Intermodal steel building units as an alternative for building low-income housing units in Puerto Rico

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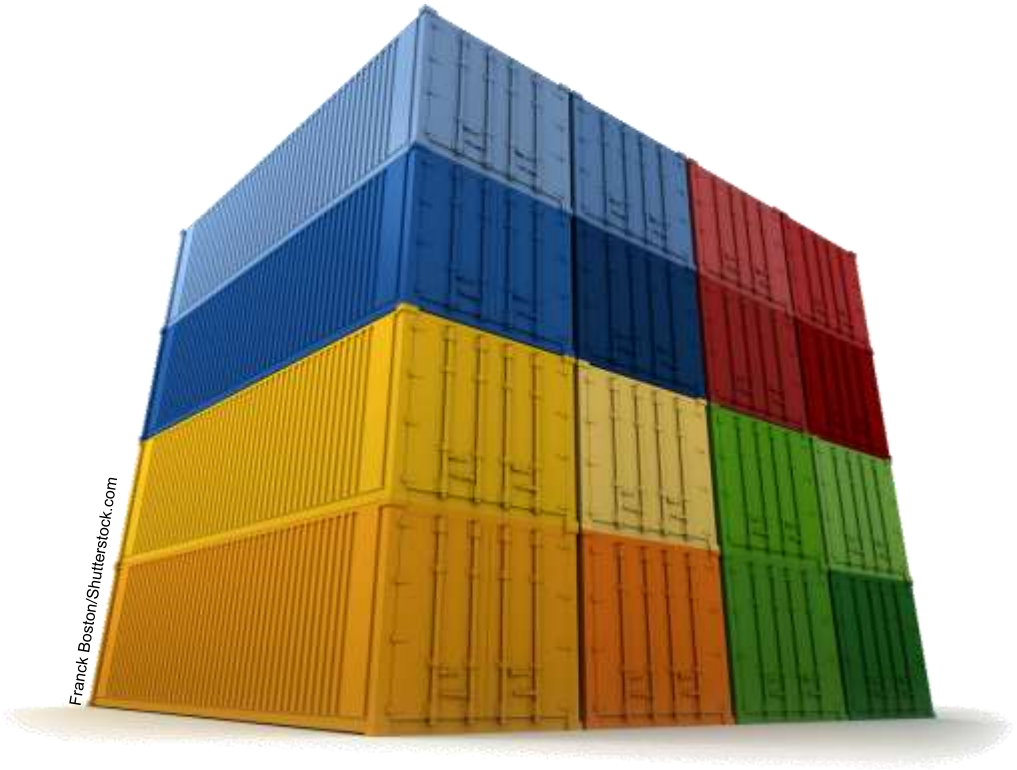

ABSTRACT

Puerto Rico currently has an excess of high-priced housing units, partly because of the recession that has been affecting the Island since 2006; on the other hand, state-subsidized housing has the largest demand, but high construction costs and government-imposed price caps have kept developers from pursuing these types of projects. The demand for subsidized housing units has been estimated at 22,000 for years 2012 thru 2016. Other jurisdictions, mainly in Europe, have adopted maritime cargo containers (technically known as Inter-Modal Steel Building Units, "ISBUs", when used for construction) as structural building blocks for a variety of edifices. ISBU-based housing provides an environmentally-friendly alternative to traditional construction that uses surplus maritime cargo containers, thereby reusing a valuable material that would otherwise become a disposal problem.

ISBUs have performance specs that surpass those of traditional concrete construction used in Puerto Rico, at a considerable cost reduction of approximately 60%. Once common prejudices regarding the safety, longevity, and quality of ISBU-based construction are overcome, this type of construction could be an innovative solution to a long debated problem that affects many stakeholders. The key to providing safe, modern housing to the poorest in our society may well come from thinking *"inside* the box".

KEYWORDS

ISBU, cargo shipping containers, construction, subsidized housing, PR economy

Introduction

The Puerto Rico economy faces several challenges it must overcome if it is to emerge from the recession it is still submerged in. This economic deceleration, although affecting virtually all individuals and industries, has had a major effect on the poor, and firms that develop housing for this sector. The economic activity that takes place post-closing of a real estate property by way of the multiplier effect affects professionals and businesses directly tied to real estate sales, and indirectly the rest of the economy through the multiplier effect.

The financial bonanza years prior to the current recession were a time where ample funds were available to finance residential developments. Given that middle and high-priced housing units typically provide higher-margin levels, developers concentrated their efforts in these types of units, even though the highest demand has always been for subsidized, low income dwellings. When the current economic crisis forced many buyers of residential units under construction to withdraw their options and down payments, developers were left with an excess inventory of units, especially high and mid-priced single houses and condos. The main obstacle discouraging developers from developing low income housing, with an expected demand of about 22,000 units for years 2012-2016 (Departamento de Vivienda de PR, 2011) is diminished profit margins Increases in maximum prices set by governmental authorities granting subsidies for these housing units have not been up to par with costs associated with building said projects, thus rendering potential developments in this price range unfeasible because of decreased profit margins.

Finding a viable alternative that entices private developers to enter into these projects not only provides much-needed dwellings for low-income people, but can also create thousands of construction jobs, a very pressing necessity under the current economic climate Puerto Rico is undergoing. During the years 2004-2010, close to 60,000 jobs have been lost in the construction industry. One proposed solution has been to reduce the size of the housing units in order to lower construction costs. In one such proposal a 585 square feet walk-up unit was intended for the typical family, consisting of two adults and two children; these dimensions are a little more than half what is typically offered for this type or project. It is very unlikely that customers, even those with very low income, would be willing to live in such a small dwelling (Departamento de Vivienda de PR, 2011). The design proposed by the PR Housing Department uses traditional building materials for the Caribbean, such as concrete, cinderblock, and steel.

A construction modality that has been gaining traction across the world is to use maritime cargo containers as the structural building blocks for development of almost any type of real estate; technically, these containers, when used for permanent building structures, are known as Inter-modal Steel Building Unit (from now on "ISBU"). These uniform "building blocks" provide an extremely sturdy, modular infrastructure for easy combination into different arrangements and costs less than the price of comparable concrete-based housing traditionally built in Puerto Rico. These containers meet or exceed all parameters associated with traditional housing construction safety standards. Because of their modularity, ISBUs can easily be combined to meet the necessities of virtually all types of residential units,

from the most expensive, to very economical, basic housing units for low-income individuals and families. One of the first ISBU-based construction projects was for a five-story student housing complex in Amsterdam.

Puerto Rico's Housing Sector Profile

Real estate prices in Puerto Rico have not been strictly correlated to the state of the economy; until the current economic recession, they had maintained their value, regardless of cyclical decelerations in the economy. This inelastic price behavior fostered speculation in them, and was responsible in part for the building up of inventories of middle and upper priced housing units. The construction of these types of units was undertaken at the expense of not pursuing subsidize, low-cost housing, since the former have traditionally provided better profit margins. This price bubble burst when the local economy stalled, beginning in 2006.

Table A shows the relationship between local GDP and construction activity for the past 10 years of available data (PR Planning Board, 2012). As can be clearly seen from the data, construction shows a declining role in terms of its total contribution to the growth and development of the Island's economy; the data shows a steady monotonic decrease in the role played by Total Construction across the years. With the exception of year 2004, Total Construction activity decreases from the previous year level, with a coetaneous GDP monotonic rise as years go by, hence explaining the decreasing role played by

Total Construction mentioned previously. The marked decline in the Total Construction figure starts in the year 2007, coinciding with the winding up of the local recession.

TABLE A
New Construction as a Percentage of GDP
Years 2002-2011

Fiscal Year	GDP ($millions)	Private Housing Construction (units)	Private Housing Construction ($ '000)	Private Housing Construction as a Percentage of GDP	Public Housing Construction (units)	Public Housing Construction ($ '000)	Public Housing Construction as a Percentage of GDP	Total Construction ($ millions)	Total Construction as a Percentage of GDP
2002	45,102.4	18,000	943,040	2.09%	724	54,490	0.121%	997,530	2.21%
2003	45,999.7	17,546	957,303	2.08%	1,370	69,017	0.150%	1,026,320	2.23%
2004	48,492.2	18,692	1,132,983	2.34%	2,115	95,828	0.198%	1,228,811	2.53%
2005	54,861.9	16,873	1,027,293	1.87%	1,070	46,971	0.086%	1,074,264	1.96%
2006	57,854.3	16,954	1,182,427	2.04%	877	60,390	0.104%	1,242,817	2.15%
2007	60,642.7	13,057	967,350	1.60%	791	39,788	0.066%	1,007,138	1.66%
2008	62,703.1	11,229	861,971	1.37%	521	41,672	0.066%	903,643	1.44%
2009	63,617.9	6,672	460,291	0.72%	64	41,171	0.065%	501,462	0.79%
2010	64,294.6	4,774	279,497	0.43%	175	12,352	0.019%	291,849	0.45%
2011p	65,567.0	3,905	253,101	0.39%	83	3,883	0.006%	256,984	0.39%

Source: Economic Report to the Governor, 2012, PR Planning Board.

Similar trends are reflected in Table B where sales of new construction unit decreases monotonically from 2006 to 2011, year in which there is a slight increase; if figures for the first two quarters of calendar year 2012 are extrapolated, the year should have ended with sales of approximately 3,000 units. Percentage-wise, the largest decrease takes place in 2009, after three full years of recession have had their negative effect on the Island's economy.

TABLE B
New Housing Construction (in units)
Years 2006-2012

Fiscal Year	New Housing Construction (in units)	Percentage Change from Previous Year
2006	13,417	
2007	10,910	-19%
2008	9,718	-11%
2009	4,681	-52%
2010	3,656	-22%
2011	4,825	32%
2012*	3,080	-36%

Source: Presentation by Estudios Técnicos, Inc. at ACH Convention, September 2012.

*Sales Extrapolated from 6 months of data up to Q2 of year 2012.

Table C below shows the distribution, by sales price range, of new housing units sold during the year 2010, the latest year for which official statistics are available (US Census Bureau, 2010). The majority of sales are for relatively inexpensive units, with 65% of units sold having sales prices at or below $149,999, thereby evidencing the Puerto Rico housing market currently demands low-cost units.

TABLE C
PR Housing Price Breakdown
Year 2010

Price Range	Housing Units	Housing Units Percentage of Total
Less than $50,000	82,419	9%
$50,000 to $99,999	263,468	30%
$100,000 to $149,999	227,899	26%
$150,000 to $$199,999	153,527	17%
$200,000 to $299,999	91,856	10%
$300,000 to $499,999	39,989	5%
$500,000 to $999,999	14,851	2%
$1,000,000 or more	5,324	1%
Median (dollars)	117,300	
Total	879,333	100%

Source: US Census, 2010.

ISBUs as Basic Building Construction Blocks

The typical ISBU is made from Corten™ steel, a special steel alloy developed by US steel that is more resistant to rust than typical steel. Under normal circumstances, Corten steel can oxidize, but it will not corrode, implying that its structural capabilities will not be compromised. Although patterns can vary slightly, most maritime cargo containers are 8 feet wide, 12 feet tall, and come in four different lengths, 10, 20, 40 feet and 45 feet, although 20 and 40 foot long containers are the most common, by far. ISBUs are extremely strong and resistant; their standard strength is due to the corrugation of their panels, and the rigid steel frame to which these panels are welded to. As can be observed from the figures provided in Table D, ISBUs Certification standards exceed Uniform Building Code requirements in each and every parameter.

Source: ISBU Association *Green Cube Approval Report*, 2009.

There are four major common misconceptions regarding ISBUs:

I. They are extremely hot or cold inside and therefore unsuitable for habitation by humans.
II. They are used for "ghetto type" housing units, and thus stigmatize those residing in them.
III. They are structurally unsound, and cannot sustain extreme weather conditions, rendering them useless for housing construction.
IV. Since they were designed for maritime cargo hauling, they cannot meet typical building code

requirements, as conventional units do.

Regarding the first misconception listed above, ISBUs can be treated with cenospheres (from the Greek word *kenos*, meaning hollow) which are ceramic nanoparticles suspended in a liquid (colloidal suspension), measuring an average 75 nanometers. These particles, similar to the double glass containers in any Thermos®, provide effective temperature insulation from heat and cold when added to paint coating used on ISBUs (ISBU Association B, 2012).

The second stigma that ISBU-based housing may have had in the past regarding their appearance has been minimized by advancements in decorative covering of both the inside and outside portions of these housing units, which make the steel frames almost impossible to identify, and look no different from typical construction. The lower costs associated with using ISBUs as structural building blocks allows for a larger portion, dollar wise, of available budgets, to be spent in decorative aspects, or on increasing the size of the edifice, as construction costs per square foot decreases.

The third typical objection to ISBU-based construction is a misconception regarding their structural integrity. In the case of Puerto Rico, which is subject to the threat of hurricanes and tropical storms half of the year, a common concern is that the structure could collapse when subjected to hurricane force winds. However, ISBUs that have been properly anchored to a flat slab are almost impossible to detach from their foundation, even under the most extreme storm conditions.

The fourth and final objection is easily overcome as shown in Table D, where different physical characteristics of ISBUs are compared against traditional construction; ISBU construction clearly outperforms traditional construction in all categories. ISBUs therefore provide a lower cost, technically better foundation upon which almost all types of construction can be built upon.

An aspect that is vital when designing and constructing ISBU-based housing units is the use of a structural engineer to make sure that modifications (such as removing portions of the side walls, windows, doors,

TABLE D

Building Code Comparison

ISBU v Traditional Construction

Parameter	ISBU Certification	UBC Requirements	Times ISBU exceeds UBC Requirements
Roof, uniform load, center	300 psf	20 psf	15.0 times
Roof, stacking, axial	53,000 per post	500 per post	106.0 times
End walls, lateral	366 psf	20 psf	18.3 times
Side walls, lateral	234 psf	20 psf	11.7 times
Racking/shear load A	16,800 lb.	680 lb.	24.7 times
Racking/shear load B	33,600 lb.	1,600 lb.	21.0 times
Flooring, uniform load	101 psf	40 psf	2.5 times

or container swing doors) do not adversely affect the structural integrity of the units. Given that ISBU-based construction in Puerto Rico is almost completely unknown, there could be resistance on the part of local authorities in granting approval to such projects. However, once the required testing and certifications are in place by a duly licensed professional (in Puerto Rico architects and engineers are the ones granted with such authority by the state), this initial reluctance should be gradually overcome.

Cost Comparison between Traditional Concrete/Steel Construction and ISBU-Based Construction

The polemic regarding price caps on subsidized housing prices that, given current traditional construction costs, does not allow developers enough profit to entice them into this market, has two possible solutions: increase price caps, or reduce unit costs. Out of these two alternatives, governmental authorities have favored the second one, since price limitations are inherent in the *raison d'être* for subsidized housing. Hence, one alternative has been to reduce unit size in order to reduce costs; this is exactly what was proposed by the PR Housing Department at the Asociación de Contratistas de Hogares's 2011 annual convention. Table E shows construction costs for the 585 square feet walk-up type unit proposed, with two bedrooms, and one bathroom. The $37,500 allocated to unit construction translates into $64.10 per square foot. It is precisely in construction costs, specifically the structure, where ISBU-based construction can provide the most advantages over traditional concrete construction. It should be noted that under the proposed model, the municipality provides the terrain free of cost to the developer, an incentive that could continue under the proposed ISBU-based construction model.

Table E
Construction Costs for New Housing Model
Terrain, Hard, and Soft Costs

TERRAIN COSTS	$0
HARD COSTS	
A. Infrastructure	12,500
B. Housing Unit Construction	37,500
SOFT COSTS	
A. Financing	3,000
B. Marketing & Sales	1,600
C. Administration Expenses	2,500
TOTAL	**$57,100**

Source: PR Housing Department Presentation during ACH's 2011 Convention Nueva visión para la construcción de vivienda asequible, 2011.

Table F below shows a very simplified P&L for the PR Housing Department's proposed 585 ft^2 walk-up units. For a developer, the $8,275 profit out of total costs of $57,100 represents a profit of 14.5%, which is a very attractive return under current economic conditions. Apart from the cost of the land, the government has to cover $16,626, which represents 23.9% of total costs of $69,650 per unit.

Table F
New Housing Model
P&L

SALES PRICE PER UNIT	$82,000
LESS: TOTAL COST PER UNIT	(69,650)
GROSS PROFIT PER UNIT	12,350
LESS:	
Taxes on Profits (Statute 47)	(4,067)
NET PROFIT FOR DEVELOPER	$8,275
TOTAL GOVERNMENTAL COSTS	$16,626
Percentage of Governmental Costs to Sales Price	25%

Source: PR Housing Department Presentation during ACH's 2011 Convention Nueva visión para la construcción de vivienda asequible, 2011.

ISBUs can be combined, in a variety of fashions, to create various designs; including multilevel units (provided the necessary structural support is included for sections that may be positioned in cantilever). With the appropriate joining pieces a wide variety of combinations between 20 and 40 feet

long units can be arranged to meet almost any need. With each ISBU contributing 320 ft.² of floor area (8 feet wide by 40 feet long), a housing unit of 960 ft.² (three ISBUs, at 320 ft.² each) could be designed to provide a typical three-bedroom two bathroom housing unit. ISBU-based housing is ecology-friendly because an existing resource, maritime cargo containers, is being reused instead of disregarded as waste. Regardless of the extremely strong structural characteristics associated with ISBUs, the finished design must be certified by a structural engineer in order to pass the necessary building code requirements inspections, which can and do vary among jurisdictions (ISBU Association, 2009).

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Typical construction costs for ISBUs are assumed to be $30 per square foot for argumentation purposes. As per the computations stemming from Table E, the average cost of construction in Puerto Rico for the typical low-income housing unit is around $64 per square foot. Hence, using ISBUs instead of concrete construction provides savings of around $34 per square foot, which translate into a total savings of $61,440 per unit ($34 times 960 ft.²). Land and utilities have been assumed to cost the same for both construction methods, and as such are not considered in the analysis. Comparison of the ISBU-based alternative against the reduced-size walk-up proposed by Vivienda, shows lower construction costs with faster unit construction times for the first alternative. Additionally, there is a 375 square feet (960 – 585) square feet advantage, which represents 63% (375 sq. ft./585 sq. ft.) additional area over the Vivienda alternative.

Conclusion

Puerto Rico currently faces a crisis in the availability of cost-effective housing for low-income individuals and families. Traditional concrete-based construction used in the Island entails costs that force developers to establish unit sales prices that exceed limits allowed by governmental agencies that provide subsidies to buyers of this type of units. A solution that has been proposed is to reduce substantially the dwelling are (one such design has 580 ft.² houses) in order to reduce costs. It is doubtful that such a small unit can be successfully promoted to the typical four member family.

ISBU-based construction provides an alternative that is considerably lower in terms of the structural component, and that can be built faster. Already several countries around the world, mostly in Europe, have had years of successful experience with them. This type of construction is less expensive, more resistant, and faster to build compared to traditional construction. Paradoxically, thinking inside the box, literally in this case, is the key to solving a problem that has plagued our low-income housing construction industry are the past decade. This change in paradigm, along with other solutions that have been proposed by construction industry leaders could be the key to achieving the goal of every Puerto Rican individual or family living in safe and decent housing.

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