Developer-driven sustainable communities: lessons from a case study of The Sustainable City in Dubai

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Keywords

Abstract

In Dubai, a private developer conceived, built, and now manages, a gated community called "The Sustainable City" (TSC), with more than 2,000 residents, shops, a school, and a hotel. TSC was purpose-built to consume almost no energy and be especially frugal with water, harnessing cutting-edge technologies and green building practices to promise residents both efficiency and luxury. But can a culture of sustainability be cultivated to ensure the behaviours requisite for achieving sustainability goals in developer-driven planned communities? A long history of grassroots intentional communities demonstrates how a culture of sustainability emerges from the design of the built environment together with the shared purpose of engaged residents. In developer-driven planned sustainable communities, residents may not cohere around a common vision; they may lack knowledge regarding sustainable practices; and they may not develop relationships amenable to sharing resources and getting social and economic needs met within the community. This research investigates the community culture of TSC, with attention to similarities and differences relative to grassroots intentional communities with sustainability goals. TSC has managed to attract residents who subscribe to the sustainability ethos, create a sense of community, and foster informal social interaction, yet a minority of residents participates in community affairs in a meaningful and regular way. The social aspects of community have largely been facilitated by the management, which does not seem to be economically sustainable. Key to TSC's success is that the developer has remained involved and been able to iteratively improve the physical design and systems, as well as social structure, to adapt to changing conditions and residents' needs. Lessons for other developer-driven sustainable communities are drawn from this case study.

Introduction

Sustainability is the capacity to continue or persist indefinitely. The idea of applying the sustainability concept to human communities achieved global prominence with the publication and wide dissemination of the report "Our Common Future" by the United Nations World Commission on the Environment and Development in 1987. The Commission's definition of sustainable development as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (WCED 1987:43) has been universally accepted. The emphasis is on meeting human needs now and in the future. In this sense, sustainability is a social and economic issue, in addition to an environmental one, and the report gives equal importance to these three interdependent dimensions of sustainable development.

Sustainability applied to society at-large is an incredibly complex topic. However, sustainability is relevant at many scales, including small-scale communities. There are several general approaches to sustainable community development: top-down government initiatives, grassroots intentional communities, and developer-driven communities (including private-public partnerships). The present research involves comparisons and contrasts between the latter two, which are both relatively insu-

lar phenomena amenable to close and careful study. As behaviourist B.F. Skinner observed:

> A community is much more complex than a laboratory experiment in human behaviour but much simpler than the large-scale enterprises analysed in political science, economics, and other social disciplines. For this reason, it is especially helpful in studying the effects of a social environment on human behaviour and, in return, the relevance of that behaviour to the maintenance and development of the environment. (1968, p. 64)

Skinner was referring to self-sufficient experimental communities, idealized in his novel "Walden Two" and emulated by dozens of groups in the 1960s and 70s, overlapping with the much larger number of communes inspired by the "back to the land movement", as it was called in the USA although it was a broader phenomenon. These could be considered planned sustainable communities, although most did not sustain. They did, however, contribute to the legacy of the concept of intentional community (Sanguinetti, 2012).

Intentional community is an umbrella term for many types of small-scale communities that often value sustainability, including religious communities, communes, cohousing, and Eco villages – which explicitly focus on sustainability. Meijering, Huigen, and Van Hoven (2007) defined intentional community by the following criteria:

- Not just familial relationships among residents
- Minimum of 3–5 adult members; members join voluntarily
- Geographical and psychological separation from mainstream society
- Common ideology
- Sharing of (a part of) one's property
- Interest of the group prevails over individual interests

Gilman and Gilman (1991) defined ecovillage by the following characteristics:

- Human-scale (sized so that members can know each other; typically 500 people or less)
- Full-featured (provides major functions to sustain members: shelter, food, sociality, manufacture, commerce, and leisure)
- Harmlessly integrates human activities into the natural world (cyclic use of material resources)
- Supports healthy human development
- Can be successfully continued into the indefinite future

The ecovillage concept evolved from the cohousing model (McCamant & Durrett, 1994) and first emerged in Europe in the 1980s (Kozeny, 2002). Cohousing is a type of intentional community typically comprised solely of housing that has historically emphasized the social benefits of community (safety, sharing, and support), but usually also incorporates sustainability values and goals. There are now hundreds of cohousing communities and ecovillages worldwide. They can be rural or urban and vary in the degree to which they are integrated eco-

nomically and socially with the broader society, with cohousing being the most integrated, and urban ecovillages tending to be more integrated than rural ones. Quantitative assessments of the sustainability of cohousing and ecovillages, though few, have affirmed their performance to be superior relative to general population averages and comparable communities (e.g., New Urbanist or developer-driven sustainable communities; Boyer, 2016; Brown 2004; Moos, Whitfield, Johnson, & Andrey, 2006; Tinsley & George, 2006). The Fellowship for Intentional Community, Global Ecovillage Network, Cohousing Association of the US (Coho/US), UK Cohousing Network, and Cohousing Research Network are excellent resources for more information on these types of communities.

Although not specified in the above definitions, intentional communities, including ecovillages and cohousing, are typically grassroots initiatives planned and managed by residents. Residents make all decisions about the community together, typically using a consensus process. This strong social component contributes heavily to community sustainability. Residents work and play together, building a group identity and common culture that keeps them on-board with sustainability goals and accountable for their contributions. As a result of relationships characterized by trust and reciprocity, residents participate heavily in sharing practices, which reduce resource consumption and avoid waste.

Meltzer (2000) developed the Community Empowerment Model (CEM) to describe how communities enable and promote sustainable practices, based on his in-depth research with 346 households across 18 US cohousing communities. In his own words, the process proceeds as follows:

> Residents are able to fashion their physical surroundings (ie. their buildings and neighborhood) to accord with their aspirations in ways not available, or even conceived of, within mainstream society. Their architecture and site planning facilitate interaction, which builds familiarity. Social intercourse is encouraged and further supported by intent. Familiarity facilitates "consciousness raising" and the spreading of "functional knowledge." Relationships of substance evolve, leading to increased sharing, support, and trust. Bonding occurs, which cements attachment to people and place and a growing "sense of community." Feelings of belonging feed a sense of self and encourage participation in "civic" life, which in turn builds skills, confidence, and a sense of self-efficacy. Empowerment provides impetus for the application of awareness and attitudes in practical ways.

Since intentional community residents self-select based on, and are united by, common values and goals for their community and intent to participate socially in community, they generally differ from the broader local population living in mainstream communities. For example, they may have greater motivation to live a sustainable lifestyle and/or more resources to dedicate to this goal (Garden, 2006). And resources are indeed required, as founding residents often invest years of work and funds during the processes of group formation and community planning and building, which can involve seeking approvals for land use zoning changes and other time-, effort-, and cost-intensive barriers. The grassroots nature of these developments also means they typically do not develop a generalizable business model. Together, these features limit

the replicability of grassroots intentional communities with a sustainability focus.

Sustainable community advocates and researchers have recognized the need for developer-driven models to make ecovillages and cohousing more accessible and mainstream (Boyer, 2015; Maguire, 2017; Williams, 2008). Likewise, developers have identified the opportunity to create ready-made sustainable communities that appeal to a perhaps surprisingly sizeable market (Boyer & Leland, 2018; Sanguinetti & Hibbert, 2018). The Ecovillage at Currumbin (https://theecovillage.com.au/) in Queensland, Australia, is an example of a developer-driven ecovillage, and BedZED in London is a result of a public-private partnership.

The emergence of small-scale developer-driven planned sustainable communities is an intriguing prospect for broad expansion of sustainable practices, if models can be articulated for generalization and replication. Based on experience with BedZED, founding partner BioRegional, an entrepreneurial charity, along with global environmental NGO World Wildlife Fund, created a framework for sustainable communities called One Planet Living (Riddlestone and Desai, n.d.). The framework highlights ten principles of sustainability (listed in Table 1), provides general guidance for each, and suggests performance indicators and targets (https://www.bioregional.com/wp-content/uploads/2017/01/Goals-and-Guidance-for-Communities-Jan-2017.pdf).

However, it is not clear how the CEM translates to developer-driven planned sustainable communities where residents are not involved in initial community design. What affordances can be made by developers to empower the community to grow and modify their environment as needed? Further, if these communities are made easily accessible and attractive to the broader population, will they attract residents without pro-environmental values or intention to participate socially in community?

The present research explores these questions in the context of a case study of The Sustainable City in Dubai, United Arab Emirates, where a private developer conceived, built, and now manages, a gated community purpose-built to consume almost no energy, be especially frugal with water, and to encourage behaviours that complement the installed technologies. In the next section we describe TSC, focusing on the construc-

tion and occupancy timeline, physical design, environmental features, and management structure. Then we describe the research methods that enabled investigation of the above research questions. Finally, we offer results along with discussion regarding their potential generalization to other developer-driven planned sustainable communities.

THE SUSTAINABLE CITY IN DUBAI

The Sustainable City (TSC) is a gated, mixed use community. Construction began in 2015 and is ongoing. When complete, TSC will consist of 500 villas, 50 apartments, a commercial center, school, hotel, mosque, and medical center. The development is about 95 % complete (as of January 2019). The learning center and hotel are the only remaining unfinished structures.

The first residents moved into TSC almost four years ago and the population has been growing steadily. Now, all of the villas are sold and nearly all are occupied (as are the apartments), with over 2,000 residents. Residents are mostly expatriates with extremely diverse nationalities. A high percentage of households employ live-in staff (e.g., nannies, housekeepers), which is common in Dubai. Unit sale costs and rent in TSC are comparable to (or somewhat higher than) units in similar neighbouring communities. It could be characterized as an upper-middle income community.

Table 1 summarizes TSC's sustainable features within the One Planet Living framework. Key features and some performance indicators will be discussed in more detail, beginning with TSC's urban form. Narrow streets and carefully oriented homes minimize solar gain. In Figure 1, TSC's urban form contrasts sharply with the neighbouring communities. Conventional autos are not permitted inside TSC. Instead, parking is at the perimeter allowing for a dense, pedestrian-oriented community and narrow streets. Small electric vehicles are also available to transport people from the parking areas and around the community.

A "green spine" bisects TSC (see Figure 2). It contains landscaping, recreational facilities, and nine "biodomes." The biodomes produce some plants and herbs for the community, but most of the output is sold to others. The green spine originally contained a water treatment plant, which enabled TSC-generated greywater to be used for irrigation of public spaces. After three years of operation, the water treatment plant was closed down and TSC was connected to Dubai's municipal waste sys-

Table 1. TSC sustainability features summarized using the tenets from the One Planet Living framework.

One Planet Living Tenet	TSC Design and Management Strategies
Zero carbon	Passive solar, PV, insulation, efficient appliances
Zero waste	Convenient recycling and waste-sorting bins, composting opportunity
Sustainable transport	Pedestrian-oriented, shared electric carts
Sustainable materials	Precast concrete blocks to reduce construction waste, reused construction wood for outdoor furniture
Local and sustainable food	Shared herb gardens
Sustainable water	Efficient appliances, greywater treatment and use, efficient car-washing equipment*
Land use and wildlife	Bee rehabilitation initiative (MYHive), animal sanctuary for rescued, senior and disabled animals
Culture and heritage	Plans for a learning center to educate community and visitors about TSC and local environment
Equity and local economy	Farmers market to support local vendors and sharing herbs from residents' biodome
Health and happiness	Rehabilitation hospital, two gyms, organized social events and wellness classes

The government requires all auto owners to maintain clean cars. Washing is therefore a major end use of water.

Figure 1. Aerial photo of The Sustainable City in summer 2017. Note the two conventional developments adjacent to TSC (credit: Diamond Developers).

Figure 2. Biodomes on the green spine (credit: Diamond Developers).

tem. This proved to be much cheaper, in part because TSC generated less wastewater than anticipated and because the treatment facility was difficult to maintain. Water conservation is critical for a sustainable community in Dubai because water is scarce and expensive. Water-efficient appliances are used and carefully controlled irrigation is used in the public areas.

Efficient energy use is key to sustainability. TSC was designed to produce enough electricity to operate with net-zero annual consumption by feeding surplus into the grid and importing power during deficit periods. The homes are oriented to maximize passive thermal conditioning with strategic shading and high-performance windows; they have high-quality thermal envelopes, efficient appliances, solar water heaters, and rooftop photovoltaics (40,000 panels across the community, which generate 10 MW of power). Figure 3 shows a typical villa.

The villas in TSC appear to use much less electricity than conventional villas in Dubai. Incomplete data suggest that the average TSC villa uses about 15,000 kWh (compared to the roughly 30,000 kWh/year for villas in other communities). These values may seem high by Western standards, but this is exceptionally low for the United Arab Emirates (UAE). This is largely because Dubai is hot – very hot. The average temperature between June and September is about 35 °C. The air conditioning season runs from March to November. As a result, about three-quarters of an average home's electricity consumption is for air conditioning. Electricity prices are only about 5 eurocents/kWh – about one quarter of average European rates – but electricity bills are still a major concern in most Dubai households because consumption is so high – often five times greater than average European residential use.

The UAE defines a "near-zero" home as roughly 90 kWh/m² in primary energy (Fayyad and John 2017). TSC homes appear to meet that criterion assuming that all of the electricity is sourced from on-site PV, including residential rooftop arrays and parking lot arrays. PV arrays over the parking lots were expected to supplement rooftop arrays. Unfortunately, the electricity supplier would not allow electricity supplied by the panels over the parking area to be shared with the residents. This kind of regulatory barrier has occurred in many sustainable communities.

Methodology

The research team followed TSC for three years, from construction to steady-state occupancy, collecting data from residents, household staff, and developer and management staff. The present research focuses on residents. The research team visited TSC twice to conduct interviews and conducted one online survey of residents.

Data collection focused on the culture of sustainability in TSC, rather than the physical design and infrastructure. Specifically, questions were aimed at understanding individual residents' at-

titudes and behaviours regarding sustainability, as well as community practices and participation in resident-led and management-led initiatives. Another focus was to understand how TSC physical design features and management practices influenced residents' attitudes and behaviours, and community culture.

For resident interviews, a semi-structured interview protocol was developed and implemented to ensure consistency and flexibility in data collection. Only slight changes were made to the protocol for the second round of interviews, to prompt residents' to share any changes over time. Key interview questions were:

- What is your main reason for choosing to live in TSC?

- Did you make any major changes in your lifestyle after living in TSC? What?

- What comes to your mind when people talk about sustainability?

- What motivates you to act sustainably?

- What features of TSC make it more sustainable than other communities?

- Would you describe TSC as being a community? Why?

- Do you see yourself as a full participant in TSC community life? How?

- How would you describe TSC culture?

- Did you need to learn any new practices after living in TSC?

Interviews were conducted in person in residents' homes or in a meeting space (unoccupied villa) provided by TSC; they lasted between 21 and 80 minutes and were audio recorded. Interview subjects were recruited through a post on the community portal on TSC's website and through word of mouth; no incentive was offered. The first round of interviews was conducted in March 2017. 68 individuals participated from 50 households. In June 2018, a second round of interviews were conducted with 21 households. 14 households participated in both rounds of interviews.

An online survey was conducted in May-June 2017 to complement the interviews by quantifying the prevalence of residents' self-reported sustainable behaviours and attitudes, as well as community participation and perceptions about community culture. Residents were recruited to participate in the survey via announcements on TSC's website and Facebook page. Incentives were offered for survey completion.

The survey was completed by 106 residents, representing about one-quarter of all TSC households at that time. A majority of respondents were female (61.5 %); ages ranged from 21 to 61 years, with a mean of 40. There was immense diversity in respondents' nationalities, with over 30 countries represented. More than half hailed from Europe, but respondents reported nationalities from four other continents, too. Respondents' length of residence in TSC ranged from less than one month to 18 months, with a mean of 8 months. Length of residence in Dubai ranged from less than 1–24 years, with a mean of 5 years.

Some key survey questions were:

- How many of your neighbours can you identify by name? [None, 1–5, 6–10, 11–20, 21–30, More than 30].

Figure 3. A corner villa in The Sustainable City. Note the waste-sorting and recycling bins in front (credit: Diamond Developers).

- If you saw something that needed readjustment, or a problem, in TSC public spaces, which would you do? [Volunteer to fix it if it does not require a professional; Inform the management in-person; Post on the portal; Post on Facebook; Do nothing; Other (please specify)].

- What types of social events do you enjoy attending in TSC? [Social events formally organized by TSC; Social events informally organized by your neighbors; None of the above].

- Have you attended or helped organize any resident-led initiatives at TSC? [No; Yes].

- I regularly stop and talk with neighbors at TSC [Agree-Disagree Likert-type response options].

- I borrow things and exchange favours with neighbors [Agree-Disagree Likert-type response options].

- Living in TSC provides a sense of community [Agree-Disagree Likert-type response options].

The survey also included questions about household energy- and water-saving measures, specifically: turning lights and zone air conditioning off when leaving a room; running full loads in the dishwasher and washing machine; air-drying laundry; taking 5 minute showers; storing cold water for other uses while waiting for hot water; and washing vegetables in a basin instead of continuous running water. Additional optional modules of the survey focused on other categories of sustainable practices (food, waste, and transportation); sample sizes were too small to enable much analysis of those items. Analyses of survey data for this paper explored relationships between community participation variables and attitudes and behaviours related to sustainability.

Results and Discussion

Results and discussion are organized into three sections. First, the role of the residents is considered, in terms of the values and habits they bring to (or develop in) the community with regard to sustainable practices and the implications of resident characteristics for developer-driven sustainable communities.

Next, the role of the community is considered, in terms of relationships between community participation and pro-environmental behaviour and implications for developer-driven sustainable communities. Finally, the role of "management" and governance is discussed.

RESIDENTS' ATTITUDES AND BEHAVIORS REGARDING SUSTAINABILITY: IF YOU BUILD IT, WHO WILL COME?

TSC has attracted many residents because of its sustainability goals. The developer has promoted a vision of sustainability – evident in the community's name – which has attracted like-minded residents. The following quotes from residents illustrate how the community's branding was successful in attracting people who value sustainability:

> We were driving [and] saw a big sign that read 'The Sustainable City', so we checked it out. The main point that attracted me was the community. I did like the solar panels to offset my carbon footprint and the waste segregation system, but I believe that sustainability is about having a community and sharing things. My main reason to live here was [its] intention [to be sustainable].

> We knew moving to Dubai was going to be a big change. We started doing our research to see how Dubai can satisfy our lifestyle that focuses on less consumption and organic food. I typed 'organic Dubai' on the browser and a place called 'The Sustainable City' popped up.

Survey results were consistent. For example, Figure 4 shows that the large majority of respondents reported a moral obligation to use energy efficiently.

However, some residents were drawn to TSC for other reasons. For example, the promise of lower energy bills (thanks to solar PV on each unit) is a significant draw since electricity from air conditioning is a huge housing-related expense in Dubai. Figure 4 shows that financial motivation to use energy efficiently was slightly more common than moral obligation. In addition, the car-free, pedestrian-oriented walkways within the community, allowing children to play outside safely, attracted young families. A number of residents were also drawn by aesthetic preferences to the "modern" and "bright" design of the homes.

Residents whose decision to move to TSC was driven primarily by aesthetics, prospective energy cost savings, or family-friendly design and amenities might not be contributing to, or assimilating into, a culture of sustainability. For example, a number of interviewees believed some of their neighbours were not properly sorting waste and recycling. Though a minority of interviewees and survey respondents openly expressed little interest in sustainability per se, that percentage is likely higher due to interviewee self-selection bias and response bias (residents may have tended to say what they thought researchers wanted to hear).

In addition to varying values regarding sustainability, TSC residents came with varying levels of knowledge and habits regarding sustainable practices. Residents' diverse nationalities contribute to this issue. For example, a Dutch couple interviewed was accustomed to even more extensive waste sorting than TSC offers, whereas the idea of sorting at all was a novel idea for a Jordanian household. Although in many other contexts residents in developer-driven sustainable communities may be less varied in terms of their knowledge and habits, some variation is guaranteed.

Some residents who were not initially invested in TSC's sustainability goals grew to value them through exposure to sustainable features and practices, much in keeping with Meltzer's (2000) CEM. For example, one resident who was not initially interested in sustainability upon moving to TSC noted: "Fast forward … [I am] 1,000 % more on board." She credited the change to being able to "actually see things happening in front of you", e.g., "learning about recycling and solar panels." In contrast, a less visible practice was composting. Only two locations across the community were available for depositing compost and few residents – regardless of their reported sustainability value – took advantage of this opportunity.

However, resident motivation and learned behaviour do not always move in the desired direction. For example, motivation to conserve energy seemed to be reduced for some residents after moving to TSC. As one interviewee put it: "I think hav-
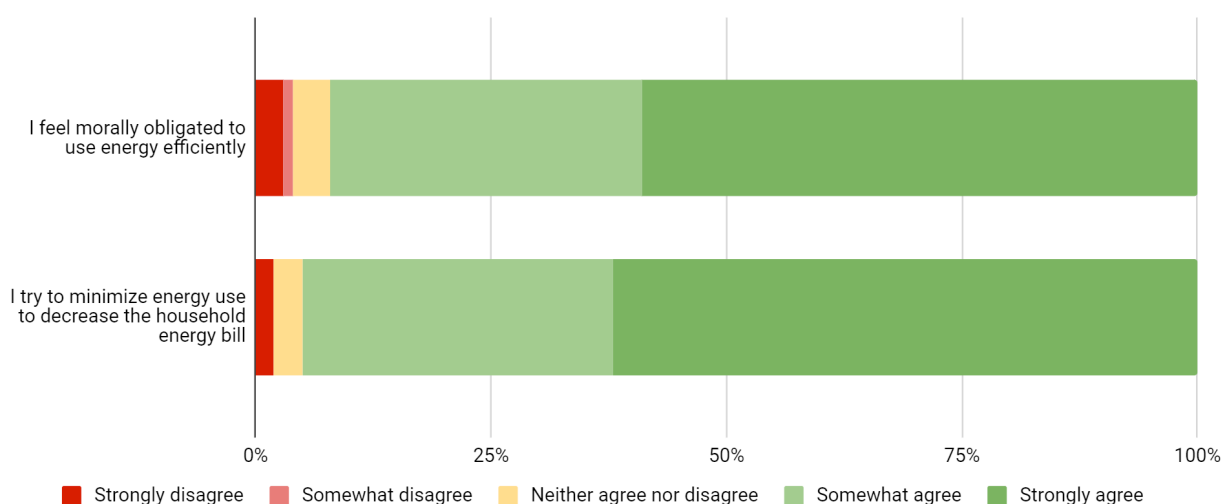

Figure 4. Residents' personal norms and financial motivation for energy efficiency.
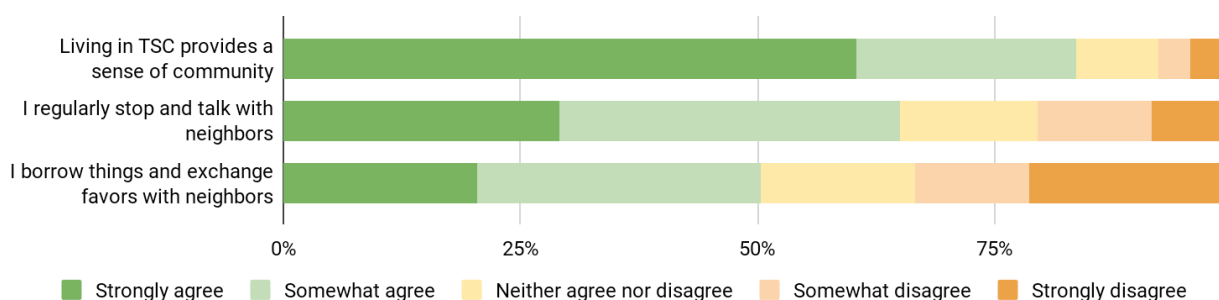
Figure 5. Community participation in TSC per resident survey.

Table 2. Correlations between community participation and sustainable practices.

	Sense of community	Regular interaction	Resource sharing	# neighbours known by name
Sense of community				
Regular interaction	.452**			
Resource sharing	.391**	.322**		
# neighbours known by name	.421**	.495**	.497**	
Energy- and water-saving behaviours	.231*	.218*	.245**	.112

* significant at alpha = .01 level

** significant at alpha = .05 level

ing solar panels [makes me] slightly less conservative about my power use than before"; another described solar power as "guilt free." This could be evidence of single action bias whereby moving into TSC and paying a premium for solar PV as well as misunderstandings about how the system works lead to decreased motivation to conserve energy (Weber 1997; Weber 2006). Lack of clarity regarding resource systems also leaves room for inaccurate rumours about how things work. For example, there was some confusion among TSC residents about whether toilet paper was to be flushed or not for proper operation of the wastewater treatment system. One resident noted, "The information is not really clear, [but] if you are really interested and you ask around you get the information."

Unlike grassroots ecovillages and cohousing communities where residents co-create a vision of sustainability and participate in community design, all systems and infrastructure in TSC were already in place before residents moved in. At TSC, lack of familiarity with some sustainable infrastructure and practices is compounded by residents' diverse cultural backgrounds. Best practices for developer-driven sustainable communities should include strategies to motivate, educate, and support residents with regard to sustainable practices. A promising starting point would be to inventory and then rate specific sustainability outcomes in terms of the degree to which they rely on occupant behaviour. The target behaviours should be defined and communicated clearly with residents, and design strategies should make those target behaviours easier and more convenient than their alternatives.

THE IMPORTANCE OF COMMUNITY IN SUSTAINABLE COMMUNITIES

According to interview and survey data, TSC seems to have established a sense of community. About 84 % of survey respondents agreed that TSC provides a sense of community and 65 % reported they regularly talk with neighbours (Figure 5). These quotes from interviewees are illustrative: "Here I know 50 families. Everybody says hello to each other"; "The place is very multicultural – like-minded people coming together. There is a sense of being on the same wavelength." Survey respondents reported knowing an average (mode) of 1–5 of their neighbours by name; 15 % knew none, 39 % knew 1–5; 20 % knew 6–10, 18 % knew 11–20, 6 % knew 21–30, and 3 % knew more than 30.

About 50 % of survey respondents reported sharing resources (borrowing things and exchanging favours) with neighbours, which directly contributes to sustainability by reducing material consumption and the need to travel outside the community. Participation in sharing materials and services is much higher in intentional communities, e.g., 100 % of survey respondents in a national survey of US cohousing households (Sanguinetti, 2014). Sharing goods and favours with neighbours was significantly positively correlated with each: sense of community, regular interaction (stopping and talking with neighbours), and number of neighbours known by name. With the exception of neighbours know by name, each of these indices was also correlated with an index of household energy- and water-saving practices. Table 2 presents these correlations.

Formally organized social events have dominantly been initiated and led by TSC management. About half (49 %) of survey respondents reported attending or helping to organize resident-led events. Those who had participated in this way reported, on average, a greater sense of community, more regular informal social interaction with neighbours, more neighbours known by name, and more resource sharing with neighbours (Table 3).

When asked what they would do if they saw a problem in the community, most commonly survey respondents indicated

Table 3. T-test results comparing mean community participation and sustainable behaviour scores for residents who have participated in resident-led events versus those who have not.

	t (df = 93-94)
Sense of community	2.15**
Regular interaction	3.30**
Resource sharing	3.91****
# neighbours known by name	5.57****
Energy- and water-saving behaviours	.388

*** significant at alpha = .05 level*

**** significant at alpha = .001 level*

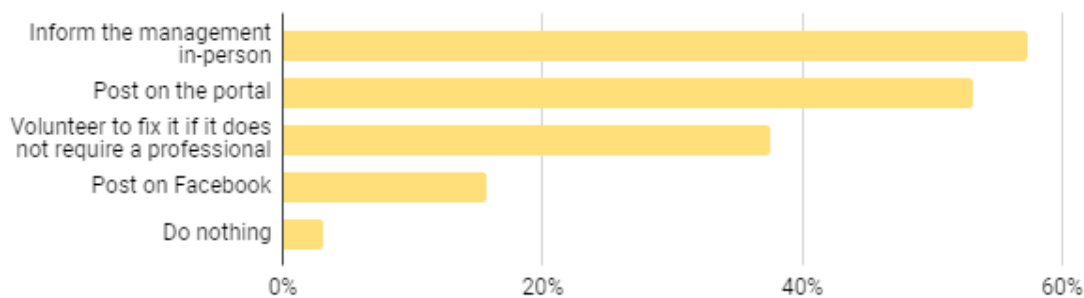***** significant at alpha = .0001 level*

Figure 6. Residents reported reactions to problems in the community, per resident survey.

they would tell the management in-person or via the community web portal which is maintained and monitored by management (Figure 6). 38 % said they would attempt to fix the problem themselves if they could. These data speak to the issue of community empowerment.

Although residents were generally effusive about the sense of community in TSC, which is no doubt higher than in many other places, one implication of these results is that resource sharing, as well as energy and water-saving practices within households, would be higher if sense of community and interaction were higher. One particularly engaged interviewee described the relationship between community participation and evolving progress with regard to sustainable practices: "We are all growing together, learning and making mistakes." Other deficits in community participation seemed to be in the aspects of organizing social events and taking initiative to address problems. Unlike informal chats with neighbours, sharing stuff and skills, and a felt sense of community, taking ownership of the community and community life by organizing events and addressing problems requires empowerment. This leads to the next discussion, which is about negotiating the role of the management in developer-driven sustainable communities.

NEGOTIATING THE ROLES OF RESIDENTS AND MANAGEMENT IN COMMUNITY LIFE AND GOVERNANCE

The role of management at TSC is exceptionally complicated, but ultimately decisions about the community beyond the interiors of individual residences are made by the developer. Day-to-day operations are also supported by a property management company related to the developer financially and by family relationships among staff in the two organizations. One interviewee described TSC as "a family business"; he felt this

was a positive aspect of the community that helped residents trust the management.

The developer along with several close family members and friends, as well as diverse levels of staff, live in TSC. Their presence creates unusual dynamics, but on the whole creates an engaged management, willing to address and quickly solve both technical and operational issues. Table 4 summarizes a variety of modifications the developer has made, deviating from the original community plan in order to adapt to changing conditions and residents' needs.

Residents know the developer and management staff; they cross paths daily, thus creating an informal path of communication and mutual accountability. Though unusual for developer-driven communities, this resembles intentional communities where there is often a "burning soul" who spearheads the development of the community, getting others onboard and remaining a leader in some respects or at least a figurehead in the community as intentional communities virtually always use egalitarian decision-making processes.

TSC management assumed a strong role early on in terms of organizing events to educate residents and cultivate a sense of community between diverse residents who were new to the community, and often new to the country as well. For example, they held educational events to orient residents to sustainable design features and systems. However, some staff was disheartened about poor attendance at these events. In contrast, one resident's perspective was: "They don't do presentations regularly, so people who moved in later missed the initial presentations." Another resident suggested, "It would be good if there was a TSC manual on how to live sustainably, e.g. what kind of washing powder to use, so it is greywater compatible … how to save water, save on the use of the AC, etc."

Table 4. Modifications made by the developer to adapt to changing circumstances.

Modification from original plan	Reason
Terminated allocation of free buggy for each villa	Avoided very low usage rates of buggies, wasted investment
Eliminated local treatment of greywater by connecting to DEWA network, also combined rey and black water	Lowered costs and avoided recurring maintenance problems
Biodomes switched from all for residents to private contractor (leaving one for residents)	High operating cost
Added gym and second swimming pool	High demand for athletic facilities
Surplus power from PV arrays over parking lots is used to operate the shared electric vehicle fleet instead of shared with housing units as planned	DEWA treated parking PV as separate, commercial customer and net energy rights not transferable, so unable to share surplus electricity (or revenues) with housing units
Off-site separation of waste	Lower-cost
Villa sales strategy shifted from mostly owner-occupied to mostly rental	Changing market conditions in Dubai
Management solicits volunteers for ad-hoc committees, but abandoned all-purpose resident advisory council	Low participation in all-purpose resident advisory council, but success of transportation and garden ad-hoc committees
Driverless bus tested, then abandoned	Safety requirements forced it to move too slowly
Added more apartments	Needed to provide for school teachers and other on-site staff. As a response to the high demand on apartments.
Added dog park and animal sanctuary	High demand among residents

In terms of social events, TSC management has organized many, from sporting events and blind dates to events on topics related to sustainability such as garden walks and an Earth Day celebration. Many events center on children since a majority of resident households have young children. The perceived sense of community among residents at TSC is largely attributable to these efforts from management.

However, the high degree of management involvement in community activities early on did not seem to be economically sustainable, as indicated by a decline in such activities and the introduction of small fees for participation in organized events or rental of community spaces. Unlike intentional communities where social events voluntarily organized by residents, TSC management must be paid, and such inward-focused community activities do not generate a profit. From the perspective of management, early efforts were intended to plant a seed for more resident-led community life in the future. However, from some residents' perspective it set a precedent such that the decline of social events or introduction of fees later on came as a disappointment.

Notably, management has demonstrated flexibility with regard to strategies for resident education and community participation. For example, they learned that waste sorting was often the responsibility of household staff, so pivoted to target staff instead of residents with educational events on this topic. Management has also actively tried to devolve some responsibilities and decision-making to residents through advisory and ad-hoc committees, but with only limited success. The transportation and garden committees have been successful. These committees had authority to make decisions with straightforward consequences – who received garden plots and where the internal bus system would go – so residents actively participated.

Some of residents' hesitancy to get involved in the more demanding aspects of community decision-making, as opposed to informal social interaction and relationships, may be a consequence of the temporary nature of most expatriates' stay in Dubai. That said, there are important resident-led initiatives, such as a widely popular moms group and running group. This quote is also illustrative: "I started a Yoga class. I do it for myself, to get to know the nice people. Those kinds of initiatives – just stepping out and doing a thing – people eventually are responsible [for building the community they want]." These of course are actions leading to immediate or short-term benefits and not the same as long-term planning.

Conclusion

A sustainable community is a community that is able to continue indefinitely within its environment. The community nourishes its members and the environment. A sustainable community is not static, but dynamic and constantly changing as it adjusts to the changing needs of its members and the environment. TSC's innovative sustainable design strategies and strong role of management in promoting community and sustainability make it unique among planned communities, and in some ways comparable to intentional communities. These features are critical in promoting a culture of sustainability at TSC, but they also present challenges – namely that some design features attract residents who do not value sustainability and the role of management as community builder is not economically sustainable. These challenges also reflect the absence of some key characteristics of intentional community, e.g., participatory design and management. Attracting a wider pool of residents and demanding less energy and time from residents than the typical intentional community can also be perceived as an opportunity for mainstreaming and promoting the values of a sustainable lifestyle to a wider audience. TSC's vision and flexibility, along with the high turnover of expatriate residents, creates an intriguing opportunity for a living laboratory to provide lessons in building a culture of sustainability in many types of communities. The story of TSC will continue to unfold, revealing how a developer-driven planned community can foster shared values and sense of community that seem vital to a culture of sustainability.

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