Investigating the Adaptive Reuse of Decommissioned Cruise Ships

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The rapid influx in cruise ship decommissioning during 2020 has created a unique opportunity to recycle or repurpose large ships using innovative strategies. This report examines the potential for the conversion of decommissioned cruise ships for housing, with a focus on the Miami-Dade County area. The goal was to investigate an alternative mode of coastal living, taking advantage of the oversupply of decommissioned ships as a primary housing structure, using semi-permanent docking in available port spaces. We identified case studies of residential cruise ships to serve as relevant precedents. We collected and synthesized raw data on the specifics of size, tonnage, capacity, age, and cost of the decommissioned ships of the year 2020, creating key datasets highlighting the magnitude of the issue. We then investigated the engineering feasibility of a docked residential cruise ship in Miami, conducting interviews with engineering practitioners having marine terminal expertise. Finally, we conducted an on-line survey to 362 adults in Miami-Dade County, (Qualtrics) to investigate perceptions from potential residents of this new living concept. We found that residential cruise ships could be moored in developed areas, such as the Port of Miami, but that infrastructure costs would be considerable, and the need for hurricane evacuation would be an issue for prospective residents. Our survey results strongly supported the proof-of-concept, with respondents expressing (88% yes or maybe) interest in living on a repurposed cruise ship. Those expressing the greatest interest are 41-50 years of age, earning at least $100,000 per year, who are single or have children, and willing to pay $849(mean) and $4000(max) per month.

CONTEXT

In 2020, a record number of cruise ships were sold, decommissioned and/or sent to the scrap yard for a multitude of reasons. The Covid-19 pandemic led to a sudden freeze in the cruise industry worldwide, leading to financial losses for major cruise corporations such as Carnival, MSC, CMV and Royal Caribbean. As a result, these companies were forced to reduce their fleet numbers; for example, the Miami Herald reported that Carnival sold 18 ships, a reduction of their fleet by 12%.[8]

In addition, a change to emission regulations by the International Marine Organization required all vessels to reduce their overall sulfur oxide emissions by 77% (IMO). These ship industry emissions have been known to cause premature deaths, cardiovascular, respiratory, and pulmonary diseases at high rates for port city inhabitants. This increased regulation called for updating engines and fuel emission systems, and with costs reaching millions of dollars this was not feasible for many ships, especially those with lower passenger capacities.[7]

About half of the cruise ships sold in 2020 were repurposed as short trip voyagers, ferry boats or permanently docked hotels. The remainder of decommissioned ships were sent to ship scrapping facilities, where usable materials such as metals and mechanical equipment are salvaged, while much of the interior elements, such as outdated furnishings and fixtures, are sent to waste.

This rapid increase in cruise ship decommissioning during 2020 has created a unique opportunity to recycle or repurpose these large ships using innovative strategies. Among the strategies seen today are Covid-19 response hospitals, permanently docked hotels, crypto currency and tech live/work communities, and reuse by domestic cruise companies. An example of how cruise ships are being reused innovatively is the MS Albatros, previously a Phoenix Reisin vessel, now acquired by the Egyptian hospitality name Pickalbatros Group, set to operate the vessel as a permanently docked hotel in the Red Sea.[5]

While there are economic benefits to cruise ship deconstruction in many developing countries, this is not without other costs. It provides steel for countries that normally would import it at high costs, while providing employment for low-paid shipbreaking workers. However, these workers are often required to work in hazardous conditions, dealing with pollution, contaminants, asbestos, and physical hazards which would not be acceptable by safety standards in the U.S. and other countries. Physical danger in shipyards leads on average to one serious accident per day, and one work-related death per week in the shipyards of Bangladesh, Pakistan, and India, resulting in it being among the most dangerous occupations in the world.[6]

PAPER

Figure 1. The drawing in this slide was created to showcase the ideal location for the semi permanently docked ship, in an area of Downtown Miami called the Museum Park Pier. This was determined as the best location through conversations with 3 coastal engineers about underwater depths and minimum wave action in the Miami Harbor. Other locations were less opportune for ecological reasons and lack of water depth. The concept would rely on creating parking within the lower floors of the ship and allowing 1 unit to span two guestrooms for adequate square footage. Units would not have individual kitchens, but communal dining would allow for meals to be eaten in a cafeteria setting or to be taken back to the unit. An open-air interior courtyard with resilient vegetation would be added for natural light and ventilation. There would be a hurricane evacuation plan in case the ship needs to relocate for large storms, a necessity communicated to users before occupation. These design concepts were communicated to survey respondents before they completed the following survey.

Source: Visualization by Ibrahim Desooky

APPROACH/METHODOLOGY

This report examines the potential for the conversion of decommissioned cruise ships for housing in existing port areas, with a focus on the Miami-Dade County area. The goal was to investigate this as an alternative mode of coastal living, taking advantage of the oversupply of decommissioned ships as a primary housing structure, using semi-permanent docking in existing port areas, and potentially creating affordable housing.

We first identified case studies of residential cruise ships to serve as relevant precedents. We then investigated the engineering feasibility of housing a permanently docked residential cruise ship in Miami, conducting interviews with engineering practitioners with marine terminal expertise. We also examined economic trends, such income and rent stress among of Miami-Dade County residents, to further understand the opportunities such cruise ship conversions may offer.

Finally, we conducted an on-line survey of adults 20 to 50 years of age in Miami-Dade County, to investigate perceptions from potential residents of this new concept. We collected 362 responses, an overall response rate of 77%, resulting in a margin of error of +/- 5 % (with a 95% confidence interval for an area population of 2.7 million).

FINDINGS

To understand the economics of residential ship conversion, it's helpful to first consider some of the many alternatives available to owners, such as dismantling and sale for scrap. During 2020, the potential income from ship scrapping greatly increased, from $200 to $400 per ton in India, and from $100 to $300/ton in Turkey. EU-tagged ships' scrap values are less, at $100-200/ton as these vessels require dismantling at EU-certified yards. Ship scrap prices in the U.S. are $80-90/ton.[6]

In spite of the potential income from salvage, obsolete cruise ships are not excessively costly. While the sale value of decommissioned ships is not widely published, information is publicly available for a number of cases. For example, the Astor, a relatively small ship of about 20,704 tons, with a 600-passenger capacity, was sold for scrapping for the sum of $1.7M.[1] However,

this ship capacity might be too small for residential reuse. A larger ship perhaps more appropriate for residential conversion, the MS Karnika, at 70,310 tons, with a 1674-passenger capacity and about 837 staterooms, was sold to a shipyard in India for $11.65M.[10] These examples begin to inform the costs of a ship to housing conversion.

PRECEDENTS FOR RESIDENTIAL CRUISE SHIPS

We referenced information on three case studies of residential cruise ships on the projects' commercial websites, which described unit costs, the various amenities offered, and other information. The MS 'The World' is the only residential ship that has been built and operational. Due to the Covid-19 pandemic, it was evacuated in March of 2020 and was expected to return to service with voyages starting in April of 2021. The other two case studies, MS Utopia and Storylines, are not yet built due to lack of funding and customer interest. Below we provide an overview of these planned or existing case studies:

MS THE WORLD

- Project Cost: $266 Million
- Capacity: 165 residences
- Unit Pricing: $825,000 to $7.3M

STORYLINES

- Project Cost: TBD – Under negotiation
- Capacity: 627 residences
- Unit Pricing: $308,616 to $9M

MS UTOPIA

- Project Cost: $1.1 Billion
- Capacity: 199 residences
- Unit Pricing: $4M to $36M

These newly built and under negotiation residential cruise ships are targeting high income households, and not broader segments of the population. It should also be noted that in addition to the unit pricing, owners in these residential ships will have monthly fees.

MIAMI-DADE COUNTY HOUSING AFFORDABILITY AND CLIMATE RISK

We collected data on household income and housing costs, to understand challenges to coastal communities in Miami-Dade County. We found that many coastal Miami residents suffer from rent stress, and that 50-60% of coastal Miami residents pay more than 30% of their monthly income in housing costs, revealing that housing costs are not compatible with household income levels.[14]

In addition, area residents face a high risk of property damage due to rising sea levels and storm surge. According to the U.S. Census Bureau, nearly one million people, roughly 37% of the county population, would be at risk of homelessness in the event of a major hurricane. This risk applies to both single and multi-family housing, including apartments, townhomes, condos, and public housing. Of these at-risk homes, 70% were built before 1990, the year in which building code reforms enacted stricter 'high velocity zone' hurricane standards.[14] With such a lack of housing affordability and risks from climate change, creative solutions are needed.

ENGINEERING AND LOCATION FEASIBILITY FOR LONG-TERM DOCKING IN MIAMI

We conducted a focus group interview with coastal and civil engineers at Moffat & Nichol, a firm with expertise in marine terminal design, to understand the technical feasibility of residential cruise ships being docked in Miami and in other port cities, such as New York, Los Angeles and New Orleans. The focus group took place on December 18, 2020, and included Abbie Wilson, Project Manager; Jackie Brower, PE, PhD; and Nicole Pauly, PE.

We began by discussing locations for such a concept. In terms of wave action, the ideal location in Miami is in the bay area as opposed to in the ocean. Most of Biscayne Bay is heavily protected by the Environmental Protection Agency due to the delicate and endangered species of coral on the ocean floor. Applying for approval to dredge and disturb these protected areas is costly and takes many years. Additionally, a goal of such a concept would be to enhance environmental conditions, not to damage them.

Currently the Port of Miami is connected to the deeper ocean waters of the Atlantic by a canal called Government Cut, and it is the only route deep enough for a ship of significant size and draft. The draft refers to the depth from the water surface to the bottom of a ship's hull. Below this draft dimension, clearance is needed to allow for movement of the ship without grazing the ocean floor, and the recommended 'under keel 'clearance is an additional 10% of the total draft. (In addition, the engineering experts recommended a lateral clearance of 10 to 15 feet from the ship to any wall adjacent to it, and in some places adding 'fendering,' a protective rubber and foam structure designed to withstand the forces of a docked ship pushing against the wall.

At the western end of Government Cut is the turning basin, a designated U-turn area for cruise ships to turn to exit the port. To the west of this area is an inlet in downtown Miami's coastline, tightly sandwiched between the American Airlines Arena and Museum Park, that could provide a possible site for a residential ship that the architect and engineers discussed during the interview.

ENGINEERING COST CONSIDERATIONS

This inlet was most likely intended for large vessel docking and has a depth of up to 24 ft, which can accommodate a large vessel with a shallower draft than most large cruise ships.[11] The experts discussed the deepening of the channel to a depth of 50 to 52 feet, the depth of other port areas. Underwater dredging costs start at $70 per cubic yard, and can be up to several hundred dollars per cubic yard if the sea floor is made of solid

Figure 2. According to the U.S. Census Bureau, nearly 1 million people in the county are at risk of homelessness in the

event of a major hurricane, constituting roughly 37% of the population. The light aqueous blue indicates

flooding in the event of 6 feet of inundation in Miami-Dade County.

Source: ESRI ArcGIS - National Oceanic and Atmospheric Administration

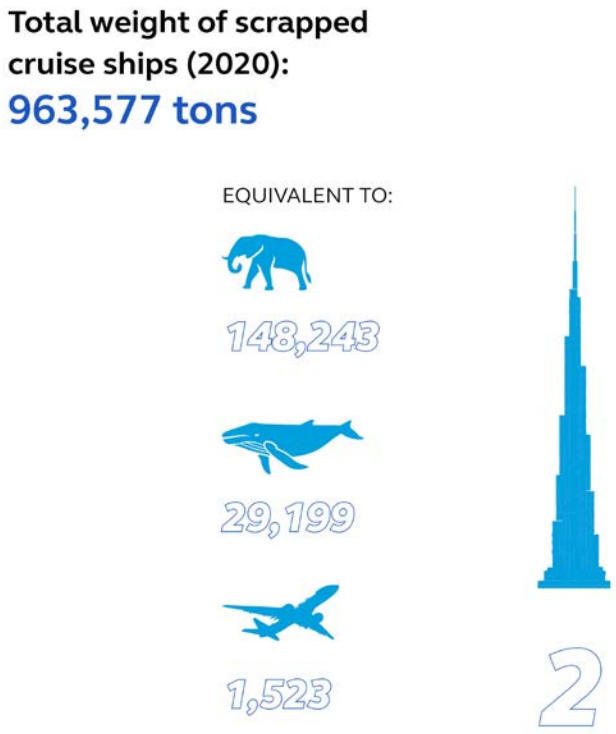

Figure 3. Totals and comparisons of tonnage of decommissioned ships for the year 2020.

Source: Visualization by Ibrahim Desooky

rock or sensitive soil. This requirement could rapidly add to a project cost.

A permanently docked residential cruise ship would also require infrastructure for power, waste management, fueling, sewer and other provisions, which may add between $2M to 4M dollars in construction costs. The Port of Miami land and infrastructure is very expensive and is designated for cruise and shipping vessels only and could not accommodate such a long-term private docking due to its already limited land and docking area.

Ports include massive structural platforms and walls that help resist both aquatic and naval structural loads, especially with the lack of bedrock in Miami's subterrain. Adjacent to the sea walls, mooring dolphins are large concrete piles used to moor ships for docking. Each mooring dolphin costs $250,000 to $500,000, and are to be spaced 50 to 100 feet apart, with extra ones at the stern and bow of the ship. These are crucial for permanent docking capability, and in our hypothetical site at Museum Park, several would need to be built to accommodate the ship, representing additional costs to the concept.

Finally, in Miami vessels do not stay at their berths during hurricanes, due to strong wind forces that could slam ships against the sea wall, yielding potential for disaster. An effective and clear hurricane evacuation plan would be required for a residential ship, and would have to be clearly communicated to potential residents prior to buying, leasing or occupying. Hurricane damage also may affect port infrastructure associated with the needs of the docked vessel, indicating a need for robust operational systems and investment. A loss of power is a serious potential during hurricane damage, which can cause distress and hazard to residents. Because residents would need to agree to relocate during a hurricane evasion, we added this portion to the survey. (Similarly, houseboats are not common in Florida waters due to hurricane force winds and wave action.)

COASTAL MIAMI-DADE SURVEY RESULTS

We conducted a survey to understand the willingness of residents of Miami-Dade County to live on a repurposed cruise ship, and if they expect that it could provide a quality of life equal or

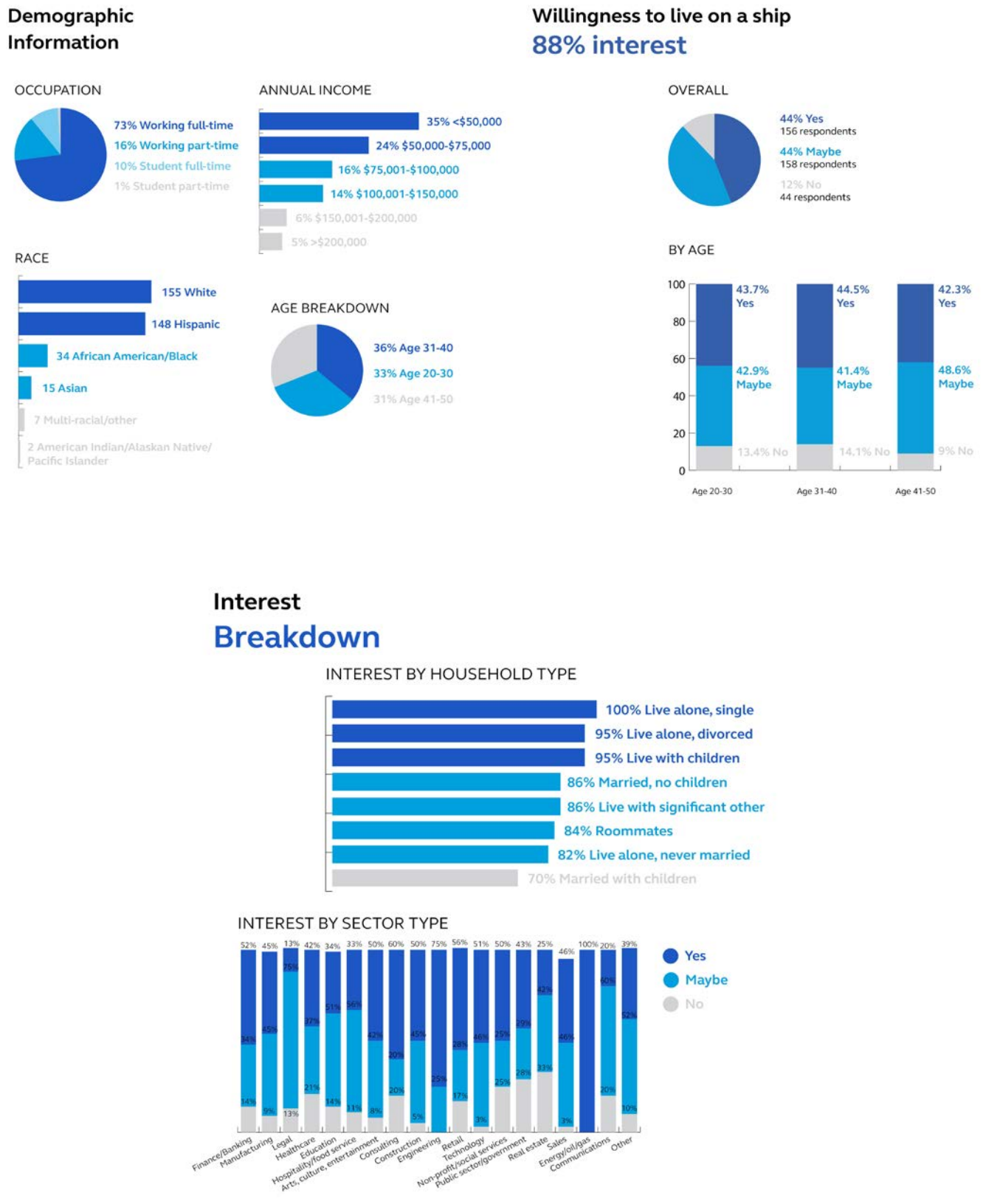

Figure 4. Understanding the demographic, willingness by demographic, household type, and sector of survey respondents.
Source: Qualtrics

better than their current condition. In addition, the survey aimed to understand the basic needs of potential end-users that developers would need to know of. Survey participants were asked a series of questions related to their current living situation and their opinions of living in a repurposed cruise ship.

The survey results showed that those people most amenable to this type of living accommodation were between 41-50 years of age, who had graduate or professional degrees, and who had annual incomes over $100,000. However, we note that those who were younger, had less education and lower income levels also responded positively. Also, targeting median to high income brackets within all three age groups could be beneficial, since those in the 20-30 and 30-40 age brackets together constitute a larger group, approximately 30%, of the coastal Miami population. (Targeting only the higher income and higher age groups might lead to results similar to the residential case studies above, which are struggling financially due to lack of funding and customer interest.)

When asked if they would be willing to live on a residential cruise ship, assuming it would cost approximately the same as what they were currently paying, 44% responded yes, 44% responded maybe and 12% said no. Survey participants were also asked how much they are willing to pay to live on a repurposed residential cruise ship; the mean response was $839, and the maximum $4000. If given an option for a short-term lease, 90% indicated they would be more likely to live on a residential cruise ship.

Given the wide range of survey respondents who expressed interest in this concept, we analyzed the results to get a better picture of who would be most willing to live on a residential cruise ship, as outlined below:

AGE

- Age 41-50: 91% responded yes or maybe
- Age 31-40: 85% responded yes or maybe
- Age 20-30: 86% responded yes or maybe

EDUCATION

- Graduate/professional degree: 91% responded yes or maybe
- Associate degree: 87% responded yes or maybe
- Some college: 87% responded yes or maybe

FAMILY STRUCTURE

- Live with children: 92% responded yes or maybe
- Married with children: 91% responded yes or maybe
- Roommates: 88% responded yes or maybe

INCOME

- Income over $200K: 94% responded yes or maybe
- Income $150-$200K: 100% responded yes or maybe
- Income $100-$150K: 90% responded yes or maybe

CURRENT RENTAL COST

- More than $4,000/month: 100% responded yes or maybe (Figure 14)
- $2,501-3,000/month: 93% responded yes or maybe
- $2,001-$2,500/month: 92% responded yes or maybe
- $500-$1,000/month: 91% responded yes or maybe

Survey respondents expressed various concerns about living on a repurposed cruise ship, however, these may not be insurmountable. The barriers to potential residents, in order of importance:

1. Expense
2. Risk of flooding/hurricane damage
3. Lack of parking
4. Lack of credit history
5. Not close enough to schools

Survey participants were asked about most important features for them to live on such a ship. The most important features, in order of importance are:

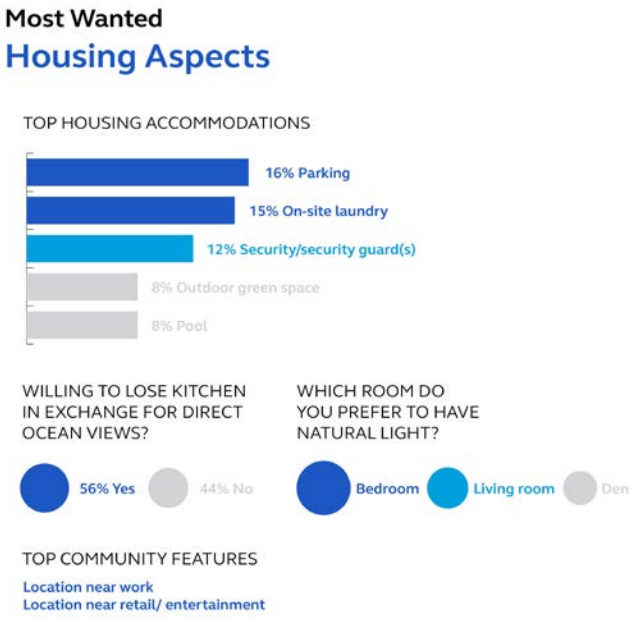

Figure 5. Participants answering whether short-term leasing would incentivize their approval of the concept.

Source: Qualtrics

1. Parking
2. On-site laundry
3. Outdoor green space
4. Security
5. Pool

Survey participants were asked what community features are of interest. The top two most important community features

are having a location near work, and a location near retail/entertainment. The top two most desired neighborhoods were Downtown and South Beach.

From discussions with interior designers, we learned that individual units could not be refurbished to add private kitchens in the future, due to fire protection protocols. Participants were asked if they are willing to forfeit having an in-unit kitchen in exchange for a direct ocean view: 56% indicated yes, they would forfeit the kitchen; and 44% responded that they would not forfeit a kitchen. Regarding their interest in communal eating on a ship, 56% would be willing to give up kitchen for an ocean view, and 51% would prefer to eat in their unit.

Participants were asked if short-term leases would incentivize their decision to live on ship: 46% responded yes it would help; and 44% responded maybe it would help.

CONCLUSIONS

This study found that the Miami-Dade County residents suffer from housing affordability stress, and that innovative ideas are needed to address the cost-to-income discrepancy. We found that residential cruise ships, from an engineering perspective, could be moored in urban areas, such as the Port of Miami, but that infrastructure costs may be considerable, and the vessel hurricane evacuation plan will need to be a major consideration for prospective residents. Our survey results strongly supported the proof-of-concept, with respondents expressing interest in living on a repurposed cruise ship. Those expressing the greatest interest are 41-50 years of age, earning at least $100,000 per year, are single/married with children, or living with roommates, and are willing to pay at least $2000 per month. The concerns raised by survey respondents do not seem to be insurmountable, but do need further investigation.

The study also found that small cruise ships are more suitable for permanent docking as they require less space and dredging, and they could function at a scale similar to a high-rise apartment complex in downtown Miami. Small vessels will be less intrusive on the urban planning of the city, and less likely to block views from land to sea.

These findings are relevant to the cruise industry and urban planning concerns, and may warrant further study in other coastal cities. For example, the engineering experts expressed the opinion that a docked residential cruise ship would be most conveniently located 'up-river', or in a body of water that is both deep and passive from a wave activity perspective. An example of this is the Hudson River, where ships are permanently moored, such as the SS United States, a retired ocean liner, and the USS Intrepid, a retired aircraft carrier.

WHAT'S NEXT

The next step for this study is to understand the cost implications behind cruise ship repurposing, including costs associated with building new pier infrastructures specifically for this use. This would also include cost estimates for interior renovation, federal and city planning approvals, and engineering and design. Further site investigations would be needed, with a deeper look into environmental impacts and reporting.

During the focus group with engineering experts, several ideas emerged that could be further explored. For example, instead of a designated port for the vessel, sharing ports or periodically moving locations may offer benefits (though would not likely work for regular working people). In this scenario, a ship would only have to pay port docking fees, as opposed to the full cost of new port construction. This idea builds on the increase of remote work we saw in 2020 due to the Covid-19 pandemic, and could possibly attract residents who are not tied to a particular location. Another possibility would be to allow for short term leases, at monthly intervals, to reduce the commitment required for those who are traveling, migratory, or hesitant about long-term contractual obligation.

ENDNOTES

1. Saunders, S. (2021). Which Cruise Ships Will Be Scrapped or Taken Out of Service Because of the COVID-19 Pandemic? Cruise Critic, Mar. 1, 2021.
2. ArcGIS. (2020). ACS Housing Costs Variables - Boundaries. American Community Survey, Updated Dec. 14, 2020.
3. Buchanan, M., et al. (2020). Sea Level Rise and Coastal Flooding Threaten Affordable Housing. Environmental Research Letters, IopScience, Vol. 15, No. 12, Dec. 2020.
4. U.S. Census Bureau. QuickFacts, Retrieved December 2020.
5. Stansfield, John. (2020) MS Albatros Leaves Phoenix Reisen's Fleet. CruiseMapper.com, Oct. 9th 2020.
6. CruiseMapper. (2015). Ship Breaking-Recycling, Old Cruise Ships. CruiseMapper.com, Nov. 26, 2015.
7. Dolven, T., and A. Harris. (2020). Cruise Lines Have a Solution for a New Clean Fuel Regulation. But Is It the Greenest Option? Miami Herald, Dec. 6, 2020.
8. Dolven, T. (2020) Carnival to Ditch 18 Ships in Total as U.S. Cruises Remain Banned amid COVID-19 Pandemic. Miami Herald, Sept. 15, 2020.
9. Liberman, S. (2019) People Pay $7M to Live on World's Largest Ship." Asbury Park Press, Apr. 22, 2019.
10. Boonzaier, Jonathan, and Trond Lillestolen. (2020) Indian Recyclers Get in on Cruiseship Culling with Karnika Buy. TradeWinds, 30 Oct. 2020.
11. Navionics ChartViewer, (2021). Navionics Chartviewer - Government Cut. Garmin, Retrieved Jan. 2021.
12. Murphy, Margi. (2020). Calls for Silicon Valley Elites to Join Floating Offices on the Sea. Telegraph Media Group, 19 Oct. 2020.
13. ArcGIS. (2021). Sea Level Rise Inundation - 6ft Above MHHW. National Oceanic and Atmospheric Administration Office for Coastal Management, Retrieved Jan. 2021.
14. Rodriguez, Rene, and Yidira Lopez. (2020). Miami-Dade is One Storm Away from a Housing Catastrophe. Nearly 1M People Are at Risk. Miami Herald, 8 Oct. 2020.
15. Thakkar, Emrys. (2020). Which Cruise Ships Are Being Scrapped or Sold Due to the COVID-19 Pandemic?. Cruise Hive, 18 Dec. 2020.
16. U.S. Census Bureau, Census. (2010) ESRI forecasts for 2020 and 2025 ESRI converted Census 2000 data into 2010 geography – Miami-Dade County. 5-mile radius of Dodge Island. Retrieved Nov. 2020.
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