

Moladi Construction System: The Courthouse Project in Tanzania

A low-tech, scalable and affordable building solution
to improve and expand social infrastructure

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The challenge

As with many developing countries, Tanzania needs to upgrade its social infrastructure and provide affordable housing for those at the bottom of the income pyramid.

Tanzania has witnessed strong economic growth, above 7% per year, over the last decade. However, similar to many of its African neighbours, the country lags behind in providing access to public services such as the justice system. According to the Ministry of Justice, the country faces a shortage of 3,115 courtrooms. Many rural areas have never had court buildings and some buildings have had to close due to poor quality. With the support of the World Bank, the government is now aiming to expand access to judicial services. Plans are underway, accordingly, to build hundreds of new courthouses and test mobile courts. Given the budget constraints and tight timelines, the government is seeking cost-effective solutions to constructing these additional assets. Of course, the courthouse shortage is hardly the only social infrastructure issue that Tanzania is facing. More importantly, the country has a huge housing deficit – 3 million units, the 2012 census suggests – especially for people in the lowest income bracket.

Globally, the need for affordable housing is driven by several megatrends: strong population growth in many developing and emerging countries, large numbers of people living in substandard or informal urban dwellings (“slums”), continuous urbanization, with an estimated 40,000 people moving into cities in Africa every day.

In industrialized countries, a common approach to affordable housing is to prefabricate building components. In many developing countries, however, bad road conditions tend to make that option impracticable and even causes problems for standard brick-and-mortar construction. The bricks may get damaged during transportation from the factory to the construction site. Hence, the need for new, customized solutions that are suitable for developing countries – solutions that are low-cost and adapted to local supply chains.

“
Train the unemployed to build for the homeless.

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Hennie Botes, Founder and CEO

The idea

Devise and implement a scalable, low-tech and affordable construction solution for social-infrastructure buildings and housing – a solution that relies on local materials and labour, thereby boosting the local economy.

Moladi was founded by South African entrepreneur, Hennie Botes in 1986, with the aim of replacing brick-and-mortar construction with an easier and more affordable approach to housing. Botes was not trained as a builder or construction engineer and hence, unrestrained by conventional wisdom: he could see for himself how cumbersome the traditional bricklaying process was, and could not accept that there were no alternatives. Describing himself as a social entrepreneur, he sees Moladi as part of a larger endeavor namely, to find a comprehensive way of providing shelter for those at the bottom of the income pyramid and more broadly, to uplift communities by using local unskilled labour.

Moladi’s Construction System involves the use of lightweight plastic formwork, which is filled with an aerated mortar (fast-setting thanks to the patented MoladiChem additive) to cast entire houses on-site. The formwork itself is assembled by clipping together a set of injection-moulded, 30 x 10-20 cm plastic panels that are removable, reusable and recyclable. Once the foundation is in place (Moladi favours a floating raft kind), a building can be constructed in as little as two days. On the first day, the formwork panels are assembled. Window frames and door frames, as well as piping and wiring are positioned within the wall cavity. Additional reinforcing bars can be added to comply with local building codes and finally, the mould is filled with the special mortar. The speed is remarkable. To build a house measuring 40 square metres, it takes a team of 18 workmen barely two hours to erect the formwork and another two hours to pour the mortar. On the second day, the formwork is removed for future use, the walls are painted with a cementitious water-based paint, lighting and sanitary equipment are installed and other finishing touches added. The building process can be monitored by just one Moladi supervisor who provides on-site training and assistance to local workmen with no prior construction experience or special construction skills.

Moladi’s system is generally associated with small affordable housing units, but it can be applied to a wide variety of infrastructure assets, including schools, hospitals or courthouses, for example, as well as multi-storey buildings. The small plastic panels used in the formwork allow for great versatility and workers are able to adapt the formwork easily to the specific needs of the project.



In Tanzania, extensive market research (conducted by Ardhi University) confirmed that the Moladi system offered the most cost-effective solution to the courthouse shortage. Moladi was duly invited to construct prototypes that can be tested under different site conditions, including single- and double-courtroom buildings, two- and three-bedroom houses for the judges and court staff as well as primary-court buildings. The first Moladi courthouse (covering about 1,200 square metres) has recently opened in Kibaha, in a ceremony attended by Tanzania's Prime Minister. Based on this success, Moladi Tanzania received the go-ahead to build 11 additional district courthouses throughout the country. Over the next five years, the government plans to build a total of 120 district courthouses. Moladi is well-positioned to win the tender process, in view of its competitive pricing, social acceptance, positive impact on the local economy and employment and last, its trusted relationship with the World Bank.

Here are some details of the Kibaha courthouse project. Following the laying of a traditional raft-and-strip foundation, the construction was carried out by a group of 25 people hired locally – many of them were women and previously unemployed. The group was trained by a two-person team from Moladi Tanzania and five university students, who, very quickly, succeeded in mastering Moladi's standard building techniques, e.g. assembling the formwork panels and erecting the completed formwork; positioning window and door frames; inserting the wiring and steel structures; pouring the mortar. The formwork panels and MoladiChem were sourced from the Moladi factory in South Africa and the floor tiles from another South African supplier. All other building materials and components were sourced locally – windows and doors, the steel structures, roofing, cement and sand for the mortar. The trained workers will now in turn provide training for new workers on other projects, so that the reservoir of trained Moladi workers grows steadily and the need for supervision diminishes.

Following the initial success of the courthouse prototypes, Moladi Tanzania was commissioned to build staff houses for the magistrates, additional public-servant houses and police stations and the associated police housing – all in keeping with Moladi's core objectives of developing the local area and helping communities to uplift themselves.



The impact

Sure enough, these buildings are high quality and are being constructed at impressively high speed, low cost, low environmental impact and are contributing to local economic development.

The main advantages of the Moladi Construction System are the speed and ease of production, the lower costs and reduced environmental impact, the quality of the end product and the localized supply chain that benefits the local communities.

Regarding costs, by employing local labour, using local materials and reusing the formwork, Moladi keeps overall project costs at a very modest level. Costs are further reduced and changes avoided thanks to the Moladi wall-construction process, which incorporates plumbing and electrical installations within the mould and makes walling surface finish unnecessary. The 1,200 square metres Kibaha courthouse was built for a total cost of about \$300,000 (including 18% VAT) or \$250 per square metres – roughly half the cost of conventional methods and competing bids. Costs should decline even further once local production of the plastic formwork panels begins. These ultra-low costs are crucial to help people with very low incomes. Another major advantage of the Moladi Construction System is its cost transparency. The use of plastic formwork means that it is very easy to calculate beforehand the quantity of materials and the working hours required.

Regarding speed, the Kibaha courthouse might have taken three years to complete via conventional construction methods. It took just six months using the Moladi methods. In fact, things would have moved even faster, were it not for the initial testing and training needed and teething troubles such as duties on formwork imports from South Africa. The second courthouse took a mere four months from start to finish thanks to the reusable assembled formwork, which is made of lightweight plastic and is easy to transport. Also, the project benefited from the workmen and women's previous experience. In future, comparable buildings are expected to take less than three months. By the end of 2016, it is planned to complete a total of six courthouses .

In terms of quality, the rapid and cost-effective construction process does not require a compromise in quality. Moladi buildings are built to last. The company's earliest buildings, dating back 30 years, remain resilient and serviceable. The cast walls have a strength of between seven to 15 newton/mm² – considerably stronger than traditional brick-and-mortar structures. The technology has undergone extensive testing and received certification from several national building authorities, including the South African Bureau of Standards and the Tanzania Bureau of Standards. The structures are also reported to be very earthquake-resistant, on the basis of tests conducted by the University of Panama.

Regarding the environmental impact, the Moladi system keeps the environmental impact to a minimum by sourcing local materials, optimizing thermal properties and adopting reusable moulds. Moladi buildings generate

about 50% less CO2 than traditional brick-and-mortar buildings of a similar size (due to the CO2-intensive brick production). The lightweight formwork can be reused up to 50 times on nearby projects, thereby reducing the CO2 emissions as well as costs associated with transport and manufacturing (between sites the assembled formwork can be transported very easily). The plastic panels can even be recycled, typically into toilet seats.

And last, regarding the effect on the local economy, in contrast to other affordable housing solutions, which use prefabrication and precast concrete to reduce manual and on-site labour, the Moladi system is specifically designed to be labour-intensive and low-tech, in order to provide local employment opportunities. Instead of using machine casting, Moladi requires the mortar to be poured manually – however, mechanical casting can be applied. Moladi also strives to build up local supply chains and assembly lines for building components such as doors and windows. Concrete tiles and pavers can be cast on-site for use in villages. Labour can be readily recruited and trained locally given the lightweight panels and the avoidance of heavy lifting, many of the workers are women (women have proved to be more reliable than men). For the Kibaha courthouse, 25 local workers completed all the formwork and walling, before local subcontractors took over to complete the roofing.

Moladi's solution involves a building system rather than a turnkey model and therefore, is scalable. The system has been applied to build several thousand units in 20 countries in Africa (e.g. South Africa, Nigeria, Tanzania), South Asia (Sri Lanka) and Latin America (Mexico, for two-storey buildings and Panama). Moladi is now preparing for expansion into the United Kingdom and other industrialized countries that have a shortage of affordable housing. One of the virtues of the Moladi system is that it can be adapted easily to local building codes and conditions, by integrating the required reinforcing structures into the cast. Currently, the system is limited to single- or two-storey buildings, but Moladi is working with engineers to upgrade its construction processes and mortar, with a view to qualifying for multi-storey buildings.



The barriers to innovation – and the solutions

The resistance shown by the established building industry and the scepticism shown by local communities can be countered by building demonstration units; supply shortages and design challenges can be resolved by enhancing local supply chains and integrating Moladi building technology from the outset.

Scaling up the Moladi solution will not be easy. There is scepticism on the part of developers and clients towards the new building technology; and there is resistance from the traditional building and masonry industry, which is keen to protect its vested interests by lobbying government, for instance. One response of Moladi's is to set up demonstration units to explain the advantages of its technologies and convince clients. Once the Moladi philosophy gains traction, the company aims to work together with local people as distributors. In the case of Tanzania, social entrepreneur Abeid Zagar was won over when visiting Moladi's South African factory in Port Elizabeth, thereby becoming an advocate of the technology. He invested in a demonstration unit as early as 2010, and was instrumental in getting Moladi selected for the courthouse projects.

To sidestep resistance from developers, however, Moladi has had to make some adjustments to its business model. In South Africa, Moladi is now adopting a turnkey model to develop buildings, including financing. Such a move is only possible when the supply chain is a mature one and easily accessible, as in South Africa.

Another barrier to innovative construction processes is the regulatory one. Moladi has actively sought and quickly gained approval by regulatory authorities in many countries. As mentioned, its technology is now certified by the Bureau of Standards in South Africa and in Tanzania. The company is registered as an official contractor by Tanzania's National Housing Institutions and it has a partnership with the country's Transnational Bank, which provides credit to Moladi and accepts the buildings as collateral.

From the point of view of government, one particularly strong selling point for Moladi is that it serves as a one-stop shop. Its Champion Teams bring together a range of experts – engineers, urban planners, architects and renewable-energy specialists – to offer a holistic vision and solution for rural development.

A further barrier for Moladi is social acceptance. It is a barrier encountered by any affordable housing solution, especially if the solution is imported from abroad. In Tanzania and many other African countries, the population will often take a very sceptical view of prefabrication measures: gypsum-board walls, for instance, are regarded as less strong and weather-proof and building site visitors tend to knock on the walls to check for solidity. Moladi's cast structures, however, always gain immediate approval because they provide the same reassuring, solid sound as traditional brick-and-mortar walls. In fact, most people are so happy with the finishing of the cast walls, they do not even request skimming or painting.

Moladi has gained further social acceptance by maximizing the benefits for local communities. Its

projects source all materials locally (apart from the formwork), and employ local workers. As mentioned, the building process is specifically designed to be labour-intensive, and can provide employment to local communities without requiring special skills or technologies. Moreover, Moladi's hiring strategy is designed to avoid conflict with the local population. During training, observers identify those trainees that are most motivated and skillful. The latter are subsequently appointed foremen who, once confirmed, may pick their own teams, without any further involvement by Moladi.

The workers are contracted on a project basis, but their prospects for further employment are good. Their initial training equips them to work on other sites and they are often specifically assigned to new projects to train workers there. And there seems to be no shortage of new sites, given Moladi's rate of expansion. Indeed, one interesting outcome of Moladi's economic boost to local communities is that the demand for Moladi housing is rising. Another beneficial outcome is that each local community has a sense of integration with the project and a sense of ownership, which reduces the incidence of building site theft.

A further challenge facing Moladi in countries like Tanzania is the local supply chain. In South Africa at least, the company has managed to develop a complete supply chain, including production of the plastic formwork, window frames, door frames and roof tiles. In other countries, however, local production capacity has to be built up. Importing the materials from South Africa is not only more costly, but also likely to cause serious delays in construction. (The Kibaha courthouse encountered import duty problems and eventually had to resort to alternative materials.) In Tanzania, negotiations are now underway for a new factory that will produce the formwork locally and Moladi is establishing alliances with local suppliers for windows, doors, floor tiles and cement, e.g. considering a collaboration with Dangote Cement. By bypassing distributors and other middlemen, Moladi will be able to reduce costs even further.

Finally, the design challenge: the Moladi system relies on standardized plastic formwork panels (30 x 10/20 cm) that impose limits on new designs and can sometimes, clash with existing designs. In the case of the Tanzanian courthouse prototypes, for instance, some general designs had already been proposed and they now had to be adjusted to comply with allowable wall heights (multiples of 30 cm) and wall lengths (multiples of 10 cm). Wall heights are also constrained by the relative slenderness of Moladi walls vis-à-vis conventional construction. These minor



changes in building design will in turn affect the sizing of windows and doors. Accordingly, Moladi takes care to integrate all phases of a project, starting with the planning phase, to gain fullest advantage of the Moladi system and avoid costly reworks or last-minute supply changes.

Lessons learned

- **Adapt the solution to local conditions and develop a service offering in tune with market requirements**
The best solution can sometimes be low-tech (involving much manual labour) and locally sourced. Such a solution is truly scalable as Moladi's experience has shown.
- **Create tangible prototypes to demonstrate the look and feel of the solution as well as the technology's potential**
Any innovative approach to affordable construction is likely to provoke scepticism. By building prototypes that people can actually see and touch, Moladi won them over and created social acceptance.
- **Work closely with regulators and government to gain official approval and backing**
In the face of traditionalist resistance and scepticism, companies can validate their new technology by obtaining certification from the government and regulators. This formal endorsement then paves the way for publicly procured projects.
- **Build a broader ecosystem, notably a dedicated supply chain, to make the solution work**
Approaches that break the status quo typically require different supplies, skills and processes. Developing an efficient local supply chain is key to implementing innovation successfully, even for a low-skill and low-tech solution such as Moladi's.
- **To overcome resistance by established companies, it may be necessary to adjust currently accepted business models**
Moladi's original and overarching mission is to provide affordable building technology (notably plastic formworks and MoladiChem), continually refine its system and optimize the product. In South Africa, however, in the face of concerted resistance and scepticism by local developers, Moladi opted to forward-integrate along the construction value chain by offering turnkey solutions as well.
- **Think holistically about the problem to be addressed and seek a comprehensive solution**
As a social entrepreneur, Hennie Botes has always thought of his construction solution as part of a broader endeavor – community advancement. The projects should not only provide shelter but also improve the lives of local communities via social infrastructure and employment opportunities. This requires a holistic solution that serves as a one-stop shop for governments by incorporating the planning of entire villages, including housing and social-infrastructure assets (schools, hospitals, courthouses), as well as measures to integrate renewable energy.



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