	16.2	7.6	10.4	13.7	11.9	6.1	3.6	7.9	8.9	9.1
Roof - weak or very weak	15.8	8.5	7.9	12.1	13.9	3.5	3.9	8.2	9.5	9.1

Source: (Statistics South Africa, 2018).

While perception on structural quality and soundness of LIH requires a full cycle analysis by structural engineers, a perception survey or opinion of residents/occupiers can also provide a good sense of the structural sturdiness of LIH as viewed by the occupants/residents. LIH envisages the conception and deployment of advanced and appropriate budgeting, cost reduction, building and construction techniques through use of locally available materials and the

prudent application of skills and technologies without compromising the housing units’ strength, performance and life of the structure (Bredenoord, 2017; Foong et al., 2017; Ganiyu, 2016; Holweg, 2007; Howell, 2011; Tam, 2011; Salem et al., 2006; Van Damme and Houben, 2018). Overall, approximately 10% of LIH RDP or state subsidised structures perceive such structures as either having structural defects or inadequacies with respect to walls and roofs. This

paints a worrying housing portrait in a context in which CC vulnerabilities linked to flooding and temperature increase likelihood of hazards to settlements. Research and development work with respect to ABTLC and CC adaptive structures becomes an important dimension in the quest to advance sustainable LIH provision and maintenance in South Africa.

Despite the afore-mentioned issues, South Africa’s human development goals for sustainable low-cost human housing settlements are consequently enunciated in instructive strategy and policy documents such as Agenda 21 (1992), the Habitat Agenda (1996), the Millennium Declaration (2000), the outcomes of the World Summit (2002), White Paper on Housing (1996), Breaking New Ground (2004) to name a few (Department of Housing, 1994, 2000, 2004). The principles, concepts, and philosophy enshrined by such related documents can be distilled to generate a set of low-cost sustainable housing performance indicators (Chakwizira and Bikam, 2007; Ross et al., 2010). At the same time a 360 degree review of similar and related policy, strategy, and action documents will point to LIH contestations and dialogues that have roots linking to rhetoric’s, rubrics, and implementation bottlenecks. This paper seeks to expand the knowledge domain on how innovative lean housing construction and development approach/models can play a “catalytic” role in the quest to redress LIH housing backlogs and deficits “blues” in South Africa.

2. THEORY AND METHODOLOGY

The paper employs a dynamic system, ABT via life cycle assessment (LCA), CC and LC theoretical approach and methodology in unpacking the LIH backlogs and deficits “blues” in South Africa (Azar, 2012; Caruso et al., 2017; Chévez et al., 2019; Fewings and Henjewe, 2019; Nguyen et al., 2016). These theoretical lenses are complemented by thematic analytical technique with respect to desktop studies and analysis of secondary data, including reviewing case studies in LIH in South Africa.

A systems dynamic approach gives the advantage of analyzing the housing sector holistically taking into account all the sub-components that constitute the housing sector as a system. At the same time, the LC theoretical frame provides measurement indicators for assessing the level of adoption, access, and replication of low-cost and alternative housing technology (AHT) uptake for resolving LIH issues. In addition, key informants from the Department of Human Settlements (DoHS), Provincial Departments of Local Government and Housing (South Africa) as well as the South African Local Government Association (SALGA) and the South African Cities Network (SACN), the Council for Scientific and Industrial Research

(CSIR) and Universities in South Africa with housing, architecture, planning, and human settlements qualifications were also consulted. The synthesis of the outcome of findings was used in compiling this paper.

2.1. Conceptual framework

A survey of both national and international literature reveals that several theories, approaches, models, and interventions can be utilised in addressing LIH needs (Huang, 2012; Ibem and Aduwo, 2013; Phengand Meng, 2018). These range from centralised models that are state-driven to decentralised models that are driven by non-state sectors with the state playing a facilitator role. In addition, different hybrid models that allow both the state and non-state sectors to respond to LIH changing needs exist. Figure 1 summarises the housing approaches based on pools and the flow including the contestation paradigm that relate to LIH delivery and provision.

LIH is a complex, dynamic and highly contested area – be it from a policy, research or practice perspective. Dialogues and conversations play out regarding how best LIH can be advanced in a low-cost but effective manner that stems out the possibility of service delivery protests linked to housing delivery under-performance. LIH backlogs and deficits contestations relate to where low-income areas are located, usually in relation to workplaces, the cost of affording approved building materials that is usually high, (no)compliance with stringent building codes, inadequate consultation and participation of housing beneficiaries, etc. (as depicted in Figure 1). These complex factors play out in terms of LIH deficits and shortages, with implications on service delivery for municipalities and housing stakeholders.

2.2. LC and LIH overview in South Africa

In LIH housing provision, the production management component is crucial in minimizing overhead project construction and building operational and management costs, and also in eliminating wastage and spillage of resources on site (Souza, 2004; Martinez, 2016). The concept of LC has its origins in the early 1990s (Koskela, 1992; Holweg, 2007; Oguntona et al., 2019). It is based on adapting, adopting and deploying the Toyota Production System (TPS) in the project management of housing building and construction projects (Antunes and Gonzalez, 2015). LC and manufacturing describe the application of TPS concept focused on identifying and eliminating waste and facilitating continuous product improvement for either processes or products (Womack et al., 1990; Suh et al., 2015; Rane et al., 2016). In any case, “Lean Thinking” is linked to “lean thinking principles”, namely building and construction norms and standards

(i.e. values, value addition, the value stream, flow, pull, and perfection (Salem et al., 2006; Schroeder, 2014; Koskela et al., 2018; Moaveni et al., 2019). Koskela (1992) popularised the adoption of TPS and lean manufacturing in civil engineering and construction management (Pekuri et al., 2014; Schroeder, 2014; Vinodh et al., 2015). Ballard (2000) describes the “Last Planner System (LPS)” as a technique applicable to the construction sector through enabling project variables to support effective and efficient building construction

and management structured workflow protocol (Ballard, 1999; Daniel et al., 2017; Durakovic et al., 2018). Invariably, the domestication of LC concepts, techniques and tools within the LIH projects/programmes and activities necessary for the provision of the least costs, accessible and affordable housing in South Africa. Consequently, this paper provides a conceptual framework for locating LIH via the ABTLC taking into account CC adaptive and resilient settlements needs for South Africa.

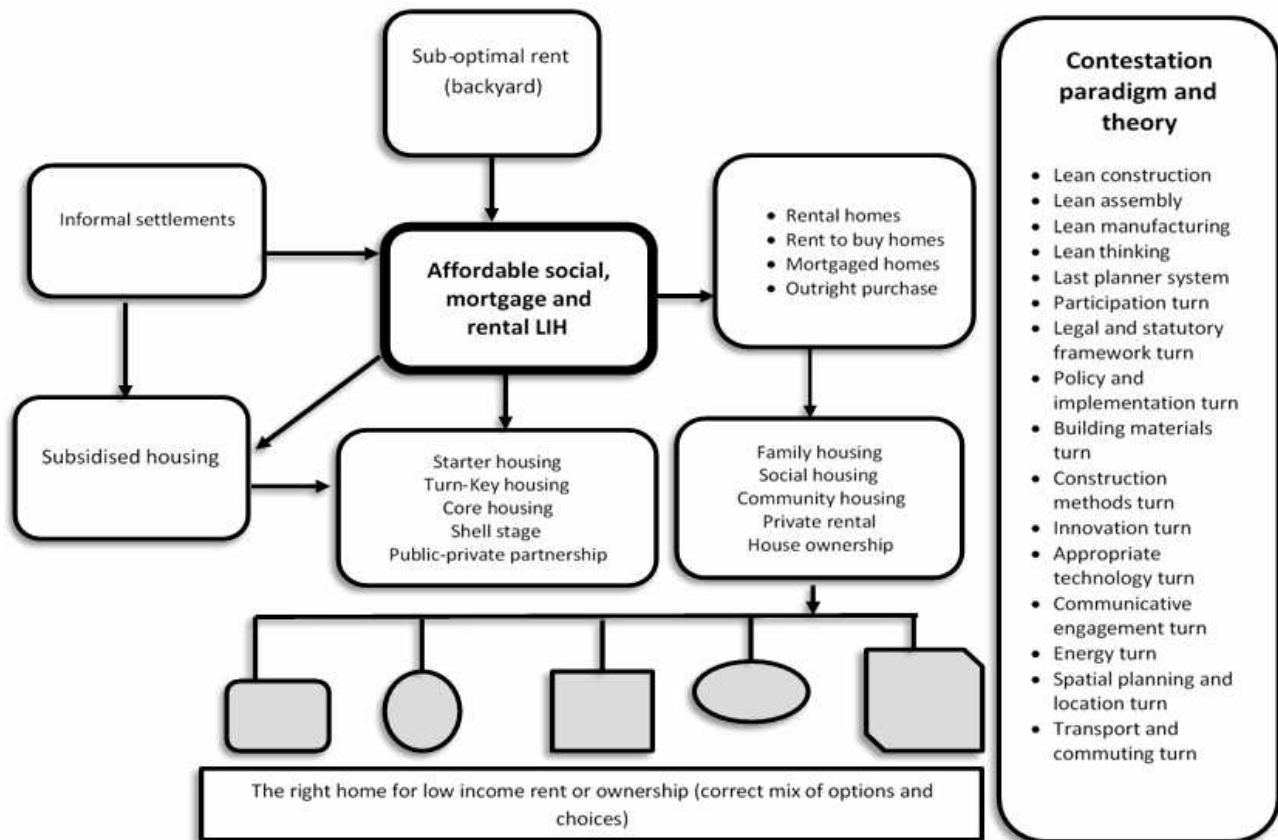


Fig. 1. An LIH delivery approach based on pools and flows depicting contestations.

3. RESULTS AND DISCUSSION

This section presents the results and a discussion on the importance of the study findings within the broad human settlement and spatial planning disciplines.

3.1. The policy implementation turns in South Africa - National LIH construction landscape overview

According to the “2009 General Household Survey prepared by Statistics South Africa (Stats SA, 2009), about 12.8% of the South African households live in a RDP or state-subsidised dwelling and 13.5% of households have at least one household member on a demand database or waiting list for state subsidised

housing” (Stats SA, 2009). An overview of estimates, with respect to the requirements for the need to provide adequate shelter in South Africa highlighting and making use of the housing backlog, from 1994 to 2009 as a case in point, is presented in Table 6.

Studies have calculated that approximately R800 billion is required to eradicate the housing backlog in South Africa by 2020 (Pillay, 2017; Msindo, 2017). Tackling run-away housing backlogs/deficits as reflected in Table 5, is challenging, demanding and exciting. The housing backlog is approximately above 2.1 million and has remained what has virtually been termed a moving average, which is currently estimated at 2.3 million (Msindo, 2017). Addressing this LIH backlogs entail adopting steps that have implications with respect to massive investment in appropriately sited and located LIH developments that are

constructed by making use of appropriate, innovative and robust housing technologies and approaches in an effort to avert the upward trajectory in housing backlog growth in the country.

3.2. South Africa’s provincial informal dwellings challenge overview

In the mid-2009, 13.4% of households in South Africa lived in informal dwellings (Stats SA, 2007).

Housing backlog is clearly linked to the country’s basic services backlog, which includes lack of access to water, sanitation, electricity and refuse removal. Migration and natural population growth in cities and major settlement nodes, together with low LIH units outputs delivery, explains largely the mismatch between housing stock units delivery and supply side constraints.

Table 6. Need for adequate shelter estimates (housing backlog) - 1994 to 2009.

Financial year	Eastern Cape	Free State	Gauteng	KwaZulu-Natal	Limpopo	Mpumalanga	Northern Cape	North-West	Western Cape	South Africa Total
1994/1995*	-	-	-	-	-	-	-	-	-	-
1995/1996*	-	-	-	-	-	-	-	-	-	-
1996/1997	309,791	181,963	472,564	345,200	141,548	126,875	28,421	174,512	165,461	1,946,336
1997/1998*	-	-	-	-	-	-	-	-	-	-
1998/1999*	-	-	-	-	-	-	-	-	-	-
1999/2000*	-	-	-	-	-	-	-	-	-	-
2000/2001	-	-	-	-	-	-	-	-	-	-
2001/2002	330,000	220,000	750,000	400,000	120,000	145,000	35,000	240,000	230,000	2,470,000
2002/2003	339,200	133,900	461,000	379,700	104,500	123,400	12,000	124,500	172,000	1,850,000
2003/2004	336,700	144,400	536,000	362,200	105,400	116,100	17,000	100,800	201,000	1,919,600
2004/2005	388,500	201,300	556,300	395,000	124,600	126,400	17,000	95,900	213,000	2,118,800
2005/2006	352,600	169,000	697,950	533,200	112,800	132,500	32,200	222,100	222,850	2,475,200
2006/2007	265,700	208,000	628,000	400,000	153,000	153,000	48,500	220,000	403,500	2,479,700
2007/2008	240,000	165,000	619,500	372,200	122,400	137,500	38,000	210,500	378,700	2,283,800
2008/2009	235,000	160,000	615,000	365,000	110,000	128,000	34,000	202,000	305,000	2,154,000

Source: (National Department of Human Settlements, 2015).

Table 7. Distribution of household by the main dwelling, per province (2007).

Province (total number of households) in 2007	Share living in informal dwelling – shack in backyard (no. of households)	Share living in informal dwelling – shack NOT in backyard i.e. in an informal settlement (no. of households)	Share living in worker’s hostel (no. of households)	Share living in traditional dwelling/hut/structure made of traditional materials (no. of households)
Gauteng (3,175,579)	8.4% (266,749)	14.3% (454,108)	3.1% (98,442)	0.4% (12,702)
KwaZulu-Natal (2,234,129)	2.3% (51,385)	6.3% (140,750)	3.2% (71,492)	27.4% (612,151)
Western Cape (1,369,180)	6.2% (84,889)	8% (109,534)	1% (13,691)	0.8% (10,963)
Eastern Cape (1,586,739)	1.6% (25,388)	6.4% (101,551)	0.2% (3,173)	36.7% (582,333)
Limpopo (1,215,935)	1.9% (23,103)	3.6% (43,774)	2% (24,318)	9% (109,434)
Mpumalanga (940,403)	2.5% (23,510)	9.2% (86,517)	3.3% (31,033)	7% (65,828)
North West (911,120)	7.8% (71,067)	16% (145,779)	7% (63,778)	2.3% (20,955)
Free State (802,872)	4.9% (39,341)	13.6% (109,190)	5.7% (45,763)	4.6% (36,932)
Northern Cape (264,653)	1.6% (4,234)	8.9% (23,554)	4% (10,586)	4.5% (11,902)
South Africa (12,500,610)	4.7% (587,529)	9.7% (1,212,559)	2.9% (362,517)	11.7% (1,462,571)

Source: (National Department of Human Settlements, 2015).

Consequently, instead of witnessing a decline in housing demand, there is always a statistically significant increase in the percentage of households that lived in informal dwellings especially in the major metropolitan areas of South Africa such as Johannesburg, Cape Town and eThekweni (formerly

Durban). The statistical distribution of households by the main dwelling type, provided by Stats SA’s 2007 Community Survey” is presented below in Table 7 (Stats SA, 2007).

Housing backlogs and deficits manifest themselves in terms of inappropriately located LIH

informal settlements as well as in the densification of existing LIH settlements in response to rapid urbanization determined by rural to urban migration in South Africa. Given the reality of urbanization, housing and related challenges in South Africa, as resulted from Table 7, we can deduce that with 4.7% representing informal shacks in the backyards of formal residential stands, with bulk infrastructure implications for service delivery. This is because formal areas have to respond and provide services and facilities beyond the planned capacity, thus creating pressure and stress on existing facilities such as water, sewer, transport, schools, health facilities etc. At the same time, a further significant share of 9.7% (stand-alone informal structures) exists, further exacerbating the capacity and ability of municipal infrastructure and systems to respond to the rapid urbanization needs of such settlements. This raises the question as to whether the municipal governments and planning systems in South Africa are adequately prepared or are ill-prepared to manage and respond to the current wave of urbanization engulfing the country in contemporary times. In any case, some 2.9% of the urban residents in South Africa are living in worker's hostels and 11.7% of the households are categorised as traditional dwelling/structures.

Considering the preceding discussion, there is little wonder that in fact, by 2010, the Minister of Human Settlements expressed concern with respect to the fact that the "number of informal settlements has increased to more than 2,700, containing a total of approximately 1.2 million households in 2010" (National Department of Human Settlements, 2010). LC presents an opportunity to address housing deficits

and backlogs as it improves the rate of turnover in delivering housing units, adopting housing technology and construction methods that reduce land needs, construction assembly processes and workflow constraints and waste (Womack et al., 1990; Koskela, 1992; Smith, 2014; Lee et al., 2017).

3.3. Housing delivery and performance implementation turn in South Africa

Gauging housing delivery through an analysis of demand and supply provides the opportunity to track progress and raise questions regarding performance with respect to LIH settlement planning and management strategies, efficiency and effectiveness. Addressing housing shortage delivery can be approached from a reactive or proactive perspective, as illustrated in Table 8, which "shows the preliminary units delivered in 2009/10 and estimated delivery until 2014. If delivery occurred at this pace - on average of 230,000 units per year (which is unlikely) - it would mean that by 2014 approximately 1.1 million housing units would have been delivered" (National Department of Human Settlements, 2010).

The worrying statistics with respect to such a scenario is that if a business as usual (BAU) picture as portrayed here is retained, then there would be over 1 million units short of the current and growing backlog of 2.1 million households, which is a conservative estimate. In order to address this, in terms of a business unusual (BUU) approach, disruptive ABT, LC and CC adaptive and resilient LIH settlement systems and programmes should be rolled out in the country.

Table 8. Estimated housing delivery from 2008 to 2014 (units).

Province	Preliminary delivered 2009/2010	Estimated delivery			
		2010/2011	2011/2012	2012/2013	2013/2014
Eastern Cape	28,633	23,400	23,400	24,463	26,058
Free State	18,829	21,462	21,462	22,438	23,901
Gauteng	39,922	48,553	48,553	50,760	54,071
KwaZulu-Natal	27,376	26,626	26,626	27,837	29,652
Limpopo	23,079	22,613	22,613	23,641	25,182
Mpumalanga	8,291	8,181	8,181	8,553	9,111
Northern Cape	6,257	6,512	6,512	6,808	7,253
North West	35,141	30,954	30,954	32,361	34,472
Western Cape	32,371	31,698	31,698	33,139	35,300
Total	219,899	220,000	220,000	230,000	245,000

Source: (National Department of Human Settlements, 2015).

Arresting housing backlogs and deficits requires the implementation of a LIH turn-around strategy that creates spaces for state and non-state actors to contribute towards LIH delivery and provision. Within the confines of either exponential or logarithmic growth, as depicted from Table 8, we can deduce that

the "housing backlog has grown exponentially since 1994 and continues to increase partly due to change in household structures, rapid urbanisation, migration to cities and large towns, lack of opportunities in rural areas, structural unemployment, more households falling into the subsidy income band and less access to

housing finance” (Reddy, 2016). The DHS recently stated, in a parliamentary portfolio committee workshop, that “it is moving away from the use of the term” “backlog”, as the “term is time-specific, and urbanisation/migration makes quantification of housing backlogs problematic” (The Presidency, 2014). Instead, the DHS now refers to “housing needs” and the “investment required to provide for these needs” (Tshangana, 2018). In this new LIH paradigm approach, the scope and role that ABTLC, within the context of a CC adaptive and resilient settlement framework, cannot be over-emphasised.

3.4. LIH lean construction, alternative, and appropriate technology turn: what is practice offering for theory in South Africa

Literature is replete with how ABTLC and CC adaptive and resilient settlement systems can be a powerful antidote in addressing LIH settlements

challenges and matters (Ashworth and Perrera, 2015; Bajjou et al., 2017; Ballard and Rubin, 2017; Bredennoord, 2017). Infusing disruptive LIH construction and building technologies, as depicted in Table 9, presents opportunities for changing the LIH projects landscape in terms of ABT implementation issues. ABT and LC present opportunities for implementing spatial transformative housing projects in South Africa, taking into account location, sitting and the need to address the spatial fragmentation induced problems in South Africa. Indeed, LC and ABT hold prospect for changing and transforming the LIH landscape and architecture, as highlighted in Table 9, since we can deduce the existence of LIH appetite for lean construction, despite visible constraints to the massification of such approaches.

These constraints are linked to change management challenges as well as the tight profit margins of the construction industry. These issues make experimenting new ideas not favourable.

Table 9. LIH projects in terms of LC and ABT implementation.

LIH Technologies	Application	Observation & comments
Government support for LIH alternative building and construction technology initiatives	In 2007, the “National Home Building Regulation Council (NHBRC) was mandated” to provide leadership in exploring new designs (i.e. quality, appearance, and affordability). The utilisation of LC and alternative building technologies in government housing projects inadequate and skewed towards Gauteng Province	Support and promotion of innovators to showcase ABT or innovative systems by Eric Molobi Innovation Hub in Soshanguve Uptake of ABTLC slow and sporadic (Salem et al., 2006)
2003: State of LIH Technologies application	High uptake and usage of compressed earth blocks (CEB), interlocking blocks (IB), shutters and concrete (SAC), everite fibre cement blocks (FCB) and eco-frame building materials (EBM)	Policy, municipal by-laws and general building regulations do not prohibit the use of ABTLC in government housing development projects (Du Plessis, 2005). Trials and pilot projects in ABTLC have not resulted in large scale commercial production and uptake of such technologies
2008 & 2010 State of LIH Technologies application	Most prevalent concrete panels technology (CPT) was Goldflex 100 & 800 Building System and Cemforce glass reinforced concrete (GRC). The second most popular technology or system is the hydroform building systems (HBS) with Gauteng province applying the technology in Soshanguve. The third most commonly used technologies are “polystyrene based with imison building” and has been used widely in Gauteng province, particularly in the backyard upgrading project in Zola, Soweto. Moladi while sand bag technology system was the most preferred technology, particularly in the Eastern Cape.	Provinces are receptive to innovators of alternative building technology (ABT) including LC, but are hamstrung by subsidy constraints thereby precluding them from mass scale procurement and migration to LC and ABT because of the initial higher costs (Salem et al., 2006). No provinces have special budgetary arrangements or procedures for the “procurement of ABT or application of LC and or procurement” (Howell, 2011). Provinces found that some of the ABT and materials including LC had “hidden costs, which made their usage in government subsidised houses more expensive” (Koskela, Howell and Tech, 2000). Unavailability of technology for large scale delivery. Majority of companies remain at a prototype phase.
Between 1994 and 2010 about 2.8 million housing units were delivered for low-income earners	17,000 of these were constructed using ABT technologies	Existence of tension between the theoretical advocacy for lean construction technology, alternative building materials and technology, and the reality of building construction industry and technology including the conservative nature of the industry (Koskela, 2000).

Sources: (National Department of Human Settlements, 2010, 2015).

3.5. The policy and legislative debate and turn

Since establishment, the Department of Human Settlements has provided leadership regarding several

legislative proposals to accelerate the achievement of ideal human settlements for the people and strengthen the legal environment. The framing and oversight function of policies for LIH, as presented in Table 10,

highlights the instructive nature of policy and legislation in facilitating transitions towards enhanced housing performance and delivery. Creating an enabling and developmental environment for housing provision and delivery is a necessary but not a sufficient condition for enhanced LIH spatial planning and settlement functioning as depicted from Table 10, in which case we can deduce that in South Africa several role players exist that play pivotal roles and functions in advancing

the cause and concern of low-income earners in South Africa; yet, LIH challenges still persist. Housing delivery and provision is therefore a collaborative action and lean construction technology transfer must be undertaken cognizant of these realities (Holweg, 2007; Bajjou et al., 2017). LIH is a contested terrain in which various stakeholders interact in complex ways, as illustrated in Table 11, with respect to LIH role players and their functions in South Africa.

Table 10. Policy framework governing shelter/housing construction in South Africa.

Housing Policy and Strategy	Headline Provisions
Housing Act, 1997	1). "Facilitates migration towards sustainable housing development process and stipulates general principles applicable to housing development including LIH"; 2). "Categorises the functions of national, provincial and local government in respect of housing development; and articulates the financial arrangements with respect to national housing programmes". "Section 2 of the Housing Act, 1997 compels all three spheres of government to prioritise the needs of the LIH groups in respect of housing development".
Social Housing Act, 2008 (Act 16 of 2008)	1). "Provides for the establishment of the Social Housing Regulatory Authority (SHRA) to regulate all social housing institutions obtaining or having obtained public funds, and it allows for the undertaking of approved projects by other delivery agents with the benefit of public money". 2). "Gives statutory recognition to social housing institutions and provides for matters connected therewith. Social housing is however, characterised by a patchwork of policies, findings and institutions that neither supports the growth of the sector nor allows for proper regulation and monitoring of funding and policy". 3). "In April 2011, the SHRA launched the Social Housing Accreditation Register and issued accreditation certificates to 18 social housing institutions".
Human Settlements Vision 2030	1). "Envisages total eradication of backlogs of more than 2,1 million housing units, which translates into about 12,5 million people". 2). "Under Vision 2030's framework, most South Africans will have affordable access to services and quality environment, instead of living in isolation in the periphery of cities. New developments throughout the country will break away from old patterns and significant progress will be made in retrofitting existing settlements".
Social Contract for Rapid Housing Delivery	1). "Was signed in September 2005 during the Housing Indaba in Cape Town". 2). "The contract was signed by the then Department of Housing, provincial housing departments, national housing institutions and private stakeholders that form part of the supply value chain in the delivery of housing".
Inclusionary Housing Policy	1). "The New Economic Growth Path has identified energy, transport, roads, water, communication and housing as key areas in its strategy to fast-track sustainable growth, employment and equity creation". 2). "Is being implemented through the Presidential Infrastructure Coordinating Committee (PICC)".

Sources: (National Department of Human Settlements, 2010; The Presidency, 2014; Tshangana, 2018).

Interventions and initiatives to address LIH have to take cognizance of the multiple agencies, actors and disciplines impacting and impacted by the housing sector, as illustrated in Table 10, if the efforts are to tackle holistically, effectively and efficiently the LIH

agenda matters in South Africa that are complex, dynamic and multi-dimensional. In any case, scaling up full LC application in the sector requires capacity building and training of all stakeholders involved in LIH delivery (Ashworth and Perrera, 2015). However,

what is encouraging is that despite challenges and issues regarding the fragmented and inadequate application of LC to benefit the low-income sector, the government and non-state sectors have an appetite for

experimenting and implementing alternative construction technologies aimed at addressing the changing housing needs of the low-income group in South Africa.

Table 11. LIH role players and their functions in South Africa.

Role player	Function and or mandate
National Housing Finance Corporation (NHFC)	Established in 1996 to mobilise housing development finance from non-state sectors. Facilitates the provision and allocation of funding in promotion of sustainable human settlements and the eradication of informal settlements.
People’s Housing Process (PHP)	The workflow process enables targeted beneficiaries to form a housing-support organisation that plays an oversight role with respect to organisational, technical and administrative support.
Women in Housing (WIH)	The National Women Build (NWB) aims at advancing the spirit of volunteerism as well as public-private partnership (PPP) in LIH provision and delivery. WIH supports the integration of women into the built environment sectors with explicit support for initiatives relating to LIH infrastructure and service delivery, the growth and development of the construction industry and, in particular, housing/building sector
Youth Build (YB)	The Youth Build South Africa (SA) programme provides for linkages and connections within the LIH network and innovation system with respect to pilot and demonstration projects. YB’s approach was piloted in Ivory Park, Midrand, in Gauteng and has been rolled out to other parts of the country.

3.6. Reconciling the LC technology paradigm with budgeting realities

Tackling LIH is incomplete without an understanding of the financial strategies and provisions as revealed in Table 12 that presents the Budget of the Department of Human Settlements 2018/2019. The budgetary allocations are split between administration, “Human Settlements Policy, Strategy and Planning, Human Settlements Delivery Support and Housing Development Finance” (Tshangana, 2018).

The budgetary allocation for the human settlements department is of approximately R30 billion (Table 12). Over 93% of the budgetary allocation is ring fenced housing development finance. The remaining 7% is shared between administration requirements and Human Settlements Policy, Strategy and Planning. Making stronger use of the LC approaches for LIH housing will result in more units being delivered as compared to using traditional construction methods. “Part of Lean’s attractiveness to construction has been its use of elemental and therefore, low-cost tools” (Lim et al., 2011). It is critical to realize that the Department of Human Settlements implements the housing delivery in partnership with the private sector and construction contractors. These contractors can only adopt lean construction provided that the philosophy of LC is well understood and the risk associated with the switch from the existing methods to the new method is low. This is because the “construction industry has a very thin operating profit margin that ranges from 2-5%” (Trivedi and Kumar, 2014). In implementing LIH ABT, LC and

CC adaptive and resilient settlement initiatives and interventions, there needs to be a “compelling reason for any company to consider adopting major if not radical building and construction operational technologies and initiatives” (Holweg, 2007). There are three interrelated building and settlement construction factors which contractors may find important, namely:

1). “Wasted time is very high in the housing and building construction sector” and Koskela (2011) “suggests that 66% of on-site labour performs non-value activities and 10% of project materials are wasted” (Koskela, 2011; Zheng et al., 2017). “Decreasing waste accumulation on project construction sites leads to a competitive advantage in cost and schedule management” (Wang and Ma, 2013; Selkämaa, 2018).

2). There are studies confirming that “average profits in the construction industry are 3% for contractors” (Sieng, 2012). According to Wang and Ma (2013) “an increase of 10% productivity in a construction/building firm in which labour (i.e. the payroll content/component) is 35% of total revenue will result in a doubling of the net profit, if the LC approach is correctly applied”. Given the “high amount of waste associated with traditional building/construction approaches, it is probable that a firm can achieve this with the LC approach” (Wang, 2014).

3). On the long-term, contractors are usually keen to explore options at the end of their careers or towards the end of a project life-cycle. “If an investor or contractor has a business that does not demand their full-time attention (i.e. has employees who can work independently on most tasks) then he or she will have a

business that can be marketed, sold and is tradable on the market” (Lin et al., 2015). “If they do not have such a competitive construction business, then they have a job and nothing to sell above the market price of its assets less its liabilities” (Gao and Low, 2014). With respect to this, construction business will always trade off the long-term benefits offered by LC in preference to the tried and tested conservative traditional construction methods as a way of risk minimization and mitigation.

Overall, the adoption and popularization of LC approach in LIH would adequately lead to the support of the implementation of the “Social Contract for Rapid Housing Delivery (SCRHD), which was conceptualised

to support the implementation of government’s Breaking New Ground (BNG) 2004 strategy” (National Department of Human Settlements, 2010). BNG was launched with the aim to accelerate the delivery of housing (i.e. LIH included) as a key strategy to fight poverty and reduce housing settlements inefficiencies on the market. Indeed, such a quantum leap is appreciated in a context in which the need to bolster the comprehensive housing plan (CHP) for the development of Integrated Sustainable Human Settlements“ (as spelt out in the Breaking New Ground strategy) is aimed at eradicating informal settlements in South Africa in the shortest possible time” (National Department of Human Settlements, 2015).

Table 12. Department of Human Settlements Budget 2018/2019.

Programmes	Audited outcome			Adjusted appropriation	Medium-term expenditure estimates indicative		
	2014/2015	2015/2016	2016/2017		2017/2018	2018/2019	2019/2020
Total Allocation R`000							
Administration	433,080	411,074	420,897	457,665	442,650	471,546	502,671
Human Settlements Policy, Strategy and Planning	78,703	75,738	86,600	93,573	89,781	95,966	102,611
Human Settlements Delivery Support	133,712	120,796	151,742	217,302	246,005	261,045	329,824
Housing Development Finance	28,712,737	29,426,936	29,927,992	32,695,760	31,577,280	32,859,348	34,851,058
Total	29,358,232	30,034,544	30,587,231	33,464,300	32,355,716	33,687,905	35,786,164

Source: Tshangana, 2018.

3.7. Towards a roadmap research and implementation agenda for resolving LIH challenges in South Africa

Considering the preceding sections, one can argue that the (re)resolution of LIH in South Africa requires an updated and robust research and implementation roadmap. Such an intervention should assume that LIH is prioritized as an intervention area, targets are set making use of ‘the last planner LC approach’ and the integrative nature of the complete and total housing approach is fully optimized. Developing a LIH and LC transition and migration plan is fundamental to realising a better performing and adept LIH sector in South Africa as illustrated in Table 13, which presents LC inspired research and implementation roadmap. The transition from the current inadequate approaches to addressing LIH backlogs and deficits “blues“ into an integrated and sustainable human settlements delivery strategy requires structured approach linked to the policy, legislative and human settlement internal and external factors (Table 12). At the same time, the development of an innovative construction and leadership academy driven by a research observatory is critical in providing LIH settlements backlog and deficit strategy intelligence to overcome emerging and emergent challenges. The role of partnerships and collaboration

in tackling housing challenges in South Africa cannot be over-emphasized.

3.8. Strengths and limitations

The LC and ABT innovation options and perspectives in the context of the reality to CC proof LIH settlements offered within this study highlights to academics, researchers, policy makers and practitioners the importance of seeking to find new, different, alternative, disruptive and innovative ways to overcoming LIH delivery and provision constraints.

This can potentially enable practitioners, project managers, clients and decision-makers to consider LC and ABT and construction techniques/technologies in the way in which LIH building and construction resources/materials as well as services are procured, implemented and managed in advancing sustainable, inclusive, resilient and integrated housing and related construction projects, and thus improve desired project outcomes. Overall, this paper is conceptual and makes a case for further empirical research using Agreement certification of South African Bureau of Standards ((SABS) as well as the “National Home Builders Registration Council’s” (NHBC) to validate the performance of LC and ABT and advanced construction techniques, low-cost building/construction materials in practice.

3.9. Implications or recommendations

Emanating from this discussion, several recommendations and suggestions can be advanced regarding moving forward the LIH provision and delivery set-up in South Africa. While LIH, LC and ABT

similar and related findings resonate from studies and findings from other countries (Koskela et al., 2000; Ogunbiyi et al., 2014; Oldfield and Greyling, 2015; Sarhan et al., 2017), the particular and peculiar implications for South Africa from this review include the following:

Table 13. Low-income and LC inspired research and implementation roadmap: some insights.

Intervention area (some examples)	Steering mechanism	Implementation platforms	Enabling legislation	Strategic plan target	Strategic medium-term and long-term target	
Distressed mining towns	National development plan (2030)	Housing development agency (HAD)	Finalisation of property practitioners bill	Develop a comprehensive and integrated human settlements legislation	Develop regulations for human settlements legislation	
	Human settlements vision (2030)			Provide integrated information and communication technology services	Provision of state of art ICT services	
	National infrastructure plan (2011)	Social housing regulatory authority (SHRA) capacity grants	Housing consumers protection measures amendment bill	Establish and strengthen partnerships in support of the delivery of low income/informal settlements housing upgrading projects	Approved low income/informal settlements housing upgrading and development plan (HSDG funded)	
	Integrated urban development framework (2016)					Development of national human settlements development plan complete with a national LIH backlogs and deficit reduction/mitigation plan
	New urban agenda (2016)	National home builders registration council (NHBC)	Home loans and mortgage disclosure amendment bill	Human settlements development bank bill	Development of urban settlement development plan for metropolitan municipalities (USDG funded) complete with a municipal LIH backlogs and deficit reduction/mitigation plan	
	National spatial development perspective (2006) – Reviewed (2018)					
	National transportation master plan (2050)	National urban and reconstruction housing agency (NURCHA)	Development of the human settlements code	Amendment of the housing act to human settlement legislation	Provide implementation support on the delivery of LIH projects	
	United nations sustainable development goals (2030)					
	Labour sending areas	Medium term expenditure framework	National housing finance corporation (NHFC) financial support	Amendment of the prevention of illegal evictions and unlawful occupation of Law Act	Increase delivery of adequate LIH projects in support of developing sustainable human settlements	Establishment of project readiness matrix and implementation scheme (i.e. covering LIH backlogs/deficits, informal settlements upgrading plans and programmes) implementation in 9 provinces and 8 metros
Rapidly urbanizing areas (metros)	Improvement of provincial and municipal contract management systems and procedures	Targeted procurement related to women, youth, military Veterans and persons living with disabilities	Revision of the social housing policy and regulations	Multi-year land assembly plan for LIH backlogs/deficits and informal settlements upgrading plan reviewed to incorporate pre-post 1994 title deeds restoration programme tenure realities	Establishment of a housing programme scholarship for next generation of experts in sector, innovative construction leadership academy and innovative construction observatory and futures research centre	
						Developmental capital grants strict monitoring and evaluation compliance
						Title deeds restoration grant
						Emergency housing grant

1). The need to continuously monitor, evaluate and review the housing policy and regulatory set-up relevancy in addressing low-income housing deficits and backlogs with the aid of clearly developed LC led indicator framework (i.e. perhaps taking the dashboard

reporting system) is vital in improving integrated LIH delivery monitoring systems in South Africa).

2). Promoting and supporting LIH pilot and demonstration projects/schemes, in which full LC, ABT and CC resilient LIH is an essential hallmark in the

quest to have a catalytic LC uptake and roll-out of alternative approaches, technologies and models for addressing the gamut of concerns that LIH's previous, current, emerging and future beneficiaries can share or have.

3). The housing sector is an industry that has immense potential for growing opportunities for skills and knowledge transfer making use of the LC, ABT and CC resilient settlement framework to advance benefits to all sectors of industry, including communities.

4). It is essential that the full value chain of research is achieved through the implementation of transformative LC, ABT and CC resilient settlement projects in South Africa. This is because housing delivery and implementation is a collaborative process that requires input from both public and non-public sectors.

5). The need for continued R&D with respect to LC, ABT and CC resilient settlements covering urban and rural areas and including areas under traditional leadership constitutes fields for further investment and exploration. Generating the appropriate mix of packages that apply across scale and spheres of government is an essential component in developing a turn-around strategy for massive upscale and uptake of LC, ABT and CC resilient settlements, which is necessary to facilitate the translation of these indicated initiatives into success. The role of academia and research institutes in supporting the theory and practice of LIH cannot be over-emphasised.

6). Political leadership and support is necessary in the promotion and roll-out of new and disruptive LIH technologies, as discussed in this paper. Ultimate success will hinge on advanced spatial planning that promotes well located and sited LIH settlements, supportive LIH infrastructure and services provision, resource and budget provision, skills and capacity building, awareness and sensitisation workshops as well as the implementation of a critical mass of such LIH projects to change mindsets and improve uptake and practical implementation acceptance in the construction sector.

4. CONCLUSION

The "human settlements sector in South Africa remains one of the most challenging areas in the social and economic environment" (National Department of Human Settlements, 2015; Ballard and Rubin, 2017; Tomlinson, 2017). This is partly because solving the housing problem has been seen as a fight against a moving average which is further complicated by the fact that housing problem fits the requirements of a "wicked problem" that requires multiple, non-conventional approaches and solutions in (re)solving the matters germane to the sector (Dearnaley, 2018). Realising the right of every citizen to a home involves far more than

the delivery of a subsidised house. Innovations in housing finance, construction/building technology and materials, subsidy mechanisms and institutional arrangements driven by the lean construction framework of analysis "is required to find appropriate responses to changing circumstances in the housing sector" (Bajjou et al., 2017; Cirolia et al., 2017). Allowing, for example, municipalities to experiment with LC, alternative smart LC inspired housing approaches, innovation and ABT and advanced construction and building technologies to "housing policy implementation, even if only on a medium-term pilot basis, is likely to inform and stimulate the ongoing refinement of public housing policy to meet changing market conditions and household needs" (Huchzermeyer, 2014; Sarhan et al., 2017). Combining LC with ABT within the context of climate change induced flood risks vulnerabilities is an important plank in retrofitting and building resilient settlements in both urban and rural South Africa. Exploring and conducting pilot tests and demonstrations with respect to CC, ABT and LC LIH spatially resilient and proofed sustainable human settlements is one way towards contributing to the sustainable development goals (SDGs), 2015, New Urban Agenda (NUA), 2016 as well as meeting the National Development Plan (NDP) 2030 goal of moving and transiting to a low carbon green economy for South Africa. The conceptual framework sketched in this paper constitutes an important framework for further guiding human settlements development in South Africa.

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